

GOVERNMENT OF MADRAS.
PUBLIC WORKS DEPARTMENT.

16th February 1882, No. 121 R.

Railway.

Read the following paper :—

Despatch from the Most Honorable the Secretary of State for India.

Railway.
No. 1.

INDIA OFFICE, LONDON,
19th January 1882.

SIR,—The Directors of the South Indian Railway Company having, with my sanction, caused their Examining Physician, Dr. Saunders, to be supplied for analysis with some samples of water used for locomotive purposes, that gentleman has submitted a report thereon, dated the 19th November last, copies of which, and of the detailed analysis of each, are herewith transmitted for your Excellency's information, and for such use as you may consider proper.

2. I shall be glad to hear whether your professional advisers consider that any advantage would be likely to arise from a trial of the substances referred to in the report as a means of protection to boilers in some of the districts in which the water is known to be of a bad quality.

I have, &c.,

(Signed) HARTINGTON.

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

INDIAN WELL WATERS.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
19th November 1881.

REPORT on fifteen waters from wells used for locomotive and other engineering purposes on the line of the South Indian Railway.

The samples were collected at the following stations :—

Number of Sample.	Stations.	Depth of Well.	Nature of Soil and Subsoil.	Distance from nearest source of pollution, drains, &c.
1	Madras Well near the tank-house.	FT. IN. 26 6	Hard morum	No source of pollution.
2	Madras Well near the engine-shed.	30 0	Do.	Do.
3	St. Thomas' Mount ...	23 3	Do.	Do.
4	Guduváncheri ...	22 6	Do.	Do.
5	Chingleput ...	28 0	Rock	Do.
6	Acharapákam ...	14 0	Black stiff clay	Do.
7	Tindivanam ...	28 0	Decayed rock	Do.
8	Vickravandi ...	22 0	Sand	
9	Villupuram ...	28 3	Stiff clay	A small pond about 50 feet north-east of wall.

Number of Sample.	Stations.	Depth of Well.	Nature of Soil and Subsoil.	Distance from nearest source of pollution drains, &c.
10	Panruti	FT. IN. 23 6	Brick earth and stiff clay ...	No source of pollution.
11	Cuddalore Old Town.	19 0	Black clay	Do.
12	Porto Novo	16 9	Sand, with slight proportion of brown clay. Fine sand with a little black clay.	Do.
13	Sátúr... ..	20 0	Cotton soil, decomposed gneiss very hard at bottom.	Do.
14	Maniyáchi	38 0	Cotton soil, soft rock or decomposed gneiss with line nodules.	Do.
15	Tuticorin	18 6	Sand	A natural water course runs past about 30 feet north, but is no source of pollution.

Considerable difficulty was experienced in analysing these waters, owing to the insufficient quantity supplied and the want of care shown in their collection, defects which necessitated the very unusual expedient of filtering some of the samples before examination.

They were gathered in ordinary old wine bottles, with loosely fitting dirty corks, and the escape of the water was only prevented by the wax with which they were sealed at the neck of the bottle; in some cases old corks were found in the bottles, and in three or four instances some of the contents had leaked out, and partial decomposition in the water of the remainder induced by the admission of air.

The general appearance of the waters was as follows, viz., Nos. 1, 2, 4, 5, 6, 8, 11, 14, and 15 were dirty and contained flocculent deposits, Nos. 5 and 6 were also of a brownish peaty colour, Nos. 2, 3, 4, 11 and 12 smell of sulphuretted hydrogen, and Nos. 7, 9 and 10 and 13 were bright and colourless.

If the object of analysing the waters had been to ascertain their wholesomeness for potable or cooking purposes these conditions would have been fatal to accurate results. The best, however, that circumstances permitted has been done in this direction; but the result tabulated must only be regarded as approximately correct, so far as the determination of the albuminoid ammonia (indicating the presence of nitrogenous organic matter of a noxious character) is concerned.

