M.R.O. 1—39,000—16-10-29.

MADRAS RECORD OFFICE.

Government of Madras.

Revenue DEPARTMENT.

G.O. No. 61 Press ~~Mis.~~

1898-99

Dated 8th March 1899.

Not to be folded or roughly handled

Proceedings of the Madras Government, Revenue Department, 8th March 1869.

No. 198. Read the following Proceedings of the Madras Government in the Public Works Department :—

Passing orders on the Proceedings of the Government of India, regarding Irrigation finance and management. } (Here enter 2nd March 1869, No. 674.)

No. 199. ORDER THEREON, 8th March 1869, No. 611.

Irrigation, No. 6.

Communicated to the Revenue Board.

(True Extract.)

(Signed) W. S. LILLY,
Under Secretary to Government.

To the Board of Revenue, with Proceedings Public Works Department, No. 674.

Exd. G. A. Turton.

Govt. of Madras
1869

REVENUE.

To

THE BOARD OF REVENUE.

Dated March, 69.

Read.

Encl.

G. O., 8th March 1869, No. 611.

MARCH.

Nos. 193-199.

Irrigation Works.—Proceedings of Government of India regarding their management and finance, communicated to Revenue Board.

Proceedings of the Madras Government, Public Works Department, 2nd March 1869.

No. 67. Read the following Proceedings of the Government of India in the Public Works Department, (Account—Irrigation,) dated Fort William, 8th February 1869, No. 9-22 A—I:—

Irrigation finance and management.

Read—

Report on Irrigation Works in India, more particularly having reference to the mode of exhibiting their financial results, by Colonel R. Strachey, R. E., Inspector General of Irrigation Works.

Letter from the Government of Madras, to the Government of India, Public Works Department, No. 1,185, dated 20th April 1868.

OBSERVATIONS.—The Governor General in Council is of opinion that no time should be lost in obtaining accounts of Irrigation Works on a proper system, but desires that before issuing final orders on the subject, the Government of India may be in possession of the views of Local Governments in regard to the several questions discussed in the Report now read.

ORDER.—Ordered that this Resolution, together with a copy of the Inspector General's Report, be forwarded to all Local Governments, with a request that they will submit as early as practicable an expression of opinion on the system of accounts proposed in the 3rd part of the Report of the Inspector General of Irrigation Works, and the method of estimating the profits of Irrigation Works, and the amount to be shown as "*Land Revenue-Irrigated.*" Also that they will report to what extent they are disposed to accept those proposals, and what steps they think should now be taken towards introducing them in practice.

Ordered, that a copy be sent to the Home and Foreign Departments for any observations that may appear necessary in those Departments.

Ordered, that the attention of the Government of Madras, and of the Commissioner of Mysore, be directed to paragraphs 97—103 of the Inspector General's Report regarding the maintenance of Minor Irrigation Works in Madras and Mysore; and that a further statement of the opinions of the Government of Madras be requested in respect to the subjects embraced in the four last paragraphs of their Secretary's letter No. 1,185, dated 20th April 1868.

Ordered also, that the Governments of the North-Western Provinces and the Punjab be requested to report specially on the possibility of relieving the Engineer Establishment of part of the fiscal duties connected with Canal management.

(Signed) C. H. DICKENS, Colonel, R. A.,
Secy. to the Govt. of India.

No. 68. ORDER THEREON, 2nd March 1869, No. 674.

IRRIGATION, No. 5.

1. Ordered that the foregoing Resolution of the Government of India, together with Colonel Strachey's Memorandum, be communicated to the Public Works Commissioners, and that they be requested to submit their opinions on the subject of paragraphs 97 to 103 of the

memorandum regarding the maintenance of Minor Irrigation Works, as well as upon the several points in the third part of that memorandum noticed in paragraph 1 of the orders of the Government of India.

2. The Accountant General and the Controller of Public Works Accounts may be invited to join the Commission in the consideration of the new system of Irrigation accounts proposed by Colonel Strachey.

(True Extract.)

Colonel, R. E.,
Secretary to Government.

To the Commission on Public Works,
" Controller of Public Works Accounts,
" Accountant General,
" Revenue Department,
} With copy of Inspector General's Report

8e-611.
Comm^n to the
Revl Board

8th March 69

Copies Collected & Revenue Dept 2.6.71

Exd. E. C. Shunker.

Revenue Dept.
Rr-681-

Govt. of {1869} Madras.

PUBLIC WORKS.

To

THE COMMISSION ON PUBLIC WORKS.

&c., &c., &c.

Dated March, 2nd.

Recd. 4th Encl.

G. O., 2nd March 1869, No. 674.

MARCH.

Nos. 67-68

Irrigation finance and management.—Passing orders on the Proceedings of the Government of India regarding Irrigation finance and management

1611.8 Bundle
with Order

Report on Irrigation Works in India; more particularly having reference to the mode of exhibiting their financial results. By COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation Works.*

In August 1866, the Government of India recorded its opinion that it would be desirable to depute an Officer to enquire on the spot into the Irrigation system of the Madras Presidency, with a view, amongst other things, of arriving at more definite conclusions as to the causes which have conduced to make the Irrigation Works at that Presidency appear so much more remunerative than those of Upper India.

Resolution No. 675 C, dated 7th August 1866.

2. The Secretary of State, in assenting to this proposal, informed the Government of India that he thought the enquiry should not be confined to Madras, but that it should embrace all the more important localities in India where irrigation is practised.

Despatch No. 65, dated 25th October 1866.

3. Having been selected to carry out this duty, I was informed by the Secretary of State of the above conclusions, and further, was instructed so to direct my enquiries as to admit of my suggesting to the Government of India a method of exhibiting the financial results of Irrigation Works, whereby a proper insight might be got into the returns on the capital invested in all new works, and, at the same time, fair comparisons obtained of the relative economy in management in different parts of the country.

4. The Government of India accordingly requested the Government of Madras to afford me every facility for reporting upon all matters connected with the Irrigation Works and system of managing them in that Presidency. But from the general tenor of the Resolution, and of the instructions of the Secretary of State, I have inferred that what it was more particularly desired that I should consider, was the method best suited for exhibiting the financial results of all Irrigation Works for the future; and that any enquiries I might think fit to make on other points, should be shaped essentially with reference to the fiscal, and not at all as to the engineering aspect of the Irrigation question.

Resolution No. 1036 C, dated 18th December 1866.

5. In this sense, therefore, it is that I have considered the facts that have come before me, and in this sense I shall proceed to state the conclusions at which I have arrived. Believing, however, that the full advantage of irrigation cannot be secured for the country without a thoroughly efficient system of management, and that such a system of management is at the same time essential to secure to the Government a suitable return on the capital invested in the works, I shall so far touch upon the question of management as is necessary to explain my general opinions on this subject also.

I.—GENERAL ACCOUNT OF EXISTING WORKS.

6. It will be convenient if I first briefly indicate the chief peculiarities of the more important Irrigation Works in the various Provinces of India. When we attempt to devise an uniform system of exhibiting results, it is only after having obtained a general view of all the varied requirements of the problem to be solved that we can properly approach the subject of our investigation.

455,—21, 10, 68.

1.—*Madras.*

7. I will commence with Madras. In this Presidency, without doubt, speaking of it as a whole, irrigation at the present time is more common and more widely extended than in any other part of India. More than three million acres, being about one-fourth of the whole cultivated area, are by the Revenue Authorities classed as irrigated; and a sum of about £1,700,000, which is nearly one-half of the land revenue, is derived from the irrigated lands.

8. The chief part of the irrigation is provided from tanks. Many of these are fed from channels specially drawn from rivers for this object, and are thus more or less works under engineering control. But the larger number are isolated reservoirs formed on some minor natural line of drainage, and are of very small dimensions. The class of works next in importance as regards the area of land irrigated, comprises the dams, known as anicuts, constructed across rivers, by means of which the water is diverted into irrigating channels drawn from them. These also vary greatly in magnitude. The largest are the works in the Deltas of the three chief rivers which fall into the Bay of Bengal within the Madras frontier. The Godavery system of canals now supplies about 400,000 acres. The Kistnah perhaps half that area. The Cauvery works supply nearly 800,000 acres. There are other minor works to which special attention need not be given. Wells I entirely exclude from consideration, as not falling into the category of Irrigation Works in the sense in which the words are used in this report.

9. From all these sources of supply, the water is, in the majority of cases, led by natural flow into the fields to be watered. The artificial raising of water is practised to comparatively a limited extent.

10. As a rule, the old native practice of making no distinction between land revenue and water-rate of irrigated lands, is maintained as regards all the older works. Under the Ryotwarree system of tenure, which prevails over the greater part of Madras, the Government is virtually sole landlord, and also proprietor of the water, and its demand for irrigated land is commonly a lump sum, in which no distinction is made between the charge due for the occupancy of the land, and that due for the use of the water.

11. Only in the case of the large Irrigation Works last constructed by the Government is any distinctive water-rate levied; and this change of system was in a measure forced on the Madras Revenue Authorities by the Home Government. This water-rate is a sum fixed at so much per acre on the land assessed as irrigable or irrigated, and is charged in addition to the ordinary land revenue which would have been payable had the land not received water. It is in practice determined in rather an arbitrary manner, being such an amount as brings up the total Government claim on the land, to the standard of the customary aggregate demand on irrigated land under the old system. Under the Ryotwaree tenure, the cultivator pays revenue on all land which he elects to keep in occupation for the year, whether the land is cultivated or left fallow, and in like manner he pays water-rate on all such land which is assessed as irrigable, whether he cultivates it or not.

12. The assessment of land as irrigable, or nunjah, is determined by the Settlement Officers, or the Collector, from time to time. It has been ruled that all land which has been irrigated for three years consecutively is, thenceforth, permanently assessed at the irrigable rate. When this has once been done, it is no longer optional with the occupier of any such land

to abandon irrigation; at least this is the practical result, for the payment of the water-rate is in such a case enforced, if the land is kept in occupation for the year, whether it be cultivated with or without irrigation, or, as before said, even if left fallow. The only remedy of the ryot is to throw up his holding, and if this be done, the land can be let to any one else who will pay the Government demand.

It may be added that the term 'nunjah,' or 'irrigable,' is practically convertible into 'cultivated with rice,' this crop being the universal staple receiving regular irrigation. Some of the other grains are occasionally watered, but the charge for such irrigation is dealt with separately; and, though watered, such crops are not classed as 'nunjah,' but as dry crops or 'poonjah.'

13. In the North-Eastern Districts of Madras, where the Zemindaree tenure assumes some prominence, the additional water-rate is levied from the cultivators of Zemindaree lands who use water, either directly, or through the Zemindar when he is disposed to make such an arrangement, on all land supposed not to have been irrigated when the settlement was made with the Zemindar. It is presumed that the water-rate on the land irrigated at the time of the settlement is included in the gross revenue then fixed.

