

## GOVERNMENT NOTIFICATION.—No. 209.

The following Preliminary Report on the Sanitary Condition of Hongkong was laid before the Legislative Council on the 10th instant, and is published.

By Command,

J. H. STEWART LOCKHART,  
Colonial Secretary.

Colonial Secretary's Office, Hongkong, 11th April, 1902.

## PRELIMINARY REPORT ON THE SANITARY CONDITION OF HONGKONG.

PUBLIC WORKS OFFICE,  
HONGKONG, 10th April, 1902.

SIR,—In accordance with instructions, received through the Crown Agents for the Colonies, from the Secretary of State for the Colonies, I have made a preliminary examination into the sanitary condition of Hongkong, from an engineering point of view, and I have the honour to submit the following preliminary report thereon.

Report—  
preliminary.

2. In the various despatches which have been sent to me for my instruction and guidance, mention is made of the possible connection between the epidemic of Plague and its recurrence, and the sanitary works, which have been carried out since my last visit, more especially the sewerage-works.

Reference to  
effect of  
works on  
Plague.

3. Inasmuch as Professor SIMPSON, M.D., F.R.C.P., has been appointed to investigate the question of Plague, it seems to me to be unnecessary for me to enter into this question; for it belongs rather to the province of the Medical man, than to that of the Engineer. Suffice it, therefore, to say that, up to the present, no evidence has reached me which leads to the belief that any engineering work, which has been carried out, has occasioned or even contributed to, the outbreak of plague, or to its periodical recurrence. Some recommendations, which I made in 1882, have not indeed been carried out, and the result of this inaction will be better described by Professor SIMPSON, than by myself. The reasons for the non-compliance with the said recommendations, will be discussed later on.

Cause of  
Plague being  
referred to  
Professor  
SIMPSON,  
no reference  
will be made  
to it in this  
report.

4. In this preliminary report, I propose to confine myself mainly to statement of fact, discussing briefly the work that has been carried out since I left Hongkong in August, 1890. It will, I think, be better to relegate nearly entirely detailed recommendations as to the works to be constructed, and measures to be adopted in future, to a second report, to be written after I have had time to investigate and consider the subject, thoroughly.

Present state  
of works  
only treated  
in this  
report.  
Detailed  
recommend-  
ations as to  
future  
programme  
defined.

5. The branches of the sanitary question which come within my province may be arranged under the following heads:—

Division of  
subject into  
heads.

- (1.) Water-supply.
- (2.) Sewerage, including House-sewers.
- (3.) Drainage or removal of rain-water.
- (4.) Scavenging and cleansing.
- (5.) House-construction and abatement of overcrowding.

I propose to treat these questions *seriatim*. Perhaps, however, before so doing, it will be well, in order to avoid repetition, to give a brief account of my professional connection with this Colony.

6. In 1881, I was directed by the Secretary of State for the Colonies to proceed to Hongkong and report to him, and "not to the Governor of the Colony," as to the sanitary condition of Hongkong. This report was printed and presented to both Houses of Parliament, in 1882. An appendix was also printed, but was not laid before Parliament.

Past history  
of my pro-  
fessional  
connection  
with Colony,  
1881-82.

7. From 1882 to 1889 I had no further relations with this Colony. The late Sir ROBERT RAWLINSON, K.C.B., Past President, Inst. C.E., was Consulting Engineer for the Taitam Water-works, the construction of which I had strongly recommended in 1882. In 1889, the Taitam reservoir, the filter-beds and service-reservoir were finished; but no provision had been made for the improvement of the

From 1882  
to 1889  
origin of  
visit in 1889.

distributary system of pipes, to meet the largely increased water-supply. Sir ROBERT RAWLINSON was requested to visit Hongkong, and report on the water-supply, and other matters. On account of his advanced years and his other avocations, he felt it impossible so to do, and I was appointed in his stead, to go out and arrange for the completion of the water-supply system, the necessary pipes for which had already been indented for from England. During my absence, however, Mr. PRICE had submitted a sewerage-scheme, prepared by Mr. F. COOPER, C.E., C.M.G. I was also instructed to thoroughly investigate the same and prepare a final scheme for adoption.

Completion of water-works commenced in 1889.

8. On my arrival in 1889, I found that Mr. PRICE had retired and had been succeeded by Mr. S. BROWN, as Director of Public Works. Mr. COOPER, though originally appointed for sanitary works, was acting as Assistant to the Director of Public Works. My first work was to make arrangements for laying the distributary pipes, which were shortly to arrive from England, so that the benefits of the new water-supply might be realised as soon as possible.

Water and Sewerage Departments constituted as an independent department.

9. The Government decided, for reasons that I need not now state, that the water and sewerage works were to be a separate and independent Department, under Mr. F. COOPER, as Resident Engineer. It became, therefore, my duty to organise this newly-created Department. Stores and workshops were provided and a complete system of accounts was inaugurated. Mr. A. M. QUILL and afterwards Mr. CROOK were appointed Assistant Engineers in the new Department.

Pipe-laying commenced in 1889.

10. The work of laying the new mains, and of improving the old distributary system was carried on with vigour. Arrangements were also made for extending the water-supply to the Peak District, and to other districts above the level of the conduits. The water-supply of Kowloon was also studied.

Sewerage scheme considered.

11. At the same time, I examined the sewerage scheme, which had been prepared by Mr. COOPER. Whilst approving in general terms Mr. COOPER'S design, I made, after consultation with him, certain modifications, tending to simplification and economy. The revised Scheme was described in three reports which I submitted to Government, doubtless after consideration and approval by the Sanitary Board, of which I was then a member. I believe that the plans of the whole sewerage system were not actually completed and submitted, during my stay in Hongkong, but all the leading lines of main sewers, such as those in Queen's Road, were studied by Mr. COOPER, and by myself. Mr. XAVIER, the only Officer of the Public Works Department, now in the service, who was with me in 1890, states that the sewerage of the High Level District was commenced during my visit of 1890. Diameters, levels and gradients were determined, and the positions of the out-falls were fixed, in accordance with the Praya Reclamation, then commenced. The complete plans were subsequently submitted to, and approved by me, after my return to England. Practically little or no sewerage-work was carried out, during my stay in Hongkong. I was appointed Consulting Engineer to the Water and Drainage Department.

Appointment of Mr. COOPER as Director of Public Works. Recommendation to keep the Water and Sewerage Departments separate.

12. On the death of Mr. S. BROWN in 1891, the appointment of Director of Public Works was offered to Mr. COOPER. I was asked by the Colonial Office whether this arrangement was consistent with the efficient construction of the water- and drainage-works, for which I was responsible as Consulting Engineer. Considering that the works had made good progress, and that the services of two expert assistants were available, I replied that I saw no cause for withholding so important promotion, from Mr. COOPER. I recommended, however, that the Water and Drainage Departments should continue to be an Independent Department, Mr. COOPER being Director of Public Works and Resident Engineer, in order that, should Mr. COOPER be succeeded by an Engineer, not having the special qualifications, which he possessed in so eminent a degree, the Department might be again rendered independent, and placed under the direction of a competent Specialist.

13. Shortly after Mr. COOPER's appointment as Director of Public Works, feeling that the work, which I was called upon to perform, no longer justified the payment of an annual salary, I resigned the post of Consulting Engineer.

Resignation of my appointment of Consulting Engineer.

Since that time, I have had no regular communication with this Colony. One or two matters have indeed been referred to and reported on by me, notably a project for increasing the water-supply, the new water-supply for Kowloon, with requisitions for stores, appointments and other minor matters. I may here add that the question of insanitary dwellings did not come before me, in 1899-1900. I was fully occupied with other matters.

#### WATER SUPPLY.

14. The present scarcity of water, which according to all rules of probabilities, may be expected to be prolonged for some time, renders it obvious that prompt steps should be taken to augment the present supply, and, what is yet more important, to take measures to prevent waste and extravagance. It would unduly delay the submission of this report, were I to attempt to make herein, any definite proposal, as to the works to be undertaken, for the definite augmentation of the water-supply, so as to meet the requirements of an increasing population. Before any reliable scheme can be submitted, surveys and other investigations must be made, which will occupy more time than I can now place at the disposal of the Colony. In this report, therefore, I will limit myself to suggesting works and operations which can be carried out promptly, and I shall merely indicate the general lines on which future extensions should be carried out, according to the evidence now before me.

Proposals for a final project to be deferred.

15. In a report, dated 9th May, 1896, Mr. F. COOPER, C.E., C.M.G., recommended the immediate execution of certain works. He also described certain other works, the execution of which might be deferred to some future date. In a report dated 17th September, 1896, I supported Mr. COOPER's recommendations.

Works that have been carried out since 1900.

16. In his report of 9th May, 1896, Mr. COOPER made the following recommendations, as to the works required to meet present requirements:—

Mr. COOPER's recommendations in 1896. P. 17, paras. 134-138, Report of 1896.

- (a.) Catch-water channels, in connection with Taitam Reservoir, bringing in water from adjacent Gathering-grounds, not draining directly to the reservoir.
- (b.) A reservoir to contain 33 million gallons, with a long catch-water channel, at Wong-nei-chong Gap.
- (c.) Additional filter-beds at Bowen Road; with a service-reservoir, so designed as to afford an additional supply, by pumping, to the Hill District.
- (d.) A service-reservoir at the Peak.

17. The whole of these works are now completed. The hydraulic motor and pumps, at Bowen Road, have been erected, and the rising-pipes have been laid. A second service-reservoir is under construction, near to the summit of Mount Gough. A service-reservoir has also been constructed, at an elevation of 650 feet, to supply the upper zone of the City. This reservoir replaces that originally constructed, near Belilios Terrace, a site now occupied by buildings.

Proposed works have been executed with additions.

18. The Taitam dam has also been raised, so as to give an additional depth of 12' 6", thus increasing its capacity from 305 millions of gallons to 406 millions. This work was in hand, when Mr. COOPER reported, and was finished in 1897.

Increased capacity of Taitam Reservoir.

19. Table I shews the effect of these works. The total supply for the year from all sources—Pokfoolum, Taitam, from collection from the streams, intercepted by the conduits, and from all other sources—has been increased from 1,109 millions of gallons in 1892, to 1,287 millions in 1901. The consumption per head per day

Effect of new works.

has varied between 12.2 and 17 gallons per head per day, on the average of the whole year. Only on three occasions, namely, in 1892, (when the distributary system was hardly complete), and in 1897 and 1898, has it been found practicable to continue the supply, without resorting to restriction.

TABLE I.

*Shewing Annual Supply afforded by Water-works compared with Rainfall arranged by Calendar Years.*

Year.	Rainfall at Observatory.	Total nett supply given during year in millions of gallons.	Estimated Population in City and Hill Districts.	Consumption of Water per head per day as average of whole year.	Number of Days during which a constant supply was given.	Consumption of Water per head per day during constant supply.	Consumption of Water per head per day during intermittent supply.
1892	90.97	1,109	180,000	16.8	366	16.8	—
1893	99.95	1,098	185,000	16.3	304	17.6	9.8
1894	104.25	1,042	190,000	15.0	273	16.3	11.1
1895	45.83	864	195,000	12.2	151	14.6	10.5
1896	72.79	949	180,000	14.4	263	16.7	8.7
1897	100.03	1,042	187,000	15.3	365	15.3	—
1898	57.02	1,133	196,000	15.8	365	15.8	—
1899	72.71	1,162	201,000	15.8	313	16.4	10.9
1900	73.71	1,281	207,000	17.0	352	17.0	—
1901	55.25	1,287	210,000	16.8	313	17.6	11.8

The effect of the new works has been to increase the gathering-ground by 54 per cent., the Reservoir accommodation by 36 per cent., and the effective water-supply by 26 per cent., whilst the population of the City and Hill Districts has increased by about 17 per cent.

The following statement shows the increase of storage and gathering-ground which has been made since 1892:—

*Gathering-ground and Storage in 1892 and 1901 compared.*

	1892.		1901.	
	Gathering-ground in acres.	Storage in millions of gallons.	Gathering-ground in acres.	Storage in millions of gallons.
Pokfoolum, .....	416	70	416	70
Taitam, .....	690	305	{ 690 403 103 89 }	406
Wongneicheong, .....	—	—		34
	1,106	375	1,701	510

NOTE.—The upper headed figures give the areas contributing direct, the lower are those intercepted by catch-water channels.

The supply has not, therefore, increased in proportion to the extension of the gathering-ground. The reason for this is that the waters of certain areas do not flow direct to the reservoirs, but are collected by catch-drains, which do not intercept the full quantity, during violent rain-storms.

A further reason is that the total supply, given in the text, includes a large quantity of water picked up, along the course of the conduits, and which therefore is only affected indirectly, by the storage. The area of these intercepted gathering-grounds is not included in the areas, given in the statement, because the supply from them, is only partially developed.

20. In addition to the works proposed by Mr. COOPER, for meeting the immediate wants of the City, works which have, as aforesaid, been fully carried out, he proposed other deferred works, for meeting the future wants of the Colony. These are:—

Further works proposed by Mr. COOPER.

- (a.) The construction of three new reservoirs within, and fed from, the existing Taitam gathering-ground. These are shewn on Drawing No. 7, accompanying Mr. COOPER'S Report of 1896. Sites Nos. 1 and 2, are on one of the tributary streams, above the existing reservoir and have a joint capacity of 110 millions of gallons, whilst that at site No. 3, is situated immediately below the by-wash of the same, and has a capacity of 20 millions of gallons.
- (b.) The construction of a reservoir, below Taitam, at site No. 4, having a capacity of 100 millions of gallons, and a new gathering-ground of 375 acres of which 128 acres is intercepted by the Taitam catch-water. As the level of this reservoir is but 180 feet, above O. D., the water, stored in it, would have to be pumped into Taitam.
- (c.) The construction of a small reservoir, in the bed of the Taitam stream, at a level of 108, having a capacity of 4 millions of gallons. This is to be merely a store-pond, to collect the dry-weather flow of the main Taitam stream, so that it may be pumped, with the water of Reservoir No. 4, into Taitam.
- (d.) The construction of a large storage-reservoir, in the Pokfoolum valley, below the existing dam. The waters of this were to be conducted to the lower zone of the City, by a special pipe. The capacity of this reservoir was to be 78 millions, and special filter-beds were to be constructed, in connection therewith.
- (e.) Raising the existing Pokfoolum dam, so as to increase its capacity by 23 millions of gallons.