These observations do not apply with anything like the same force to that portion of the investigation which treats of the mineral constituents of the waters, since these are unaffected by atmospheric action or the lapse of time between their collection and examination. All the waters, with the exception of Nos. 1, 2, and 5, contain a large quantity of solid matter; this consists of salts, such as carbonates and sulphates of lime, &c., which are not readily soluble and which are consequently deposited on the boiler plates and tubes when the water becomes concentrated by evaporation. When possible, therefore, I have tried to ascertain the proportion of those solids which are readily soluble, and, for that purpose, treated the direct residues with distilled water, employing one-tenth of the original volume analysed; the results show, that with the exception of Nos. 1, 5 and 7, the waters contain a large quantity of matter which would form "scale." Nos. 10, 13, 14 and 15 are the worst in this respect.

Soluble salts, with the exception of the chlorides, are not injurious; of the latter, chloride of magnesium does the most mischief.

In Nos. 6, 11, 14 and 15 the estimation of chlorine was unusually high, and although the amount of chloride of magnesium could not be ascertained, on account of the insufficiency of the quantity of water, it was undoubtedly present in these four samples, and may have been so in others.

All the samples (excepting Nos. 1, 2 and 4, in which the supply of material was too scanty) were examined for sulphates, which were found in considerable quantities, excepting in Nos. 3, 5, and 7, in which the amount was low, whereas in Nos. 12, 14, and 15 (and notably in 14) they existed in some abundance.

Sulphate of lime is a very undesirable constituent of water, as it not only forms "scale" of itself upon the boiler, but by retaining a certain portion of carbonic acid, in solution at the boiling point, the action of this gas upon the carbonate of lime prevents it being precipitated as a powder.

Madras well near tank-house, South Indian Railway.—Well 26 feet 6 inches deep, sunk through a stratum of hard morum.

The whole of the fifteen samples, excepting, perhaps, Nos. 5 and 13, represent what is technically known as *hard* waters, and are all quite unfitted for use in boilers, and especially in multitubular boilers.

A water is said to be "*hard*" in which certain salts, such as the carbonates of magnesia and lime, are held in solution by the presence of free carbonic acid. The action of boiling upon such a water is to expel this carbonic acid, for the want of which the carbonates are deprived of their solubility, and are thrown down in the form of a precipitate, which adheres to the plates and tubes in the form of a "*crust*" or "*scale*."

It must, however, be understood that the solubility of the carbonates does not depend entirely upon carbonic acid, since the water itself, *minus* this acid, will dissolve them to a small extent.

In such a case the hardness is said to be "*temporary*."

When the hardness is not materially reduced by raising the water to the boiling point, such hardness depends upon the presence of sulphates, and chlorides of lime, and magnesia, in which case the hardness is styled "*permanent*."

Occasionally it happens that the hardness of a water is partly owing to the presence of free sulphuric acid, or hydrochloric acid.

The crust or scale, therefore, which forms in locomotive and other boilers, consists of sulphate of lime, and carbonates of lime and magnesia, which in the course of the process of precipitation takes down any organic matter which may be present; this explains the beneficial action boiling has upon waters polluted with nitrogenous matter. As a fact of interest it may be remarked that incrustations are usually produced by waters possessing much temporary hardness.

In most of the fifteen samples the hardness is temporary only, and, therefore, the waters would be all improved by the adoption of "*Clarke's*" well known *softening process*, by milk of lime, or by the addition of sufficient "*caustic soda*" in the boiler to render the water stronger alkaline.

In the cases shown in the table in which the hardness is *permanent* the water may be improved by placing into the boiler pieces of *carbonate of Baryta*.

In the Royal Dockyards, where sea water is used containing many times the amount of impurities found in the worst sample under consideration, a material known as "*Harris's Patent fluid*, and new block composition for the removal and prevention of incrustation in steam boilers" of which, in reply to my questions on the subject, Mr. Weston, the Government Chemist of Her Majesty's Dockyard, Portsmouth, writes as follows:—

"Our water (sea water) although hard gives us no trouble, as the composition (Harris's) prevents the lime depositing as "*scale*" and throws it down as a powder."

Harris's composition, as far as I can learn, is made of *Tannin* bound up in *gelatine* (the animal matter spoken of in prospectus), and the advantage claimed for it by the inventor is that it precipitates and loosens "*scale*."

Tannin per se has an injurious effect upon iron; but in the above composition it is so guarded, or locked up by the animal matter, as to be liberated very slowly, and perform its function upon the scale without injury to the surface of the boiler. The block composition is said to last at the rate of 1 lb. per horse-power per month of twelve working hours per day.

