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G.O. No. 3315	Press
67-68	~~Min.~~
Dated 3-11-	1865.

Not to be folded or roughly handled

(1) Number of pages 62
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Public Works DEPARTMENT.

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*Proceedings of the Madras Government, Public Works Department,
3rd November 1865.*

No. 67. Read the following Proceedings of the Madras Government in the
Military Department:—

Communicating letter from the Quarter Master General, forwarding the Proceedings of the Committee appointed to report upon the quality of the water supplied to the Troops at Madras, with a view to hasten the consideration of the measures necessary to improve the drinking water used by the Troops at the Presidency generally. (Here enter 12th October 1865, No. 3,786.)

No 68. ORDER THEREON, 3rd November 1865, No. 3,315.

MILITARY WORKS, No. 3.

The Government are of opinion that the only source from which it is probable that potable water, which shall be perfectly free from impurities, can be obtained for the use of the Garrison, is the roofs of the buildings within the Fort, and they note that orders have already* been issued to the Superintending Engineer of the 4th Division, to report on the mode in which he would propose to collect and store that water. Colonel Boileau will expedite his report.

* G. O. No. 3,015, 11th October 1865.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,

Secretary to Government.

To the Superintending Engineer of the 4th Division.
.. Military Department.

Exd. S. T. Augustin.

MILITARY DEPARTMENT.
PROCEEDINGS OF THE MADRAS GOVERNMENT.

Read the following papers :—

From the Quarter Master General, Head Quarters, Ootacamund, 29th September 1865, No. $\frac{607}{9504}$; to the Secretary to Government, Military Department, Fort Saint George.

I have the honor, by order of His Excellency the Commander-in-Chief, to forward the Proceedings of the Committee ordered in G. O. C. C. 10th September 1864, to report upon the quality of the water supplied for the use of the Troops at Madras.

2. The Committee have been delayed in their Proceedings from causes explained in Colonel Brewster's letter, dated 9th ultimo, and their Proceedings are still suspended for like reasons.

3. The Commander-in-Chief is aware that the subject is also in the hands of the Sanitary Commission; but he would express an earnest hope that an evil of such magnitude may be remedied with the least practicable delay.

4. That the Troops should be forced to consume water which is declared to be so impure, that its purification even by filtration is an impossibility, is a statement so startling, that the Commander-in-Chief is unable to reconcile it with the ascertained* improved salubrity of the Presidency, and with the health of the Troops stationed there.

*Paragraph 29 of Municipal Commissioners' Report for 1864, in Fort Saint George Gazette of 19th instant.

The Committee named in G. O. C. C., dated 10th September 1864, now, after many alterations composed as follows,

PRESIDENT,
Colonel H. CRAIGIE BREWSTER, 76th Regiment,
MEMBERS,
Deputy Inspector General of Hospitals J. E. MAYER,
Lieutenant Colonel C. V. WILKIESON, Royal Artillery,
Surgeon P. G. FITZGERALD, M. D.,

convened for the purpose of examining the waters of the so called seven Wells (real number ten) reporting upon the Wells of Madras generally, and suggesting from whence a supply of pure water might be obtained, have the honor to report :—

That the waters of all the ten Wells within the compound of the so called seven Wells, are unfit for internal use.

The very able paper drawn up by Mr. Mayer and appended to this report, based on a double analysis, also appended, carried out by himself and Mr. Wyndowe, a Member of this Committee, but now absent in England, prove that the total impurities contained in these waters vary from 23.10 grains to 70.10 grains in the gallon, while those of an organic nature vary from grains 3.90 to grains 7.85 in the gallon.

Taking into consideration the fact that in the salubrious climate of England, no waters are considered even passable for internal use which contain a greater quantity of organic impurities than two grains in the gallon.

The Committee has no hesitation in pronouncing its verdict of unfitness.

The Committee does not consider it necessary to enter upon the subject of filtration, because the waters in question contain so large a quantity of organic and inorganic matter, as to render their purification an impossibility, as will be clearly seen by a perusal of the remarks on filtration which accompany Mr. Mayer's report. Although the labors of the Committee have been cut short by the departure of Mr. Wyndowe, and the consequent abandonment of any further analysis of the waters of Madras, it has no hesitation in recording its decided opinion, that no permanent or

sufficient supply of pure water could ever be secured from within the densely populated area of Madras, and that such a supply as that required could only be obtained by a careful search several miles outside the inhabited quarters of the town, and, if found, maintained pure by a rigid prohibition of all encroachment, within a wide circle, by the Native population.

The Committee has only further to add, that its labors have been suspended by the departure of Mr. Wyndowe, and the pre-occupation of Mr. Mayer with his Divisional duties, and has the honor to forward this report of its proceedings, and to request further instructions from His Excellency the Commander-in-Chief.

MADRAS, 2nd September 1865.

RESULT OF ANALYSIS OF WATER FROM WELL NO. I.

Sensible properties.
 Appearance... To the unassisted sight, clear transparent.
 Microscopical appearances... Gave clear evidence of the presence of animal life as well as vegetable growth.
 Obtained from deposit after standing (with proper precautions.) Distinct, reminding one of water taken from a ship's tank, or water which has stood some days in a glass.
 Odour... There is an absence of that grateful and pleasant briskness that good water should impart to taste.
 Taste... Perfectly Neutral.

Chemical properties.