None of these works are yet completed, and the small reservoir at No. 3 site, alone, is in hand.

21. The following would be the probable effect of the proposed works. The reservoirs, at sites Nos. 1, 2 and 3,\* are, practically, within the existing gathering-ground of Taitam reservoir. Their construction would not add to the total water-supply, due to the rain falling on, and flowing off from, the gathering-ground, but merely would render a greater proportion thereof available for use, by storing water that would flow to waste. The effect of these works would be practically the same as that which would be produced by increasing the capacity of the Taitam Reservoir, by further raising the dam, were it safe so to do.

Effect of deferred works as proposed, Taitam District.

22. When Mr. COOPER wrote his Report in 1896, he calculated, in accordance with previous experience, that the reservoirs on sites Nos. 1, 2 and 3, as well as the augmented Taitam dam would fill, even in a very dry season.† Subsequent events, however, have shewn that such is not the case.

As to the advisability of augmenting storage without increasing the gathering-ground.

\* No. 3 indeed will receive the water from a small additional catchment area, which now escapes the Taitam Reservoirs.

† On closer examination of Mr. COOPER'S report, it does not appear clear whether he considered that all these reservoirs would fill in a very dry season.

The Taitam Reservoir never filled in 1901. Consequently, the additional reservoirs would not have filled, and the water-supply for the water-year 1901-2, would not have been increased, by their construction, by a single gallon.

If, however, the new reservoirs had been filled during the water-year 1900-1 and kept full, up to the end of that water-year, then their contents would be a most valuable addition to the supply at the present season. But would they have been filled? I find from the Log-book that, although the rainfall for 1900-1901 was 75 inches, the Taitam Reservoir did not overflow, or at least, if it did, the quantity which escaped could not have been great. Unfortunately, there is no means of estimating, with even an approach to accuracy, the amount of water overflowing during any season. The only plan, therefore, is to ascertain the probable quantity which may be collected from a given area, with a given rainfall, from the results obtained during years in which there was *no* overflow. Again, the rainfall recorded at the Observatory has hitherto been assumed as the basis of all calculations, as to water-supply. Now, observations have been made at Taitam and Pokfoolum for a number of years, and it appears that the rainfall at Taitam is *not* always equal to that at the Observatory, but often greater. One has, therefore, to fall back on the assumption, not wholly scientifically warranted, that the rainfall at Taitam and at the Observatory, though not equal, are at least proportional. In other words, when a deficiency is recorded at the Observatory, there will be a proportional deficiency both at Taitam and Pokfoolum. Again, supposing that the rainfall observations, taken at the Taitam and Pokfoolum stations, are absolutely exact, it does not follow that they represent the rainfall, over the whole of the gathering-ground. The rainfall on the heights may be more or less than that on the relatively low ground, where the gauges are situated. Therefore all calculations based on rainfall observations, made at any one station, are, to say the least, open to doubt. The only facts that we can rely upon are that, during recent years, unusual droughts have occurred, and that during these droughts, a certain supply has been collected from given gathering-grounds.

Summary of conclusions with regard to Taitam system.

23. I have come, therefore, to the preliminary conclusion that, as regards the Taitam system, the construction of additional reservoirs, within and fed by the existing Taitam gathering-ground, will not appreciably augment the water-supply, simply because there was no overflow in the two successive water-years, 1899-1900 and 1900-1901. The only way in which additional storage could effect any improvement, would be to make it so large as to make it possible to carry forward a reserve-stock, from some previous year or years of superabundance.

Arrangement of statistics by calendar years misleading.

24. The arrangement of rainfall statistics and water-supply by calendar years, is misleading. The principal quantity of rain falls in May, June, July, August (*vide* Table II). In September, also, welcome rain may be expected, filling up reservoirs that may be already falling, and replenishing the streams that are intercepted, along the lines of conduit. September, therefore, may be included as a water-giving month. In the five months, May to September inclusive, water has to be stored, in order to maintain the supply, through the ensuing seven dry months, during which but little rain is to be expected. Most of the water, reaching the water-works, during the dry months, is rain that has been absorbed and stored by the soil, and which is percolating through it, to the various streams, which form the feeders of the reservoirs. Some also may come in the form of violent showers, when a large percentage of the rain-water runs off from the surface.

TABLE II.

Year.	MAY.		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		DECEMBER.		JANUARY.		FEBRUARY.		MARCH.		APRIL.		TOTAL.		GRAND TOTAL.			
	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.	Observatory.	Taiham.		
84-85,	9.04	13.97	11.03	13.54	14.95	18.81	10.81	14.95	15.37	14.10	13.33	3.44	3.00	1.35	1.35	1.35	1.35	0.87	0.96	2.70	2.35	2.47	2.37	14.36	14.00	25.51	25.40	81.84	83.73	
85-86,	4.86	4.24	31.36	10.62	14.12	27.87	31.25	5.84	5.46	8.47	8.71	2.91	1.53	1.50	1.50	1.50	2.01	1.90	1.54	3.14	2.59	1.78	5.67	1.66	16.33	12.66	99.86	100.17		
86-87,	1.78	10.15	10.62	28.24	24.03	9.08	9.15	3.00	3.65	5.72	47.20	2.81	1.70	0.00	0.00	0.00	8.43	8.70	1.89	2.19	2.95	3.57	5.64	4.94	20.55	22.97	76.37	70.26		
87-88,	2.05	3.10	5.47	12.68	15.24	13.15	15.08	10.96	10.79	43.71	1.83	2.03	3.20	0.79	0.35	0.85	0.18	0.10	3.97	4.11	10.43	11.71	6.98	7.74	23.20	26.86	68.91	77.34		
88-89,	19.53	16.76	23.86	10.53	10.13	13.35	19.45	6.41	7.90	73.67	8.19	4.55	0.77	1.54	0.09	0.18	0.72	0.00	0.72	1.48	2.49	1.27	12.27	0.00	28.59	39.26	89.19	89.19		
89-90,	48.84	0.00	0.00	0.00	0.00	0.00	0.00	11.86	0.00	90.07	8.72	8.72	0.00	0.00	0.00	0.00	2.59	0.00	0.00	0.00	4.15	1.96	1.96	1.02	20.42	0.00	113.49	0.00		
90-91,	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97	11.43	13.97
91-92,	28.00	13.97	31.86	21.32	30.37	23.82	33.10	23.02	18.05	16.79	13.45	12.90	11.43	12.37	12.60	10.64	95.18	7.43	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92-93,	8.57	6.81	10.54	34.37	35.41	35.94	10.79	12.52	15.32	7.01	9.94	10.61	7.82	7.05	8.07	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
93-94,	16.13	20.95	21.86	7.09	10.57	7.74	21.22	20.25	23.26	8.72	14.22	9.15	15.04	18.82	14.54	68.21	97.11	6.53	17.87	17.65	21.36	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
94-95,	20.01	22.88	16.24	16.54	22.87	14.87	9.47	10.13	9.68	16.53	20.80	15.52	16.10	5.34	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
95-96,	5.64	6.72	3.65	4.97	8.24	4.44	18.87	18.39	18.46	6.13	7.75	7.06	3.96	6.56	5.23	39.57	47.06	19.17	0.90	0.60	0.47	0.32	0.64	0.18	0.00	0.00	0.00	0.00	0.00	
96-97,	1.15	1.35	0.65	18.65	18.00	13.67	12.42	11.67	10.80	3.20	5.57	3.62	9.99	12.51	9.71	47.39	49.10	6.45	7.91	7.10	5.92	2.97	2.67	1.00	1.30	2.76	1.88	2.36	3.74	
97-98,	14.86	16.68	17.08	20.35	25.20	22.05	5.57	4.45	8.45	25.55	33.19	19.87	8.34	9.25	2.75	77.67	88.77	10.14	6.42	8.32	4.39	7.32	7.57	5.31	4.48	0.38	0.37	1.16	1.11	
98-99,	3.70	6.18	3.72	14.45	15.87	17.31	7.05	9.40	9.90	8.81	12.85	5.30	6.19	7.65	42.20	41.10	10.90	6.72	10.12	8.48	0.79	1.01	0.55	0.02	0.02	0.02	0.02	0.02	0.02	
99-00,	7.16	9.66	5.76	18.68	19.40	17.06	10.13	13.61	11.31	19.98	24.54	20.41	6.30	9.47	7.45	66.55	76.68	14.90	0.88	0.08	0.26	1.64	2.66	1.76	1.79	1.75	2.14	0.77	0.98	
00-01,	9.31	14.53	9.41	26.32	24.25	26.04	10.13	17.00	12.70	6.69	6.72	4.91	4.31	4.85	56.66	79.35	18.81	1.61	3.84	1.31	5.78	13.08	7.65	0.41	0.69	0.77	0.41	0.69		
Observatory:	213.86	292.92	17.23	13.72	333.41	128.91	143.11	143.11	112.21	112.21	89.40	26.93	10.72	10.72	10.72	10.72	33.56	24.79	33.56	43.66	43.66	43.66	99.28	334.45	334.45	1446.66	1446.66	1446.66		
Average over 17 years:	12.58	17.23	1.01	0.79	19.61	7.70	8.35	8.35	6.59	6.59	5.23	1.59	0.63	0.63	0.63	0.63	1.97	1.46	1.97	2.57	2.57	2.57	5.81	19.68	19.68	85.10	85.10	85.10		
Taiham:	122.73	220.18	148.02	147.89	148.02	147.89	147.89	147.89	147.89	147.89	147.89	147.89	147.89	147.89	147.89	147.89	16.62	10.68	16.62	15.53	15.53	15.53	56.23	310.28	310.28	960.19	960.19	960.19		
Average over 10 years:	12.27	22.02	14.80	14.79	14.80	14.79	14.79	14.79	14.79	14.79	14.79	14.79	14.79	14.79	14.79	14.79	1.66	1.07	1.66	1.56	1.56	1.56	5.65	21.03	21.03	60.05	60.05	60.05		
Pokfulam:	154.38	374.00	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	314.14	27.51	12.35	27.51	27.51	27.51	27.51	36.41	30.26	30.26	261.05	261.05	261.05		
Average over 15 years:	10.29	24.93	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	20.95	1.82	0.82	1.82	1.82	1.82	1.82	4.43	15.89	15.89	46.09	46.09	46.09		

\* Gauge removed during this period.

25. I therefore recommend that, for the future, water-supply statistics be arranged by the "water-year" extending from 1st May to 30th April inclusive. Table III gives the statistics of the years 1895-96 to 1900-01 arranged in this manner.

Arrangement of statistics by the "water-years" recommended.

TABLE III.

*Shewing Annual Supply afforded by Water-works compared with Rainfall.  
Arranged by Water-year.*

Year.	Rainfall at Observatory for water-year.	Total nett supply given during year in millions of gallons.	Average Estimated Population in City and Hill Districts.	Consumption of Water per head per day as average of whole year.	Number of Days during which a full supply was given.	Consumption of Water per head per day during constant supply.	Consumption of Water per head per day during intermittent supply.	Remarks.
		<i>Millions.</i>						
1895-6	53.84	805.5	190,000	11.6	139	15.5	9.6	
1896-7	67.70	1,004.3	187,000	14.7	351	14.9	—	
1897-8	99.18	1,087.9	190,000	15.7	365	15.7	—	
1898-9	55.58	1,121.9	198,000	15.5	335	16.1	9.5	
1899-0	76.07	1,203.5	204,000	16.2	343	16.4	10.8	
1900-1	76.25	1,309.4	209,000	17.1	352	17.3	—	

26. The Water Authority therefore should, in future, report to Government annually, on two dates, namely, as soon as practicable after 1st October, and again at or after 1st May. The first report should state the stock in hand, on 1st October, and the maximum stock, in the reservoirs, during the wet season and at its conclusion. The measures of restriction, which should be taken, during the coming dry season, should also be set forth.

Return to be made in accordance with water-years.

The report, rendered as soon as practicable after 1st April, should set forth, in full, the operations which have taken place during the elapsed water-year, namely, the quantity of water collected from various sources, during the past water-year, and the total supply given to the City and Hill Districts with the balance, carried forward. In short, all the information, which is now given in the (calendar) annual reports of the Water Authority, should be recorded, but it should be arranged by the water-year and not by the calendar-year. The annual report of the Water Authority may contain a resumé of the results of the calendar-year, but this return will only be of use with regard to financial matters.

27. The regular submission of these two reports, will call the attention of the Water Authority and of the Government, to the situation, as regards water-supply. It will be seen whether the stock in hand will probably suffice to carry on the supply unrestricted, during the coming dry season, or whether restriction will be necessary, and if so, when and how it should be applied.

Object of these reports.

For example, if the reservoirs have not filled, by the end of September, and if their level is falling, at that date, it will be well to apply severe restriction and continue it until they are full, or until sufficient water is in stock, to maintain an unrestricted supply with safety, during the coming dry season. If welcome rain should fall, during the dry season, then the constant supply may be re-established, forthwith. It will be better to apply restriction, during the wet season, when, even in dry years, the natural moisture is abundant, than to defer it until the winter months, when the greatest commercial activity prevails in the City, and when the demand for water is greatest. In short, at the end of September the Water Authority should submit a budget, setting forth the stock of water in hand, with



an estimate of the probable receipts from rain and the estimated expenditure, during the coming dry months, and at the end of the water-year he should submit a balance-sheet, shewing the actual transactions of the past water-year.

Estimate of amount of storage required to maintain a supply equal to average of a cycle.

28. The following statement, arranged in debtor and creditor form, serves to give a general idea of the amount of storage which must be provided in order to maintain a uniform supply equal to that due to the average rainfall of a long cycle. Or, in other words, to carry forward, from years of abundance, to supplement deficiencies during years of drought. It is evident that the maximum supply that can be maintained, at a constant rate, over a given cycle of years, is that due to the average rainfall, during the said cycle. To do this there must be sufficient storage in order that there shall be no overflow, even in the wettest year.

Now, the *average* rainfall at the Observatory, for 17 consecutive years, amounted to 85 inches, nearly.