By the gradual dissolution of the said block composition an unctuous coating on the surface of the water is produced, which mechanically prevents the adhesion of scale on the iron plate.

The block composition is not suitable for locomotive multitubular boilers, on account of the small water surface presented, but a fluid preparation is specially prepared to meet this objection. It has no action upon gun metal cocks, and is said to be the only material of its kind possessing this advantage; it is used at Portsmouth and Chatham Dockyards, at all the departments of the Royal Arsenal at Woolwich; also by the Kent Water Company, and many other large establishments.

It is also stated that both block and fluid compositions will keep well in an Indian climate.

I have had no opportunity of testing this stuff practically; but the evidence adduced of its utility seems to me worthy of consideration.

Several other methods are employed for preventing incrustation upon boilers, but, as I have not been able to learn anything respecting their composition or merits, I do not feel justified in recommending them.

(Signed) W. SEDGWICK SAUNDERS, M.D.,
Public Analyst for the City of London.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
12th April 1881.

No. 1.

Analysis of Water.

Madras well near tank-house, South Indian Railway.—Well 26 feet 6 inches deep, sunk through a stratum of hard morum.

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Sample in a wine bottle, and consisted of 19 ounces of a dirty water, strongly impregnated with the odour of sulphuretted hydrogen.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit ...	24.0
Soluble salts in residue at 212° ...	16.1
Hardness (expressed as carbonate of lime) ...	09.2
Permanent hardness (do. do.) ...	04.7
Chlorine ...	05.1
Chlorine (expressed as chloride of sodium) ...	08.4
Or as parts { 00.06 Free (or saline) ammonia ...	00.0042
per million. { 00.46 Albuminoid ammonia (organic matter) ...	00.0322
Lead, copper, iron ...	None.
The quantity furnished was insufficient to determine the alkalinity, nitrates, or sulphates.	
(Signed) W. SEDGWICK SAUNDERS, M.D.	

LABORATORY, 13, QUEEN STREET, CHEAPSIDE
13th April 1881.

No. 2.

Analysis of Water.

Madras Well near the engine-shed, South Indian Railway.—Well 30 feet deep, bored through hard morum.
Sample in a small bottle, consisting of about 8 ounces of a yellowish colored water, with much flocculent matter, and strongly impregnated with the smell of sulphuretted hydrogen gas.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit ...	27.0
Soluble salts in residue at 212° Fahrenheit ...	19.1
Chlorine ...	04.2
Chlorine (expressed as chloride of sodium) ...	06.9
Or as parts { 00.25 Free (or saline) ammonia ...	00.0175
per million. { 00.66 Albuminoid ammonia (organic matter) ...	00.0462
Iron, copper, lead ...	None.
Quantity insufficient to do more.	

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
14th April 1881.

No. 3.

Analysis of Water.

Vickravandi Station of South Indian Railway.—Well 22 feet deep, sunk through sand.
Sample contained in two wine bottles, each holding about 20 fluid ounces. Water bright and colourless, but smelt slightly of sulphuretted hydrogen.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit ...	40.0
Soluble salts in residue at 212° ...	27.
Hardness (expressed as carbonate of lime) ...	15.5
Permanent hardness ...	06.5
Alkalinity (expressed as carbonate of lime) ...	14.5
Chlorine ...	04.7
Chlorine (as chloride of sodium) ...	07.7
Nitrates (expressed as nitric acid) ...	02.8
Sulphates (expressed as sulphuric acid) ...	00.4
Or as parts { 00.06 Free (or saline) ammonia ...	00.0042
per million. { 00.18 Albuminoid ammonia (organic matter) ...	00.0126
Iron, copper, lead.	

(Signed) W. SEDGWICK SAUNDERS, M.D.

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LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
19th April 1881.

No. 4.

Analysis of Water.

St. Thomas's Mount Station of South Indian Railway.—Well 23 feet 3 inches deep, bored through hard morum.