14. A like system is followed with respect to Inamdars. For all land recorded in their rent-free grants as irrigable, they are entitled to receive water without charge. Any land so recorded as dry, which afterwards is watered, is liable to the water-rate.

15. I was left with the impression that the check on these extra payments for the irrigation of Zemindaree and Inam lands is at the present time but imperfectly carried out in the Godavery and Kistnah Districts. Also that on all Government canals the system of control over the distribution of the water, and the check on the payments for water supplied to land assessed at dry rates, is everywhere unsatisfactory.

16. On the Godavery and Kistnah Canals, the Engineers have a full control over the water-supply and its distribution. But they have no relation whatever with the control of the special water revenue, excepting that they are expected to assist the Collector in determining whether any remissions should be given when they are claimed on the ground of the water-supply having been deficient.

17. In the Tanjore District, the Engineers have professional charge of the works, but not of the water-supply or distribution, which is in the hands of the Revenue Officers exclusively. Naturally the Engineers here have no sort of concern or interest in the fiscal results of the works.

18. As regards the minor tanks and other works, the Engineer is nominally responsible for seeing that they are kept in order; but I am led to think that this responsibility is often by no means strongly felt, and that, in practice, the Revenue Officers, as frequently as not, are the agents for calling the attention of the Public Works Officers to the requirements of the minor Irrigation Works.

19. Throughout Madras the Government has, with very few exceptions, virtually accepted the duty of maintaining all the Irrigation Works at the public expense, in consideration of the Ryot paying the irrigable rate on watered land: and this holds irrespective of the size of the work. From this obligation has arisen the practice of making provision through Government Officers for the repairs of the infinite number of small tanks

which are scattered over the country,—a practice which has given rise to much discussion, but which cannot be discontinued unless some important change of system is adopted in relation to this class of works.

20. There has been no special branch of the Public Works Department at Madras charged with the duty of superintending the maintenance and spread of irrigation. Consequent on the great diffusion of the smallest class of works, and other circumstances dependent on the past history of the Public Works Department, the division of labour which in other parts of India has for some years past begun to break up this Department, in common with all other administrative departments, into separate branches, specially charged with separate and distinct duties, has in Madras not yet been thought desirable. Every Public Works Officer, without distinction, performs all the duties of the Department of every sort which have to be performed in the geographical area in which he is posted, without relation to their nature. Roads, canals, jails, barracks, or whatever they may be, he superintends all works in his range.

21. This system being carried through the organization, there has not been, till within the last few months, any special branch of the Public Works Department for the consideration of the special class of questions arising in connexion with Irrigation Works. At the same time, owing to the complete severance of the Engineers from all concern with the revenue derived from the works, and from this portion of the administration being exclusively in the hands of the Revenue Officers, there has been nothing to develop a record of the class of facts which are of interest in common in an engineering and in a fiscal point of view. There is consequently an almost complete blank as to all those particular data which should have supplied the information I was directed to try to obtain.

22. Very little interest has hitherto been taken in ascertaining the exact cost of any of the Madras Irrigation Works, and as little in the actual results obtained from them either in the way of pecuniary returns, or in useful effect produced. Nowhere could I find any precise knowledge of the quantities of water used, and nowhere any trustworthy comparison between the quantity of water used and the area irrigated. Nowhere any attempt to determine the actual cost of any part of the operations of the Engineer in relation to the Irrigation and to the profits obtained from it.

23. I should explain that what I have just said refers to exact and precise data. Much, it is true, has been written as to the value of the Madras Irrigation Works. But all such discussions have, in my estimation, failed to take that complete and precise view of the actual facts which they should take to be of real value in the sense to which I refer. Not only have the calculations made of the profits claimed for the works been highly speculative, but no careful analysis that I have been able to hear of has ever been made either of the outlay properly chargeable to Capital, or of the annual charges for Maintenance. Annual Reports on the condition and results of Irrigation Works, such as have for many years past been drawn up in the North-West Provinces and Punjab, are not prepared in Madras; and the Madras Government has excused itself from the preparation of such returns on grounds the validity of which may at least be doubted.

Madras letter No. 1006, dated 12th April 1865.

The Annual Return till now submitted by the Madras Government is rendered quite untrustworthy from the causes above-noticed. I believe it would be safe to say that hardly any two of the works entered in that Return are strictly treated in the same manner, or in a correct manner.

24. In the case of one of the most important systems of works, the Cauvery Upper Anicut and the canals dependent on it, the Capital Account is quite wrong, the total cost of the works as stated in the Official Returns, respresenting the cost of a single work only, and being probably only one-eighth or one-tenth of the actual sum which should be regarded as the capital laid out. In this case also are omitted the very great bulk of the charges for maintenance, and the whole of the cost of management, so that the expenditure in 1865-66 for the irrigation of an area of something more than 750,000 acres is made to appear to be £244. The actual outlay could not possibly have been much less than £15,000, and may have been as high as £20,000. In another instance, the Godavery system of canals, the gross profits are reckoned as being the entire increase of land revenue from all sources which has accrued in the district since the works were brought into operation. In almost all cases the charge for the maintenance of the works excludes the cost of the Engineering establishments which supervise the works and repairs. In all, I believe, is the cost of collection of the income, whatever it be, entirely omitted. Erroneous entries also make the results appear worse as well as better than they actually are. In one case, the income excludes not less than one-tenth of the whole true amount because the account is prepared in one Collector's Office, which only notices the returns due to his own District, whereas the irrigation also extends into a neighbouring District, of the returns from which the other Office is ignorant.

25. The Madras Government itself has become aware that these Returns are not trustworthy, and has stated this in sending up the Return for 1865-66. The Government of India had some time back pointed out various probable causes of inaccuracy in these Returns, and further comments were made by the Secretary of State, but the actual facts go very far beyond what was then supposed.

Madras letter No. 885, dated 22nd March 1867.
Government of India Resolution No. 1230 C, dated 18th December 1865.
Secretary of State No. 48, dated 31st August 1866.

26. It is not necessary to enquire at length into the causes which have led to the preparation of these very inaccurate statements. It will suffice to say that the duty has been left to the Local Officers who have either misapprehended the object in view, or have fallen into errors of one sort or another, which have not been corrected by any central controlling authority, and which have been repeated year after year until they have grown into a sort of system, which it has not been thought the duty of any one to disturb or question.

27. The result of my enquiries regarding the Madras Irrigation Works has therefore been to show that nothing of a precise nature can be said of their financial value at the present time. All of the Returns must be entirely re-cast to render them of any real value. *First*, some distinct conclusion must be come to as to the system on which the profits of these works are to be estimated, for a separate water-rate does not exist at all in many parts of Madras, and the common practice is to make a combined charge for the land and water together. *Second*, an exact account must be taken of all elements of charge properly debitable to the works. Under these circumstances, it seemed to me inexpedient to ask for any fresh information in detail at the time of my visit to Madras in 1867. Its preparation would have given much trouble, and both the substance and form of any new statements might eventually have required change, in the case of my proposals as to the principles on which the profits of Irrigation Works were to be reckoned, and as to the form of the Revenue Account not meeting the

approval of the Government of India. I also thought it undesirable to attempt any revision of the Returns myself. This would have been a long operation, and such a duty is clearly one that could much more properly and satisfactorily be carried out by the Local Officers after the general principles to be followed had once been settled. My suggestions as to the form of Revenue Return henceforth to be be adopted will be found in a later part of this Report.

28. Although, for the reasons above stated, no trustworthy account can be given by me of the precise returns of any of the Madras Works, it may not be out of place to attempt to exhibit in an approximate way the results of one or two of the more important among them.

29. I will first take the Godavery system of Canals. From the peculiarities of the Madras Revenue system, there is no record of the area of land held under Zemindaree tenure readily available, and the extent of such land under irrigation can only be guessed at by me. The Ryotwarree land irrigated from the Godavery is about 200,000 acres, and judging from the water-rate paid by Zemindaree lands, I suppose that these last afford about an equal irrigated area, or that about 400,000 acres are irrigated in all. In 1864-65 the Ryotwarree lands irrigated in the Godavery District contained 202,111 acres, and produced Rs. 12,31,872 aggregate land revenue and water-rate. In 1848-49, before the new works had been constructed, the irrigated area was 127,320 acres, producing Rs. 4,13,513. There was, therefore, an increase of about 75,000 acres of area, and of 8 lakhs of Rupees of revenue on the Ryotwarree lands alone. But it is probable that some part of the additional 75,000 acres irrigated paid revenue as dry land at the earlier period. If we suppose that half of this area paid Rs. 2½ per acre, which is about the old dry revenue rate, it will make about one lakh for the former revenue on this land, which should be deducted from the 8 lakhs of increased income before arrived at. Thus the net increase on the Ryotwaree lands may be taken at 7 lakhs of Rupees. To this must be added the water-rate on the Zemindaree and Inam lands, amounting to rather more than 5 lakhs, so that the total result from irrigation will be 12 lakhs. The proceeds from navigation and sales of grass produced on the canal banks, amount to about Rs. 40,000, giving an aggregate of Rs. 12,40,000 for the income.

30. The outlay may be reckoned as follows:—

	Rs.	Rs.
Repairs		1,50,000
Establishments—		
Direction	6,000	
Executive	23,200	
Irrigation	22,700	
Navigation	14,000	
		65,900
Share of Revenue collection at 4 per cent. on 12 lakhs		48,000
Total outlay ...		2,63,900
Leaving a net income of		9,76,100

31. The Capital Account shows a total of Rs. 39,35,000. To this may be added 10 per cent. for Establishments, giving a total of 43¼ lakhs. The above income on this amounts to 22½ per cent.

32. Taking the corresponding figures for 1865-66, the result will be an increase of income of about 4 lakhs due to increased water-rate, and an increase of outlay of about Rs. 40,000, leaving a net profit of Rs. 13,38,000, which amounts to 28½ per cent. on the Capital, amounting to 47 lakhs.

33. The Officials Returns for these years make the profits appear about double the above. The figures which I have given are avowedly only approximate, but are probably not far from the truth.