To ascertain the amount of storage the account has been made out for One Acre only, so as to avoid inconveniently large figures, and, for the same reason, the observed rainfalls have been taken, to the nearest inch only. It has been also assumed that 60 per cent. of the rainfall is available for collection.

Then the average supply that one acre would given is :—

Gallons

$$22,635 \times 85'' \times 0.6 = 1,154,385 \text{ gallons per annum.}$$

$$= 3,162 \text{ gallons a day.}$$

The problem, therefore, is to see how many days' stock there must be in hand at the end of each water-year.

Water-works in Account with Rain for One Acre, 60 % being assumed as available.

	<i>Gallons.</i>		<i>Gallons.</i>
1884-85	<i>Dr.</i> to stock in hand, assumed, 250,000	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 82'', ... ..	„ by Balance, ... ..	209,257
	<u>1,363,642</u>		<u>1,363,642</u>
1885-86	<i>Dr.</i> to Balance, ... ..	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 100'', ... ..	„ by Balance, ... ..	412,972
	<u>1,567,357</u>		<u>1,567,357</u>
1886-87	<i>Dr.</i> to Brought forward, ...	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 76'', ... ..	„ by Balance, ... ..	290,743
	<u>1,445,128</u>		<u>1,445,128</u>
1887-88	<i>Dr.</i> to Brought forward, ...	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 69'', ... ..	„ by Balance, ... ..	73,441
	<u>1,227,832</u>		<u>1,227,832</u>
1888-89	<i>Dr.</i> to Brought forward, ...	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 99'', ... ..	„ by Balance, ... ..	263,581
	<u>1,417,966</u>		<u>1,417,966</u>
1889-90	<i>Dr.</i> to Brought forward, ...	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 103'', ... ..	„ by Balance, ... ..	643,849
	<u>1,798,234</u>		<u>1,798,234</u>
1890-91	<i>Dr.</i> to Brought forward, ...	<i>Cr.</i> by Consumption, ... ..	1,154,385
	„ to Rain 67'', ... ..	„ by Balance, ... ..	399,391
	<u>1,553,776</u>		<u>1,553,776</u>

1891-92	<i>Dr.</i> to Brought forward, ... 399,391	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 128", ... .. 1,738,363	„ by Balance, ... .. 983,374
	<u>2,137,759</u>	<u>2,137,759</u>
1892-93	<i>Dr.</i> to Brought forward, ... 983,374	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 88", ... .. 1,195,128	„ by Balance, ... .. 1,024,117
	<u>2,178,502</u>	<u>2,178,502</u>
1893-94	<i>Dr.</i> to Brought forward, ... 1,024,117	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 90", ... .. 1,222,290	„ by Balance, ... .. 1,092,022
	<u>2,246,407</u>	<u>2,246,407</u>
1894-95	<i>Dr.</i> to Brought forward, ... 1,092,022	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 105", ... .. 1,426,005	„ by Balance, ... .. 1,363,642
	<u>2,518,027</u>	<u>2,518,027</u>
1895-96	<i>Dr.</i> to Brought forward, ... 1,363,642	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 54", ... .. 733,374	„ by Balance, ... .. 942,631
	<u>2,097,016</u>	<u>2,097,016</u>
1896-97	<i>Dr.</i> to Brought forward, ... 942,631	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 68", ... .. 923,508	„ by Balance, ... .. 711,754
	<u>1,866,139</u>	<u>1,866,139</u>
1897-93	<i>Dr.</i> to Brought forward, ... 711,754	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 99", ... .. 1,344,519	„ by Balance, ... .. 901,888
	<u>2,056,273</u>	<u>2,056,273</u>
1898-99	<i>Dr.</i> to Brought forward, ... 901,888	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 56", ... .. 763,536	„ by Balance, ... .. 508,039
	<u>1,662,424</u>	<u>1,662,424</u>
1899-900	<i>Dr.</i> to Brought forward, ... 503,039	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 76", ... .. 1,032,156	„ by Balance, ... .. 385,810
	<u>1,540,195</u>	<u>1,540,195</u>
1900-01	<i>Dr.</i> to Brought forward, ... 385,810	<i>Cr.</i> by Consumption, ... .. 1,154,385
	„ to Rain 75", ... .. 1,018,575	„ by Balance, ... .. 250,500
	<u>1,404,385</u>	<u>1,404,315</u>

Detailed Monthly Account for Rainy Season of 1894.

<i>Dr.</i> to Stock, 1st May, 1894, ... 1,092,022	<i>Cr.</i> by Consumption during 6 months, 577,194
„ to 100" received—May to October inclusive, ... 1,358,100	„ by Total Stock at end of season, 1,872,928
<u>2,450,122</u>	<u>2,450,122</u>

Total water in stock at end of season, ... .. 1,872,928  
 Less original stock, ... .. 1,092,022

Therefore the quantity to be stocked in addition to that originally in stock was... 780,906

29. It is assumed that there was a stock in hand of 250,000 gallons, at the commencement of the first year. Had there been much less than this amount in hand, then there would have been a deficiency in 1887-88; for there would have been only 73,447 gallons, or about 23 days' supply in hand, at the end of the water-year. There is, of course, a balance of 250,000 gallons, at the end of the period, to carry forward to the next year. Deduction.

It will be observed that, at the end of the water-year 1894-95, there was a balance of 1,363,642 gallons, to carry forward, at the end of April, to the next year, or rather more than a whole year's supply. But even this would not suffice, because there must, in addition, be space in the reservoir to receive the excess of rain over consumption, in the subsequent wet months. As it happened, the next year was one of low rainfall—54 inches. Therefore it will be more instructive to see what happened during the water-years 1893-94 and 1894-95. Here the balance brought forward on 1st May, 1894, was 1,092,022 gallons. From May to October, 1894, inclusive, 100 inches fell, as shewn in the statement given, and at the end of October there was a stock in hand of 1,872,928 gallons, or 780,906 gallons more than the stock at the commencement.

It is, therefore, evident that events may take place, which will necessitate carrying forward a balance of 1,368,642 at the end of the year and we might require room for 778,906 more, in all 2,147,548 storage capacity, or 675 days' supply would be the amount of storage required, to equalise the supply for a long cycle of years, and bring it up to the amount due to the average rainfall of the period in question.

In a recent paper, before the Institution of Civil Engineers, it was stated that in India two full years' supply was found to be necessary in the case of Town supplies. Applying these figures to Taitam the gathering-ground of which is 1,093 acres, then the daily supply, due to 85 inches of rain, is 3,456,000 gallons, and the storage to maintain it would be  $3,456,000 \times 675 = 2,332,800,000$  gallons. These figures are not given as absolute but only to indicate the order of magnitude of the storage requisite for full development of a given area.

Suffice it, therefore, for the present to say that the proposed reservoirs, within the existing Taitam gathering-ground, will add but little to the available supply.

30. Therefore, within the Taitam District, additional gathering-ground, with appropriate storage, is required, rather than an extra storage, with the same gathering-ground. Now additional gathering-ground can only be obtained by going lower down the valley, and pumping the water collected, up into the Taitam Reservoir. The construction of reservoirs, at sites Nos. 4 and 5 should, in my opinion, take precedence of any works at sites Nos. 1, 2 and 3. Indeed, I am of opinion that it would be well to go further in this direction, and construct a reservoir or reservoirs still lower down, of ample capacity, so as to collect the rainfall of the whole gathering-ground, down nearly to sea level. Mr. COOPER does not give any particulars of his Nos. 4 and 5 reservoir-schemes, and I have difficulty in ascertaining the reasons why he limited himself to a small portion only, of the lower gathering-ground.

31. I recommend, therefore, that the Taitam-tuk valley, with its various ramifications be surveyed from about high-water mark, up to about 250 feet Q. D. be carefully surveyed, with a view of ascertaining what storage accommodation can be obtained, by the construction of one or more reservoirs, so as ultimately to develop, to the utmost possible extent, the full gathering-ground. Gauges should also be erected, to measure the flow of the main Taitam stream, as low down as possible.

32. One of the advantages of the low-level pumping scheme is that considerable relief could be obtained, almost immediately. A gauge has been erected, at or near the site No. 5. This gauge has been recorded for some time past. Taking last season's record, it appears that *at least* 30 millions of gallons passed this gauge, during September last, and about half that amount in October. I am convinced, by personal inspection, that this gauge is not measuring the full flow of the stream, and, moreover, it is not sufficiently large to measure, even an ordinary flood-discharge, so that the recorded flow is considerably below the truth. If, therefore, a small reservoir had been in existence, at site No. 5, and a steam-engine and pipe had been provided, about 45 millions of gallons could have been pumped into the Taitam tunnel, or about the stock in hand at the moment of writing this Report.

Additional gathering-ground as well as storage required.

Lower part of Taitam-tuk valley to be surveyed for reservoir sites.

Advantages of a low-level supply by pumping.

33. The results to be obtained from the provision of additional storage, at Pokfoolum, are more promising of success than those to be obtained from similar works, within the existing Taitam gathering-ground. The present proportion of storage to gathering-ground is far less in the case of Pokfoolum than it is at Taitam. At Pokfoolum there is, at present, 70 millions of gallons storage to a gathering-ground of 416 acres, or 168,000 gallons storage per acre, whilst at Taitam there is 406 millions of gallons storage to 1,093 acres or 371,000 gallons storage per acre. Consequently, by augmenting storage at Pokfoolum, an increase of supply may be anticipated; if it be safe to assume that the proportion of available rainfall is the same in both cases. This, however, seems to be doubtful, for, according to the evidence before me, it appears that the overflow at Pokfoolum, last year, was not great.

The effect of the proposed works in connection with Pokfoolum.

34. There are, however, sentimental if not real objections to Pokfoolum as a source of supply. The crests of the hills, forming the boundary of the gathering-ground, are crowned with houses. These do not indeed drain into the gathering-ground, but there will always be a suspicion that filth may be washed down from them, into the reservoir. There is also more traffic, through the Pokfoolum gathering-ground, than in the case of Taitam. Lastly, the buildings of the Convent are on the immediate margin of the site of the proposed reservoir, so that there would be suspicion of contamination from them. Therefore, I consider that works at Taitam should have precedence over those at Pokfoolum.

Disadvantages of Pokfoolum as a source of supply.

35. If, however, the proposed low-level reservoir is to be constructed at Pokfoolum, then I beg to record my opinion that it will be more convenient, if not more economical, to pump its contents into the existing conduit, than to lay a new main and construct new filter-beds, as proposed by Mr. COOPER. The creation of a third zone of supply, within the City area, will further complicate a system that is already sufficiently intricate. Pumping will only be wanted, for a portion of each year, when the supply from the old reservoir is less than that which the existing filters can treat.

Pumping preferable to gravitation supply from Pokfoolum.

36. In a report, dated 7th August, 1894, I discussed the disadvantages of the intermittent system of supply, in any case, and I further pointed out that, in the case of Hongkong, the well-known evils of this system were aggravated, by the fact that the distributary system was designed for a constant supply, and, therefore, houses were not provided with cisterns, ball-valves, and other appliances, essential to the proper conduct of an intermittent supply. The evils of an intermittent supply were thus summarised:—"The intermittent supply, even in its most perfect form, has a radical defect. The water must be stored, in or near the dwelling, and is, therefore, liable to contamination, of the most serious nature. \* \* \* \*"

As to the intermittent system.

Cf. cit. paras. 21-32.

"In addition to this defect, which is inseparable from the intermittent system, it presents, as carried out in Hongkong, the following disadvantages:—

- (a.) The entrance of foul air, foul liquids, and possibly disease-germs, into the public water-mains.
- (b.) The growth of fungoids and corrosion in the pipes.
- (c.) The undue wear and tear of the distributary system.
- (d.) The difficulty of equitable distribution of water, throughout the water-works area.
- (e.) The waste of water.
- (f.) The failure to provide efficient fire-service."

These evils are fully discussed, in the subsequent pages of this report. I must, however, record my opinion that the intermittent system is, at the present moment, being carried out with great skill, and as efficiently as the existing conditions permit.

As to the times at which the intermittent system should be applied.

37. In the 41st paragraph of the said report, I stated that:—

“It seems clear that intermission should be postponed to the last moment, and that, if it has to be adopted, then the water should be shut off for at least 15 hours a day.”

In writing this, I had principally before my mind, the relatively small reduction in consumption, that intermission brings about. In paragraph 14, of the said report, it is shewn that the consumption is not reduced, in direct proportion to the hours of daily intermission. By giving a supply for half the day, only, the consumption is not reduced by one-half, but almost inappreciably. Indeed, in order to bring about a reduction of one-half, the hours of supply must be limited to three hours or one-eighth of a day. This condition exists, even now.

What I decided to emphasise was, that it was better to have a short period of severe intermission, than a long period of slight intermission. Whatever may have been my views in 1894 as to the time at which restriction of consumption, by intermission or otherwise should be introduced, subsequent events shew clearly that, if the reservoirs are not full in September, restriction should be resorted to, and continued until at least sufficient stock is accumulated, to carry on the unrestricted supply, until the end of the water-year.

Shutting off house-services as a means of restriction.

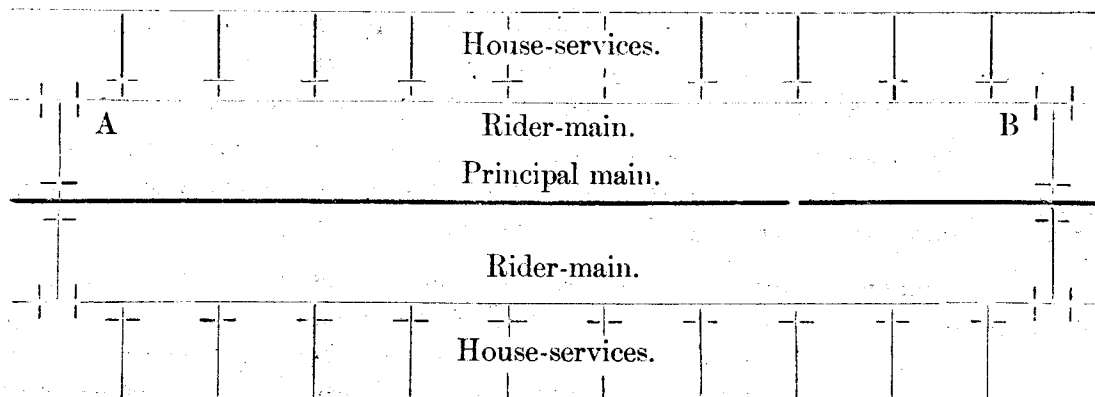
38. In the 41st paragraph of the report cited, the following suggestion is made:—

“Indeed, it is worthy of consideration whether, if restriction has to be adopted, the best plan would be to shut off all house-services, leaving the people to obtain their water from public taps, temporarily erected, if necessary, in the manner adopted in England during frosts.” I still consider that this would be the best course to pursue, especially if, at the termination of the wet season, the reservoirs were not full. Only houses provided with meters, would be allowed to retain a constant supply, and then a proper price for water would bring about the required economy. If this measure did not produce the desired reduction in consumption, then intermission might be resorted to. There is, however, a slight practical difficulty in shutting off all house-services, owing to the easy accessibility of the service stop-cocks. They can easily be opened again, by unauthorised persons. This, however, would be obviated by the adoption of the arrangement, which I will now describe, as a means of improving and facilitating the intermittent system of supply.