Water contained in two wine bottles, one sample bright and colourless, the other having a dirty sediment, with a loose cork floating about, traces of sulphuretted hydrogen in each.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit ...	70.
Soluble salts in residue at 212° ...	48.5
Hardness (expressed as carbonate of lime) ...	19.4
Permanent hardness ...	08.1
Chlorine ...	15.7
Chlorine (expressed as chloride of sodium) ...	25.8
Or as parts { 00.06 Free (or saline) ammonia ...	00.0042
per million. { 00.07 Albuminoid ammonia (organic matter) ...	00.0049
Iron, lead, copper ...	None.
(Signed) W. SEDGWICK SAUNDERS, M.D.	

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
20th April 1881.

No. 5.

Analysis of Water.

Gudurancheri Station, South Indian Railway.—Well 22 feet 6 inches deep, bored through hard morum. Water contained in two wine bottles. Samples very dirty and of a brownish peaty colour.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit ...	21.0
Soluble salts in residue at 212° ...	09.0
Hardness (expressed as carbonate of lime) ...	06.2
Permanent hardness (do. do.) ...	04.8
Total alkalinity (do. do.) ...	05.2
Alkalinity of the soluble salts (expressed as carbonate of soda) ...	Nil.
Chlorine ...	01.4
Chlorine (expressed as chloride of sodium) ...	02.3
Nitrates (expressed as nitric acid) ...	02.3
Sulphates (expressed as sulphuric acid) ...	Traces.
Or as parts { 00.03 Free or saline ammonia ...	00.0021
per million. { 00.05 Albuminoid ammonia (organic matter) ...	00.0035
Lead, iron, copper ...	None.
(Signed) W. SEDGWICK SAUNDERS, M.D.	

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
29th April 1881.

No. 6.

Analysis of Water.

Chingleput Station, South Indian Railway.—Well 28 feet deep, bored through rock. The water was contained in two wine bottles. One sample was very dirty and peaty coloured, the other quite bright and colourless.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit ...	91.0
Soluble salts in residue at 212° ...	77.0
Hardness (expressed as carbonate of lime) ...	15.0
Permanent hardness (do. do.) ...	06.5
Total alkalinity of water (do. do.) ...	10.3
Alkalinity of soluble salts (expressed as carbonate of soda) ...	None.
Chlorine ...	19.3
Chlorine (expressed as chloride of sodium) ...	31.8
Nitrates (expressed as nitric acid) ...	17.5
Sulphates (expressed as sulphuric acid) ...	08.6
Or as parts per { 00.03 Fine (or saline) ammonia ...	00.0021
million. { 00.08 Albuminoid ammonia (organic matter) ...	00.0056
Iron, lead, copper ...	None.
(Signed) W. SEDGWICK SAUNDERS, M.D.	

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
5th May 1881.

No. 7.

Analysis of Water.

Acharapakum Station of South Indian Railway.—Well 14 feet deep, sunk in black stiff clay and hard morum.
Two samples contained in wine bottles, each holding about 20 ounces, water bright and colourless.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	43.0
Soluble salts in residue at 212° Fahrenheit	15.0
Hardness (expressed as carbonate of lime)	09.0
Permanent hardness (do. do.)	05.5
Total alkalinity (do. do.)	23.0
Alkalinity of soluble salts (expressed as carbonate of soda)	None.
Chlorine	04.3
Chlorine (expressed as chloride of sodium)	07.0
Nitrates (expressed as nitric acid)	02.0
Sulphates (expressed as sulphuric acid)	01.7
Or as parts per { 00.03 Free (or saline) ammonia	00.0021
million. { 00.08 Albuminoid ammonia (organic matter).	00.0056
Iron, lead, copper	Traces of iron only.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
9th May 1881.

No. 8.

Analysis of Water.

Tindivanam Station of South Indian Railway.—Well 28 feet deep, sunk in decayed rock.
Samples were contained in two wine bottles holding about 20 ounces each, water cloudy, with a flocculent deposit.

Details.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	79.8
Soluble salts in residue at 212°	51.4
Hardness (expressed as carbonate of lime)	20.4
Permanent hardness (do. do.)	05.3
Total alkalinity (do. do.)	19.4
Alkalinity of soluble salts (expressed as carbonate of soda)	None.
Chlorine	12.4
Chlorine (expressed as chloride of sodium)	20.4
Nitrates (expressed as nitric acid)	14.0
Sulphates (expressed as sulphuric acid)	04.4
Or as parts per { 00.06 Free (or saline) ammonia	00.0042
million. { 00.22 Albuminoid ammonia (organic matter).	00.0154
Iron, copper, lead	Faint traces of iron only.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
12th May 1881,

No. 9.