	Dr. Mayer.	Dr. Wyndowe.	Mean.
Solid ingredients in one Imperial gallon obtained by calculating from residue of evaporation of 2/10th gallon by Dr. Mayer, and of 1/10th by Dr. Wyndowe.	grs. 30.15	grs. 30.7	grs. 30.45
Amount of organic matters present obtained by ignition of above residue re-carbonating and calculating from loss, on one Imperial gallon.	grs. 7.25	grs. 6.2	grs. 6.75
Difference between these two determinations being	grs. 22.90	grs. 24.5	grs. 23.70
Hardness to soap test, having reference to standard water containing 16 grains carbonate of lime to the gallon, with which 22° of the graduated burette forms a permanent lather, and each degree may be assumed equivalent to 0.727 grs. of carbonate of lime, or 0.959 grs. of sulphate of lime.	11°	11°	11°
Of the above hardness temporary that is removable by boiling, &c.	3°	3°	3°
Permanent...	11°	11°	11°
Chlorides determined by the volumetric method, and calculated as chloride of sodium in one gallon.	grs. 12.56	grs. 12.56	grs. 12.56
Bases in solutions by carbonic acid.			
Iron...	Traces.		
Lime...	Average quantity.		
Magnesia...	In quantity rather more than the average water.		
In solution in boiled water.			
Lime...	Is rather large amount.		
Magnesia...	Do.		
Chlorides...	Is rather large amount.		
Sulphates...	Do.		
Nitrates...	Do.		

These last results being qualitative merely, the results are as agreed between the opinions expressed are formed upon the result of the application of the volumetric method of water, viz., 1/10th gallon—each of which is a separate experiment.

(Signed) J. MAYER,
 Deputy Inspr. Genl. of Hospitals.
 S. JARDINE WYNDOWE, M. D.,
 Chemical Examiner.

RESULT OF ANALYSIS OF WATER FROM WELL NO. II.

Sensible properties.

Appearance... Clear, transparent.
 Microscopical appearance as in No. I. Gave evidence of the presence of animal life as well as vegetable growth.
 Odour... Void of
 Taste... Not so fresh as good pure water should be, but in this respect it is better than No. 1.

Chemical properties.

	Dr. Mayer.	Dr. Wyndowe.	Mean.
Reaction to test paper...	Decidedly acid becoming alkaline after boiling some time.		
Solid ingredients in one gallon Imperial determined as in No. I.	grs. 31.60	grs. 31.9	grs. 31.75
Amount of organic impurity...	grs. 6.90	grs. 7.4	grs. 7.15
Salts, &c.	grs. 24.70	grs. 24.5	grs. 24.6
Hardness to soap test, vide No. I.	13°	13°	13°
Of which temporary hardness...	3.5°	3.5°	3.5°
Its permanent...	9.5°	9.5°	9.5°
Chlorides determined volumetrically as chloride of sodium in one gallon.	grs. 11.1	grs. 10.5	grs. 10.8
Bases in solution by carbonic acid.			
Iron...	Traces.		
Lime...	Average quantity.		
Magnesia...	Rather above the average quantity.		
In solution after boiling.			
Lime...	Rather large amount.		
Magnesia...	Do.		
Chlorides...	Already determined quantitatively		
Sulphates...	Present but not in excess.		
Nitrates...	None.		

(Signed) J. MAYER,
 Dy. Inspr. Genl. of Hospitals.
 (,) S. JARDINE WYNDOWE, M. D.,
 Chemical Examiner.

RESULT OF ANALYSIS OF WATER FROM WELL NO. III.

Sensible properties.

Appearance... Perfectly clear and transparent.
 Microscopical appearances... Individual forms of (animal organic life, besides the other appearances as described in Nos. I and II.
 Odour... Free from odour.
 Taste... Has a taste slightly saline.

Chemical properties.

	Dr. Mayer.	Dr. Wyndowe.	Mean.
Reaction to test paper...	Decidedly acid in the cold.		
Solid ingredients in one gallon Imperial.	38.65	36.60	37.62
Amount of organic impurity...	5.0	6.1	5.55
Salts...	33.65	30.5	32.07
Hardness to soap test...	13°	14°	13.5
Of which temporary hardness...	3°	2.5	2.75
Do. permanent...	10°	11.5	10.75
Chlorides determined volumetrically as chloride of sodium in one gallon.	25°=14.615 grs.	25°=14.615 grs.	25°=14.615 grs.
Bases in solution by carbonic acid.			
Iron...	Traces	Do.	
Lime...	Average	Do.	
Magnesia...	Average	Do.	
In solution after boiling			
Lime...	Average	Do.	
Magnesia...	Large	Do.	
Chlorides...	Not determined here.	Not determined here.	
Sulphates	Large	Do.	
Nitrates...	Nil	Nil	

(Signed) J. MAYER,
 Deputy Inspector General of Hospitals.
 (,) S. JARDINE WYNDOWE, M. D.,
 Chemical Examiner.

RESULT OF ANALYSIS OF WATER FROM WELL NO. IV.