34. In Tanjore, the lands irrigated from the channels drawn from the Cauvery on the average of 10 years before the improvements began, that is, from 1820 to 1829, contained about 550,000 acres, and produced a revenue of Rs. 29,30,000. In 1864-65, the whole irrigated area in Tanjore was 744,322 acres, and produced Rs. 36,06,147, showing an apparent increase of nearly 200,000 acres, and of Rs. 6,70,000; but this includes Tank irrigation, the precise extent of which I have no means of ascertaining. The annual outlay at the present time for the repairs of the works which supply this area, must be in excess of one lakh of Rupees, and with the cost of Establishments, the whole yearly expenditure cannot be reckoned at less than 2¼ lakhs, and if we suppose this to exceed the yearly charges of the former period by 1 lakh, and allow ¼ lakh as additional charges for collection, the net increase of income may amount to 5½ lakhs. The capital expended on the whole of the works in the Delta since 1830 is most likely in excess of 20 lakhs, and may amount to 30 lakhs. These figures are necessarily set down in a very arbitrary way, and I give my estimate for what it is worth. On the former sum, the profit would amount to about 27½ per cent. and on the latter, to about 18 per cent. The Official Returns show profits of about 200 per cent.

35. The Returns from the Kistnah and the Pennair Works, which are shown to give profits of about 16 per cent., will probably be found, when due allowance is made for all items of outlay, not to yield more than 10 or 12 per cent. on the correct sum debitable to Capital. In the case of the Kistnah, the works have been in operation about ten years, and in that of the Pennair about five years.

36. On the whole, however, I am quite satisfied that, though the Madras works do not give such returns as have been supposed, yet they are in the aggregate most amply remunerative to the State; and it is not at all improbable that properly prepared accounts may show that some of those works which now appear as causing loss really give fair profits.

37. There is only one other point to which I need call attention in relation to Madras irrigation. I will not disguise that it was with a certain shock that I first heard the Zemindaree lands of that Presidency spoken of by the Revenue and Public Works Officers. There was a sort of implied conviction that the cultivators of these lands had no claims on the Government to be furnished with the means of irrigation, or other material advantages. I do not mean to say that such a feeling is seriously defended by Madras Officials, or that active encouragement has been given to it by definite Government action; but that it exists in a covert and indefinite form to an objectionable extent, and has given rise to results which are to be regretted, I am quite satisfied.

38. It is not difficult to understand how such a feeling has arisen under the peculiar tendencies of the Madras Ryotwaree system. The Government ryot holds the same relation to the Government as landlord, as the ryot of the Zemindar holds to the Zemindar. It seems a natural conclusion on the part of the Officers who may be regarded as the land agents of

the Government, that what is done by the Government for its own ryots, should be done by the Zemindar for his; and that in this point of view, the condition of the ryots on Zemindaree lands is no concern of the Government. I need hardly say that in such a narrow view of the case, the duties of the Government to all its subjects, apart from any special landlord's duties, are obviously lost sight of.

39. But it is unnecessary for me to say more on this head than to indicate the erroneous disposition to which I have referred, and to express my conviction that in the future all will be done that is required to remove it, and to secure to all of the aggricultural population alike, independently of the tenure under which the land is held, equal facilities for the enjoyment of whatever advantages in the way of irrigation can be made available. I am aware that some special arrangements may be necessary in respect to the irrigation of Zemindaree lands to admit of full effect being given to this principle, but I cannot for a moment believe that any practical difficulty worth speaking of would be met with.

2.—*Bombay.*

40. I now pass on to Bombay. In this Presidency, with the exception of a small class of works existing in Candeish, and less frequently in the Deccan, there is nothing deserving special notice out of Sindh.

41. The Candeish works are small masonry dams, called Bundaras, placed across the streams which flow from the Western Ghâts. They are of considerable value to the district, though not important as engineering works. There are no available accounts of a reliable nature to show the exact financial results of the Candeish Irrigation Channels, but the return is no doubt appreciable. They are not, in any proper sense, under engineering management, though the necessary repairs are carried out by the Public Works Department. From their small size, indeed, and their general character, they only call for the minimum of control, and what there is of this, is exercised by the Collector.

42. In all the Bombay Districts I understand that a separate water-rate is recorded in the assessment of the land when irrigated; and this, if I mistake not, is extended even to the case of well irrigation. But no attempt has ever been made to estimate the net profits from irrigation after deducting all the contingent charges to which the State is put from the construction or maintenance of the works, or the collection of the additional income obtained by means of them.

43. The irrigation of Sindh having formed the special subject of a Memorandum which is already before the Government of India, much time need not be given to the statement of my views regarding it.

44. In Sindh, cultivation may be broadly said to be impossible without irrigation in some shape, as there is almost no rain. The inhabited districts are everywhere traversed by canals drawn directly from the Indus, or some of its branches, without the aid of masonry works, and these have, for the most part, been in existence for a great length of time. Excepting the Mitrow Canal, no very important new work has been added to the canals of Sindh since the Province came into the possession of the British. Valuable extensions to them have, however, been carried out; and, within the line which it has till now been thought right to draw in Sindh in respect to Canal works, a fair amount of attention has been bestowed to them, and a large sum is expended yearly on their maintenance.

45. The line to which I refer as having at all events been practically laid down as to the Sindh Canals, is that the system we found should be

adhered to. In the paper to which I have referred, I have stated my reasons for thinking why that system should be given up, and in what direction a change should be made.

46. At present the Sindh Canals, excepting the Mitrow, are, in all administrative respects, under the Revenue Officers. There is a small Engineering staff maintained to supervise the clearances which are yearly required to keep the channels in working order. But it can hardly be said that any serious attempt has ever been made to take in hand, on proper engineering principles, the improvement of the existing works, still less to re-model them.

47. Excepting where new lines of canal have been opened, the condition of things in Sindh is such as has long ago fixed pretty exactly the distribution of the available water. The supply being under no engineering control, the canals filling when the Indus rises, and running dry when it falls, the cultivators along the canals help themselves to what water they need, and what they can get, under a rough system of self-government which hardly calls for any administrative interference, and anyhow receives very little.

48. The system under which a combined assessment for the land and water has been established further removes much of the apparent necessity for any detailed supervision of the irrigation, and, so far as I am aware, not the smallest attempt is at present made to exercise any supervision. I am quite prepared to hear that this abstinence from interference may be supported as suitable to the condition of the people and the country in respect to the irrigation as it now exists. It no doubt has the sanction of custom, whatever that be worth.

49. In making these observations, nothing is further from my intention than to imply that the Revenue Officers or the Engineers employed under them on these canals have in any way failed to carry out the duties entrusted to them. I believe, on the contrary, that there has been much care and attention given to what has been considered proper. But I have no hesitation in declaring my own opinion in the plainest way to the effect, that the present system is rude and unscientific in the highest degree, and is susceptible of almost unlimited improvement.

50. Of the canals in Sindh it is now difficult to do more than say that they are essential to the existence of the country; that they are maintained at such a cost; and that the revenue is such an amount. As to the due preservation of a balance between cost and production, nothing can be told. No special canal accounts or reports are rendered, and there is apparently very considerable difference of opinion between the Revenue Officers and the heads of the Sindh Irrigation Department as to the present condition of the canals compared to what it was some years back.

51. It is neither necessary nor expedient that I should refer in a more precise way to a controversy of this nature. The most important lesson which I am able to derive from it is, that the administration is not what it should be, or such a question could never have arisen. My own impression may be summed up by saying that there is only one complete remedy possible for whatever has gone wrong, and that remedy is to be sought in the placing a complete responsibility for the thoroughly efficient condition of all the canals and their economical management on a properly constituted professional department, and limiting the duties of the Revenue Officers strictly to questions relating to fiscal matters.

52. In speaking of the canals of Sindh, I distinguished the Mitrow Canal from the rest. The Mitrow Canal has been constructed entirely

under the British Government, and was laid out on what at all events were considered proper professional principles. There has, however, unfortunately been a strong difference of opinion as to its value. It would seem to be impossible that this could have happened under a proper administrative system, and I cannot avoid the conclusion that whatever defects there may be in the operation of this canal, they are much more likely to be attributable to a defective system of management, than to any fundamental errors in the design. But as regards this work, I have no definite facts to go upon, and any further speculative comments would be out of place.

53. Thus in Bombay, as in Madras, it appears to me that systematic management and recording of statistical and financial results of canal irrigation still have to be created. The small importance of the Deccan works, and the peculiar character of the Sindh works, sufficiently explain how it is that so little has been done in Bombay in this direction.

3.—*The Punjab,*

54. In the lower portions of the Punjab, along the Sutlej, Chenab, and Indus, Inundation Canals exist much of the same character as in Sindh, and till the present time they have continued to be managed on the old system of the country in like manner. The Punjab Government has recently made proposals for taking up these canals and bringing them under professional management in a more systematic manner than had been before thought necessary. The Government of India has given a general assent to the proposal, and such steps as may be found suitable will no doubt in due course be taken.

55. My opinion has already been stated in respect to the Inundation Canals of the Punjab in my report on the general proposals of the Government of that Province as to the extension of irrigation, and it will be sufficient if I here refer to it. (Note, dated 1st August 1867).

56. Besides the Inundation Canals, there are minor irrigation channels in the Punjab Territory managed under the Revenue Officers. Such are the water-courses in the Peshawur Valley and in the Kangra District. I have no specific knowledge of the manner in which these works are managed. But I believe that they are mainly, if not altogether, village works, and that the land revenue is raised in a lump-sum, including all charge for water on the land irrigated from them. These works have never been under Engineering supervision. The attention of the Punjab Government has quite recently been directed to the question whether it may not be desirable to place them under some professional control.

57. The total area irrigated by Canals in charge of Government Officers in the Punjab for the last year of which we have returns, was 800,000 acres.

4.—*Perennial Canals of the North Western Provinces and Punjab.*

58. The larger canals of the North Western Provinces and the Punjab are so exactly alike in all their characteristics, that they may be dealt with together in this review.

59. These canals differ in many important respects from the irrigation works of the South of India. First, they have the peculiarity of being perennial, the supply being maintained at much the same volume throughout the year, at least so far as the wants of the country require that this should be done. The next important distinction of these canals is derived from the great difference of the climate of the North of India

as compared to the South. The agricultural year in Northern India is sharply divided into a cold season or rubbee, and a hot season or khureef. In the former are produced the ordinary crops of temperate climates. In the latter exclusively those of the tropics. In Southern India the temperate forms of agricultural produce are almost unknown, and there is, so to speak, one continued hot season throughout the year. It is one of the things which most strikes a traveller from the North of India, that in the South there seems no very special time for sowing or reaping any of the crops. This, however, is not to be taken too literally, for the periodical summer rains give a considerable degree of regularity to agricultural operations. But it is quite common to see rice, for instance, in all stages of maturity at the same time growing below the tanks of Madras. Under favourable circumstances, as one crop ripens and is cut and removed, a second will take its place. In a less striking manner the same irregularity is seen with other crops. In Northern India, on the contrary, if the khureef or hot-season crop is not matured before the end of October, the sun ceases to have power enough to ripen it, and therefore it becomes essential to sow before a certain period of the summer is past. The special requirements of the cold-weather or rubbee crop, which consists of temperate species, in like manner dictate a close limitation of all the agricultural operations on which it depends within certain fixed periods of the year.