Improved arrangements for giving an intermittent supply.

39. Inasmuch as many years must elapse before works of sufficient magnitude, materially augmenting the general supply, can be carried out, and, therefore, before the occasional introduction of the intermittent supply can be avoided, it is proper to consider the arrangements that can be made in order to render this system as efficient, and as little objectionable, as possible.

40. The following arrangement would greatly improve matters. At present, house-services are connected, directly, to the street mains. I suggest that subsidiary mains, wrought iron pipes, of small diameter, should be laid parallel to the principal mains (“Rider-mains”), on one or both sides of the street, thus:—



The house-services should be disconnected from the principal main, and connected to the rider-mains. In this way, the Town would be divided into blocks

of convenient size, the water-supply to which could be turned on and off, independently, and in rotation. The water could then be turned on to and shut off from a large group of blocks, in rotation. No. 1 block would receive water from 3 a.m. to 4 a.m., No. 2 from 4 to 5; and so on.

"Rider  
mains" and  
"Block"  
system.

In short, the Town would be supplied just as London was, when the intermittent system was in force. The principal mains would always be changed, under full pressure. No pollution could enter, through open ball-hydrants—rather an important point, at the present moment especially.

41. I recommend this arrangement, not merely because it will improve and facilitate the management of an intermittent supply, and mitigate its evils, but also because it will be a permanent improvement. It will facilitate the shutting-off of house-services, because the valves, on the rider-mains, may be so arranged, as to be practically inaccessible to unauthorised persons. Such is not the case with the house-service cocks, now in use.

Advantages  
of proposed  
"Block"  
system.

It will greatly facilitate the application of the existing law, with regard to the prevention of waste. Arrangements may be made, whereby the test-meters may easily be applied, when required.

The detection of waste will also be facilitated. The Inspector need only apply the "stethoscope," to one of the valves, commanding the whole block. If there be no sound of flowing water, he can pass on to another block. He need only examine, house by house, if he finds symptoms of leakage, within the given block.

Lastly, it will be most advantageous, if the streets are asphalted, or otherwise improved. The Rider-mains may be laid along the side-walks, so that if a house-service requires renewal, re-construction or repair, the street-surface need not be disturbed.

42. The consumption of water per head per day, for all purposes, about 17 gallons, is not extravagant. Nevertheless, there is ample evidence to shew that much waste occurs in houses of every description, both European and Chinese. Indeed, I have reason to believe that, in the matter of waste and extravagance, there is little to choose, between these two classes of houses; for, after all, the taps in European houses, are in the hands of Chinese servants.

Waste  
prevention—  
its necessity.

Now, the fact must be realised that the water-supply, derivable from and within the Island of Hongkong is finite. The area of the island is small. There are not many available gathering-grounds or reservoir-sites remaining, especially if they are to be at a sufficient altitude to supply by gravitation. Two important gathering-grounds, or rather the water-rights appertaining thereunto—those of Quarry Bay and Aberdeen—have been granted to private individuals, and their resumption would disturb important industries. It is clear, therefore, that economy in the use of water is absolutely necessary.

43. Waste of water may be classified under two heads—"Negligent" and "Wanton." Negligent waste may be defined as that caused by imperfection of taps and fittings, leaky taps and pipes. This may be due, either to the use of imperfect materials, in the first instance, or by neglect in maintenance and repair, or to both.

Causes of  
waste classi-  
fied.

Wanton waste is almost wholly due to neglect to close taps, and also, to some extent, to extravagance in the use of water, owing to the existence of baths of unnecessary size, watering gardens and the like.

44. Negligent waste, which elsewhere as a rule, is the most important cause of excessive consumption, is to be prevented by the use of good materials and by good workmanship, in the first instance, and by assiduous house-to-house inspection followed by prompt execution of repairs. As all house-service materials have been provided and fixed or approved by Government, there can be no doubt that the house-services are good, in the first instance. House-to-house inspection is

Prevention  
of negligent  
waste.

also practised, as far as the available staff will permit, so that there can be little doubt that the house-services are maintained in as good a condition, as in any other well-regulated town.

Prevention  
of wanton  
waste.

45. Though the gross consumption of water is not great, especially for a tropical town, and though there may be but little negligent waste, there is evidence to shew that there is much wanton waste. Now, inspection, no matter how perfect, is practically impotent to check wanton waste. The law may make it penal to leave a tap open, but it is usually impossible to bring the offence home to an individual, and so secure a conviction. I learn however that prosecutions have, not infrequently, led to convictions. One may, indeed, shut off the service, but to do so is to punish many, for the offence of one. The only way to check wanton waste is to measure the consumption of water, in each tenement, by means of meters, and to charge an adequate price for all water consumed, over and above a prescribed quantity.

Original  
draft Ordinance  
of 1890  
not passed—  
Draft of 10th  
June, 1890.

46. It is to be regretted that the Water Ordinance of 1890 was not passed, as originally drafted. The said draft Ordinance was discussed and approved by the Sanitary Board and by the Executive Council. It contained the following clause:—“(16.) The Water Authority may direct that the supply of water taken or used by “or through any service shall be measured or regulated by means of a meter or “otherwise as may be provided by any Regulations made hereunder:” thus, contemplating the general use of meters. The word “may” was probably used because, at the time that the Ordinance was drafted, the water-works were not in full operation, and, therefore, it was hoped that the ordinary precautions against negligent waste would suffice to keep the consumption within bounds. Be this as it may, the clause in question was strongly objected to, by the Unofficial members of Council, on the ground that it would be most inconvenient to owners of house property, who would have to control their tenants, or pay for the water which the latter wasted. The Ordinance was re-drafted, I will not say amended, and passed, in the form in which it now stands. Clauses 10 to 13, inclusive, (Ordinance 16 of 1890), were inserted in lieu of the objected to clause, which permitted the general use of meters. It was hoped that these clauses would suffice to keep consumption within reasonable bounds. I venture to believe that if meters were introduced together with a proper scale of charges, the consumption of water would be so reduced, that the necessity for restriction would never recur, or at least be a rare, instead of a normal, occurrence.

Application  
of powers  
given by  
existing  
Ordinance.

47. The powers, given by Ordinance 16 of 1890, have been several times applied by Mr. COOPER, and from his various reports, it appears that in every instance a most marked reduction has been brought about by its application (*vide* Annual Reports of Director of Public Works.) I find, however, that of recent years, these provisions have not been enforced, partly on account of inadequate staff, partly because of the prevalence of intermittent supply, during which the system is inapplicable. The powers of the Ordinance do not appear to have ever been applied, on a comprehensive scale, but rather as an experiment to demonstrate the existence of waste.

The pre-  
scribed  
method of  
of waste  
prevention  
compared  
with  
meterage.

48. The method of waste prevention, prescribed by the existing Ordinance is, to say the least, cumbrous, and somewhat difficult of application. If applied generally, a large staff of Inspectors would be required. The construction of rider-mains, as herein before described, would much facilitate the application of these clauses. The test-meters might be left in place permanently, and read occasionally, and if waste existed in any block of tenements, the supply to them might be shut off, as the law directs. The numerous test meters would, however, have to be provided and maintained by the Government, instead of at the expense of the individual as would be the case, if the general use of meters, provided for in the Draft Ordinance, were adopted. The actual maintenance is performed by Government, but the cost thereof is covered by the meter-rent, which covers also interest and sinking-fund.

A very large staff would be required for examining the test-meters. The inconvenience to the consumer would be great, because the penalty for wanton waste is to discontinue the supply for a month. It would be out of the question to provide each house with a test-meter. The system must be applied by blocks or groups. It may happen that the waste takes place in one or two houses out of a large block of tenements, in which case inmates of all the houses in the block would be punished, by shutting off the supply, on account of the misdeeds of a few.

49. The general introduction of meters, in connection with every house-service, would, I am convinced, be far more effective and cause less inconvenience to the general public. The cost of the necessary stock of meters would be considerable, but it would be an interest-bearing asset, as the meter-rent would be so fixed as to cover maintenance, interest, depreciation and sinking-fund. I therefore unhesitatingly recommend the introduction of meters, in every case in which there is an internal house-service.

Universal  
meterage  
recom-  
mended.

The landlord might be empowered to add meter-rent and extra water charge to any existing house-rent. He might also have the option of having the service, disconnected if he did not care for the responsibility connected with a meter. Tenants might enter into direct agreements with Government as to payment for water and of meter-rent. I may mention that the Municipal Council of Singapore have, as I am informed, decided to introduce meters generally.

50. In accordance with Ordinance 19 of 1897 meters are used, in the case of all house-services in Kowloon and in the Hill District. The quantity allowed—15 gallons per head per day—is so large, and the price, namely, twenty-five cents per 1,000 gallons, is far too small to exercise any deterrent effect. The price should be at least fifty cents per thousand, as recommended by a Committee of the Sanitary Board, appointed 18th April, 1890, and composed of N. J. EDE, Esquire, the late J. J. FRANCIS, K.C., and myself. I think, moreover, that it would be well to provide an ascending scale of charges, the details of which may be considered, when the meter principle is adopted or otherwise.

Meters in  
Kowloon and  
in the Hill  
Districts—  
effect of  
price of  
water.

51. I have inspected the Kowloon water-works and find that they have been carried out in a thoroughly satisfactory manner. Naturally, water is a scarce commodity in Kowloon, owing to the great increase of population, and small area of gathering-ground that was available, at the time these works were undertaken. It is satisfactory to note that the supply is holding out as well as could be expected, considering the drought that has hitherto prevailed during the current water-year.

Kowloon  
watersupply.

52. I have not yet inspected the site of the proposed Kowloon Water-works, nor have I examined the plans.\* When I have had the opportunity of going into this question, any remarks that I have to make, will be submitted in a special report.

Proposed  
new Kowloon  
supply.

53. It has been suggested that a supply of water, from the New Territory, could be brought over to Hongkong. Such is doubtless the case, but it would certainly be a very costly work. The area of gathering-ground, on the slopes of the hills immediately facing Hongkong, is not great and there do not appear to be any good reservoir sites, at the necessary elevation, on this face. Indeed, the proposed reservoir, about to be constructed for the supply of Kowloon, is close to the ridge-line and will derive most of its water by means of catch-water drains, from the North slopes of the hills, that is to say, on the sides furthest from Kowloon. Further North again, there appears to be another available site. This will, however, necessitate a conduit nearly 20 miles long. Then, conducting the water across the harbour, by a submerged syphon, will be difficult, though by no means impossible. It will, however, certainly be costly. If a bridge or tunnel be made for general communication purposes, then the problem would be simplified.

As to the  
possibility of  
obtaining a  
water supply  
from the  
New Terri-  
tory.

\* Since the above was written, I have made a preliminary inspection of the site, but am not yet in a position to report.



Gathering-grounds and reservoir sites to be reserved on New Territory.

54. I do not, therefore, consider that the scheme of bringing water, across the harbour from the New Territory, is one that should be contemplated at present, or until all the resources of the Island have been fully developed. I am, however, decidedly of opinion that all available sources of water-supply, within the New Territory, should be carefully studied, not only as regards Hongkong, but with regard to the territory itself. When settling the land, gathering-grounds and reservoir sites should be reserved, so that they may not be found to be occupied, when they are wanted.

Conclusion.

55. The conclusions which I have arrived at may be summarised as follows:—

- (a) The works recommended by Mr. COOPER, as urgently required, have been carried out, with good results.
- (b) The works suggested by Mr. COOPER, as future or deferred extensions, have not been constructed. In one sense this is well, for subsequent experience has indicated that some of the works that he proposed in 1896, would not have realised the results which he anticipated. Mr. COOPER based his calculations on but four years' observations. Now there are ten years of records to guide one.
- (c) I have come to the conclusion that increased storage, alone, that is with the existing gathering-grounds, will not effect any material increase in the supply. What is required is an increase of gathering-ground, with an appropriate proportion of additional storage.
- (d) The most suitable site for future extension is the Taitam-tuk valley below the present Taitam dam.
- (e) The water, collected below the Taitam dam, will be at a low level and must be pumped up, into the Taitam tunnel.
- (f) One great advantage is presented by the adoption of pumping, and that is that an appreciable relief may be attained, in a short time. Had pumping works existed, last September, below Taitam, at least 30 millions of gallons could have been pumped into the tunnel, during that month, and about half as much in October.
- (g) The present supply is, were it properly distributed, sufficient for the wants of the existing population. There is, however, no margin for any material increase.
- (h) The time has, therefore, arrived for preparing a comprehensive scheme for the ultimate and full development of the sources of supply in Hongkong, commencing with the Taitam-tuk valley.
- (i) The necessity for the introduction of an intermittent supply, with all its evils, would be obviated or at least rendered much less frequent were waste and extravagance repressed.
- (j) In my opinion, universal meterage is, in the present case, the only efficient and equitable means of preventing waste and extravagance. I, therefore, recommend that the law be altered to the form in which it was originally drafted, and that meters be introduced, in every case in which there is an internal service.
- (k) The price of water, supplied by meter should be increased.
- (l) As some years must elapse before works of sufficient capacity can be constructed to obviate, entirely, the occasional necessity for an intermittent supply, I recommend that the arrangements be made as described for improving that system, and reducing its evils to a minimum.
- (m) As a means of restriction, rather than to introduce intermission, it would be better to shut off all house-services, other than those provided with meter, leaving the people to obtain water from the public fountains.