<i>Sensible properties.</i>			
Appearance...	...	Clear and transparent.	
Microscopical appearances..	...	As described in Nos. I and II.	
Odour...	...	Free from odour.	
Taste...	...	Slightly unpleasant.	
<i>Chemical properties.</i>			
Reaction to test paper...	...	Neutral.	
Solid ingredients in one gallon Imperial.	Dr. Mayer.	Dr. Wyndowe.	Mean.
Amount of organic impurity...	50.95	50.1	50.525
Salts...	5.90	5.65	5.775
Hardness to soap test...	45.05	44.45	44.75
Of which temporary Hardness...	18°	19°	18.50
Do. permanent...	7°	7°	7.00
Chlorides determined volumetrically as chloride of sodium in one gallon.	11°	12°	11.50
Bases in solution by carbonic acid.	35°=19.461 grs.	35°=19.461 grs.	35°=19.461 grs.
Iron...	...	More than a trace.	Traces
Lime ..	...	Large	Large
Magnesia...	...	Average	Fair
In solution after boiling.	...	Average	Average
Lime...	...	Very large	Very large
Magnesia...	...	Not determined	Not determined
Chlorides...	...	Very large	Very large
Sulphates...	...	Nil	Nil
Nitrates...	...	Nil	Nil

(Signed) J. MAYER,

Deputy Inspector General of Hospitals.

(..) S. JARDINE WYNDOWE, M. D.,

Chemical Examiner.

WELLS NOS. 5 AND 6.

		Well No. 5.	Well No. 6.
Sensible properties	Appearance.....	Clear.....	Clear.
	Odour.....	Not free from ..	Not free from.
	Taste.....	Not pleasant after swallowing.	Not pleasant after swallowing.
Microscope.	Much vegetable and animal life.		Rotatoria plentiful; animal and vegetable life abundant.
	Reaction to test paper...	Acid slight.....	Acid slight.
	Solids in 1 Imperial gallon.	Grains 23.10.....	Grains 34.00.
Chemical properties	Organic matter in do.	Do. 3.90.....	Do. 7.10.
	Inorganic do. in gallon...	Do. 19.20.....	Do. 26.90.
	Chlorides in a gallon...	Do. 4.38450.....	Do. 9.35360.
	Hardness to soap test...	8°	13½°
	Do. temporary.....	2°	2°
	Do. permanent...	6°	11½°
	Bases in solution by Carbonic acid.		
	Iron.....	Traces.....	Traces.
	Lime.....	Small, (average).....	Small, (average.)
	Magnesia.....	Under average.....	Under average.
In solution after boiling.	Lime.....	Average.....	Large.
	Magnesia.....	Small.....	Small.
	Chlorides.....	As above determined.	
	Sulphates.....	A little below average.....	Little above average.
	Nitrates.....	None.....	None.

(Signed) J. MAYER.

RESULT OF ANALYSIS OF WATER FROM WELLS NOS. 5 AND 6.

<i>Sensible properties.</i>		No. 5.	No. 6.
Appearance.....	Clear.....	Clear.	
Microscopical appearance	Much vegetable and a few animal organisms.	Rotatoria plentiful; animal and vegetable life abundant.	
Odour.....	} No difference in these respects from the other Wells.		
Taste.....			
<i>Chemical properties.</i>			
Reaction to test paper... ..	Slightly acid.....	Do.	
Solid ingredients in one gallon, Imperial.	Grains 22.40.....	Grains 33.15.	
Amount of organic impurity.....	Do. 3.55.....	Do. 6.65.	
Salts.....	Do. 18.85.....	Do. 26.50.	
Hardness to soap test... ..	8°	13°	
Of which temporary hardness... ..	1° 5	2°	
Do permanent.....	6° 5	11°	
Chlorides determined volumetrically as chloride of sodium in one gallon.	Grains 4.67....	Grains 9.35.	
<i>Bases in solution by Carbonic acid.</i>			
Iron.....	Traces.....	Traces.	
Lime.....	In small quantity.....	In small quantity.	
Magnesia.....	In very small do.	In very small do.	
<i>In solution after boiling.</i>			
Lime.....	Average quantity.....	More than average.	
Magnesia.....	Small do.	Very small.	
Chlorides.....	Determined	Above.	
Sulphates.....	In small quantity... ..	Average property.	
Nitrates.....	None.....	None.	
No. 5, though not good, better than other Wells analysed.			
No. 6, decidedly bad.			
Dr. Wyndowe's analysis signature omitted.			

(Signed) J. MAYER.

RESULT OF ANALYSIS OF WATER FROM WELL NO. 7.

<i>Sensible properties.</i>		...	Perfectly clear.
Appearance.....	...	Animalculæ present, species not recognizable.	
Microscopical appearances...	...	Free from.	
Odour...	...	Nothing perceptible.	
Taste...	...		
<i>Chemical properties.</i>		...	Faintly acid.
Reaction to test paper...	...	Dr. Mayer.	
Solid ingredients in one gallon Imperial..	29.5	Dr. Wyndowe.	Mean.
Amount of organic impurity...	7.85	30.85	30.11
Salts...	21.65	7.65	7.75
Hardness to soap test...	15° 5	23.20	22.42
Of which temporary hardness...	2° 5	18°	
Do. permanent ...	13°	3°	2.75°
Chlorides determined volumetrically as chloride of sodium in one gallon.	14.5°=8.476 grs.	15°=8.769 grs.	14.75°=8.622 grs.
Bases in solution by carbonic acid...	...	...	chloride sodium.
Iron...	Traces.	Traces.	
Lime...	Average.	Average.	
Magnesia...	Traces.	Traces.	
<i>In solution after boiling.</i>		...	Average.
Lime.....	...	Small.	Small.
Magnesia.....	...	Not determined	Not determined
Chlorides.....	...	here.	here.
Sulphates.....	...	Large.	Large.
Nitrates.....	...	None.	None.