Analysis of Water.

Villupuram Station of South Indian Railway.—Well 28 feet 3 inches deep, sunk in a stiff clayey soil, sample bright and colourless, consisting of about 30 ounces, contained in two wine bottles.

Details.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	58.7
Soluble salts in residue at 212°	29.4
Hardness (expressed as carbonate of lime)	16.0
Permanent hardness (do. do.)	01.7
Total alkalinity (do. do.)	22.0
Alkalinity of soluble salts (expressed as carbonate of soda)	Traces.
Chlorine	11.5
Chlorine (expressed as chloride of sodium)	18.9
Nitrates (expressed as nitric acid)	03.0
Sulphates (expressed as sulphuric acid)	04.9
Or as parts per { 00.09 Free (or saline) ammonia	00.006
million. { 00.04 Albuminoid ammonia (organic matter).	00.003
Iron, lead, copper	Traces of iron only.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
13th May 1881.

No. 10.

Analysis of Water.

Panruti Station of South Indian Railway.—Well 23 feet 6 inches deep, sunk through brick earth and stiff clay.
Samples bright and colourless, and contained in two wine bottles, each holding about 20 ounces.

Details.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	45.8
Soluble salts in residue at 212°	28.0
Hardness (expressed as carbonate of lime)	12.4
Permanent hardness (do. do.)	01.0
Total alkalinity (do. do.)	23.1
Alkalinity of soluble salts (expressed as carbonate of soda)	03.7
Chlorine	07.1
Chlorine (expressed as chloride of sodium)	11.7
Nitrates (expressed as nitric acid)	01.5
Sulphates (expressed as sulphuric acid)	04.9
Or as parts { 00.03 Free (or saline) ammonia	00.002
per million. { 00.06 Albuminoid ammonia (organic matter)	00.004
Iron, lead, copper	None.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
16th May 1881.

No. 11.

Analysis of Water.

Cuddalore Old Town Station, South Indian Railway.—Well 19 feet deep, sunk in black clay.
These samples were very foul and smelt strongly of sulphuretted hydrogen gas.

Details.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	64.7
Soluble salts in residue at 212°	47.9
Hardness (expressed as carbonate of lime)	07.4
Permanent hardness (do. do.)	01.3
Total alkalinity (do. do.)	19.2
Alkalinity of soluble salts (expressed as carbonate of soda)	02.6
Chlorine	20.9
Chlorine (expressed as chloride of sodium)	34.4
Nitrates (expressed as nitric acid)	Traces.
Sulphates (expressed as sulphuric acid)	05.7
Or as parts { 00.00 Free (or saline) ammonia	00.000
per million. { 00.20 Albuminoid ammonia (organic matter)	00.014
Lead, iron or copper.	Insufficient water sent to determine.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
18th May 1881.

No. 12.

Analysis of Water.

Porto Novo Station of South Indian Railway.—Well 16 feet 9 inches deep, sunk in sand with slight proportion of brown clay and fine sand with black clay.
Sample contained in two wine bottles. Water cloudy with much sediment and of a faint oily odour.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	86.8
Soluble salts in residue at 212°	72.8
Hardness expressed as (carbonate of lime)	15.5
Permanent hardness (do. do.)	06.2
Total alkalinity (do. do.)	14.0
Alkalinity of soluble salts (expressed as carbonate of soda)	Traces.
Chlorine	12.9
Chlorine (expressed as chloride of sodium)	21.2
Nitrates (expressed as nitric acid)	01.3
Sulphates (expressed as sulphuric acid)	21.4
Or as parts per { 00.03 Free (or saline) ammonia	00.002
million. { 00.20 Albuminoid ammonia (organic matter)	00.014
Iron, lead, copper	None.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
20th May 1881.

No. 13.

Analysis of Water.

Satur Station of South Indian Railway.—Well 20 feet deep, sunk in a cotton soil and decomposed gneiss.
Sample in two wine bottles. Water clear and free from colour and smell.