- (n) All water-supply statistics should, in the future, be arranged by the water-year, commencing 1st May, and not by the calendar year.
- (o) The project for supplying Hongkong with water from the New Territory need not be contemplated at present.
- (p) The newly acquired territory should be carefully examined as regards gathering-grounds and reservoir sites. These when settling the land should be reserved forthwith so that, when required for Hongkong, for the New Territory or Kowloon, they may not be found in occupation.

## SEWERAGE.

## INCLUDING HOUSE-SEWERS.

56. The Separate System of sewerage has been greatly criticised; but I have never as yet seen or heard any serious and logical objection to it. Suffice it, therefore, to say that, were I to design the sewerage works of Victoria again, I should, in all matters of principle, introduce the identical system. I have introduced the separate system, in two tropical towns, namely, Kingston, Jamaica, and Port Louis, Mauritius, and I have never had any reason to regret so doing. Works on the same principle are now well advanced at Port of Spain, Trinidad. Before these works were commenced, the Hon. WALCH WRIGHTSON, C.M.G., M. Inst. C.E., the Director of Public Works, Trinidad, was, at my suggestion, sent to Jamaica to inspect the Kingston works and make enquiry as to their working. He consulted, not only the persons in charge, but also unofficial medical practitioners, many of whom were much opposed to sewerage of any kind, and on his return, he adopted, without modification, the plans that I had prepared.

The separate system.

57. It is alleged that the Government have neglected to carry out my recommendations with regard to the sewerage works. From conversations which I have had with various persons, I have come to the conclusion that this allegation is due to the fact that my Report of 1882 was published as a Parliamentary Blue-Book and has been largely circulated. On the other hand, Reports, written in 1889-90, have not received so much publicity.

As to the extent to which my recommendations have been carried out.

58. In a Report on the Drainage\* (Sewerage) of the Lower Western and Central Districts of Victoria, addressed to the Honourable W. M. DEANE, C.M.G., then Acting Colonial Secretary, I find the following words (para. 5):—

Recommendations as to sewerage made in 1882 cancelled by subsequent reports.

“The methods for the improvement of the drainage (sewerage) of this and other districts, suggested in my report of 1882, have not been tried. This is fortunate, for my subsequent experience leads to the conclusion that they would not have remedied the evils which existed then; and which exist still.”

This report, therefore, and others of the same date (1890), virtually cancel all the recommendations, as to Drainage and Sewerage, which I made in 1882.

59. In the next paragraph (para. 6), of the same report, I indicate the “Separate System,” as it has been called, in the following words:—“It will now be necessary to re-sewer the whole district, with earthenware pipes; and to divert the sewage proper, or dry-weather flow of the sewers, from the storm-water channels, which are not, and cannot be made suitable for its reception. The existing stone channels, therefore, should revert to their legitimate use, the conveyance of storm-water, from the surface of the district, and from the hills above it.” This sentence sums up in short the principles upon which the whole Sewerage System has been designed and constructed. It expresses, in a few words, the difference between the present system, and that which I suggested in 1882, by which the existing Storm-water Drains would have continued to serve as Sewers, as well as drains; an arrangement which I and, I believe, the majority of engineers, now utterly condemn.

Separate system and the degree to which it can be introduced in practice.

\* The word sewerage should be substituted as more in accordance with modern nomenclature.

It is to be observed that I do not make use of the word "Separate System" in these reports. My reasons for avoiding these words were, doubtless, that it had become, even then, a powerful irritant; but more so, because it is not practicable or desirable to introduce an *absolute* Separate System. A great deal of dry weather surface-water, such as the washings of back-yards, is, to all intents and purposes, Sewage, and must, therefore, be admitted to the sewers. With it, some rain-water must also enter. The quantity of rain-water, thus admitted to the sewers, can, by proper arrangements, be reduced to an almost negligible quantity, so much so, that it is scarcely necessary to increase, materially, the size of the sewer-pipes to enable them to convey it, in addition to the sewage-proper.

Definition  
of terms.

60. I find that, in the discussion of Sewerage and Drainage matters, confusion often arises, through the lax use of terms. People often speak of "sewers" when they mean "storm-water drains," and *vice versa*. Again, the word "sewage" is often taken to mean human excrement, in contradiction to domestic slop-water, which is often but erroneously supposed to be an innocuous fluid, which, excreta being excluded, may be neglected, or dealt with in some elementary manner. Whereas it is a fact that only in a limited number of diseases, do fœces and urine contain pathogenic organisms, whereas slop-water may, and often does, contain not only those found in the excreta, but also those of almost every other zymotic disease. The but too current idea that, if excreta are removed, no more need be done, is therefore, the reverse of the truth.

In recent writings, I have found it desirable to define these expressions, and to give technical meanings to the several terms, perhaps not in strict accordance with the Dictionary or with English Acts of Parliament, but in accordance with the sense in which they are to be used, in discussing the subject. \*

Sewage.

"Sewage" means water, sullied, foul or contaminated with matter, in solution or suspension, derived from the use of water in the daily avocations of man, whether it contains fœces or urine, or not.

Surface  
water.

"Surface water" means rain-water, flowing off from the surface of the ground or from those of yards, roofs, and the like.

Sub-soil  
water.

"Sub-soil water" is water which has been absorbed by the soil, and which is retained by, or percolating through its pores.

Sewer.

A "Sewer" is a pipe or conduit, used or intended to be used, for the reception and conveyance of Sewage as defined.

Street-sewer.

A "Street-sewer" is a sewer situated on Crown land, and which is the property of the Crown.

House-sewer.

A "House-sewer" is a sewer situated within a private tenement, which is the property of the owner of the tenement in question.

Drain or  
storm-water  
channel.

A "Drain or Storm-water channel" is a channel or conduit open or covered, used or intended to be used to receive and convey surface-water. Here the word drain will include a "nullah."

Sub-soil  
drain.

A "Sub-soil drain" is a channel, conduit or pipe, used or intended to be used for the reception and conveyance of sub-soil water.

The meanings of "Private drain" and "Private sub-soil drain" are obvious.

I shall use these terms throughout this report and any others that I may write, strictly in the sense of these definitions. I strongly recommend that they be used in the same sense, in all future documents. On reading over my old reports, I find that I have not always been as strict in my terminology, as is desirable. If, therefore, any are to be re-published, I should like to make the necessary corrections therein.

\* According to a decision of an English Court, "Sewage" is anything which gets into a sewer. A silver spoon if it gets into the sewer is sewage, which is absurd.

61. The leading differences between the Sewerage Project of 1888 and that of 1890 occur in the number, position and levels of the out-falls. Designing before the Reclamation works were commenced, when the fore-shore was relatively shallow, and irregular on plan, Mr. COOPER proposed three principal out-falls, namely, at Belcher's Point, Possession Point, and a third, near to the Bowrington Canal. This, however, he regarded as temporary only, and suggested the ultimate prolongation of this section of sewer to North Point; where a pumping-station was to be provided.

Difference between Mr. COOPER'S project of 1888 and that of 1890. Western and Central Districts.

The gravitation out-falls were to be laid at about Low-water mark, Spring Tides. As, however, the new Praya was to be constructed in deep water, and with a regular alignment, along which there would be a strong tidal current, I proposed to provide five out-falls, for the Western and Central Districts, constructed in the face of the new Praya wall, sewerage being carried out into deep water. By increasing the number of out-falls, it became possible to increase the gradients of the sewers. The out-fall levels were raised. The centre-line of the out-fall was to be fixed at mean sea level, instead of low-water-mark, Spring tides, so that the sewer would be free from tide-water, for one-half the year, instead of for a short time only as would be the case with an out-fall at extreme low-water mark. As regards the street sewers, there is no difference, in principle, between the two projects.

62. As regards the Eastern District, Mr. COOPER proposed a temporary out-fall, at the Bowrington Canal; but ultimately to intercept the sewage of the whole district from the harbour. I proposed also to effect interception, by a different arrangement however. In lieu of a deep sewer, I proposed to use a cast-iron syphon pipe.

Differences between schemes for Eastern District.

As regards this section of the town also, there was no difference, in principle, as regards street-sewers.

63. As far as can be ascertained, in the absence of complete and distinct record-drawings, the works of the Western and Central Districts have been carried out, in accordance with the report of 1890. I may here say that much difficulty and delay has been caused, with regard to my present work, and that great inconvenience is caused to the several Departments concerned with Sewerage and Drainage, by the absence of complete, up-to-date, record-drawings. This want is, doubtless, due to insufficiency of Staff, for Mr. COOPER is far too careful a man to neglect to have proper records, if he had the means of making them.

The works as executed. Western and Central Districts.

It may be safely asserted however that such is the case, in all matters of principle. Some slight alterations in detail may have been made. The whole of the out-falls and some sewers on the Reclamation have not yet been completed, on account of the non-completion of the Praya Reclamation works.

64. The proposed arrangement for the interception of the sewage of the Eastern District, has not been carried out. The sewage is admitted to the harbour, by numerous out-falls not extending to low-water mark. The reason why interception was not carried out was, I believe, as follows. Then, as now, the reclamation of this fore-shore was contemplated. It was therefore considered that, if out-falls on the New Praya wall were permissible, they could also be adopted, in the case of the Eastern Reclamation, thus saving the cost of the intercepting-syphon, as well as that of pumping: at any rate, it was not thought well to attempt interception, until something had been settled concerning the future of the foreshore.

Works executed in Eastern District.

As regards the street-sewers of this district, they have been executed in virtual accordance with the project of 1890.

65. I am of opinion that the Sewerage System is working well, especially when the scarcity of water is considered.\* All the sewers in the higher districts have excellent gradients and, with the normal flow of sewage, even now, keep themselves

Working of Sewage System satisfactory.

\* Saving and excepting the defects hereinafter set forth; some of which are due to improper use rather than to defective design or construction.

free from obstruction or deposit. There is, however, a tendency to deposit in the flatter sewers, those running along Queen's Road, and across and along Des Vœux Road and new Praya; so much so that it is thought necessary to pass a scraper through them, periodically, as a matter of routine. Such is also the case in the sewers along Garden, Robinson and other Roads, but there the obstruction is chiefly due to the entrance of roots, generally of the Banyan tree. The only way to remedy this is either to do away with the trees, or put in cast-iron pipes. Trees in a town are a nuisance and should not be permitted. Of all trees for such purposes the Banyan is one of the worst. The roots of plants of the fig tribe grow with surprising rapidity, and have great power of penetration.

The occurrence of deposit in the low-level sewers is not as it should be. The gradients of the sewers in Queen's Road and Des Vœux Road are good, and there is an abundant flow of sewage through them. Those on the new Reclamation must be regarded as temporary only. Levels recently taken by Mr. XAVIER, give evidence of considerable settlement. The centre lines of the sewers, at the outlets, are materially lower than originally projected (mean sea level or 3.70 O.D.), apparently owing to settlement. Consequently, these sewers are tide-locked for a larger proportion of the year, than was intended, and therefore there are longer periods of stagnation than is perhaps desirable. The sewers on the Reclamation will therefore require re-construction. It does not seem desirable however to do so forthwith. It will be better to wait until the Reclamation works are not only completed, but also fully occupied by buildings; when the soil will be so far consolidated, that further movement will be improbable. For reasons which I shall give in the next paragraph, the accumulation of deposit in the low-level sewers, is a cause of expense, rather than a danger to health.

As to the nature of the deposit in sewers.

66. I have examined the deposit, which was being removed from a sewer on the Des Vœux Road. It certainly was not sewage deposit, which is a black, foetid, semi-fluid substance. It was composed of coarse sand or grit, broken glass, small bottles, bits of joss-sticks, and the like, stained black by sewage. It was moreover nearly inodorous. Moreover there was little smell, from the manhole. Clearly, the deposit is not due to the sewage proper, but to solid matter, which ought not to have found its way into the sewers. I am informed that the sample which I saw, was typical in character.

As to the manner in which the solid matter finds its way to the sewers.

67. It is not easy to discover, exactly, the manner in which so much detritus finds its way into the sewers. Some, doubtless, is put in by the inhabitants, to save themselves the trouble of removing it from their back-yards, through the house, often through a well-furnished shop.

There is also evidence to show that the scavengers occasionally open sewer-manholes and throw dry refuse into them and into the gulleys. This is aggravated by the improper construction of the gulleys, both sewer and storm-water. The scavengers also, when washing down the gutters sweep much detritus into the gulleys, which ought to have been removed by dry scavenging. It is obviously to the interest of the scavenging-contractor to dispose of as much refuse, in this way, as he can, and so to save the expense of removing it by boat, the more so, because, unlike excreta, the refuse has no market value.

These inconveniences are seriously aggravated by the division of authority which exists. The sewers are under the control of the Public Works Department, whilst the scavenging is directed by the Medical Officer of Health. I shall revert to this matter later on. It seems certain therefore that Mr. COOPER was right in stating, as he always did, that the accumulation of deposit in the low-level sewers was due to the introduction of matter which should never find its way, in any quantity, into a sewer, and which no sewer could, under the circumstance, be expected to carry off.

68. Mr. COOPER always held that no amount of flushing would suffice to remove such deposit as now finds its way to the sewers, and that it would accumulate, whatever were the gradient of the sewers. I cannot quite agree with this opinion, for, unless the deposit only comes from the immediate vicinity of the low-level sewers, a supposition that is hardly tenable, then it must find its way down the higher level sewers, which have superabundant gradients, and in which no appreciable deposit is found. Therefore, there must be some velocity which will sweep forward even the deposit complained of.

Flushing low-level sewers.

Therefore, it is desirable to provide means of flushing the low-level sewers, with great vigour, using sea-water for the purpose. The flush-tanks must be filled by pumping, for the tides are both insufficient in lunge and too irregular, to fill a flush-tank at high water. The flushing must, moreover, take place at the time of low water or, at least when the water is below mean-sea level. Therefore no automatic arrangement can be used. I hope, before leaving, to submit a project for flushing one set of low-level sewers at least.

69. The following statement shows the number and position of the automatic flush-tanks that have been constructed, in connection with the street sewers.