(Signed) JOHN MAYER,

Deputy Insp. Genl. of Hospitals.

(..) S. JARDINE WYNDOWE, M. D.,

Chemical Examiner.

RESULT OF ANALYSIS OF WATER FROM WELL No. 8.

<i>Sensible properties.</i>			
Appearance...	...	Clear.	
Microscopical appearances...	...	Less amount of animal life present, but ascillatoria distinctly observed.	
Odour...	...	None.	
Taste...	...	None.	
<i>Chemical properties.</i>			
Reaction to test paper...	...	Neutral.	(• File remark in memorandum.)
	Dr. Mayer.	34.80	Mean: 34.60
Solid ingredients in one gallon Imperial.	...	35.00	6.70
Amount of organic impurity...	...	6.70	28.20
Salts...	...	28.30	16°
Hardness to soap test...	...	15°	17°
Of which temporary hardness...	...	3°	3°
Do. permanent...	...	12°	14°
Chlorides determined volumetrically as of chloride of sodium in one gallon....	...	15.5 = 9.0613 grs.	16° = 9.353 grs. 15.75° = 9.207 grs of chloride of sodium.
Bases in solution by carbonic acid...	...		
Iron...	...	Traces.	
Lime...	...	Average.	
Magnesia...	...	Small.	
<i>In solution after boiling.</i>			
Lime...	...	Average.	
Magnesia...	...	Small.	
Chlorides...	...	Not determined	
Sulphates...	...	Large.	
Nitrates...	...	None.	

(Signed) JOHN MAYER,
Deputy Insp. Genl. of Hospitals.

(..) S. JARDINE WYNDOWE, M. D.,
Chemical Examiner.

RESULTS OF ANALYSIS OF WATERS FROM WELLS 9 AND 10.

<i>Sensible properties.</i>			
Appearance...	...	No. 9. Not clear from numerous...	No. 10. Clear and visible but impurity still present.
Odour...	...	...	...
Taste...	...	...	...
<i>Microscopical Appearance...</i>			
	...	Not remarkable...	Same as No. 9.
	...	Animal and vegetable,	...
	...	latter more...	...
<i>Chemical properties.</i>			
Reaction to test paper...	...	Acid.	Acid.
Solids in 1 imperial gallon...	...	28.20...	70.10
Organic impurity....	...	5.25 ..	5.70
Inorganic do ...	...	22.95...	64.40
Total hardness...	...	11.5°...	26.5°
Temporary do ...	...	3°...	9.5°
Permanent do ...	...	11.5°...	17.0°
Chlorides determined volumetrically in one gallon....	...	9.93820...	26.95160
Bases in solution by excess of C.O.	...		
Iron....	...	Traces.	
Lime....	...	2 Traces...	Very large.
Magnesia....	...	Small (average)...	Rather large.
Bases present after boiling.	...	About average...	
Lime...	...		
Magnesia in the...	...	Small ...	Not too large.
Chlorides...	...	Small...	Little above average.
Sulphates...	...	Determined above.	Much above average.
Nitrates...	...	Fair...	None.
	...	None...	

(Signed) J. MAYER

RESULT OF ANALYSIS OF WATERS FROM WELLS Nos. 9 AND 10.

<i>Sensible properties.</i>			
Appearance...	...	No. 9. Somewhat opaque from suspended impurities...	No. 10. Clear with floating particles.
Microscopical appearance...	...	Both animal and vegetable matters present, more of latter.	Same as No. 9,
Odour.	...	Nothing peculiar....	Earthy.
Taste.	...	do....	Brackish.
<i>Chemical properties.</i>			
Reaction to test paper...	...	Acid.	Acid.
Solid ingredients in one gallon imperial.	...	grs. 27.85...	grs. 71.15
Amount of organic impurity...	...	grs. 5.05...	grs. 5.5
Salts....	...	do. 22.8...	do. 65.65
Hardness to soap test...	...	15°5...	28.°5
of which temporary hardness....	...	4°5...	12°5
do. permanent....	...	11° ...	16°
Chlorides determined volumetrically as chloride of sodium in one gallon....	...	grs. 9.94...	grs. 26.89
Bases in solution by carbonic acid ...	...		
Iron....	...	Traces...	Traces.
Lime....	...	Small proportions.	Large quantity.
Magnesia....	...	Average quantity....	Rather large quantity.
<i>In solution after boiling.</i>			
Lime....	...	Small proportions....	Moderate proportion.
Magnesia....	...	Small quantity....	Moderate quantity.
Chlorides....	...	Determined....	Above.
Sulphates....	...	Small quantity....	Rather in excess.
Nitrates...	...	None....	None.
MADRAS, } 27th May 1865. }		(Signed) S. JARDINE WYNDOWE, M. D., Chemical Examiner.	

The general characters of these waters are, 1st., that all of them contain animal and vegetable organisations, and that the amount of these organic matters vary from 3.90 grains to 7.85 grains in the gallon, i. e., that the smallest amount found present doubles that which the Authorities at Home consider passable.

No attempts have in these examinations been made to ascertain the respective amounts of animal and vegetable matter, (both being included under the head of organic matters) nor, on reflection, will this appear necessary, as the total amounts found, are so much above that, which is henceforth to be permitted, in water that may be pronounced fit for internal use. Had the total amounts found, been smaller and nearer the prescribed limit, the question of respective amounts would then have assumed a practical bearing and have become one of importance; but we are of opinion that it can be scarcely so regarded in waters which all of them contain organic matters in the gallon, so much in excess of the recognised limit: and for which reason alone they must in their present state be regarded as unfit for internal use.

