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*Proceedings of the Madras Government, Public Department,
26th March 1874.*

No. 145. Read the following despatch from the Right Honourable the Secretary of State for India:—

Sanitary.
No. 1.

INDIA OFFICE, LONDON,
25th February 1874.

My Lord,—The despatch of your Excellency in Council, dated the 21st April, No. 12 of 1873, transmitting copy of the report for 1872 of the Analysis of Potable Waters in the Madras Presidency, has been considered by me in Council.

2. In reply, I forward, herewith, copy of a memorandum on the report by the Army Sanitary Commission for the consideration of your Excellency in Council and for the adoption of such measures as may seem to you to be necessary. I would especially direct your attention to the remarks, at page 42, on the measures required for improving the water-supply of the various stations.

I have, &c.,
SALISBURY.

His Excellency the Right Honourable
The Governor in Council, Fort St. George.

MEMORANDUM by the Army Sanitary Commission on the Report of Water Analysis in the Madras Presidency for the year 1872.

During this year 234 wells, nine tanks, two rivers, one spring, and one canal supplying water to eighteen stations in Madras Presidency were analyzed by Dr. Hastings, Dr. Sinclair, Dr. Nicholson, and Mr. Harvey, and this report contains the results of their work tabulated on Dr. Macnamara's plan, together with brief notes on the stations, and a prefixed letter by Dr. Macrae, Acting Chemical Examiner for the Presidency.

It is proposed in this memorandum to give—

- (1.) General sketch of the sanitary relations of these water sources at each station.
- (2.) To state generally the measures which appear to be more or less applicable for improving the water supplies.
- (3.) To conclude with a few remarks on certain points of importance bearing on the sanitary relations of organic impurities in water contained in Dr. Macrae's letter.

I.—SANITARY CONDITION OF WATER SUPPLIES.

Secunderabad.—The present report contains analyses of twenty-seven wells at Secunderabad conducted by Dr. Hastings which present the same general characteristics as those in the report for 1871. The granitic subsoil of the district, as stated in the memorandum on last year's analysis, ought to yield water of great purity, and yet there is scarcely a well in the station which does not afford evidence of old or recent sewage impurity, either infiltrated through the granitic sand, or washed in from the surface. The wells are generally from twenty to fifty feet deep. The extent to which these waters are polluted cannot in many cases be ascertained, because the analyses are in certain points incomplete from absence of estimates of albumenoid ammonia, and in some cases there appear to be typographical errors in the tables.

In every case the solid contents in the well waters are in excessive amount for such a soil. The lowest quantity is 21 grains per gallon, and from this minimum it rises to a maximum of 137 grains per gallon.

The loss by ignition is from about 2 grains to 51½ grains per gallon.

The precise nature of the destructible matter is not known in each case, but much of it appears to consist of nitrous or nitric acid compounds.

Another indication of the extent of impurity is supplied by the "hardness," which ought to be very small indeed in granitic waters. This nevertheless appears to range from 9° to 37°. The amount of oxygen required to oxidate dissolved organic matter or nitrites is also large, exceeding considerably the proportion required for ordinary well waters.

Together with these impurities the amount of chlorides is excessive for granitic waters, while the great variety in the proportions of chlorides within so limited an area, varying as they do from less than 2 grains up to 30 grains per gallon, would indicate foreign impurity. What is still wanted, however, for the completion of this test is an estimate of the amount of chloride of sodium in the natural rain and water of the district.

Many instances are given in which there were excessive quantities of nitric acid marking the presence in the subsoil of old organic matter now oxygenated.

The following description of one of these wells, by no means one of the worst of them, may be cited here :—

"Well; no number; in Commissariat Lines, near 4th Cavalry Lines, Bowanpilly; 22 feet deep; 18 diameter; a kuteha well; people walk in and dip their chatties into the water; used by 4th Cavalry for all purposes; thought good by them; is 13 feet from a nullah.

"Dirty white colour; earthy taste; disagreeable stale smell; turbid; plenty organised forms; a small red worm with hooklets arranged in sets of four along the body. *Cyclops quadricornis*, *cypris tristriata*, *chilodon cucullus*, *colops hirtus*, *cyclidium distorum*, *astasia limpida*, *paramoecium caudatum*, *paramoecium (aurclia?)*, *rotifer vulgaris* (large and small), *vorticella*, *confervee* two kinds (1) *spirogyra nitida* (2) like *amphiplema*, *epithelia*, were all seen under the microscope."