60. Among the conditions of climate which distinguish the North of India from the South, must also be noticed the winter rains of the former, which become more abundant as the latitude becomes higher. This second rainy season is, of course, peculiarly favourable for the second agricultural season; and the rubbee crop is, no doubt, in a great measure dependent on this important meteorological phenomenon.

61. These peculiarities of the climate and of the agriculture, render a perennial supply of water, if not essential in Upper India, at all events of the highest importance. As a rule, no land under ordinary culture will bear more than one crop in the year. If two crops are taken, it is due to peculiarly rich soil, or to the aid of unusual manure, or some such exceptional circumstances. Hence, in Upper India, we find that a portion of the lands will be cropped in the rubbee, and lie fallow in the khureef, and *vice versâ*. In the South, the rule is that the bulk of the crops are on the ground at the same time, and the majority of the lands fallow at the same time, according to the period at which the rainy season happens, allowance being made for exceptional crops, which in some instances may be of such importance as to make the general rule inapplicable.

62. Naturally, the characters of the Irrigation Works of the North and South have been adapted to these different conditions. The large rivers which flow from the Himalaya have been made to yield the perennial supply of water needed for the double system of crops suited to the climate of the North. The rivers of the South, which are for the most part only full during the rainy season, have, by a corresponding adaptation of their peculiarities to the wants of the agriculture, been made to supply, for the shorter period during which they are available, the larger volume of water needed consequent on nearly the whole area being brought under crop at one time.

63. Next, the canals of Upper India differ from those of the South in the length to which the chief irrigating channels of the former have to be carried from the heads of the supply. The physical formation of the country in which the larger Madras canals are formed, has led to the anicuts from which they are drawn being placed at the heads of the deltas of the

main rivers, which are but little more than 30 miles from the sea in any case. Hence, the irrigating channels in the Madras Canals have to supply what may be roughly termed a semi-circular area, having for its centre the anicut, and a radius reaching to the sea. The canals therefore immediately begin to sub-divide, and there are no large channels excepting for a short distance near the anicut. Again, the districts in which the chief Madras works are formed being deltas, there have been found many natural channels well suited to take the place of irrigating canals with very little alteration, at all events on the first opening of the works. The canals of Upper India, on the other hand, from the necessities of the case, are extended in long lines of large capacity through a country where there are no pre-existing channels fit to serve as irrigating canals.

64. Moreover, the Canals of Northern India have almost everywhere been constructed in districts densely peopled and already well cultivated, where cart-traffic is largely in use, and where it is absolutely essential to provide numerous bridges, not only over the main canals but over all the branches and distributing channels, to meet the legitimate demands of the internal traffic of the districts traversed by the canals. The perennial nature of the canals of Upper India makes this obligation to provide bridges the more complete. The Madras works in these respects differ greatly from those of the North. There is hardly a bridge to be seen in connexion with most of the great Irrigation Works of Madras, and I believe that it would not be a serious exaggeration to say that the expenditure for bridges alone on the Ganges Canal has been more than the entire sum spent for all purposes on the Godavery Works.

65. There is yet another very important cause of difference to be mentioned: it is that the fall of the surface of the country watered by the canals of Upper India is much stronger than that of the Madras deltas. This, combined with the larger volume of the Northern canals, requires the provision of a special class of works to obviate the excessive velocity which would otherwise be generated in the channels by the great slope. It is to the want of sufficient experience on this point that should be attributed all the difficulties that have arisen with respect to the Ganges Canal.

66. The canals of Upper India are commonly drawn from the larger perennial streams just within the first ranges of the Himalaya. Till now, permanent masonry dams have not been formed across the parent streams for any of these canals. But the propriety of constructing such works has been recognized, and as opportunity offers they will be made. In this respect the Northern canals have a great advantage in respect to economy of first construction, a sensible part of the cost of the Madras canals being due to the construction of the anicuts, and the maintenance of these works being heavy in proportion. The position of the heads of the canals of Upper India has, however, led to a special source of expense, from the necessity for crossing the drainage from the hills in the upper part of the canal's course. In none of the canals of the North of India has it been possible to avoid a large expenditure on this account, which has nothing analogous to it in the Madras works.

67. On the whole, the obligatory expenditure on the canals of Upper India has been much larger than that of the Madras Canals, and it is not possible to make any proper comparison of the relative economy of the construction or maintenance of the two classes of canals without taking into consideration the whole of the circumstances to which I have now referred, and without obtaining a precise account of the elements of charge in detail, data for which are at present quite wanting.

68. On turning to the revenue derived from these works, we find that the tenure of land in the North and South is as different as the climate, and that corresponding differences have hence arisen in the mode of assessment of the water-rates, and in every part of the system of irrigation and management. Irrigation in the North Western Provinces and Punjab having been introduced into a country where, as a rule, the settlement of the land revenue is made with village proprietors, and where the State takes no note of the actual occupier in collecting the land revenue, it naturally happened that the additional charge for the canal water was made in the form of a special cess on the cultivator of the land actually irrigated. So also, having regard to the great variety of crops in the two very distinct agricultural seasons, and to the general poverty of the cultivators from whom the water-rate was levied, a system of separate rates for the several chief crops was established. This position of affairs again led to the management of the whole fiscal administration of the canals falling into the hands of the Canal Engineers, with whom the distribution of the water lay, and to whom alone the exact circumstances under which each village received its water-supply were fully known.

69. Although it is not for a moment to be disputed that there is still great room for improvement in the canal administration of the Upper Provinces, yet it seems to me indisputable that these Provinces are the only part of India where anything deserving the name of properly organized administration in connexion with irrigation exists at all. Taken as a whole, the present system is, in my opinion, very excellent in most respects, though I consider that it carries the Canal Engineers too far into the details of fiscal management, which could be as well cared for by persons not having technical engineering knowledge. But the precise adjustment of the line to be drawn between the province of the Engineer and the Revenue Officer, is obviously one of those matters on which it is impossible to dogmatize with advantage. It is more than probable that the system of fiscal management of irrigation canals will require modification from time to time, as the social condition of the population changes with the advance of civilization; and all that can be desired is to effect a good practical solution of the problem having regard to the particular points which experience indicates to be deserving of attention.

70. Among the advantages of the truly organized administration of the canals of Northern India will be found the existence of a regular series of annual reports on their results, now extending over many years. It is true that these reports have only lately begun to assume that precise form which it is so important to give to them; but they nevertheless contain valuable records of the past, and have under the more active supervision of the last few years already been instrumental in bringing about many and great improvements in the management of the canals.

71. Taking a general view of the entire financial results of the larger canals of Madras, and of the North of India, there is, I think, reason to believe that the former have been more remunerative than the latter in relation to the capital laid out. But there is no evidence to show the precise amount of the superiority. Nor, when regard is had to the far larger obligatory outlay on the Northern canals, is it by any means clear that any advantage would remain to the South if the comparison were confined to the outlay on the classes of works which are common to both, or if a fair set-off of special charges were made. So far as engineering skill and good management are concerned, I see no reason whatever to think that they are evinced in a higher degree in the one part of

India than in the other. The Madras works are in many cases designed with singular boldness, and have been executed with great success, and no one is more ready than I am to acknowledge their high merits. But I can find no ground for denying the presence of like characteristics in the canals of the North Western Provinces and the Punjab, and I may sum up my conclusions on this matter by saying that the probability is that the essential wants of the country have in both cases been well met under the special conditions of each, by the class of works which we actually find to exist. In both cases, highly intelligent Engineeers have for a long series of years given their time and thought to the perfection of the works, and I think it would be obvious presumption on the part of myself, as of any one else, to question their suitability to the ends they have to meet, without a more exact knowledge of the whole subject than is likely to be obtained by any cursory inspection.

72. I may conclude these remarks on the canals of the North Western Provinces by stating that the area irrigated by the works under Government Officers, according to the last returns at my command, was about 800,000 acres.

4.—*Other parts of India.*

73. There is no systematic irrigation in operation under the Government in Bengal, Oudh, the Central Provinces, or Burmah. In Mysore the Irrigation Works are numerous, and have the general characteristics of those of Madras, and call for no special comment.

II.—On the system of management of Irrigation Works most likely to be advantageous.

74. The principle which I conceive to underlie all thoroughly successful administration is this, that the agency employed should be truly competent to perform the duties expected of it, and that there should be a controlling authority completely responsible for the proper performance of the whole of those duties. In proportion as we approach or recede from this standard, will it be found that administrative action is successful or otherwise. In practice it will often be difficult to ascertain in a precise manner how the best agency and system of control is to be secured, on account of the complication of interests which have to be dealt with in the general direction of a large department. Nor is theoretical perfection ever attainable, and most commonly a great deal must be tolerated which is known not to be satisfactory. All of these difficulties may have to be met in the present case, but this can give no sufficient cause for abandoning the true standard by which results should be judged, and our course of action, within the limits of what is practicable, guided.

75. Confining ourselves for the present to that class of works which would properly fall under the full control of Government Officers, and excluding the minor works, the construction or maintenance of which, either on account of their simplicity or their intrinsic small importance, may be better left in the hands of the cultivators themselves, it will be apparent that the duties to be performed may be classed under the three following heads:—

First, construction and maintenance of works;
Second, management and distribution of water-supply;
Third, fiscal administration.

76. No serious question is now likely to arise regarding the agents who should carry out the first class of duties. In their nature they must

obviously be performed by professional Engineers, if they are to be properly performed. It can only be regarded as a strange anomaly, and anachronism that an attempt should quite recently have been made at Madras to impose on the District Revenue Officers the execution of the repairs of some of the very largest Irrigation Works. Such a course if anywhere tried again will almost certainly be immediately abandoned as it was at Madras. That it should there ever have been thought of seems to me a most convincing proof of the necessity for a complete re-organization of the system of irrigation administration.

77. The second branch of duties is that connected with the management of the water-supply. It has before been stated that in Upper India these duties are exclusively in the hands of the Canal Engineers; that in the last constructed works at Madras, the Engineers exercise a control over the water-supply and distribution, almost as complete; while in the older works, such as those in Tanjore, the management is exclusively in the hands of the Revenue Officers. The questions then arise, which of these systems is the best, and is there any sufficient reason for adopting the one system in one place, and the other in another? Is it expedient to maintain the old system such as prevails in parts of Madras, Mysore, and Bombay, under which the management of Irrigation Works is virtually in the hands of the District Revenue Officers, the Engineers only intervening, when called upon so to do, to execute repairs, or to correct obvious defects; or should this business be transferred to the Irrigation Engineers?