Of the total amounts of impurities in these waters, a few words will suffice. As the Reports shew that they vary from 23.10 to 70.10 grains in the gallon: and that these impurities contain besides the organic matters, chlorides and sulphates in various quantities. The quantity of sulphates in each water has not been determined. The qualitative examination taken in conjunction with the absolute determination of solids; and then of organic and inorganic matters; with the determination of the amount of chlorides volumetrically, being for all practical purposes, we believe, sufficient. Had there been any reasonable doubt as to the character of these waters, then undoubtedly the absolute determination of the sulphates would have been not only desirable but necessary. As it is well known that sulphates and chlorides together present in any quantity in any water, act injuriously both on men and cattle; and further that, many sulphates in the presence of organic matters, especially in tropical temperatures, are subject to a process of reduction, and are thereby converted into sulphurets, which last by the simultaneous oxidation of the carbon of the organic matters, and by a continuance of the other processes, are converted into oxides; while sulphuretted hydrogen is given off—a gas that is notoriously hostile and deadly to all animals endowed with the higher forms of organisation. For these reasons, all waters in which sulphates and organic matters are present, especially in tropical countries, are unfitted for internal use. It will then be only necessary in order to form an accurate estimate of the quantities of these waters, to bear in mind,

1st., that they contain large quantities of animal and vegetable matters; 2nd., that chlorides and sulphates are present in various quantities; and finally that independent of the deleterious combined action of chlorides and sulphates on the human body; organic matters with sulphates are present.

It does not appear, after the general considerations now submitted, that there is any necessity for dilating on the individual characters of the waters of any one of the Wells which have been examined. Well No. 5 is the least objectionable, but even this water, independent of other impurities, contains double the amount of organic matter that is regarded as passable. It only remains to offer a few remarks on question of filtration. The received opinion has been that all impurities which are soluble cannot thus be separated; and this is undoubtedly true so far as relates to the mechanical effects obtained, by the use of paper, cloths, sieves, sand, &c., all which have no chemical or special action on the fluid passed through their interstices, but if the filter be made to consist partly of a porous substance such as sand, and partly of another capable of exercising a chemical

** Vide Note appended.*

or special action, such as powdered charcoal or magnetic oxide of iron: then the case is altered, and the degree of purification to be obtained by these means remains to be determined by repeated experiments on a large scale. It may be said that the numerous experiments of Doctor * * * and others for the various water Companies at Home have already determined this point. It appears to us notwithstanding that this point has not been so satisfactorily or clearly settled as could be wished; inasmuch as the results obtained immediately after new filter beds have been set up and those obtained sometime afterwards, have been greatly at variance, and further that the results obtained by different experimenters have not always coincided. It is evidently nothing beyond the truth for Mr. A. or Dr. B. to give a certificate to the effect that, a certain apparatus will cause the most striking and wonderful improvement in bad and foul water &c. &c.; but in practice and on a large scale, it is not possible to renew the sand and charcoal every few hours, and to have sets of sponge constantly undergoing a process of purification so as to be ready for constant change. Thus it happens that what can be obtained by careful operative Chemists in the Laboratory, far exceeds that which the practical Engineer can obtain on the large scale outside; where the constant care, watching, and change resorted to in the Laboratory, (the re-setting up of the Apparatus as it were) is impossible.

Professor Parkes, in his late work published for the benefit of the Medical Officers at Netley, gives the statement shown in the margin: it remains to be seen, how far further experiment will confirm these statements, and whether by percolation through large beds of sand and charcoal such impure waters as these now reported on, can even at first be deprived of 88 per cent. of organic matter and 10 per cent. of inorganic.

There is one fact bearing on this point which we think it our duty to bring prominently before the Committee, and through them before Government. Repeated borings (not less than 150) in every part of the thickly inhabited localities of Madras, with the examination of the soil thus turned up, have proved that, however pure the water at certain depths might originally be, it could not long remain so, as the superincumbent and surrounding soil is saturated with filth decomposing organic matters of every kind, and it is scarcely necessary to observe that water by percolating through such soil, will, of necessity, become loaded with organic impurities, and thus render it unfit for internal use. The evidence on these points is so conclusive and so easily obtainable, that it does not seem needful to insist on them further; a little consideration will show that if these statements are really true of Madras, they will obtain in more or less marked degree, wherever there is a dense population with habits and customs such as those of the Madras people, and that the soil will be soddened and fouled with organic decomposing matters in like manner: the facts, therefore, admit of generalisation, and it may be received as a law, that, wherever there is a dense Native population, there the soil will become foul; and that it is from this cause impossible to obtain for any length of time, good water from the Wells sunk within the polluted area, however good the water may be when first drawn. From this the natural and only sound inference to be deduced seems to us to be, that it will be necessary for Government to look for water beyond this polluted

area: and if the supply be required only for the Fort, probably the simple apparatus now in use at the so-called 'Seven Wells' would be sufficient, supposing that the Wells be sunk a mile or thereabout beyond the limit of dense population.

NOTES on the Magnetic Oxide of Iron.