Flushing street sewers.

LIST OF FLUSHING TANKS IN HONGKONG.

Size of Tank in Meters	Size of Tank in Inches	Position	Capacity in Gallons
6	24	Davis Street, Top, near Rope Works,	430
6	24	Smith Field, Castle Depot,	500
6	24	Whitt Street, Top,	250
6	24	Bonham Road, near the bridge, near No. 754,	350
6	24	Near St. Paul's College, Wyndham Street,	287
6	24	Kennedy Road, 1,379 and 1390,	300
6	24	Nethersole Hospital,	357
6	24	Near Brand Street, opposite No. 198,	600
4	16	Stone Nullah Lane, No. 79,	63
4	16	Butter Street, near Tung Hing Theatre,	188
4	16	Robinson Road, near Cringleford, No. 719,	188
4	16	opposite Excelsior, No. 703,	225
4	16	near Eureka, No. 707,	225
4	16	St. Joseph's College,	225
4	16	Peak Road, between Nos. 1146 and 1098,	250
4	16	Junction of Peel Street and Caine Road, Nos. 1,086, 1,405 and 122,	250
6	24	Caine Road and Arbutnot Road, near Roman Catholic Cathedral,	374
6	24	Stanley and Portinger Streets, No. 34,	225
6	24	Golden Road and Upper Albert Road near No. 580,	250
6	24	Muddy Road, near the Peak Tramway, right and left of bridge, @ 188,	376
6	24	Government Wharf, Wuzlan Pier,	225
4	16	Government House, @ 186,	372
6	24	S.W. Corner of Naval Yard,	300
4	16	Lung On Street, near the Public Laundries, @ 78,	156
4	16	Russell Street, Bowrington Canal, No. 746,	312
4	16	Mutzelon and Bridges Streets Junction,	250
6	24	Yee Wo Street, Causeway Bay,	300
6	24	Jardine Bazaar,	300
4	16	Tung-taw,	78
4	16	First Street, opposite to No. 6,	218
4	16	How Fong Lane, end Ship Street,	300
2	8	Wongquecheong, near Black Rock and E.H. 52,	300
3	12	Holland Street, Des Voeux Road West,	225

6,775  
 Forward,..... 9,229

		HILL DISTRICT.		Gallons.
				<i>Brought forward, .....</i>
				9,229
1	S.	Barker Road, .....	112	112
1	M.	$4\frac{1}{2}$ Near <i>Mountain Lodge</i> , .....	110	
1	M.	$4\frac{1}{2}$ No. 6 Police Station, .....	110	
1	M.	$4\frac{1}{2}$ Des Vœux Villas, .....	63	
1	M.	$4\frac{1}{2}$ Government Pavillions, .....	81	
1	M.	$4\frac{1}{2}$ Rural Building Lot No. 7, Taikoo,.....	125	
1	M.	$4\frac{1}{2}$ " No. 14, Plantation Road,.....	94	
1	M.	$4\frac{1}{2}$ Peak Church, .....	110	
1	M.	$4\frac{1}{2}$ Magazine Gap. in Plantation Road, .....	250	
				943
				10,284
			GRAND TOTAL, .....	10,284

The total capacity, of those which are fed from the water-works, amounts to 7,718 gallons. Suppose that these discharge twice a day (some usually discharge but once), then the total consumption of potable water will be 15,436 gallons a day.

The remainder are supplied from nullahs, or streams, and their joint capacity amounts to 2,566 gallons. I am decidedly of opinion that more use might be made of the water of nullahs and streams but I should be inclined to reserve it for the Drains.

As to the  
necessity of  
additional  
flushing.  
Sea-water.

70. It has been suggested that more flushing is desirable, and that sea-water might be used for this purpose. I am, however, of opinion that the *Street Sewers* (saving and excepting those low level sewers, already referred to) require little or no more flushing, than they get at present. It is the *House Sewers* that require flushing. If these are kept clean, by adequate flushing, then the street-sewers will take care of themselves; if they have proper gradients, as they certainly have, in all the upper parts of the town, I do not consider that it would be well to go to the expense of introducing a supply of sea water throughout the town, merely to flush the *Street Sewers*. Chinese houses, if properly constructed, with scavenging-passages in rear, practically, have no house sewers. In European houses, the consumption of water is sufficient to keep both House and Street-Sewers clean. Of course, it would be a great improvement, if every house Chinese or otherwise was provided with a water-closet or flushing tank. To provide a complete network of distributary pipes, for salt water, all over the town, so as to reach every tenement, would be exceedingly costly. Again, there is little information as to the durability of cast and wrought-iron piping, when used in connection with sea-water. It is conceivable that some relatively costly material, such as lead or copper, might be required, for service-pipes at least. Altogether I do not consider that the advantages of introducing a duplicate supply, universally, as regards *House* and *Street Sewers*, would justify the great cost of such a work. I do, however, consider that, in some cases at least, salt-water might be provided for scouring gutters and flushing storm-water drains as well as for flushing the low-level sewers. I will revert to this subject when discussing the Drainage question (Storm-water Drains and Nullahs).

Gulleys and  
traps.

71. I learn with surprise that many gulleys in the public streets, connected with the street-sewers are untrapped. I am unable to say why this omission has been made. The only explanation which I have heard, is that it was considered better to ventilate the street-sewers, through untrapped gulleys at the sides of the street, than by gratings in the manhole-covers in the centre thereof. I can, however, scarcely conceive that this was the reason. Certainly, all gulleys and other inlets to the street-sewers, ought to be trapped. I must however say that I have not noticed many nuisances from the untrapped sewer gulleys. Probably this is due to



the fact that the opening, from the gully to the sewer, is greatly restricted. The state of the weather may have some influence in this matter, for sewer air does not always ascend.

The original idea was to provide two traps, in the side-channels of the street, one (in case of junctions, two) was to have been small, and with a closely-barred grating, destined to take any dry-weather flow to the street-sewer. The second, placed lower down, was to have a large and open-barred grating, was to have been connected to the storm-water Drain, and was intended to take flood water, during heavy rain.

This arrangement has been found to present the difficulty that when the side-channels are washed down an undue amount of road detritus, vegetable matter and the like, is swept into the sewers through the Street Sewer gully. This inconvenience has been greatly aggravated by the improper use of the gully-gratings, that have been provided. Large open-barred gratings with sloping bars, were to have been provided solely for use in the inlets to storm-water drains. They were made large and open-barred, to admit rain-water freely. The sewer-gratings were to have been small and close-barred, so as to admit as little surface water as possible to the sewers. But I find that the *Drain*-gratings have often been used as *Sewer*-gratings.

Much dry-refuse, also, is but too often thrown into the gulleys, both of the Street Sewers and of the Drains. To remedy this evil, the Honourable the Director of Public Works has devised a special form of trapped gully, common to both sewer and drain, trapping both. It is provided with a locked cover, so that it is inaccessible to unauthorised persons. One of these is in use at the foot of Icehouse Lane. Some minor modifications may be desirable. I am, however, of opinion that this arrangement might be tried, on a larger scale, when doubtless, some thoroughly satisfactory type will be evolved. The radical remedy for this trouble will, however, be found in an improvement of the scavenging system, a question to which I will return later on.

72. I am of opinion that more *trapped* sewer-gulleys are desirable, in some parts of the town. The side-channels of the streets in many cases, are very nearly level. Now the side-channels receive the effluent from down-pipes from verandahs, the washings of which are practically sewage. Indeed, I believe that chamber-slops are, in some cases, poured down the rain-water pipes. The effluent from the down-pipes has often a long distance to travel, before reaching a gully, and owing to the flatness of side-channel and its small fall, stagnation results. In such cases, it would be well to provide additional gulleys, near to the foot of the down-pipe. This, moreover, would have the effect of diminishing at least, the necessity for washing the side-channels, an operation which tends to introduce into the sewer road-detritus, and other solids.

More trapped sewer gulleys required.

73. At the present moment, street scavenging and the cleansing of gulleys is directed by the Sanitary Board. House sewers are also constructed and supervised by the Board. The management of the Sewers, below ground, is directed by the Public Works Department. Consequently, there is a division of authority. If the street-sewers become choked, then the Sewerage Authority attributes the blame to the scavengers, and so forth.

Duality of control and division of authority.

74. I therefore recommend that the maintenance of the Street Sewers be entrusted to that department of the Sanitary Board, which has the control of scavenging, namely, the Medical Officer of Health. I may here state that with the sewers, drains including nullahs, open or covered, should be included.

Cleansing of sewers to be entrusted to Sanitary Board.

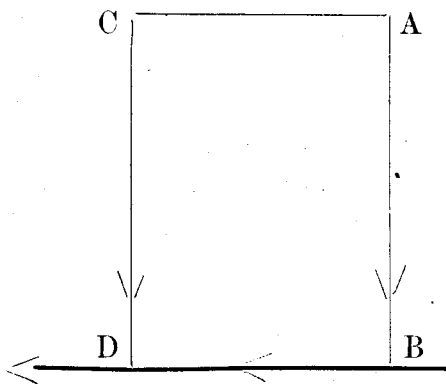
By the word "maintenance" I mean the scavenging of the Sewers, namely, flushing, removal of obstructions, and all operations which do not involve breaking-up the surface of the ground. Extensions, alterations, and new works generally, should, as heretofore, be executed by the Director of Public Works, and when complete, handed over by the Sanitary Board.



I have conferred with the Medical Officer of Health on this subject, and he states that he is quite prepared to take over the administration of the street sewers as well as drains, nullahs, etc. He will not require the services of an Engineer for this purpose. At most, it will be only necessary to increase the number of Sanitary Foremen. The Foremen, now in charge of the Street Sewers, should be transferred, for in the absence of Record Drawings, they possess the necessary knowledge of the Sewerage System. As the Director of Public Works is a member of the Sanitary Board, he would be able to give advice upon any engineering points, that might arise.

Ventilation  
of sewers.  
Vents not  
Ventilators  
required.

75. I have fully set forth my views, as to the Ventilation of Sewers, in a report of 1890; and I have little to add to what I then wrote. The main point to be remembered is that it is impracticable to establish a constant current of air in a given direction through a sewer, by means of ventilating shafts. Sewage, unless it be stagnant, evolves an inappreciable amount of gas, though it is capable of tainting a vast quantity of air. Personally, therefore, I have never been able to recognise the advantage of sewer-ventilation, in the sense of drawing a current of air through sewers, and thus contaminating more air than necessary, with sewage emanations. It always appeared to me that the best place for contaminated air, was the sewer itself. My impression is that the idea of ventilation has, to a great extent survived from the days of large combined sewers and drains, not self-cleansing, into which men have to enter, for the purpose of cleaning them. What is wanted are Vents, not Ventilators, in order to prevent an accumulation of pressure, when there is a sudden rush of sewage. Much may be done, in this direction, by connecting across the summits of sewers, by means of pipes, laid so high as to be dry.



Let A.B. and C.D. be two branch-sewers, flowing to some main sewer, B.D. If the heads were connected across, by a dry pipe C.A.; then, supposing that there were a sudden rush of sewage down, say, A.B., the air displaced would enter B.D., rise up again through D.C., and flow through the dry pipe C.A.; to replace the air displaced from A.B. If the heads of a large network of sewers, are connected in this manner, there can be no prejudicial accumulation of pressure. It is not essential that the connecting-pipe should be dry. It may serve as a Sewer, for the houses along its length. Thus, A.C. might flow from A. to C., but it should open into a manhole at A., at a higher level than the outlet of the sewer A.B. An inspection of the sewerage plans, shews that there are many places in which the suggested arrangement could be carried out, at very small cost. I am of opinion that it would be desirable so to do.

Ventilation  
by house  
ventilators.

76. My views as to the necessity or otherwise for the ventilation of *Street-Sewers* are not, I admit, universally shared by the profession; I am not now referring to *House-Sewers*, where very different conditions prevail. Ventilation, by gratings, in the manholecovers, situated in the middle of the street, is certainly objectionable; though in accordance with very general practice. Ventilation, by means of untrapped gulleys, is still more so.

Assuming that, in accordance with common opinion, street sewers have to be ventilated, the most efficient way of so doing has to be considered. In my opinion, the best way is to make every house-sewer and ventilating-pipe a sewer-vent or ventilator, by omitting the intercepting-trap of the house-sewers. Mr. CROOK, when I last met him, informed me that he had done so, in several cases. This system is common, indeed, almost universal, in America. Several local Authorities, in England, have adopted this plan, and a large number of experts are in favour of it. I have adopted it, in the case of Kingston, Jamaica, and Port Louis, Mauritius, and further, have decided to do so, in the case of Port of Spain, Trinidad. In the two first-named places, the works have been in operation for some years, and I have heard no complaints concerning this manner of ventilation, or more properly, Venting.

77. In the case of Hongkong, an objection may be raised to this system of combined House and Street Sewer ventilation, on account of the great differences of level, which exist, between contiguous dwellings. The mouth of a given ventilating pipe will often be near to, and at the same level as, a neighbouring dwelling-room.

Application of combined ventilation of house and street sewer to Hongkong.

I do not, however, consider that this is an objection, of great practical importance. The number of ventilating-pipes would be so great, that the nuisance, from each, would be inappreciable. It is to be remembered that sewer-air will not be continually pouring out of all and sundry ventilators, like smoke from a chimney. The air will be going down some, up others, according to wind, temperature and various other conditions. The diffusion and dilution will be so great as to prevent any appreciable nuisance. At any rate, the nuisance will be less than that due to the untrapped gulleys or gratings in a street or lane; often narrow and surrounded by lofty houses. Again, every house-sewer of any length is, or ought to be, provided with a ventilating-pipe, which will, from time to time, emit stench, and which, I maintain, will generally be quite as offensive as if the house-sewer were one in uninterrupted communication with the street-sewer, possibly more so, on account of inadequate flushing of the *house-sewers*.

The main point to be considered is whether there are sufficient house-ventilators, to bring about the desired end. In the case of new Chinese houses, erected according to the laws now in force, or which, it is to be hoped, will shortly be in force, there will be practically no house-sewers. The sewage flows from the backyards, into an open channel, in the back-lane, which discharges into a trapped-gully, connected with the street-sewer direct. As there is no house-sewer, there is no ventilating-pipe. To carry out the idea, in such cases, it would be necessary to take power to erect ventilating pipes, against the houses, or elsewhere.