78. The positive arguments in favour of a professional management are that, for the economical and certain distribution of water in prescribed proportions to different localities, engineering skill is absolutely needed; that this skill is equally requisite to admit of trustworthy opinions being formed as to the sufficiency of the water-supply, the causes of deficiencies, and the best way of preventing or remedying them; the possibility of extending the use of the available volume of water, and the means of accomplishing this; the manner of dealing with the drainage of the irrigated lands and utilizing to the utmost the surplus waters passing from them or the irrigating channels; the decision of disputes among consumers of the water as to the shares to which they are equitably entitled, and the quantities they actually receive. In fact it may be said that, among all the steps that have to be taken in relation to the supply of the water and its distribution, there is not a single one which does not call for professional knowledge. The properly qualified Canal Engineer has this knowledge; the Revenue Officer is, as a rule, wholly devoid of it, and it may be safely said that no knowledge of the sort in question which he will possess will be of sensible value. As a fact, when there is a non-professional management, the whole of the matters above-mentioned are entirely neglected until the evils caused by such neglect become so serious as to lead to an Engineer being called in to apply a remedy.

79. Nor does this complete what has to be said on the subject. In truth, the full benefit of engineering skill and knowledge can never be applied to the construction and maintenance of the works unless the Engineers are constantly watching their operation, and have an intimate acquaintance with all their peculiarities, and the precise wants which they are to supply. Not only is professional knowledge necessary to secure the best management, but a complete practical knowledge of the details of management is necessary to secure the most satisfactory application of professional skill to the works. To know how best to design and construct his works, the

Engineer must know how they are used; and to know how best to use the works the managing Officers must have engineering knowledge. The conclusion seems unavoidable that the Engineers should have the management of the irrigation.

80. And what is it which the Engineer is alleged to be unable to do in respect to the management of Irrigation Works? So far as I am able to follow the advocates of the non-professional system, it is alleged that custom has determined the shares in which the water has to be distributed, of which the Engineer will be necessarily ignorant; that the distribution has till now gone on satisfactorily under the supervision of the Revenue Officers; that the land revenue is directly dependent on the regular supply of water where it is wanted, and that the Revenue Officers who are responsible for the land revenue, and are in fact the guardians of the interests of the State in the land, are best informed on such subjects, and, therefore, best qualified to direct the distribution of the supply; that the Revenue Officers will have greater general authority in the District, and be better able to carry out the works and operations needed in connexion with the irrigation; and generally, that the laws, rights, and customs relating to irrigation are so closely connected with the occupation and cultivation of the land, that it will be impossible for irrigation to be managed in a satisfactory way unless by the Revenue Officers, and that to transfer the administration from these Officers would be alike injurious to the State and the people, and unacceptable to the latter. Further, it is said by some that, after all, the cultivators know much better what they want than the Canal Engineer can do; that existing methods of irrigation are excellent, and really call for no serious change, and cannot be sensibly improved; that special controlling establishments will give occasion for acts of oppression. In short, there is a general denial of the value of professional supervision, and a general affirmation that the system which custom has handed down to the present generation is, as a whole, sufficient and satisfactory.

81. I am quite content to rest the conclusions to be adopted on such an issue. I believe that there is one thing only which leads with certainty to success and progress, and that is knowledge; that there is no condition of affairs in which improvements of great value may not be made by the help of increased knowledge; and that of all places in the world where such improvements may most reasonably be hoped for, India stands very prominently forward. I reject the doctrine that Revenue Officers, avowedly quite devoid of all the special knowledge which is required for anything but an empirical management of the supply and distribution of water, are proper persons to be left in charge of such a duty one day after it becomes possible to replace them by persons possessed of such knowledge. I dispute the position that, under a reasonable system, professional Engineers would be one whit less capable of dealing justly with established rights to water-supply than the District Revenue Officers, or less careful of the interests of the community and of the public revenue dependent on the efficiency of the irrigation, or less able to command respect and co-operation from the people of the country in which the works lie. On all these points we have direct evidence, obtained from actual experience in Upper India, that professional Engineers are to be trusted quite as fully as Revenue Officers; and, on general grounds, it may safely be predicated of the professional Officers, that inasmuch as their exact knowledge of the things to be done will necessarily be more complete, those things will be better and not worse done by them. With no less confidence do I assert that great and valuable improvements may without the smallest doubt be made in the Irrigation

Works of all parts of India, and that the scope and necessity for improvement is especially great precisely where the non-professional system of management has till now been followed.

82. As to questions of law, rights, and customs, so far as these really affect the management of irrigation, I can conceive no reason why they should not be as well understood by a specially trained class of Engineers, as by the Revenue Officers. If it be implied that the administration should be absolutely subject to the prescriptions of mere custom, I at once challenge the opinion, and affirm on the contrary that to subordinate our action to such a rule is to shut our eyes to the light, and to reject progress. Is it seriously desired to exclude from the management of Irrigation Works the class of persons who are precisely the best able to improve their usefulness, because they are not likely to have sufficient respect for the ignorance of the past?

83. I will further only say that the same considerations which have of late years led to the formation of separate branches of the public administration to manage the Revenue surveys and settlements, the Telegraphs, the Post Office, Education, Civil and Criminal Justice, and so forth, also indicate the propriety of taking the management of Irrigation Works from the District Civil Officers, and entrusting it to a special professional body. It is comparatively but a short time ago since most of these branches of public business, so far as they had any recognized existence, were almost exclusively in the hands of the members of the Civil Service, and since the Collector of a District exercised in his own person the chief executive authority in almost every branch of the administration. Even now this state of things exists in many parts of India. In truth, we have to go back very few years in the history of Indian administration to reach the days when no attempt had been made to establish that division of labour in the public service which our present increased knowledge shows us to be essential for anything like satisfactory progress. The entire Department of Public Works is, so to speak, a creation of yesterday, its existence in anything like its present shape only dating from about 14 years back. Before that time, in Madras, the District Civil Officers were in fact the executive Officers of the Public Works administration, such as it then was, and, as a matter of course, the Canal administration was exclusively in their hands. In the newer Irrigation Works, under a modified system of general administration, the management of the water has been placed much more completely under the Canal Engineers, and I have never heard it alleged that the results are unfavourable to the professional Officers.

84. On the whole, it seems to me entirely to the operation of what I suppose I must call a prejudiced preference for the past, that is due the disposition to object to the substitution of a properly qualified special professional management of Irrigation Works, for the system of *laissez faire* such as exists in Tanjore and Sindh, and which, in my judgment, does not deserve the name of management at all. I think it right to allow no disguise in the expression of my convictions on this point, because I believe that proper progress is only to be secured by abandoning the old system wherever it still prevails. I know well that I may be accused of presumption in venturing to oppose my opinion in such uncompromising terms, (which opinion it might be said has been formed on an imperfect and superficial acquaintance with the facts,) to the convictions of public officers who have for years been charged with the administration of the land revenue, and whose lives have been passed, so to speak, in the midst of the system which they support. But in the face of this

risk, it is my duty to state my conclusions; and that they may be strongly contested is an additional reason for leaving no doubt as to their real scope.

85. So much as to the necessity for placing the management of the water-supply of Irrigation Works under a special professional department, to the exclusion of the ordinary Revenue Officers. I now have to refer to the 3rd class of duties, those connected with the system of fiscal administration, and the supervision of the assessment of the charges for the use of the water and the collection of the revenues.

86. One of the questions which has been often discussed in comparing the relative merits of the Irrigation system of Southern and Northern India, is the proper position of the Canal Engineer in relation to the realization of the Canal revenues. As was before stated, the Madras system gives the Engineer no concern whatever in the revenue; that of the North-West makes him exclusively and entirely responsible for the assessment and determination of the payments, leaving to the District Revenue Officers the simple duty of receiving the actual payments. I have already briefly explained how these different systems arose.

87. I have before implied that both of these systems appear to me to err: the former in excluding the Engineer from all concern in the revenue; the latter in throwing the fiscal duties too much upon him. There would seem to be a possible medium between them, which should secure the advantages now claimed by the supporters of both systems. The advocates of the North-West system allege that, as the Engineer has the full control of the distribution of the water, he will know best what should be charged for its use in every case, and will best be able to ensure the just claims of the State being established and realized. The Madras argument is, that the Engineer's time should not be occupied with other duties than those which are truly professional, and that the fiscal arrangements can quite well enough be carried out by the ordinary Revenue Officers.

88. There can, it seems to me, be no doubt that if the Canal Engineer be the Officer responsible for the distribution of the water, his duty should extend at least so far as to see that the demands for payments are in the aggregate properly made. He should have a complete knowledge of the areas irrigated and the details of the various crops, and it should be a part of his duty to compare the quantity of water used with the area irrigated. He would thus have the means of bringing a check to bear on the demands for payments for water, by instituting a comparison between the quantities of water supplied, and the irrigated area, and the charge made for irrigation. He should be further responsible that the greatest amount of useful work possible is in fact obtained from the water which is brought into the Canal, and he should be made to account exactly for the whole supply. From what I have heard at Madras, I am satisfied that the absence of this control there leads to the demand of the Government being imperfectly made, and that sensible loss of revenue is the consequence.

89. But beyond this it would appear to be at least not necessary for the Engineer to go. It cannot be regarded as important that the details of the estimation of the areas irrigated should be checked by the Engineer in charge of the Canal, nor that the details of the assessments should be calculated or controlled by him. In these matters there is room for some variation of practice. So far as the ordinary land revenue is affected by irrigation, certainly the ordinary District Revenue Officers will continue to be the proper authorities to deal with it, and this must also apply to cases

where, as in Madras, there is a consolidated assessment. Where a special water-rate is levied, it seems most probable that the assessment and fiscal management would be better made under separate Officers acting independently of, but in close communication with, the Engineers in charge of the works and distribution of the water.

90. In all cases, however, it appears to me essential that one superior authority should control the whole of the fiscal arrangements, the management of the irrigation, and the engineering duties proper. And this consideration brings us back to the principle laid down at the commencement of this discussion, namely, that for efficient administration there must be a single directing authority, completely responsible for the satisfactory performance of their duties by all branches of the agency employed, both in respect to special details, and to the general objects aimed at. For the full realization by the community and the State of the greatest advantage possible from irrigation works, it is indisputably necessary that the whole of the operations to be performed should be carried out in relation one to another, and under the control of an authority which will be competent to direct them all, so as to obtain the greatest useful effect from each. It will be requisite therefore,—to secure a comprehensive view being taken of all the wants of the country in relation to irrigation, and of the means available for meeting those wants; to ensure the construction of the works most suitable for utilizing the available means, and afterwards the management of the works in the most efficient way; and lastly to provide for the realization of a proper return to the State on its outlay, while strict economy is exercised in the administration, and the burden on the agricultural community which uses the water is not unduly increased. To accomplish such a purpose a special Irrigation Department must be organized, to which should be completely and exclusively entrusted the control of all the branches of the administration of irrigation.