As this substance has lately been brought prominently before the public, and has been much lauded on account of its special action in purifying waters; and as moreover, a Committee of the National Exhibition have lent the sanction of their names to it, as a voucher for the above mentioned special quality, it appears almost necessary in a paper of this kind to offer a few words respecting it, particularly in reference to the two questions of Natural and Artificial supply.

Magnetic Oxide of Iron, it is well known, is a natural product found largely in certain localities, but it is very questionable whether it can every where be so readily obtained, and in such quantity as to make its use practicable on a large scale. All the reliable information on this head, that has been procurable will be given at the latter part of this note; and if it should turn out, that this product can only be had here and there, and in places at considerable distances from those situations, whereat filter beds are to be made: then, the only resource will be the artificial product—and in order to afford a clear view of the practicability of resorting to it, the shortest way will be to give the mode of preparation, this is as follows: which with the information marginally given will enable any one to manufacture the compounds under consideration.

Process.

To obtain artificially Magnetic Oxide of Iron having the Formula Fe_3O_4 such quantity of the green Proto Sulphate of Iron, as will afford the required quantity of Oxide being taken, the crystals are to be dissolved in pure water, two-thirds of the solution thus formed are to be poured into a second vessel, to this portion which is to be boiled, Nitric acid being added till brown vapours are no longer given off; the Iron contained in this portion will now be in the form of Sesqui Oxide, while in the one-third which has not been boiled, the Iron remains in the form of Protoxide. The two solutions are to be mixed together; the mixed solutions are then precipitated by the Volatile Alkali or Carbonate of Soda, and are boiled: during the boiling the mixed Oxides unite and form the black Magnetic Oxide. Fe_3O_4 . To form the Magnetic Oxide Fe_3O_4 the processes are precisely similar, in all details except that only half the quantity instead of two-thirds (as in the first case) is peroxidised by boiling with Nitric acid.

After the details above given, it does not seem necessary to enter further into the question of whether the artificial Magnetic Oxides can be obtained so readily and economically, as to render their use practicable on the large scale, as any process involving accurate weighing, solution, accurate division by graduated measures, boiling and precipitation, besides some expenditure for reagents, would be inapplicable.

Every equivalent or 139 grs. of the crystallised green Sulphate of Iron contains 36 grs. of the protoxide of Iron, therefore 1 lb. Averdupois or 7,000 grs. will contain $x = 1813$ grs. or 4 oz. 65 grs. of the protoxide, and any other quantity in proportion; but it is not the protoxide of Iron that is wanted; it is the magnetic oxides, of which there are two—now to understand how these oxides are formed, as well as the reasons for the process here given, it will be advantageous to set down in order the various oxides of Iron with their appellations and Formulae, it being premised that Fe stands for ferrum Iron and O for oxygen.

Protoxide Fe_2O_3 : Sesqui Oxide Fe_2O_3 these Formulae convey in short, the important information that the protoxide of Iron is composed of one combining quantity of Iron, and one combining quantity of Oxygen; and that the Sesqui Oxide is composed of two combining quantities of Iron, and three combining quantities of Oxygen, this being understood, the composition of the magnetic Oxides, will be at once evident. Their respective Formulae being

Fe_2O_3	and	Fe_3O_4	since it is patent to every one, that one atom of the protoxide and
Fe_2O_3		Fe_3O_4	one of Sesqui Oxide when
$\frac{2}{3}$		$\frac{3}{4}$	united equal, i.e., the
$\frac{2}{3}$		$\frac{3}{4}$	first magnetic Oxide,
$\frac{2}{3}$		$\frac{3}{4}$	and in like manner it
$\frac{2}{3}$		$\frac{3}{4}$	is equally plain, that
$\frac{2}{3}$		$\frac{3}{4}$	two atoms of Protoxide $2(\text{Fe}_2\text{O}_3)$ and one
$\frac{2}{3}$		$\frac{3}{4}$	atom of Sesqui Oxide $\frac{\text{Fe}_3\text{O}_4}{3}$ when united
$\frac{2}{3}$		$\frac{3}{4}$	equal $\frac{\text{Fe}_2\text{O}_3}{4}$ the second magnetic Oxide.

The above composition having been clearly demonstrated by repeated and careful analyses, they suggested the artificial process, of which the dominant conditions are that the protoxide and peroxide should be brought together in the particular proportions shewn, and in a recent state,—how this is effected will be seen in the text of this paper.

The process has, however, been made available for the manufacture of sufficient portion of artificial magnetic oxide, to test its efficacy as a filtering and purifying agent. The same water in the same quantity was used in each of the experiments recorded in the Table of Results marked Y.

TABLE Y.

The water selected for the following trials was notoriously bad, it was taken from a Well in the compound of the Madras Medical College. The quantity experimented on was the 16th of an Imperial Gallon.

Previous to any filtration, one-sixteenth of a gallon was evaporated to dryness, first on a porcelain dish and finally in a Platinum capsule of known weight. It left a total amount of residue—grains 15.08, and after ignition (with the usual precautions) grains 12.52, which was taken as the inorganic impurity present, and the loss grains 2.56 as the organic. Nine separate amounts of a gallon of the same water, were then carefully filtered through the materials noted below. The filtrates were then separately evaporated, and the residues left, weighed and used as above the filtering material used; these various residues were then ignited, the respective residues again weighed are set down in order—the loss in each case being the organic matter. The figures thus obtained by being respectively deducted from the amounts originally present, shew by the difference how much had been separated by each filter material.

Total impurity present previous to filtration 15.08 grains, i. e., over the Gallon 241.28 grains this total represent organic and inorganic impurity.