The re-action of this water was alkaline; its hardness 17° 15.

Oxygen required in 100,000 parts.

For readily oxidizable matter	04
Do. at 60° F.	17

Grains per Gallon.

Ammonia, free and combined	2.3
Nitric acid	Trace.
Total solids	30.0
Loss by ignition	7.7
Carbonate of lime	6.0
Magnesia	2.5
Chlorides	2.7

"A thoroughly filthy and unwholesome water, supposed to cause guinea-worm."

It may be useful, by way of contrast, to quote from the "report of the General Board of Health on the water-supply to the metropolis," the following analyses showing what the chemical constitution of rain-water may be after draining through a siliceous sand which has not been polluted by sewage. It represents the condition of the subsoil water in the district now occupied by Aldershot.

Grains per Gallon.

Silica	55
Lime as silicate	375
Sulphate of lime	280
of magnesia	557
Chloride of magnesium	552
of sodium	1.440
Potassium	354
Organic matter and water of combination	1.245
Total	5.353

Hardness about 2°50.

In this case the chloride of sodium represents the amount naturally due to the district as there was no population, and the organic matter is mostly of a peaty character.

Another analysis of a different source on the heath gave.

2.76 grains of inorganic and .76 grains of organic matter per gallon.

If Aldershot Common were covered with villages and houses without attention to surface cleansing, without drainage except into cesspits, and if all the stop water were allowed to sink into the ground, there would be ample reason to expect that after a time the wells would present the same characteristics as those of Secunderabad, and if the climate were a tropical one, the Analyst might have to record, as in the present case of Secunderabad, "diarrhoea, dysentery, cholera, malarious fevers with enlargement of the spleen, and guinea-worm are prevalent diseases."

It is evident that so long as these wells continue to be supplied by rain passing through a subsoil more or less fouled by population, so long will the waters present these characteristics.

Some of the wells are so very impure that the only remedy would be to fill them up.

So far as Her Majesty's British troops are concerned, the safest way would be to obtain water from wells or other sources at a distance from possible impurity arising from the presence of population, and to conduct the water by pipes to the barracks and hospitals. The other wells might be improved on the principles to be hereafter mentioned.

2. *Kamptee*.—The six water sources examined by Dr. Hastings at this station are all very much alike. They are wells dug through black cotton surface soil, kunkur, sandstone, and gneiss. The depth of one is stated to be forty-eight feet. They are all hard, chiefly from lime and magnesia salts. The hardness varies from 14° 35 the lowest to 23° 1 the highest.

The total solids vary between 26½ and 47½ grains per gallon, of which from 4° 9 grains to 14 grains per gallon are destroyed by ignition.

They all contain from about a grain to 5½ grains of nitric acid per gallon, showing the presence of oxidized organic matter in the subsoil carried by the water into the wells.

A considerable amount of oxydizable organic matter exists in the water itself, and in some of the wells chlorides are in too great amount.

None of these wells in their present condition can be said to yield good water, but possibly they might admit of improvement.

3. *Sectabuldee*.—Dr. Hastings gives the analyses of two wells at this station. Both are alkaline—one is stated to have a hardness of 7°, the other of 27° 3. The harder water contains 28 grains of solid matter per gallon, of which 7 is removed by ignition.

The remainder consists of lime and magnesia, salts and silica.

There are present 2.7 grains of nitric acid and 2° 1 grain of chlorine per gallon. The amount of recent organic matter is very small.

The softer well is new and contains 21½ grains of solid contents per gallon, of which 3.3 grains are removed by ignition. There is a small amount of organic impurity and about a grain of nitric acid per gallon.

The waters are favourable specimens of Indian station well water, but might be better protected.

4. *Thyetmyo*.—Dr. Sinclair's report on the waters of this station contains the analyses of thirty well waters and one analysis of water taken from the Irrawady river about a mile above the station, which affords points of comparison with the well waters of considerable interest.

The wells are from twenty to sixty-six feet deep, and are dug through a brown sand, with clay of fresh-water origin and then through supposed marine strata of sand, gravel, calcareous nodules, &c.

The Irrawady water is described as having "a whitish tint, pleasant taste, no smell, slightly turbid, no organized forms." Its hardness is only 2° 8. The amount of oxygen required for organic matter is .19 per 100,000 parts.