Details.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	56.3
Soluble salts in residue at 212°	26.0
Hardness (expressed as carbonate of lime)	08.8
Permanent hardness (do. do.)	01.0
Total alkalinity (do. do.)	23.8
Alkalinity of soluble salts (expressed as carbonate of soda)	07.4
Chlorine	03.0
Chlorine (expressed as chloride of sodium)	06.26
Nitrates (expressed as nitric acid)	04.0
Sulphates (expressed as sulphuric acid)	04.4
As parts per { 00.05 Free (or saline) ammonia	00.003
million. { 00.06 Albuminoid ammonia	00.004
Lead, iron, copper.—Insufficient water sent to determine.	

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
27th May 1881.

No. 14.

Analysis of Water.

Maniyachi Station of South Indian Railway.—Well 38 feet deep, sunk through cotton soil, and decomposed gneiss. Sample contained in two wine bottles. Water of a yellowish colour with clayey deposit.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	492.1
Soluble salts in residue at 212°	403.9
Hardness (expressed as carbonate of lime)	64.6

	Grains per Gallon.
Permanent hardness (expressed as carbonate of lime)	23.2
Total alkalinity (do. do.)	11.2
Alkalinity of soluble salts (expressed as carbonate of soda)	02.8
Chlorine	68.0
Chlorine (expressed as chloride of sodium)	112.0
Nitrates (expressed as nitric acid)	03.5
Sulphates (expressed as sulphuric acid)	38.0
Or as parts per { 00.03 Free (or saline) ammonia	00.002
million. { 00.00 Albuminoid ammonia (organic matter)	00.007
Lead, iron, copper	None.

(Signed) W. SEDGWICK SAUNDERS, M.D.

LABORATORY, 13, QUEEN STREET, CHEAPSIDE,
28th May 1881.

No. 15.

Analysis of Water.

Tuticorin Station of South Indian Railway.—Well 18 feet 6 inches deep, sunk through sand
Sample contained in two wine bottles. Water opaque with whitish flocculent suspended matter.

Details of Analysis.

	Grains per Gallon.
Total solids dried at 212° Fahrenheit	216.3
Soluble salts in residue at 212°	150.0
Hardness (expressed as carbonate of lime)	30.0
Permanent hardness (do. do.)	21.6
Total alkalinity (do. do.)	22.5
Alkalinity of soluble salts (expressed as carbonate of soda)	04.2
Chlorine	82.7
Chlorine (expressed as chloride of sodium)	136.2
Nitrates (expressed as nitric acid)	15.5
Sulphates (expressed as sulphuric acid)	17.1
Or as parts per { 00.05 Free (or saline) ammonia	00.003
million. { 00.12 Albuminoid ammonia (organic matter)	00.003
Lead, iron, copper	None.

(Signed) W. SEDGWICK SAUNDERS, M.D.

NAME OF STATION.	Number of Sample.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Madrass Wall near Tank-house.	24.0	27.0	40.0	70.0	21.0	91.0	43.0	79.8	58.7	45.8	64.7	86.8	56.3	492.1	216.3
Madrass Wall near Engine-shed.	16.1	19.0	27.0	48.5	9.0	77.0	15.0	51.4	29.4	28.0	47.9	72.8	26.0	403.9	150.0
Vickravandi.	9.0	..	15.5	19.4	6.2	15.0	9.0	20.4	16.0	12.4	7.4	15.5	8.8	64.6	30.0
Saint Thomas Mount.	4.7	..	6.5	8.1	4.8	6.5	5.5	5.3	1.7	1.0	1.3	6.2	1.0	23.2	21.6
Gduduvancheri.	..	..	14.5	..	5.2	10.3	23.0	19.4	22.0	23.1	19.2	14.0	23.8	11.2	22.5
Ohingaleput.	..	..	..	..	None.	None.	None.	None.	Traces.	3.7	2.6	Traces.	7.4	2.8	4.2
Acharapakkam.	..	..	..	..	None.	None.	None.	None.	Traces.	7.1	20.9	12.9	3.8	68.0	82.7
Tindivanam.	..	..	..	..	None.	None.	None.	None.	Traces.	11.5	34.4	21.2	6.26	112.0	136.2
Villupuram.	..	..	..	..	None.	None.	None.	None.	Traces.	1.5	3.0	1.3	4.0	3.5	15.5
Panruti.	..	..	..	..	Traces.	8.6	1.7	4.4	4.9	4.9	5.7	21.4	4.4	38.0	17.1
Cuddalore Old Town.	..	..	..	..	Traces.	0.021	0.021	0.042	0.06	0.02	0.00	0.02	0.03	0.02	0.03
Porto Novo.	..	..	..	..	Traces.	0.021	0.021	0.042	0.06	0.02	0.00	0.02	0.03	0.02	0.03
Satur.	..	..	..	..	Traces.	0.021	0.021	0.042	0.06	0.02	0.00	0.02	0.03	0.02	0.03
Mantychi.	..	..	..	..	Traces.	0.021	0.021	0.042	0.06	0.02	0.00	0.02	0.03	0.02	0.03
Tuticorin.	..	..	..	..	Traces.	0.021	0.021	0.042	0.06	0.02	0.00	0.02	0.03	0.02	0.03