Residue left after ignition, found equal to 12.52 grains, i. e., on the Gallon 200.00 grains Difference, i. e., organic matters burnt off equal 2.56 grains, calculated on the Gallon equal 40.46 grains (74.7 vide note.)

A.	B.	C.	D.	E.	F.	G.
Material used for filtration.	Total left after evaporating filtrate.	Residue left after ignition of B.	Difference B and C.	Organic matter separated by each agency, i. e., difference between D and original amount present.	Per centage amount separated.	Amount separated by each filter, calculated on the Imperial Gallon.
1. Ordinary filter paper...	14.69	12.36	2.33	2.33	93	9.96
2. Swedish filter paper...	13.87	12.24	1.63	1.63	65	9.16
3. Clean white sand...	15.14	13.69	1.45	1.45	58	9.12
4. Sand and Charcoal...	14.93	12.94	1.99	1.99	79	10.02
5. Natural Magnetic Oxide of Iron...	14.16	12.49	1.67	1.67	64	11.72
6. Artificial Magnetic Oxide of Iron...	14.14	12.50	1.64	1.64	65	11.62
7. Finely divided mica or tale...	14.22	12.39	1.83	1.83	75	15.04
8. Swedish paper and Magnetic Oxide of Iron...	13.99	12.37	1.62	1.62	67	15.20
9. Swedish paper, Magnetic Oxide of Iron...	13.91	12.33	1.58	1.58	67	15.20

Column F has been inserted for the sake of the comparison which can thus be made between the results here set down and those obtained by other experimenters who have recorded their results in this way "inter alios" Doctor Parkes.

Column G has been inserted, 1st, because many experimenters have chosen this mode of expression, and secondly, because the results thus shown will probably be more readily appreciated by those who are not professed Chemists.

It being remembered that, in the 16th. one Gallon, 2.56 grains of organic matters are present, therefore 40.96 grains will be present in one Imperial Gallon.

A few remarks on the Table just given seem to be called for, in order to point attention in the first instance to the differences in the materials employed. Nos. 1, 2, 3, and 7 are materials to which no other than mechanical action has ever been attributed by this agency, they separated from one-sixteenth of a gallon of the same water respectively.

	grains.
1 Ordinary paper...	23
3 Clean white sand...	51
7 Finely divided mica...	73
2 Swedish filter paper...	93

These figures, if the original amount of organic matter present in one-sixteenth of a gallon be taken as 100, give the per centage proportions shewn in Column F, thus it appears that of these four mechanical agencies, No. 2 is by far the best; No. 7 the next best, and so on;

and that out of 100 parts, the best mechanical means tried was only able to separate 36.36 parts. Nos. 5 and 6 are materials to which special purifying powers have been attributed. The per centage quantities separable by their means are shewn in the same column of the Table to be 34.00 nearly and 36.00 nearly; i. e., these special agencies are neither of them quite so powerful as that exercised by the best mechanical means. Finally the results of filtration by mixed agency as shewn by Nos. 4, 8, 9 shew not only great diversity of results, but that those obtained by means of sand and charcoal (No. 4) require in order to make such materials effective, certain other precautions which could not be adopted in this or that case, without vitiating the first principal of comparative investigation that, viz., of placing all the substances experimented on under "precisely similar conditions,"—and it will be observed that in none of these experiments has this canon been departed from—the simplest means, the same sized funnels and the like quantities of materials were in each instance employed. In no instance have special arrangements, packing, or adjusted pressure been resorted to; but without these means, the filtration by double agencies, as shewn by Nos. 8 and 9, appears to exceed in a slight degree the purification that is obtainable by single mechanical agencies, whether the magnetic oxide of iron acts by its insolubility and specific gravity in such a manner as to form very minute pores through its mass,—or by any special mode of action, has not been investigated by us. The artificial product is a finer powder than the natural magnetic oxide, and it acts both singly and in conjunction with Swedish filter paper better than the natural product, which considerations tend to impart to the idea that, after all, it acts mechanically, and not from its possessing any peculiar purifying power. From a partial examination of Spencer's Filtering Apparatus it was evident, 1st, that, a sponge under a graduated pressure was employed as a preliminary mechanical means of intercepting impurity, 2ndly, that pieces of sponge cut very small, were interspersed through the material in the body of the filter. What further special arrangements may have been employed we are unable to say,—as it was not thought worth while to destroy the Apparatus for the sake of such information, it was sufficiently evident that all the precautions before adverted to, and generally deemed necessary in the manufacture of Filters, had been carefully attended to. With all these advantages, however, the results obtained by its use, were above those obtained by the use of Swedish filter paper alone only in the proportions shewn by the figures below:—

Swedish filter paper, 1.63.
Spencer's filter, 1.60.