Albumenoid ammonia amounts to .007, and nitric acid to 1.11 per 100,000. Nitrous acid is said to be present. The total solid contents are about 11 grains, and the loss by ignition 1.3 grains per gallon.

The amount of chlorides is about 15 grains per gallon.

The easily salts are carbonates of lime and magnesia and sulphate of magnesia, all in minute quantities.

There appears to be no pollution up the river, so that if the data have been reported correctly we have here an account of a natural unpolluted water.

The Analyst remarks that the presence of both nitric and nitrous acid make this a suspicious water. But a reference to the memorandum of the Army Sanitary Commission on the first report on analyses of Madras waters, 1871, will show that the amounts of oxydizable and ammoniacal organic matter, of nitric acid and hydrochloric acid, in this river flowing through a thinly-peopled country are considerably less than the amounts of these substances which exist in the rain of country districts in densely peopled highly cultivated manufacturing England.

We have thus additional points of comparison by which to estimate the purity of waters, and it would be well to complete the inquiry by collecting rain water at a short distance from the station, and comparing its constituents with those of the Irrawady water.

If we suppose the Irrawady water to represent the chemical constitution of water as it enters the subsoil, then the analyses of the well waters at the station afford definite information as to the changes which the water undergoes in passing through the subsoil.

The hardness increases to from 15° to 25°. The total solids which are about 11 grains per gallon in the river water are from 28 grains to 77 grains per gallon in the well waters. The loss by ignition in the well waters is from 5 to 8 or more grains per gallon.

The oxydizable matter is high in some of the wells, as is also the amount of chlorides, nitrates, and ammoniacal organic compounds.

Taken as a whole, and with a few exceptions, the waters are ordinary well waters, better perhaps than most Indian well waters, but capable of improvement.

5. *Tonghoo*.—Dr. Sinclair gives the constituents of twenty-six well waters at this station.

The wells are from twenty to thirty feet deep, and are sunk through a surface soil of laterite and clayey humus with a subsoil of sand.

The tables appear in some points to be incorrectly printed, for some of the wells are stated to show hardness of less than 1°, while the total solid contents after ignition are from 8 to 10 grains per gallon or more. There are no details in the tables to account for these apparent discrepancies in the results. The weight destructible by heat shows the presence of a considerable amount of organic matter and nitric acid.

Most of the waters require large proportions of oxygen for oxydizing organic matter, while ammonia, albumenoid, ammoniac, and nitric as well as nitrous acid are present in considerable quantity in most of the wells.

The chlorides vary from about a third of a grain per gallon to upwards of 4½ grains per gallon, the smaller proportion probably showing the natural amount due to the waters of the stations.

Very few of the waters are good, while a number of them are scarcely fit for use.

A classification of waters should in this instance be made so that the best wells might be selected for drinking and culinary purposes, improved and protected, while the others might be used for washing, bathing, and cleansing generally.

6 & 7. *Moulmein and Shwayghoon*.—Fourteen wells examined by Dr. Sinclair at Moulmein and four at Shwayghoon present the same general characteristics as those at Tonghoo, except that the Shwayghoon waters appear to be the purest. The wells are from twenty to forty-four feet deep.

The soil and subsoil in which all are dug is laterite. The construction of wells is the same. There is the same low scale of hardness from 7° to 29° 45'; one water at Shwayghoon is returned at 35° co-existing with the presence of from 4 to 5 grains per gallon of incombustible solids at Moulmein and scarcely a third of this amount at Shwayghoon. Nitric acid is present in all the wells as are also ammonia and albumenoid ammonia; chlorides are in very small proportion. These wells require management and improvement.

8. *Bellary*.—Dr. Nicholson has furnished analyses of eleven wells and two tanks at this station. The wells are dug through a surface soil of black cotton earth to a sandy subsoil of

decomposed gneiss and beds of kunkur under which is gneiss rock. The analyses as given in the tables are incomplete so far as concerns organic impurities, although the oxygen test shows that these must be of considerable amount.

Solid impurities exist to an unusually large extent. The purest well in this respect contains about 12 grains per gallon, but all the others exceed this amount to a great degree. One well contains about 70 grains per gallon, two contain above 100 grains per gallon, one contains above 140 grains, and another, the worst, has no less than 224 grains of solid impurity per gallon.