78. The question of Sewer Ventilation is one of the utmost difficulty, and concerning which no two authorities agree. Probably no one system is capable of universal application. Therefore, I recommend tentative procedure. The City of Victoria is sub-divided into several districts, each having its special outfall. Let one district be taken in hand. Let the sewer-gulleys be trapped; using improved traps, as suggested by the Director of Public Works. Let the gratings of the manhole-covers be stopped up, and above all, let the heads of the sewers be connected-up, as described in paragraph 75, then see what happens.

Recommendation, as to ventilation.

If any inconvenience occurs, owing to traps being forced, or otherwise, then let arrangements be made for the provision of Vents. My opinion is that these should be numerous and small, and above all, as inconspicuous as possible. Cast-iron pipes, of from four to six inches in diameter, carried up the sides of houses, just above the roof-gable, will in most cases be best.

A conspicuous ventilating-shaft is always assumed to vomit forth stench, whether it does so or not. I remember a case in Malta, where a ventilating-shaft,

like a mill-chimney, was the subject of prolonged and heated correspondence, between the Admiral Superintendent, and the Sewerage Authority, the former reiterating complaints of the stench which it emitted, and demanding that it should be raised. During the whole of this time, this ventilator was absolutely disconnected from the sewer.

On account of the great differences in level, which obtain in Victoria, it may be well to divide the sundry districts into zones of equal level, by introducing properly-formed traps in the street-sewers. Each zone might be separately vented, thus preventing a great out-pouring at any one group of vents. I do not recommend that this be done, until the necessity for so doing has been established by experience. Any attempt to produce a definite current, in some fixed direction up or down, is to be deprecated. It will not succeed, on account of the wind-eddies which prevail in Hongkong. It is moreover undesirable.

Construction of house sewers vested in Sanitary Board.

79. The construction, renewal, alteration and repair of House-sewers is now supervised by the Sanitary Board, who are provided with a Sanitary Surveyor, for this purpose. The construction is performed, only by certain contractors, licensed by the Board. No unauthorised person is allowed to do any work, in connection with house-sewers. The Architect designs the house-sewers and the plan is submitted to the Sanitary Surveyor, for his approval. If the contractor for the construction of the house, is not one of the licensed contractors, he must arrange with one of them, to carry out this part of the work. The house-sewer contractor, finds the pipes and other appliances, obtaining them wherever he pleases. After completion, but before the ground is filled in, the work is inspected and tested for watertightness, by the Sanitary Surveyor.

Quality of pipes and materials.

80. The pipes and other materials are procured locally, and are, doubtless, the best that are at present available.

I am, however, of opinion that they are not of the pattern and quality that is now considered essential. I see pipes, apparently of Chinese make, that are not fit to be used, for any sanitary purpose, whatsoever. Speaking from memory, neither the Chinese pipes, nor those manufactured by the Aberdeen Company, are as good as they used to be.

The objections to the use of indifferent materials.

81. The use of indifferent pipes and fittings is a serious evil. The Sanitary Surveyor, in order to get work done at all, has to pass house-sewers, constructed, not as he thinks they ought to be, but in the best way that he can get them done, under the circumstances, and with the available pipes. If crooked or deformed pipes are used, it is impossible to construct a true and accurate sewer. Then house-sewers are indeed tested, after construction, with water under pressure. If, on testing, one or more pipes prove to be leaky, then the only satisfactory plan is to take out the whole length and re-lay it. It is difficult, almost impossible to break out one pipe and replace it, with another so as to make a satisfactory job.

Pipes should be inspected and tested before use.

82. It is therefore desirable, in the interest of all concerned, including Owners and Architects, that all sewer-pipes should be tested and inspected, before they are used. The Contractor would then know that he is using materials with which he can make good work, and that will pass the final inspection and test provided that he lays and joints properly. Under this arrangement, much less will be left to the individual judgment of the Inspector. He will not be called upon to decide whether the work is good enough, in his opinion, or as good as can be made with the materials available, but whether it is in accordance with the general Specification, a document which should be accessible, both to Architects and to Contractors.

Tests to be applied to sewer pipes.

83. Every Sewer-pipe should be tested with an Hydraulic Pressure, of one atmosphere. Few pipes will actually burst under this pressure, this test is mainly of use for detecting cracks or porosity; of course, occasionally, a very bad pipe will burst. A test may indeed be effected by placing the pipes upright, with their spigots embedded

in a mass of clay-puddle. To test in this manner, will occupy twenty-four hours or more, whilst, given a proper testing-press and appliances, the hydraulic test is usually effected in one or two minutes.

In addition to the hydraulic test, pipes should be callipered and examined for straightness, and no pipe deviating, more than some specified amount from the standard dimensions, must be accepted. I shall be happy to furnish, when I return to England, a copy of the Standard Specification, which has been used for some time past, for sewer-pipes manufactured for works, carried out under my direction. The standard regulations concerning house-sewer construction, though not textually applicable to Hongkong, might also be of use.

84. It is perhaps now too late to introduce the system which has been adopted elsewhere, under which all pipes and appliances are imported by the Sewerage Authority.

As to the arrangements for inspection and testing.

I am of opinion, therefore, that all pipes should be inspected and tested before use. There would be difficulty in testing at the works of the manufacturer, as many of them are at a great distance. Probably, the best plan would be to provide a depôt, at which testing could be effected. This might be worked, on the lines of a Bonded Warehouse, contractors stacking pipes there, and taking them away after testing as they required them. It would not be necessary that each individual contractor should take away the identical pipe that he brought in. He might merely obtain a receipt for so many approved pipes, and be entitled to draw against the same.

85. To establish a Standard of Quality, it will be well to import a small consignment of pipes, bends, junctions, traps and hoppers, made to the specification, and of the standard pattern, which has been adopted elsewhere. I have adopted a five-inch pipe, as the universal size for house-sewers. I am of opinion that a four-inch pipe is too small, and a six-inch too large. A five-inch house-sewer suffices for almost every class of tenement. Formerly there was difficulty in obtaining five-inch pipes. Now this is not so. Thousands have been supplied to works abroad; and numerous Local Authorities now specify five-inch house-sewers. I have largely employed this size for street-sewers.

Importation of standard pipes, traps and appliances.

86. I find that even Licenced Contractors do not pay sufficient attention to house-sewer construction. The Sanitary Surveyor is often called upon to inspect house-sewers, that are obviously imperfect, and which should never have been reported as ready for inspection, frequently he has to pay two, three, or more visits, before he can finally pass the work. These repeated inspections, not merely waste the time of the Government Officers, but cause inconvenience to the owner, as they delay construction, and postpone the occupation of the tenement. If the pipes and material, were inspected and tested, before use, there is no reason why a house-sewer should not be passed, at the first inspection. Failure so to do, must be due to want of care, on the part of the contractor, for which he should suffer. I therefore recommend that a fee of \$10 be paid by the contractor, to the Government, for every inspection, after the first.

Fee for inspection.

87. House-sewers, running under houses should be made of cast-iron pipes, properly coated with Dr. ANGUS SMITH'S composition. The present practice in such cases, is to bed the ordinary sewer-pipes in lime and red earth concrete. This is not good enough. If cement were used, the cost of bedding in concrete, would be nearly if not quite equal to the extra cost of the iron pipe. Again, bedding in concrete necessitates or ought to necessitate two inspections, one before the concrete is put in, and a second after so doing to see if the pipes have been dislocated by ramming in the concrete.

Drains under houses to be of Cast-iron.

Cast-iron  
down pipes  
and ventila-  
ting pipes.

88. I am glad to see that the use of cast iron is becoming more general than it used to be, for rain-water pipes, ventilating-pipes and the like. It would be good to make the use of cast-iron compulsory for all such purposes. Cast-iron pipes offer such facilities for construction and fixing, that they will probably cost little more than stoneware pipes properly jointed and fixed.

Ventilation  
of house-  
sewer.

89. In the case of House Sewers, efficient "Venting" is more necessary, than in the case of Street Sewers. Indeed I am prepared to admit, that even Ventilation, in the sense of the establishment of a current of air, or the permission of a current of air to flow through the system, is in the case of House Sewers, desirable. But the arrangements which will secure effective Venting will effect Ventilation also, if properly constructed. A house-sewer, especially that of a lofty building, must, in order to be efficiently vented, be open at both ends. If it were not, then a sudden rush of sewage, such as the flush of a water-closet would either force or un-seal traps.

The present arrangement of House-sewer ventilation is one that is common elsewhere; though not now universal. The ventilating pipe terminates in an open outlet above the roof. At or near ground-level there is an opening, on the house side of the disconnecting-trap, called a ventilating *inlet*. This, here as elsewhere, quite as often serves as an *outlet*, and causes a nuisance. To get over this difficulty, it is common in England to use a flap-valve of talc, opening inwards, so as to close when there is a down-draft. Now in the first place this talc valve generally gets out of order; and either never opens or never shuts. It seems, however, to have escaped the notice of those who devised this arrangement that when the Talc valve is closed, on account of a down draft, the house-sewer is unventilated or un-vented, for it is open only at one end.

By abolishing the Intercepting Trap, this difficulty is obviated, another great advantage of the system of common ventilation of House and Street-sewers. If there be an intercepting trap, then the only way of properly ventilating a House-sewer efficiently, is to place the so-called *inlet* in some unobjectionable place, either by carrying up a pipe or otherwise.

Details of  
house-sewer  
construction.

90. The construction of house-sewers might be improved in many matters of detail, greater ease of access, for the purpose of removal of obstructions, might be given. All these arrangements are, however, fully described and figured in the Instructions for the construction of House-Sewers, a copy of which I propose to provide. I will, therefore, not pursue this subject further at present.

#### DRAINS, STORM-WATER CHANNELS AND NULLAHS.

Objections  
to covered  
drains.

91. No Drain, Surface-water Channel, or Nullah should be covered or closed in, if this can possibly be avoided. A Drain must necessarily receive some filth or garbage, which is practically sewage, or rats and other animals will die in it. The dry-weather flow through it, will be negligible, certainly insufficient to flush it efficiently; on account of the large size, necessary for conveying storm-water. I have invariably observed that covered storm-water Drains are productive of greater nuisances than decently-constructed Sewers. Storm-water Drains should, whenever practicable, be open, so that they may be scavenged, like a street. If they must be covered, then they should be large enough for men to go through them, with ease. Unfortunately, it is not possible to re-open all the storm-water drains in Victoria.\* At Kowloon, and on the New Territory generally, covered drains should be avoided.

The existing  
drains of  
Victoria.

92. The want of complete Records, again prevents me from making any definite recommendation as to the course to be adopted with regard to the Drains in Victoria and the Hill-District. There can be no doubt that the Drains now receive more filth and sewage than they ought to do. This appears to be due, partly to

\* Some, in the Hill-District might be opened.

defective scavenging, whereby much dirt and even excreta are thrown into the drains through the gulleys; and partly to overflows or leakages from the Street Sewers. The first evil may be cured by improved scavenging, a question which will be dealt with in a subsequent section, and the second, by more efficient inspection of Sewers. I can cite a case, in support of the latter statement, which came to my personal knowledge: On visiting one of the open storm-water Drains, which had been constructed, from my designs, in 1890, I found that a stream of unmistakable sewage was flowing down its floor. This had been evidently going on for a considerable time, unknown to the officer in charge of the sewers. On examination, it was found that a manhole of a sewer above was blocked with dry-refuse, and that the sewage was overflowing into the nullah or drain. The trap, leading to the sewer-pipe, under the floor of the drain, was also plugged up with refuse. This incident supports the recommendations which I have made, to the effect that the maintenance of Sewers and Drains should be handed over to the Sanitary Board. An Engineer and one Inspector cannot possibly inspect a spread-out town, like this City, in an efficient manner. The Board, on the other hand, have numerous Inspectors, who are continually circulating, through the town, and who therefore could not fail to detect and report such an obvious nuisance, were it their duty to do so. At present it is not their duty, and, naturally, they confine themselves to their business.

93. I understand that the amendment of the Drainage System has never been considered, in a comprehensive manner. Probably this is due to the insufficiency of staff. Deviations and re-constructions have taken place, from time to time, and some improvement has doubtless taken place. From such plans as exist, it would appear that numerous Drains exist that are obsolete and useless; or at least could be made so, by some re-arrangement of the side-channels of the street. They were originally put in to serve as sewers, a purpose for which they are no longer required, on account of the construction of Sewers. It appears that, up to 1894, and even later, little was done to re-construct House Sewers. It was obviously impossible to connect an old House Sewer, one foot or more square, to a pipe. Therefore, some of the old Drain Sewers were allowed to remain, and still exist, notwithstanding the fact that they are no longer needed. I am, therefore, of opinion that the whole Drainage System should now be examined and surveyed and levels taken. This done, a comprehensive scheme of reform should be drawn up.

The whole system of drainage to be revised.

94. I can, with the information available, only describe the general principles which should guide the design of drains or storm-water channels.

Principles on which drains should be designed.

The most important point is to keep storm or surface-water on the surface, that is in the side-channels, to the utmost extent possible. So long as side channels can carry the waters of a heavy storm, no covered drain should be permitted. It would be better to risk occasional inundation, than to have the permanent nuisance of a covered drain. At any rate, the covered Drains should be reduced to a minimum length. Some covered storm-water drains must always exist, notably those which traverse the City, from South to North, bringing down rain-water, from the hills above; the covered Nullahs, in short. These are fairly numerous, so that there should be no difficulty in bringing surface-water into them, by short lengths of covered drain. Some of the South—and North—running Drains might, in places be uncovered, even now. In cases where insanitary areas are resumed by the Crown open channels should, wherever practicable, be substituted for covered. A proper arrangement of street will permit this to be done.