A further experiment was made to ascertain if double filtration through Spencer's Filter and Swedish Filter paper would make any difference in the results. It was found to do so, reducing the quantity of organic matter left present in the filtrate to 1.57, and the amount separated would thus equal .99, which represented as a per centage—39.00 nearly. From this experiment viewed in connection with what has been previously advanced, we are strongly inclined to look upon filtration generally, (excepting that through various kinds of charcoal (vide Note) as essentially a mechanical act, and that the finer the pores of the filter, the more insoluble the filtering materials; the greater its specific gravity, and the less its liability to be disturbed—the more perfect will be its action. We doubt the utility of any material like sponge either on the small or on the large scale, as however perfect it may render an Apparatus for a while, it is well known that very frequent renewal and careful washing, as well as exposure to the air (ozonisation) to get rid of foetid odours is necessary to keep these Machines in good order, but

notwithstanding all the objections that we have here urged to particular views relative to modes of action, or to forms of Apparatus, we think, with reference to the manufacture of filter beds for Towns, &c., that Table Y shews undeniably that the natural magnetic oxide of iron holds a high place as a filtering agent; by its means nearly 34 per cent of organic matter was separated, it is superior to finely divided mica, and only inferior to the artificial magnetic oxide, and to Swedish filter paper; both which are inapplicable for all but Table or Laboratory experiments.

If the statement made at page 37 by Dr. Parkes, noted by us in a former part of this paper has been held in mind, it will be observed that we have not been able to confirm them. The utmost amount of organic matter that we have been able to separate by filtration, is less than 40 per cent, and differs widely from 88 per cent, as stated in the work above mentioned.

With reference to the ready procurability of the natural magnetic oxide in various parts of India, we beg to submit such information as we have been able to obtain.

Inquiries at the Government Central Museum have shewn that magnetic iron ore is to be found at many places in the Vellore Talook, &c., *vide* page 25 of the Catalogue of articles contributed by Madras to the International Exhibition of Works of Industry and Art, held in London 1862.

By reference to the Catalogue of the iron ores of Southern India, it will be found that the following are named as localities from which iron ores can be obtained in numerous villages in the Northern Division of Arcot; in some places in the Bellary District; in many places in the Canara District; in several localities in the Chingleput District; in several places in the Cuddapah District; in some places in Guntoor and Kurnool; from one place in Madura; from twelve different places in Malabar; some places in Masulipatam; from many places in Mysore, Nagpore, Neilgherries, Rajahmundry, Salem, Tinnevely; but whether it can be had in quantity in all these places is not stated.

In reply to some inquiries casually put to him, Dr. Aitken states that he has seen immense quantities of magnetic oxide at Coimbatore finally.

In the Memoirs of the Geological Survey of India, Volume IV, Part 2, valuable information is to be found in reference to the localities in which magnetic oxide of iron is to be met with, and in the Appendix to this Volume, the magnetic iron beds of Kunjamully near Salem, are admirably described; they are said to be very extensive and the supply of ore inexhaustible.

Unfortunately for the purpose considered by the authors of the work quoted, *i. e.* the manufacture of iron, the absence of appropriate fuel in quantity interferes so greatly as almost to interdict it, or if not to reduce any profit obtainable thereby to a minimum. In like manner the cost of transport from one place to another will, it is apprehended, interdict the use of the magnetic oxide as a material for filter beds, except such places as those in which the oxide in question is found: 3½ Rupees per ton is the price paid of our Porto Novo Company for the carriage of the ore, a distance of 20 or 25 miles.

ORDER, No. 3786, 12th October 1865.

Communicated to the Department Public Works, in connection with paragraphs 4 and 5 of the Order of Government, Military Department, No. 3690, dated the 4th instant, in view to the prompt consideration of the measures necessary to improve, with the least practicable delay, the supply of drinking-water to the Troops in Garrison in Fort Saint George, and at the Presidency generally.

(True Extract.)

Marshall
Secretary to Government.

To the Quarter Master General.
 „ Public Works Department. *With 20 spare Copies.*
 „ Adjutant General, ...
 „ President Sanitary Commission, ...
 „ Principal Inspector General Medical Department, ... } for information.
 „ Controller of Military Accounts, ...

Exd. J. E. Cashart.

1137 (10)
D. N. 1865 Sept
Pres. of Govt. for November
No 4022

(No. of Court
in the Military
Dept)

Dated 12 } Oct/65
Recd 14 }

No 3786

Communicating
letter from the Quarter Master
General, forwarding the report
of the Committee appointed
to report upon the quality of
the water supplied to the troops
at Madras, with a view to
hasten the consideration of
the measures necessary to
improve the drinking water
used by the troops at the
Presidency generally.

No 67.

No 3315. 3d Nov 1865

Public Works Department
No 3315
Proceedings of the Madras Government
Under date the 3rd Nov 1865
I read the following.

Proceedings of Government
in the Military Department
Communicating letter from the
Q. M. General, forwarding the report
of the Committee appointed to report
upon the quality of the water sup-
plied to the troops at Madras
with a view to hasten the con-
sideration of the measures necessary
to improve the drinking water used
by the troops at the Presidency generally.

J. E. 12th Oct/65
No 3786

The Government are
of opinion that the only
source from which it is
probable that potable
water, which shall be per-
fectly free from im-
purities, can be obtained
for the use of the Garrison,
is the roofs of the build-
ings within the Fort, and
they note that orders
have already been issued
to the Superintending Engineer.

W. M.
J. E.
* G. O. No 3015-11 Oct/65

Of the 4th Division to
report on the mode in
which he would propose
to collect and store that
water - Colonel Doikam
will expedite his report.

A. B.

21

The importance of the
to the mil Dept
(See p. 2 of Report)

(20)

15th Nov 1865
Recd of Govt for four

25000

Recd of the 11th Cont

25000

11th Cont

Potable water for the Troops
in the Garrison Madras, Division of the
Madras Government on the last method
of obtaining - communicated to the
Military Department and Subd. Supd.
4th Division

No. 68

25000 3315. 2nd hour 1865