The latter is only used for bathing; it contains 107 grains of sulphuric acid in combination per gallon.

Several wells contain nitric acid: one has 4½ grains, another 7½ grains, and a third above 10½ grains of acid per gallon.

In some wells the amount of chlorides greatly exceeds that in others.

The amount varies from about quarter of a grain to 5, 6, 10 and 20 grains per gallon. The most characteristic saline impurity in these wells is combined sulphuric acid, which varies from about 2½ to 107 grains per gallon.

With very few exceptions the well waters are impure and bad. The waters most capable of improvement are those supplied by the tanks.

There is one well, called the "Artesian Well," which is a large square tank 60' × 50', reduced downwards to 25' × 15', and finally ending in a shaft twenty-three feet deep and a foot in diameter. The water is raised by bullocks and sent in stone-built and "water-tight" under ground channels 1000 yards and 700 yards long into wells for the barracks and a cistern for the hospital now disused.

This water has a hardness of 10° 5. It contains readily oxydizable matter, ammonia, albumenoid ammonia, and nitric acid, but less than a grain of chlorine per gallon.

Dr. Nicholson cites this case as telling against the organic matter test, as the water is "free from the slightest trace or suspicion of organic contamination."

We have doubts on this point. It has to be shown that the unquestionable presence of nitrogenized compounds is not due to infiltration from the subsoil along the course of the under ground channels (an event which takes place with imperfectly-laid iron pipes), or to infiltration into the wells from whence the water is drawn. It is not likely that inorganic subsoils can impregnate water with nitrogenous organic compounds.

These must have had an organic origin.

9. *Vizagapatam and Waltair*.—Dr. Nicholson has furnished an interesting report on the waters of this station, connecting the results of chemical analyses with the topographical positions of the wells.

Fifteen sources have been examined, thirteen of which are wells, one tank, and one spring. The wells belonging to Vizagapatam are dug in a tongue of land formed by the sea on which the town is built.

All the sources examined are exposed to the ingress of sea water, or salt from spray or from old saline impregnations of the subsoil.

The whole district appears to be more or less of marine production, and the wells on the lower levels yield a large amount of chlorides. A spring from which it has been proposed to supply the town yielded chlorine equal to nearly 80 grains of chloride of sodium and 10 grains of chloride of magnesium per gallon.

The amount of chlorine in wells near the Native Infantry Lines varies from nearly 9 grains to 45½ grains per gallon.

At Waltair, which is situated in another and higher district at no great distance, the much smaller amount of chlorine would appear to indicate mainly the effect of spray. Some of the wells are quite shallow, nine to twelve feet deep; the deepest appears to be forty-seven feet.

The analyses of all these waters is incomplete on account of absence of estimation of ammoniacal compounds.

The proportion of oxygen required for organic matter is large, and several wells contain nitric acid. They all contain very large quantities of solid matter in solution. The least impure well contains no less than 56 grains per gallon; the most impure contains as much as 166 grains of solid matter per gallon, chiefly chlorides and sulphates.

The total hardness varies from 25° to 51°6.

In dealing with waters of this class and in similar localities all that can be done is to select the best waters for drinking and for culinary purposes, and to restrict the use of the others to purposes not immediately connected with these.

The Waltair group of wells affords the best water, and possibly the most likely source of a water-supply for Vizagapatnam (at least near at hand) would be somewhere in the direction of this village. It may likewise be possible to collect roof water for drinking purposes.

10. *Vizianagrum*.—The wells examined at this station by Dr. Nicholson are eight in number, and are from twenty-three feet to forty-two feet deep.

They are dug in a sandy soil with occasional beds of ferruginous gravel and kunkur overlying gneiss and felspar rock.

Certain of them, although at a distance of fifteen miles from the sea, present indications of old marine impurities. Their solid contents vary from 20 to about 168 grains per gallon, mostly chlorides and sulphates. They all show considerable organic impurity. Both nitrites and nitrates have been detected in two of the wells.

In cases such as this the only thing to do is to collect as much rain water as possible for drinking and culinary purposes.

11. *Berhampore*.—This station is low and flat and about six miles from the sea.

Dr. Nicholson has examined the water of seven of its wells; they are thirty to forty feet deep. The soil is decomposed felspar with beds of gravel apparently of marine origin. Subsoil water is nowhere more than six feet from the surface, and is stated to be distinctly brackish.