Solid Salts in residue, dried at 212° Fahrenheit ..
 Soluble Salts in residue, dried at 212° Fahrenheit ..
 Hardness, expressed as Carbonate of Lime (Ca CO₃) ..
 Permanent hardness expressed as Carbonate of Lime (Ca CO₃) ..
 Total alkalinity expressed as Carbonate of Lime (Ca CO₃) ..
 Alkalinity of soluble Salts as Carbonate of Soda (Na₂CO₃) ..
 Chlorine (Cl) ..
 Chlorine expressed as Chloride of Sodium (Na Cl) ..
 Nitrates expressed as Nitric Acid (N₂O₅) ..
 Sulphates expressed as Sulphuric Acid (H₂SO₄) ..
 Free or saline ammonia (NH₃) expressed in grains per gallon ..
 Albuminoid, or organic ammonia ..
 Free or saline ammonia (NH₃) expressed in parts per million ..
 Albuminoid, or organic ammonia ..

No. 43.

ORDER THEREON, 16th February 1882, No. 121 R.

COMMUNICATED to the Consulting Engineer for Railways, whose attention is called to paragraph 2 of the despatch, the subject of which should be reported on.

(True Extract.)

(Signed) J. SHAW-STEWART, Colonel, R.E.,
 Joint Secy. to Govt., P.W.D.,
 Railway Branch.

To the Consulting Engineer for Railways.

Exd. S. T. Austin.
 Spare Copies



RAILWAY.

Gobt. of (1882) Madras
PUBLIC WORKS.

To

THE CONSULTING ENGINEER
FOR RAILWAYS.

Dated February, 16th.

Issued.

Recd.

Encl.

G.O., 16th February 1882, No. 121 R.

FEBRUARY.

Nos. 42-43.

Analysis of waters used on the South Indian Railway Lines.—Despatch from the Secretary of State forwarding a report on the — and requesting to know whether any advantage would be likely to arise from a trial of the substances referred to in the report as a means of protection to boilers, communicated to the Consulting Engineer for Railways for report.



B / No 906 W of 5 April 1882
P.W. Dept.
To

The Under Secy of
State for India

Sir,

In compliance with
Lord Cranbrook's Des-
patch, No. 14, Public, of
24th Decr. 1879, I audi-
enced to forward in
duplicate a list of Des-
patches received from
Her Majesty's Secy of
State which remain
unanswered in the
P.W. Dept. at the end of
the quarter ending 31st.
March 1882.

Despatch with
2 Enclosures
12/4/82

Cu
Shi

4.4.82
Sg. W.
P.70

List of Despatches received from the Rajah's Secy of State for India, which remain unanswered at the end of the year ending 31 March '82.

13. - This list is submitted in accordance with instructions conveyed in Secy of State's Public Despatch to the Govt. of Madras, No. 14, of 24th Decr. 1879.

No. of Date Date of
of Despatch Receipt

S. A. 16 24-7-81

23-6-81

Subject

Requesting to be furnished with a report the S.E., Mt. Circle has been of the working of the steamer launch for the year ended 31 March '82. (vide f.b. no. 121 R. of 6.2.82)

Remarks.

70 112 13.2.82 Para 2. Analyser with some samples of water used for domestic purposes

19.1.82

Communicated to the C.E. for Ryo. for reports (vide f.b. no. 121 R. of 6.2.82)

Th. J. R.

4.4.82
Th. J. R.

B W 906 w d 5 April/12