91. Although such a special department must, for complete efficiency, be in a great measure composed of professional Engineers, and must be mainly directed by officers having technical qualifications, it will by no means follow that it should exclusively consist of such persons. On the contrary, it is most probable that a separate revenue or fiscal branch of the administration should be formed, composed of Officers having qualifications similar to those of the ordinary Revenue Establishments, and that to these the revenue business of the irrigation works should be specially entrusted. The Engineers in charge of the works should, as far as is practicable, be relieved of merely fiscal duties, and their attention restricted to the construction and maintenance of the works, and management of the water-supply. The superior controlling Officers should be so organized as to secure the harmonious working of the whole machinery, and make its several parts mutually beneficial one to another, so deriving the greatest possible advantage from the judicious application of the principle of the division of labour. In short the management of irrigation works should be conducted on the general system which experience has proved to be most suitable for Railways, and other large remunerative public works, the duties being divided between one or more engineering branches, and a fiscal or business branch; the former being responsible for all that concerns the works, and their operation, and the latter for the detailed transactions which relate to the realization of the revenue; the whole being under a single supervising head.

92. It would be among the duties of the central Irrigation department to provide for a periodical annual review of the operations of the whole

administration in each Province, and of each of the more important works in detail. Such an annual report would afford an efficient means of control by the Local Government on the working of the administration, and must be regarded as an essential requirement in the cause of future progress. It cannot be too distinctly present to us that the origin of all good management is to be found in an exact and intelligent perception of the facts to be dealt with, and that this can only be got by the careful recording and comparison of the results of the operations of all our works.

93. It may, perhaps, appear to some persons that the question at issue on the subject of Irrigation Administration is rather one of the degree of change which is desirable, or of the time when change should be made, than one of principle. To some extent this is no doubt true. In every province of India the advantage of placing the chief control of Irrigation Works under a special branch of the Public Works Department has been already recognized, and wherever change has been made in the system of management, it has been in the direction of taking it from the Revenue Officers and entrusting it to Engineers. So far as this progress has gone, I accept it with satisfaction. But the degree to which what I consider the proper principle still continues to be disregarded in some parts of India is so great, that it has been necessary for me to state at length my opinions on the whole subject.

94. It is of course also perfectly true that much that is useful may be accomplished, not only in such a business as irrigation, but in most other operations requiring technical skill, without any exact professional or scientific knowledge, and that in the forced absence of such knowledge from any cause, it would be most unwise to reject the best available agency which we can secure. It should, however, certainly be the aim of those who desire the increased usefulness of existing works, and the satisfactory construction of new ones, to avail themselves to the utmost of a management possessing professional knowledge, and to do what they can to hasten its introduction.

95. Again, I do not deny that there might be reasons which may appear sufficient to those in supreme authority for rejecting the prospect of obtaining improved irrigation at the price of introducing any considerable change of system, and for deliberately resting content with what is acknowledged to be worse, rather than strive to attain what would be better. But my arguments are not concerned with such an imaginary state of things. I am enquiring how the greatest improvements are to be obtained, and, of course, a hypothesis such as I have just made, which in its very nature rejects the idea of improvement, is altogether incompatible with this discussion. I may add, however, that I wholly disbelieve that any considerations of general policy of the nature alluded to can possibly apply with justice to the case of any of the irrigated districts of India, excepting, perhaps, on the North-Western frontier of the Punjab, where the population is suspicious and fanatical in an extreme degree.

96. Neither do I assert that it is necessarily expedient to make a sudden or fundamental change in any existing system in order to make it conform to what I consider the best system. My argument is, that a management such as I have described, is certainly the best possible, and should be got as soon as is practicable; and that the constant aim of the Government should be to accomplish this.

97. Before concluding my remarks on the subject of the management of Irrigation Works, a few words may usefully be said regarding the minor works which are so numerous in Southern India. The manner of dealing with these works has been the subject of much controversy,

opinion being divided whether they should continue as at present under the supervision more or less active of the Public Works Officers, or whether they should be wholly transferred to the management of the District Revenue Officers.

98. In these discussions there has I am satisfied been an unfortunate disposition to accept as a foregone conclusion that the duty of carrying out the repairs of the minor tanks must fall either on one of the Departments or the other. The possibility of getting rid of all direct Government interference has hardly been noticed, and yet it is a course which seems to me to be almost essential.

99. The Government, as I before had occasion to observe, has accepted, *de facto*, the responsibility for maintaining all Irrigation Works in consideration of the irrigated assessment on the lands watered by the several works being duly paid. It is alleged, and with much appearance of truth, that if the Government simply gave up the duty of repairing the smallest class of works, and made a corresponding reduction of the revenue to dry rates, the result would sooner or later be that the works would fall into complete ruin, and the cultivation would seriously suffer. The want of care and forethought among the agricultural population is such as to make it extremely probable that to spare themselves a small present outlay or exertion, they would risk the complete destruction of their irrigation works. It is hence argued that the Government must some how or other provide the agency for executing needful repairs.

100. It seems to me, on the contrary, that for all those works which are so small as not to justify the outlay necessary for a thoroughly effective engineering supervision, the Government should adopt an entirely different system. That it should, by a legislative enactment, if necessary, divest itself completely of the responsibility for maintaining any Irrigation Works it pleased to reject. That, in like manner, a legal responsibility should be placed on the village community which benefitted by any irrigation work to maintain it, a suitable reduction of the land assessment being made to cover the additional charge put on the community and saved to the Government. This reduction, however, should be given in the form of a *payment*, which would be made on the certificate of a Government Officer that the work was in satisfactory repair, but not otherwise. A proper system of inspection would be organized under the Irrigation Department, in which the subordinate Revenue Officers might readily assist. The Irrigation Department should have the power to enter into any needful arrangement with any person to carry out at the cost of the community concerned, the repairs of any work which was not satisfactorily maintained, and provision should be made for levying by a special rate any sum disbursed for this purpose.

101. In the maintenance of the works to which such a system would be applicable, there is nothing which calls for engineering skill, and the necessary work to be done is perfectly familiar to the people themselves. It might no doubt require some care and perseverance to establish such a system and bring it into effective operation; but that there would be any fundamental difficulty in carrying it out, I entirely disbelieve. I have already made definite proposals, of the nature above explained, for divesting the Government of the responsibility of maintaining the smaller class of tanks in Mysore. The question still is under consideration, but the measures suggested by me have, in their general tenor, been assented to by the Local Officers.

102. At the same time that the charge of the smallest class of tanks is rejected by the Government, a like change of system should be carried out, as far as needful, in respect to the irrigation channels in connexion

with canals. The main distributing channels which it was obligatory on the Government to maintain, should be declared to be wholly and exclusively under the control and at the charge of the Government, and all others should be completely left to the cultivators themselves, some reduction in the assessment being at the same time allowed, if thought equitable.

103. So far as it might at any time be expedient for the Government to afford pecuniary aid to the poorer class of cultivators, either to enable them to construct small tanks, or to dig wells, there could of course be no possible objection to that aid being given through the Revenue Officers; and in such cases it would be proper to require the Irrigation Department to give its advice whenever it was desired so to do. But the grant of such help is a totally different thing from the supervision of engineering works; and I consider that it is likely to be neither useful nor convenient to entrust the Revenue Officers with engineering work, if it can possibly be avoided, and that, unless in altogether exceptional cases, it can never be really necessary to do so.

104. It is not necessary for me to extend my remarks further on this subject. I will only add, in explanation of my purpose in entering upon this discussion, that it forms no part of my intention to suggest that any change of existing systems should be carried out merely by authority. What I have put forward only expresses my own conclusions on one of the most important branches of the duties which arise in relation to Irrigation Works; and holding the very decided opinion which I have formed on the necessity for a certain system of administration to secure the best possible results, I feel that I should not be acting up to the responsibility put upon me by the office I hold, if I hesitated to state that opinion in a perfectly distinct form.

III.—On the returns required for the exhibition of the financial results of Irrigation Works.

105. The financial returns of the results of Irrigation Works now required, only call for modification in respect to the details of the manner in which they are prepared; their general character is unobjectionable, though there is much to be desired in the way of increased precision and accuracy. These returns comprise a Capital Account and a Revenue Account, as is customary in such cases.

106. The Capital Accounts have hitherto been very frequently altogether untrustworthy, in consequence of proper attention not having been paid to their preparation. It has not been thought to be a part of the duty of the Accounts Branch of the Public Works Department to prepare these statements, or to check their accuracy or completeness. They have been drawn up in various ways by various Officers, and too often have received no critical examination whatever. Where they have been carefully gone into, as in the North-West Provinces and Punjab for the last year or two, the scrutiny has been exercised exclusively by the Executive Department without any reference to, or check by, the Accounts Department. It has never yet been declared to be the duty of the Accounts Office to determine authoritatively from time to time what sums were to be debited to the Capital of the several Irrigation Works, and what to their Revenue Accounts, nor has anything like a discriminating audit been established to distribute the expenditure of Public Works Officers between the Capital and Revenue Accounts of Irrigation Works, and other heads of charge.

107. Of course the remedy of this defect for the future, and so far as concerns new works, is extremely easy. All that is needed is that instructions

should be given to the Controllers of Public Works Accounts to perform the duty referred to, the principles on which the distribution of charges is to be made being defined, and rules laid down for deciding doubtful points.

108. More difficulty will be found in obtaining a reliable Capital Account for the old works already executed, on which the expenditure was spread over many past years when the system of accounts was not so precise as at present. For these the best approximation that is now possible must be got from the old accounts, making allowances, where necessary, for elements of charge the exact amount of which it may not be now possible to determine with precision. Some doubts will arise as regards the cost of Establishments, and some as regards the separation of the charges against Capital from those against Revenue. These must be solved in the best way practicable; and it is probable that with care the results finally deduced will not vary by any important amount from what an exact account would have shown.

109. As will hereafter be explained more fully, it will also be necessary to take an arbitrary starting point for the Capital Account in dealing with the oldest class of works. The only practical way of reviewing the financial results of the outlay on these works, is to compare the income as it was at a certain arbitrary starting point with the income now received. In such cases it will necessarily be assumed that all outlay before the fixed date taken, was a direct set-off against the gross revenue. After that date the outlay properly chargeable to Capital will be passed to the Capital Account, and a proper apportionment of the expenditure between Capital and Revenue will have to be made.

110. The question has been raised with respect to this class of older works, in which much that was valuable already existed before our Engineers began to make improvements, whether it will be possible to take account of the first cost of what we found ready to our hands, and how, if an allowance is not made for such first cost, any useful comparison can be instituted between the profits of the older and the newer works.