The waters present the same general characteristics as those of Vizianagrum, except that the amount of old marine impurity is much less. All the waters contain nitrates. "A new well" is stated to show no less than 7 grains of nitric acid per gallon, probably due to old-standing impurities in the subsoil.

The quantity of oxygen required for oxidating organic matter in these waters is large. Some wells are better than others. The water-supply at this station requires to be dealt with on the same general principles as at Vizianagrum.

12. *Cuttack*.—Cuttack is situated on a delta, and derives its water from wells, tanks, and river. Dr. Nicholson has furnished analyses of sixteen of these wells, two tanks, and of the river water.

The river Mahanuddy, which runs within two miles of the town, may be considered the type water of the district. It appears from the analysis to be remarkably pure. Its hardness is 3°4 only; all removable. The total solid contents amount only to 6.8 grains per gallon, of which about a tenth of a grain is due to chlorine and four-tenths of a grain to nitric acid.

This water is considered to be so much better than the well waters, that people send for it to drink.

The nearest approach to the river water is reached by the water of tanks, which appear to be unusually soft and free from impurity.

It is interesting to observe that the well waters are of a very different stamp, although the district is so low that it might be flooded by the river but for precautions taken to prevent this.

The wells vary from twenty to forty feet or more in depth, and appear to be dug in the alluvial soil. Of the well waters only one has a hardness under 12°; the highest has 77°. The best well, No. 1, contains about 18 grains of solid matter per gallon, and in other respects resembles the tank water.

It appears to be, what the Analyst states, "a fair specimen of pure subsoil water."

The other wells contain total solids amounting from 30½ grains to 182 grains per gallon, chiefly chlorides and sulphates.

Two wells only contain nitrates, but to the extent of 3.8, and nearly 20 grains of nitric acid per gallon.

The wells generally bear marks of impurities from surface occupation of the ground. The best only should be used, but the real source of a filtered water-supply for the station, as pointed out by the Analyst himself, is the river Mahanuddy.

13. *Cannanore*.—Mr. Harvey has analyzed the water of twenty-six wells and one tank at Cannanore. The average rainfall at this sea-coast station is 125 inches. The wells are dug through laterite generally to a depth of forty or more feet. The waters are remarkably soft, varying from a little more than 1° to 6° or 7°.

Their general character is alkaline. The total solids vary between 4 and 21 grains per gallon with a small loss of a grain or two by ignition.

All the well waters examined, twenty-five in number, contain nitric acid generally to the extent of about quarter of a grain per gallon.

The amount of chlorine is very small in most of the samples, rarely exceeding one or two grains per gallon. In four or five cases this amount is considerably exceeded. In one case the filtered barrack water contained 7 grains per gallon of chlorine. The amount of oxygen required for organic matter is high, and nearly all the samples show the presence of ammoniacal compounds.

When compared with other Indian well waters, those at Cannanore must be considered as favourable samples. This point is of importance in connexion with the occurrence of typhoid fever among troops at Cannanore, for with these analyses before us the local cause of typhoid must be sought elsewhere, and hence the probability is greatly increased that atmospheric contamination by fecal effluvia has been a determining cause of this disease.

The wells require improvement, and safer means of drawing and distributing water for troops should be introduced.

14. *Trichinopoly*.—The thirty-three wells, one tank, and the canal river supply examined by Mr. Harvey in this locality present almost every quality of waters.

Some are tolerably good, others are unsafe, and not a few are unfit for domestic use. The surface soil in which the wells are dug to depths varying from under twenty to thirty-eight feet consists chiefly of laterite and loam; the subsoil is gneiss and trap.

The tank and canal supply are liable to fouling by native habits, and many of the wells are polluted by drainage through a foul subsoil.

The hardness of these well waters varies from 5°6 to 64°2.

They all contain considerable amounts of rapidly oxidizable organic matter, nearly all contain ammoniacal compounds, and many of them contain nitric acid.

The smallest amount of chlorine is about 1½ grains per gallon in two wells; in all the others the amount of chlorine greatly exceeds this proportion, and in one well it is as much as 61.7 grains per gallon.

The total solids are as low as 15½ grains per gallon in one well only; in all the others their amount is very much larger. In one well the total solids reach the large quantity of 161 grains per gallon, of which no less than 31 grains are destroyed with evolution of nitrous fumes on burning.