These covered Nullah drains, those running down through the town have, for the greater part of their length, ample gradients and keep clear of deposit, even with the normal dry-weather flow through them. From about Queen's Road to the Praya, they have necessarily flat gradients, and their inverts, though higher than they were, are considerably below high water mark. Consequently, the dry-weather flow is

wholly insufficient to flush them, in the tide-locked parts, and stagnation takes place. In addition to the filth, brought down by the drain from above, some is doubtless washed in by the tide. I venture to believe that the nuisances complained of, with regard to the Drains, are due to stagnation in their flat parts; and I am convinced that many nuisances, attributed to the Sewers, are really due to the Drains. From time to time, up-currents occur and stenches issue from the open mouths of these drains, or from the untrapped storm-water gulleys, leading to them. To prevent up-currents of air, tide-flaps were formed, tried and failed. I believe that they were wrecked during typhoons.

To flush the lower, flatter and tide-locked parts of the drains, a perfect torrent of water would be required; far more than could ever be afforded by any water-works. It may even be impracticable to supply a sufficiency of salt-water for this purpose. It would be somewhat dangerous to trap the mouths of the drains, with cast-iron plates dipping below low-water level. An obstruction might be caused, which might bring about the bursting of the drain, during a rain-storm. This actually happened in 1889.

I am free to admit that both the flushing of the lower part of the existing Drains and their ventilation throughout, are problems of the greatest difficulty.

It seems, therefore, that the best programme, for present adoption, may be summed up as follows:—

- (a) Abolish all unnecessary Drains, and reduce the lengths of any that cannot be dispensed with, to a minimum.
- (b) Whenever practicable, open any Drains that are at present covered.
- (c) By careful scavenging and management of the Sewers, minimise the amount of filth that finds its way to the storm-water Drains.
- (d) Flush the branch Drains with the water of the streams above.

When a complete plan of the Drains is before me, I shall be glad to further consider this difficult subject.\*

Recommendation that the maintenance and scavenging of drains be entrusted to the Sanitary Board.

95. I recommend that the maintenance of all sewers, drains, storm-water channels and nullahs, covered or open, be handed over to that Department of the Sanitary Board, which is charged with street scavenging and cleansing, namely, to the Department of the Medical Officer of Health. By "maintenance" I mean scavenging, cleansing, flushing, removal of obstructions and all operations, which do not involve breaking up the surface. New works should be carried out, as heretofore by the Public Works Department, and then handed over to the Sanitary Board. There would then be no division of authority. If a Sewer or Drain were obstructed, then at least, the responsible person would be known. The Medical Officer of Health now commands the services of a numerous and well organised scavengers' staff. The Public Works Department has one Engineer, two European and three Chinese foremen, to supervise the City of Victoria, the Peak, Aberdeen, Shaukwan, and the whole of the Kowloon Peninsula, an absurdly inadequate staff.

The Medical Officer of Health—I speak after conference with him—would hardly require any addition to his staff, other than the transference of the Overseers and Foremen, now in charge of the Sewers and Drains.

To carry this arrangement into effect, he must be provided with correct record-drawings of the existing Sewers and Drains. He should, moreover, have the services of a Chinese or Eurasian draftsman to keep the plans up to date.

The existence of such plans is absolutely essential to the proper administration of the Sewerage and Drainage works, whatever be the nature and constitution of the Authority to whom they are entrusted.

\* This plan is now being prepared.



## SCAVENGING AND REMOVAL OF EXCRETA.

96. The Scavenging of the City is carried on, under the direct supervision of the Medical Officer of Health, and is now performed in a far more complete and efficient manner, than in times past. Formerly there were Depôts for dry-refuse, scattered about the town, in rather insufficient numbers. Householders were supposed to cause their dry-refuse to be conveyed to these depôts, which were, from time to time, emptied by a Contractor who removed the rubbish in boats. As the distances to the Depôts were, in many cases, great, the inhabitants, not unnaturally, did not do so completely, but either stored it in back-yards, stuffed it down the sewers, or got rid of it, in some irregular manner. As the dry-refuse is worthless, the Contractor had no interest in seeing that the rubbish was fully collected and removed. The less refuse collected, the better was it for him.

Organization of scavenging department.

The City is now divided into ten Districts. Every two Districts are presided over by a Senior Sanitary Inspector. Under him, again, in each several District, there is a European Sanitary Inspector, as well as a Portuguese or Indian Foreman. The Contractor merely furnishes baskets, brooms, and gangs of labourers, with Chinese Foremen, who work under the direction of the aforesaid Inspectors, who, again, are under the supervision of the Medical Officer of Health.

The Contractor also provides junks, of approved pattern, with which he removes the rubbish and throws it into the sea, at specified places. The Contractor is responsible that no refuse is thrown into the harbour, and if this takes place, he has to pay the cost of dredging out any accumulation, near to the stations of the receiving-junks. The whole system appears to work well. The only defect seems to be that, despite the stringent provisions of the contract to the contrary, too much dry-refuse finds its way into the Drains and Sewers. I suspect that this is due to want of care in completely removing the dry refuse, before washing down the side-channels in the streets. This evil is undoubtedly aggravated by the improper construction of the gulleys. The gulleys are now cleansed by the scavengers. I believe that, when the scavenging of the Sewers and Drains is under the Scavenging Authority, more care will be taken, by all concerned to prevent matter from entering which will have to be removed by the same Authority, or rather by the Contractor under him.

97. Removal of excreta is now performed by an independent Contractor; who pays the sum of \$73,000 annually, with respect to the manurial value of the excreta. It is to his interest, therefore, to remove as much as he can, provided that it is worth carrying. As heretofore, no doubt some excreta, too dilute to be worth carrying, such as the washings of the pots, finds its way to the sewers. As long as it goes to the Sewers, and not to the Drains no harm will result. It will only necessitate a little additional care in the cleansing and washing-out of gulleys.

Removal of excreta.

## HOUSE CONSTRUCTION AND OVERCROWDING.

98. I have no hesitation in stating, that as regards overcrowding, the present conditions of Victoria are, generally, rather worse than better, than they were in 1882. As regards cubic capacity, per individual, they are about the same; but, as regards ground-area, the conditions are worse, owing to the great number of lofty houses that have been built, during the past twenty years; or less. Many of the old rookeries, the centre of the town exist, in a state little different to that which I described in 1882. Even the new buildings on the Praya Reclamation are, as regards construction, scarcely less insanitary than the old. I do not propose here to go into details, with regard to house-construction and overcrowding. This matter has received the attention of Professor SIMPSON, and he will no doubt deal with it in his final report; and I know that my views and his, are in complete agreement.

Comparison of present state with conditions of 1882.



In this matter, the recommendations, made from time to time, during the past twenty years by the Professional Advisers of Government have been practically set aside. The reason for this is simple. If the number of people, which can be packed on a given plot of ground is reduced by limiting height, and by reserving open spaces, obviously the value of that plot, is reduced also. Now land is costly in Hongkong, either it has to be excavated in the hill-side, or reclaimed from the sea. Naturally, the land-owner desires to get the best rental for his land, by crowding as many tenants upon it as possible. Consequently, during the past twenty years, numerous Building Ordinances, drawn up by the Professional Advisers of the Government, have been brought before the Legislative Council, but in each case, many salutary provisions have been withdrawn or emasculated at the request of the Unofficial Members of Council, representing the landed interest. The Government has hesitated to use its official majority. Since the outbreak of plague, the mercantile section of the community have realised that their interests are not quite independent of the health of the Chinese population. Commerce is disturbed by quarantine in other ports and otherwise. Hence the Petition, which was sent to the Secretary of State for the Colonies.

The Commercial and Land-owning interests are opposed. The former desire freedom from epidemic or pandemic disease. The latter, the majority of whom are Chinese, and not British subjects, desire to get the greatest possible rents, which connotes overcrowding and insanitary dwellings. The two objects are absolutely incompatible, one or other must go to the wall. Which is to yield, the European who founded the Colony, or the Chinese who comes to it for his own purposes?

As to re-  
sumption of  
insanitary  
areas.

99. One thing is certain, and that is so long as dwellings are overcrowded and insanitary, no amount of external sanitation will give immunity from epidemics of disease. The water-supply, sewerage, drainage, scavenging-all may be perfect, but there will be no complete security, so long as dwellings are over-crowded and filthy. Vigorous measures, such as those now enforced by the Sanitary Board, will no doubt mend matters and tend to prevent an epidemic, but they cannot be depended upon to prevent one certainly and entirely.

The Government in short have to face the problem, which is still awaiting complete solution elsewhere; namely the housing of the working classes. In London and other towns, it is found almost impossible, on account of the high price of land, to buy up insanitary properties and replace them with proper dwellings at a remunerative price. That is to say, it is not, as a rule, practicable to buy up insanitary areas, and rebuild the dwellings, so that they can be let at a rent that the displaced population can pay; and at the same time pay interest and sinking-fund, on the capital expended, in purchase and reconstruction. So much is this the case, that many hold the opinion that full value, computed upon rack-rental, and with consideration for compulsory sale, should not be paid, in the case of insanitary building. I am further of opinion that nothing short of the general resumption of insanitary tenements, and their entire re-construction, will bring about any thorough improvement in the sanitary condition of Hongkong. Unless some drastic legislation be adopted, limiting the purchasing price, resumption and reconstruction will prove unremunerative and the loss will have to be paid for by some one. Is the loss to be borne by the community at large, or by the owners of the insanitary property, or how is it to be proportioned? The Housing of the Working Classes Act, 1890, lays down precise instructions, as to the valuation of insanitary property, and enjoins that deductions be made with respect to its improper use or condition. It further enjoins that the usual allowance of 10 per cent. for compulsory purchase, shall not be added.

Resumption  
of Taipingshan.

100. The resumption of Taipingshan affords an example of the non-remunerative character of insanitary districts, under existing conditions, as to the purchase of property. The greater part of Taipingshan is still vacant. There are on it only a

few dwellings, by no means too sanitary in character. The non-occupation of this district is, I understand, due to the fact that the Government cannot find tenants who are prepared to pay the price per square foot that the Government paid for this district. It is said that the tenants are not forthcoming because of the very moderate, I may say insufficient, restrictions as to height and open space that the existing law requires.

101. It seems to be undesirable that so valuable a site as Taipingshan, should remain so long unoccupied. It is of course out of the question to allow buildings of the old and insanitary type to be erected thereon. Rather than allow it to be unoccupied, it would be better to build sanitary buildings and let them for what they would fetch. It has however been suggested to me that Taipingshan affords an excellent site for much-needed public buildings. It would, I am informed, be the best possible place for the Proposed Medical School, owing to its propinquity to the Civil Hospital, the Alice Hospital and the Tung-Wa Hospital.

Re-occupa-  
tion of Tai-  
pingshan.

Again, it would be an excellent spot for some dwellings of the subordinate staff of Government officials. These persons now have the greatest difficulty in obtaining quarters, at rents that they can afford to pay, that are consistent with decency, self-respect and health. Having had some experience in selecting subordinate officers for Hongkong and elsewhere, I am prepared to say that I feel certain that competent well-conducted men cannot be obtained far less retained for the salaries now offered, as long as house-rent and living is as costly as it is. If good quarters were provided, similar to Married Sergeants' quarters, it would greatly facilitate matters. One of the first questions asked by candidates is whether quarters are provided, and what is the cost of living. If I could assure them that free quarters are provided, and describe their character, I could often secure the services of competent men who now refuse to accept employment.

102. Most of the defects which I have described are due to the insufficiency of the Public Works staff and to repeated changes which take place there. Much difficulty has been experienced in the preparation of this report, by the absence of proper record-drawings and surveys. I am sure that none of the Engineers, who have held the post of Director of Public Works, failed to appreciate the necessity for proper surveys and records, and the fact that they are wanting is, to my mind, proof positive that the Department has for years past been undermanned. I have, however, expressed my opinion fully on this matter in another place. I shall hope to make some further suggestions on this point in a special report.

Insufficiency  
of staff.

103. The following is a brief resumé of the conclusions which I have arrived at, with regard to sewerage, drainage, scavenging and house-construction:—

Summary.

- (a) The Sewerage System has been carried out, in general accordance with the principles laid down by myself in 1890.
- (b) On the whole the system is working well, though there are some defects, not however difficult to remedy.
- (c) Deposit accumulates in the low-level sewers. This is not sewage, but road detritus and other solid substances, which ought not to enter the sewerage system.
- (d) The entrance of improper solids into the sewers is principally due to two causes—want of care in scavenging, and improper construction of the sewer-gulleys.
- (e) Sewer-gulleys ought to be trapped, and provided with close-barred gratings.
- (f) Flushing is sufficient in the upper and steeper parts of the Sewerage system.
- (g) More use should be made of the water of Nullahs for flushing purposes, but this should be reserved mainly for the Drains.

- (h) It is probable that salt-water flushing is desirable for the low-level sewers. This is, however, a question, upon which I must reserve my opinion, pending further investigation.
- (i) The materials and appliances now used for house-sewers are of indifferent quality. Pipes should be inspected and tested at a *depôt*, before use. A supply of standard goods should be imported.
- (j) The whole Drainage system requires careful reform. All unnecessary covered Drains should be abolished.
- (k) To avoid division of authority, bringing about to some extent the evils described under (c), it is desirable that the maintenance, that is, cleansing and flushing of the Sewerage System and Drainage System be transferred from the Public Works Department, which has a miserably insufficient staff, to that department of the Sanitary Board, which has the supervision of the scavenging (the Medical Officer of Health.) Under the expression Drain I mean and include all storm-water channels and nullahs whether covered or open, within the urban area.
- (l) The transfer of the maintenance of sewers and drains from the Public Works Department to the Sanitary Board will not necessitate any material augmentation of the staff.
- (m) New work and structural alterations in connection with sewers and drains, should be carried out by the Public Works Department, as heretofore.
- (n) Scavenging is efficiently performed, saving as regards the matter referred to under (l).
- (o) As regards surface crowding and insanitary dwellings, the state of the town is rather worse than it was twenty years ago.
- (p) No amount of external sanitation will absolutely avoid the recurrence of epidemics, so long as a large proportion of the dwellings are insanitary and over-crowded.
- (q) To improve insanitary dwellings extensive resumption and re-construction will be necessary.
- (r) Resumption and re-construction cannot be remunerative, so long as full market prices are paid for insanitary property.
- (s) If on new areas, only sanitary buildings are to be erected, the value of the land will be decreased.
- (t) The Public Works staff is much undermanned in every branch, both technical and clerical.

I have the honour to be,

Sir,

Your obedient Servant,

OSBERT CHADWICK.

The Hon. The COLONIAL SECRETARY.