111. The reply to these questions must, I think, be in the sense already suggested, namely, that our examination into the profits of the older works must be confined to the returns on the outlay which has taken place within a given period. By adopting this course, some practical compensation will be obtained for the inequality in first cost of the old works as compared to the new. The old work will have the advantage of a relatively small Capital Account, but at the same time the apparent profits from it will be reduced, because on the proposed system the profits will be restricted to the sum by which the present income exceeds the old income realized at the time our operations began, or before the opening of the Capital Account. The new work on the other hand, while it has a Capital Account charged with the entire cost of the undertaking, also obtains credit for the entire increase of income due to the irrigation, because in the nature of the case there was no such income before the work was begun.

112. But although it may not be possible to place the accounts of the old and new works on a footing which will admit of exact comparisons, yet the means of obtaining useful information as to the relative cost and profits of such classes of works will not be altogether wanting. In all cases it will be very desirable to draw out the Capital Accounts in a way which shall indicate readily what have been the main elements of charge for each particular work. By help of such a statement it will at once become apparent what are the works which the Capital Account in any case actually represents, and hence may be inferred the amount of help

which has been afforded by the old pre-existing works. In an old canal in which for instance the main channels were obtained free of cost, it would be seen at a glance that the Capital charge for this part of the work was extremely low. In new works by help of these figures, the special characters of each would also readily be distinguished. It must be recognized as a necessary condition of works such as these, that the obligatory expenditure upon each will vary according to circumstances. The engineering difficulties to be overcome will not always be alike, nor the other circumstances which affect the outlay, such as the cost of labour, materials, and land, and the quantity of work to be executed. The very great difference which exists between the Godavery Canals and the Ganges Canal in respect to road-bridges for example would be made to appear by a reference to a Capital Account drawn up in the manner proposed, and the several other causes of the higher cost of the latter canal could be readily distinguished.

113. By dealing with the Capital Accounts in this way, it will also be possible to make some allowances for any omissions which have unavoidably occurred in drawing up the Capital Accounts of the older works. If any item of charge which is known to be necessary, and which burdens the accounts of the newer works of which the accounts have been kept with greater precision, does not appear for the older works, it may be safely inferred that, to some extent at least, the Capital Account has been under-charged, and that a larger relative profit should be expected.

114. In carrying on or extending works already begun or existing, it will obviously be proper to regard all the outlay, past or future, which is properly chargeable to Capital, whether it may have been supplied from the annual grants from Revenue, or from funds raised by loan, as forming one sum on which the profit is to be estimated. It will be critically correct to consider that all existing Irrigation works, for which Revenue Accounts are henceforth drawn up, have been constructed by borrowed funds, and that the capital so invested is a portion of the public debt. In fact, under the old system of open loans, there was no real distinction possible between grants from revenue and from loans; and any sum spent from Revenue on such works is a true investment by the Government, and may quite properly be regarded as represented by an equivalent amount of the debt. Moreover, in the accounts of expenditure, there is no distinction made between the outlay provided from Revenue, or otherwise, and to attempt any distinction in the separate accounts of irrigation works would be useless, or rather impracticable. For the purpose of establishing a proper check on the raising of money by loan for these works, all that is needed is to draw up exact statements in sufficient detail of the yearly sums borrowed and actually spent. This being done, the whole of the sums standing to debit in the Capital Accounts may be quite safely taken to represent the true investment of the Government on which the returns are to be estimated, and at the same time to show the portion of the public debt which has virtually been raised for the construction of these works, and on which the interest should at least be covered by the net income.

115. The proposed classification of the elements of the Capital Account will be found annexed. It has been prepared for the purpose of including all cases likely to arise in practice, and it does not follow that all the sub-heads will be applicable in every case. It may be added that the same classification will be suitable for the detail of the charges for maintenance, the comparison of which on different works is also desirable.

116. The only other point calling for attention in connection with the Capital Accounts is the system of charging for the cost of supervision when new works are executed by the regular fixed establishments employed on canals in operation. Of course, where new works are wholly carried out by special establishments, the entire cost of these will be a charge against the works. In the other cases, it seems likely to be the best plan to charge a fixed percentage on the outlay on works debitable to Capital, as the cost of establishment for the supervision of such works, and to deduct this from the total charge for the establishments for working and maintenance. I think 10 per cent. will, in future, be sufficient and near enough to a fair average rate, and will be a convenient rate for calculation. In the North Western Provinces and Punjab from 10 to 12 per cent. has been commonly taken. Where the accounts have already been drawn out, making a reasonable allowance of this sort, it will not be worth while to disturb them as regards the past: but for the future, and in cases where no account has yet been taken, I think 10 per cent. may be adopted.

117. I next have to consider the Revenue Accounts. In these, as I have already intimated, no sort of uniformity has been established in the manner of keeping the accounts or of estimating the profits, and no proper control has been exercised by the Accounts Department on the preparation or audit of the final accounts. As observed in respect to the Capital Accounts, the mere deficiency of departmental criticism and control will be readily got over. The essential point for present consideration is the system on which to reckon the income and charges, and to this I shall now proceed.

118. And first, the distinction must be recognized between ascertaining the mere financial results of any irrigation work with reference to the outlay of Capital which it has occasioned, and the special economy of management of that work having regard to the relation between the income and cost of maintenance, and the extent of the irrigated area, the volume of water supplied by the works, and so forth. So far as the finances are concerned, the exact measure of the success or failure of the application of Capital to the construction of irrigation works is to be found in the resulting improvement of the public revenue. If the net improvement exceeds the increased charge caused by the payment of interest on the Capital, the investment has at least not been unprofitable.

119. To estimate properly the financial results of any work, therefore we must be careful to take into account the entire increase of public revenue from whatever source derived fairly attributable to the direct operation of the work. Hence the calculation should evidently include the whole increase of land revenue due to the introduction of irrigation, as well as all direct water-rates separately charged, and all other receipts, such as navigation dues, mill-rents, sale of produce of land, &c.

120. The financial results of any outlay, in the sense in which they have been now used by me, must be reckoned simply on the Capital actually laid out, whatever have been the advantages or disadvantages under which the outlay took place, and whatever be the condition of the works, or the present value of what remains of them. The system, hitherto recognized in a partial degree, of allowing a deduction to be made for deterioration from the total amount of the original Capital outlay before reckoning the rate of income, charge, or profit, seems to have been intended to give the means of establishing a departmental or administrative standard by which to judge of the economy of management and the scale of income, in relation to the works as they actually existed from time to time. If half

of the works were by any accident swept away, the Officers in charge could of course only be expected to realize from the residue a revenue proportionate to the actual value of what remained. This consideration was no doubt too theoretical, and the deduction has been made in some cases in the Madras Returns, in far too arbitrary a manner. The mode in which such deductions might properly be made from the Capital Account will be referred to in the sequel.

121. Neither will financial considerations of profit be affected by the works having been partially based on old pre-existing works, for which no money was paid. Any increased profit thus obtained can only be regarded as due to a natural advantage which the Engineers have been skilful or fortunate enough to turn to their purpose. It is manifest that as each work will have a special character in respect to its design, and its first cost, so it will be as regards its remunerative value. Hence there will be no necessary close analogy between the gross or net returns from different systems of works existing under different conditions. The financial results must in every case be regarded as having an absolute rather than a relative value, and the profits can only be properly considered in relation to the Capital actually laid out on each particular work in question. The comparison of the financial results of different works one with another, will doubtless have a certain useful effect, and the examination into the causes of differences may lead to important administrative or fiscal improvements. But it must not be regarded as a discredit to the design of any project, or to the management of any work, that elsewhere a larger profit is obtained, under other conditions which do not in fact apply to the particular work under review. The differences in the character of the Capital Accounts of two systems of irrigation works, as before explained, will often give a means of judging to what extent similar results may fairly be looked for from them, or whether important variations should be expected.

122. I have said that the calculation of the profits of irrigation works should include the whole increase of land revenue due to the introduction of irrigation. The propriety of this view will not, I think, be questioned, though some difference of opinion may arise as to the way of estimating the exact amount of increase. One great cause of the want of success which has till now attended the efforts of the Government to obtain reliable accounts of the profits of irrigation works has been the erroneous system under which it was attempted to separate the profits due to the water from the profits arising from the land. It will be clear from the description which has been given of the mode of charging for irrigation in Madras and Sindh for instance, that the share of the income due to the water could there only be settled in an arbitrary manner, as there is a consolidated assessment on irrigated land. In Sindh, where cultivation is practically impossible without irrigation, the separation of the value of the water, from that of the land, could be made on no principle at all that I can conceive. Even in those Provinces where a special water-rate is charged on irrigated lands, it does not at all follow that it represents truly the real advantage to the State due to the irrigation. If the land revenue be raised merely because the land receives water, and would have to be lowered again if the water-supply were cut off, it is obvious that this increase of revenue is in fact as directly due to the irrigation as any income obtained from a separate water-rate.

123. The truth of these views as I before said will hardly be questioned; they have been accepted fully by the Madras Government and

its principal Revenue Officers, (see Madras No. 1185, dated 20th April 1868), and in the North Western Provinces and Punjab some attempt has recently been made to arrive at an estimate of the increase of land revenue due to irrigation works, and credit for this has been taken in the Canal Revenue Accounts. But these estimates have, I think, been made in an arbitrary manner, and on what I conceive to be an erroneous principle, and one which it is difficult to apply in practice, namely, that we should take as due to irrigation, the sum by which the revenue on any irrigated land exceeds what it probably would have been if the land had been left without irrigation. Now this at once removes us from the region of fact into that of speculation. Every Revenue Officer on such a principle would make his calculations, of what the revenue might have been without the canal, according to his own personal views. A far simpler, and at the same time a far better plan would surely be to take the actual facts of each case, and simply to recognize as the profits due to irrigation all increase of land revenue which actually takes place after land has been converted from unirrigated to irrigated.

124. In the case of an altogether new Irrigation work, where all the land supplied was before unirrigated, it would follow, on such a system as I have proposed, that the profits under the head of land revenue due to the work would be found by deducting from the actual land revenue of the irrigated land from time to time, the revenue which was paid immediately before irrigation was begun.

125. In the case of an old system of works where irrigation existed before, but improvements or extensions were made by an outlay of Capital, we should deduct from the present land revenue of the whole irrigated area for the time being the revenue on that same area at the date when the improvements were brought into operation, whether the lands were then irrigated or unirrigated.