A few wells have a low degree of hardness and a comparatively small quantity of total and destructible solids together with small amounts of nitrogenous compounds and chlorine. These may be considered as fair and improvable waters, but as for the remainder they are mostly quite unfit for any domestic purpose.

15. *Mangalore*.—There are only four analyses of wells at this station given by Mr. Harvey. The wells are from twenty-six to fifty-six feet in depth, excavated in a subsoil of laterite, clay, and gravel.

The average rainfall of the district is 140 inches.

The water samples although incompletely analyzed from want of time show that the sources are of a degree of purity far above the average of Indian wells. The hardness in all of them is under 4½°.

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The total solids vary from 3·3 grains to 15 grains per gallon.

The amount of nitrogenous matter is very small, and the amount of chlorine although high is much less than usual with waters of this class. With care these wells should afford good water.

16. *Palamcottah*.—The wells, three in number, examined by Mr. Harvey at Palamcottah are twenty-nine feet deep and excavated in alluvial clay and sand resting on granite.

They are harder than the Mangalore samples, viz., from 9°1 to 11°5.

They contain 3½, 19, and 24 grains of solid matter per gallon, from a fourth to a fifth of which is destructible by fire.

They all contain nitric acid and nitrogenous organic matters and chlorine in proportions, similar to those in the Mangalore samples, from which they differ chiefly in hardness.

17. *Quilon*.—Three samples of water have been analyzed by Mr. Harvey at this station.

It is situated in a laterite region with ninety inches rainfall, and the subsoil is sandy.

The wells are shallow wells, and can receive little else than surface drainage.

The waters are very soft and contain from 1·4 to 1·6 grains of solid matter per gallon. The amount of nitrogenous matter and chlorine is very small, and the waters are fair samples for domestic use.

18. *Vellore*.—Mr. Harvey supplies analyses of one well and one tank at this station. Both waters have alkaline reaction. Their hardness is 16°8 and 11°9, respectively.

The total solids are as high as 35 grains per gallon for the tank water and 44½ grains per gallon for the well. Both contain nitrogenous matter and too much chlorine (the tank 3 grains and the well 6½ grains per gallon). Neither are good samples of culinary waters.

II.—MEASURES REQUIRED FOR IMPROVING THE WATER SUPPLY AT THE STATIONS.

(a.) Several of the stations included in this report are so situated that the well waters must necessarily contain marine salts.

But the amounts of these may vary to a considerable degree in different wells at no great distance from each other and in the same well at different times.

In such cases the presence of marine salts, unless the water were absolutely brackish and unfit for domestic use, would scarcely be so likely to prove injurious to health as putrescent organic matter would be, especially if this were readily oxidizable.

In the instances supposed and where purer water sources cannot be reached, the only apparent course to take would be to select the least saline wells for domestic purposes and to use every possible precaution to cut off all ingress of decaying organic matter from the well.

The best water for drinking and cooking purposes, especially for the former, would be roof water carefully collected, stored, and filtered for use.

(b.) At all the other stations where well waters form the only available sources of supply it would be an easy matter with these analyses in hand to select the waters most suitable for culinary purposes and to make this a duty of station sanitary police.

Hard nitrogenous waters containing large amounts of solid and combustible contents can never be wholesome, especially for Europeans in tropical climates.

All such should be rejected and their use confined solely to bathing or other cleansing purposes.

At many stations of this class roof water carefully filtered and stored should be kept for drinking.

(c.) Wherever such river waters as those described in the report are at hand, clearly the best course to take would be to supply stations with these waters after filtration, and to conduct the water, in water-tight channels, either above or under ground.

(d.) Wells situated among, or close to, large groups of population are not likely, under present sanitary arrangements, to admit of much improvement.

But where wells are not so placed and where the vicinity can be kept free of nuisance, the well waters might be improved by rigid attention to sanitary police of the neighbouring ground, by cleansing or deepening the well to improve the supply, by raising the tube of the well two or three feet above the ground-level, cutting off the immediate subsoil water by surrounding the upper six feet of the tube with concrete, and by providing a cover to keep out dust and decaying matters.

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(e.) The method of drawing and distributing well water likewise requires change.

It will serve little good purpose to improve the wells themselves if all manner of dirty vessels and cords are dipped into the water and the washings of the drawers' feet allowed to flow back into the wells, or if pure water is to be carried in filthy bags for use. Ground about the well should be drained away from its mouth, an iron bucket, chain, and windlass provided for raising the water, or a suitable pump, and for troops the water should be distributed, if not by pipes, from a cistern near the well, at least by metal vessels.

There appears to be no reason for doubt that, if these precautions were adopted, many wells at present scarcely fit for yielding culinary water would afford a tolerably pure supply.

These are the main practical points raised by the present report, and the Commission desire to commend them to the attention of the authorities on the spot.

III.—ESTIMATION OF ORGANIC IMPURITY IN WATERS.

Dr. Macrae says, "It will be seen that nitric acid is present in all the waters in which it was looked for. In England, and pretty generally in Bengal, this substance is looked upon as the result of oxidation of organic nitrogenous matters, and it is asserted that no water can be safe for drinking when it is present in any quantity. If chlorides are also present the Home authorities insist upon it that the water should not be used. They are doubtless right as regards English waters, but the dictum does not apply to India."

As similar averments have been already made in other reports from Madras it may be well once for all to deal with them.

In the first place, we were not aware, until we saw these statements in the Madras reports, that it had ever been alleged that either nitric acid or common salt in the proportions in which they usually exist in drinking waters had any injurious effect on health. Such a statement was never made by this Commission.

The presence of either salt in drinking waters, unless in such proportions as would lead ordinary observers to reject them as unwholesome, is of importance only as an index of the purity or impurity of the water from other causes.

The presence of common salt in well waters proposed by Dr. Angus Smith as a test of their wholesomeness was dealt with at page 159 of the India Office Blue Book for 1872 in reference to Dr. Cornish's report, and it will be sufficient to extract the substance of what is there stated:—

"Organic matter being present in water as shown by analysis, the point to be determined is, where did it come from? Is it of vegetable or animal origin?"

Dr. Smith makes use of the fact of the co-existence of common salt with organic matter in water as affording an important indication of its animal origin.

A human being consumes about 100 grains of salt a day, which passes out of the body into the soil, unless conveyed away as sewage and finally into the subsoil water. The question has nothing to do with brackish water, or the effect of this on health.

Dr. Smith has pointed out how errors in the use of this test may arise, and shows how they may be avoided by ascertaining the average amount of chlorides in the rain or drainage of any district. He then says, "Any amount of common salt above the average of the district obtained in a well, in a city or camp, or near habitations of men or animals, is an almost certain proof of impure drainage."

It is in reference to this excess that he says, "one grain per gallon is too much."

It is evident that in using this test the effect of common salt on health is not taken into account; it is simply used as an index of the animal origin of organic matter, which is the real poison sought for.

As regards the presence of compounds of nitrogen in certain wells, it may be stated generally that nitrites may be assumed as indicating the presence of recent organic matter undergoing change and are therefore of much more importance in questions of health than nitrates, which indicate the change completed.

But, in arriving at a conclusion as to the hygienic relations of any given water sample, other considerations must be taken into account, for which we must refer to Dr. Smith's estimation of

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organic matter in water, printed and sent to India on the recommendation of the Army Sanitary Commission.

ARMY SANITARY COMMISSION,
WAR OFFICE, 26th January 1874.

(Signed) J. J. FREDERICK,
Secretary.

No. 146. ORDER THEREON, 26th March 1874, No. 358.

Ordered that copies of the foregoing despatch and its enclosure be printed and furnished to the Surgeon-General, Indian Medical Department, with reference to his letter, dated the 22nd March 1873, No. 109, and for communication to the Chemical Examiner.

2. Ordered, also, that copies of the papers be furnished to the Military Department, Board of Revenue, Revenue Department, Public Works Department, the Sanitary Commissioner, and to all Collectors and Presidents of Municipal and Local Fund Boards, and that their special attention be drawn to the remarks of the Army Sanitary Commissioner on the measures required for improving the water-supply of the various stations.

(True Extract.)

D. F. CARMICHAEL,
Acting Chief Secretary.

To the Surgeon-General, Indian Medical Department.

„ Military Department.

„ Board of Revenue.

„ Revenue Department.

„ Public Works Department.

„ Sanitary Commissioner.

To all Collectors.

„ Presidents of Municipal Commissions.

„ do. of Local Fund Boards.