126. It seems plain that, by this rule, the *actual* increase of revenue consequent on the construction of the works, or carrying out the improvements, will in each case be determined without the introduction of any arbitrary considerations at all. If it be said that the increase of land revenue on irrigated lands which follows the introduction of irrigation, is not wholly to be attributed to the irrigation, but will partly depend on that gradual natural increase of value in landed property which has nothing to do with the application of irrigation, the truth of the position may at once be conceded. But in reply it must be said that to distinguish this part of the increase of revenue from the other, is quite impossible; moreover, that if it could be done, it would not be worth while doing it. The object of the Government in drawing out financial returns of the sort under discussion is to enable it to arrive at a clear knowledge of the consequences of its outlay of capital on these works in relation to its income after the outlay has been made. The essential thing for the State in a financial point of view, is that there shall be in such cases an improvement of the revenue, immediately consequent on the outlay which shall at least cover the interest on that outlay. If this improvement takes place, never mind by what causes, the financial safety of the operation that has been undertaken will be secured. In short, although the fallacy of the argument *post hoc ergo propter hoc*, may in this case be admitted most fully, it must be added that the *post hoc* is here in fact all that is important, and that the precise amount of theoretical error introduced into our calculations of the true profits of our irrigation works by the suggested system will be absolutely small, and for the purposes in view, quite unworthy of notice.

127. If this principle be adopted for reckoning the increase of income due to the construction or improvement of irrigation works, it will follow of course that an analogous system must be adopted in respect to the outlay. In the case of altogether new works, there will have been no charges for irrigation before the works were brought into operation, and the net income will simply be the whole gross income, less the whole charges for maintenance, &c. But in old works improved, it will be otherwise. Here the real net increase of income will be the whole gross increase of revenue, *less* the whole increase of charge; or the same result will be obtained in a somewhat more convenient way for our purposes by taking the difference between the present and former net incomes.

128. In practice it will be desirable that the annual accounts shall show distinctly the whole of the current charges, and the whole of the current revenue, without deduction. Therefore the Revenue Account to exhibit the actual Revenue and Charges in a clear manner, and at the same time to bring out a correct result as to the net income, should show on the credit side, first, the present total land revenue of the irrigated area, and then as a deduction the old *net* land revenue of that area; and this may be regarded as the gross increase of land revenue, to which would be added any separate water-rates and other sources of income. On the debtor side will be shown the present total current outlay; and the balance will of course be the true net income. The old net land revenue will be got by deducting from the old gross land revenue, and separate water-rates, &c., formerly derived from the land now irrigated, the proper share of the old revenue charges on that revenue, and all the proper special charges for the maintenance and management of the old works, taken in the manner that will be shown further on.

129. A few words will suffice to explain all that need be said further as to the Revenue Accounts, the proposed form of which is annexed.

The credit side will show all the elements of income, that due to Irrigation being prepared as already explained.

The debit side will exhibit all the charges. These will properly consist of the following items:—

First, the cost of maintaining the works, needful plant, machinery, &c.

Second, the charges for the special Canal Establishments.

Third, the charges for the cost of collection of that part of the Irrigation Revenue which is managed by the District Revenue Officers.

Fourth, sums paid as remissions or compensations for short supply, accidental floods, or other causes.

The third of these items is the only one calling for special comment. Till now no such charge has appeared in the Canal Accounts, but it is clear that it will be necessary to debit the Canal Revenues with a reasonable share of the general Land Revenue charges, to allow for the cost of collecting the enhanced Land Revenue, and the separate water-rates, which are everywhere received by the Collector's Establishments, as well as to cover the cost of the Collector's management of the works, where that system prevails. The proportion of these charges, which should be borne by the Irrigation Works, will depend on the system under which the administration of the works is conducted, and the extent to which the Collector's Establishments are entrusted with the management of the Irrigation, and must be left to be determined separately for each particular case, or system of management.

130. I need not attempt to lay down any formal rules for dealing with this apportionment of the Land Revenue charges, but an illustration of how I think it might properly be made in Upper India will explain my intentions. The existing system in this case assigns to the Collector the entire management and collection of the increased Land Revenue, and the collection only of the separate Canal water-rate. I will assume that the charges for the Land Revenue administration might reasonably be held to be divisible in the proportion, say of one-fourth for mere collection, and three-fourths for administration. The charges for administration might fairly be divided according to area, those for collection according to the sums collected. Suppose now a total area of 1,000 acres, of which 700 acres were unirrigated, and 300 irrigated, the Land Revenue on the former being Rs. 700, and on the latter Rs. 750. At the same time suppose the direct water-rates to be Rs. 650. The irrigated area then would be as 300 to 1,000, or three-tenths of the whole, and the irrigation collections, as Rs. 1,400 to Rs. 2,100, or two-thirds of the whole. Also let the total cost of the Land Revenue Establishments be Rs. 200. Then three-fourths of Rs. 200, or Rs. 150, would be debitable as above proposed to the cost of administration, and would be distributed according to the area; so that three-tenths of it, or Rs. 45, would be chargeable to irrigation. One-fourth of Rs. 200, or Rs. 50, would be the proportion of charge for collection, and would be distributed according to the collections, so that two-thirds of it, or Rs. $33\frac{1}{3}$, would be debited to irrigation. In all Rs. $78\frac{1}{3}$ would be debited to irrigation, and the residue Rs. $121\frac{2}{3}$ to ordinary Land Revenue. As the area of irrigated land and amount of irrigation revenue would not be liable to sudden fluctuations, a fixed percentage might be obtained something in the above manner, which would then suffice probably for many years without change.

131. For convenience of comparison, it will be desirable to classify the charges for Establishment in an uniform way. The suggested sub-heads will be found annexed.

132. It will also be expedient to add to the Revenue Account of each work, a statement to show what has been its result to date, in respect to the discharge of the interest which has accrued on the capital laid out, by the net profits derived from it. There is an account now drawn out with this intention, but its form is somewhat cumbersome. What it seems desirable to give is a statement of the former balance of undischarged interest on Capital, and of the amount due for the year on the same account; also the former balance of charges in excess of income. From the sum of these items will be deducted any net profit, or to it will be added any surplus charge not covered by the income of the year.

In this account it seems needless to carry forward any accumulated balance of *profit*, after all the arrears of interest, &c., shall have been paid off, and the work clears an income in excess of the interest due on the Capital. Nor does there seem to be any utility in carrying on the accumulated account of charges, and interest, after they have been discharged by surplus income.

133. A memorandum of the Capital Account will be a necessary addition to the Revenue Accounts of the year.

134. Here reference may be made to the proper way of writing off sums from the Capital Account for such reasons as were before noticed.

The right course seems to be to make it obligatory, that whenever a sum is written off from Capital, a corresponding debit should be made to the Revenue Account. The profits would thus be applied to discharging the debt representing the Capital. If the whole work ceased to exist, and the profits had allowed of the whole capital being replaced or refunded, a proper equilibrium would have been established. The obligation on the Revenue Account to supply all restorations of the works, is evidently quite analogous.

135. This disposes of all that need be said regarding the Annual Revenue Accounts of separate works. But the question next arises whether it will not be further expedient to show in the Public accounts of the Empire, under a separate and distinct head, the aggregate of the revenue due to Irrigation Works, and the aggregate of the charges which their construction and maintenance involves. At present there is much difference of practice in the manner of exhibiting the income due to Irrigation Works in the general accounts. At Madras, this income is exclusively shown under Land Revenue. In the North Western Provinces, Punjab, and Bombay, part is shown under the head of Public Works, and part under Land Revenue. In all Provinces, the charges are partly classed under Land Revenue, and partly under Public Works.

136. The Government of India in its Resolution No. 10, dated 1st February 1868, has already recognized in general terms the increasing importance of the Irrigation revenue, and brought forward for discussion the above suggestion for separating the receipts and expenditure due to irrigation works, from the heads of Land Revenue and Public Works, and exhibiting them under a new head to be added to the existing series.

137. The Government of India remarked that, with a growing expenditure on Irrigation Works, it will become yearly more important to show, in a distinct and tangible form, on the face of the Annual Accounts, the results of that expenditure, on the Revenue and Charge of the year. The re-action of such a distinct perception of the true importance of this class of works on their administrative control would also probably prove of much value. The large income which would be shown to be due to Irrigation (and this particularly applies to Madras), would indicate in an unmistakable manner the necessity for making all needful grants for the maintenance of the works which secure that income. The frequent complaints which have arisen in past years, as to the insufficient grants for such purposes, would almost certainly soon cease in the face of the facts which such an account would exhibit in an incontrovertible form. At the same time the immediate juxta-position of the Charges and Revenue would afford a ready and most useful check on the economical management of the Irrigation Department, and would constantly keep in view the necessity for strict frugality, and indicate where the administration was best conducted so far as financial considerations were concerned.

138. This important subject was discussed at Madras by me in person with the Revenue Board and the Chief Engineer for Irrigation Works in February last, and the conclusions then come to have been approved by the Madras Government.

These conclusions were, that the present head of *Land Revenue* should be divided into two—*Land Revenue Ordinary* and *Land Revenue Irrigated*. This sub-division to be made both under the head of Revenue and Charge. The head *Land Revenue Irrigated* to include the whole aggregate income derived from irrigated lands, whether received in a consolidated assessment, or in separate items of land revenue and water-rate. All

the miscellaneous items of income derived from Irrigation works would also be brought to credit under the same head. Henceforth all these elements of income would be entirely excluded from the Public Works Budget.

139. The charges of all sorts properly debitable to Irrigation Works would, in like manner, be exhibited under the head *Land Revenue Irrigated* on the expenditure side of the Account. These charges might properly include the following items:—

1st.—The cost of all new works constructed from Revenue, and all outlay for repairs and maintenance of works in operation.

2nd.—All special charges for Establishments solely employed on Irrigation Works, and a proportionate charge for other Public Works Establishments partly employed on them.

3rd.—A proportionate amount of the charges of the Land Revenue Establishments as already explained.

4th.—The interest on the sums obtained by loan and applied to the construction of new works.

Under the existing arrangement, the bulk of the outlay on new works of magnitude, and a proper share of the establishment charges for them, and of charges for tools and plant, would be charged against the loans, and would appear as "Land Revenue Irrigated—Extraordinary."

140. There could be no inconvenience in making the transfer of any of the above elements of outlay to the *Land Revenue Irrigated* head, from the heads under which they may now appear in the detailed Sections of the Budget, in the manner in which the transfer of a part of the cost of the Revenue Establishments is now made to the Judicial head. In this way all double credits or charges could be avoided.

141. It will of course be seen that this proposal contemplates the substitution of the *total* revenue of all sorts derived from irrigated land, as the basis of the new entry in the general accounts, instead of the profits specially due to the irrigation works only, which will be what is dealt with in the separate Revenue Accounts of the individual works. The reason for making this arrangement will be readily understood. It was observed in the Madras Report, that at that Presidency any distinction between the income from Irrigation Works due to the land and due to the water could, in the majority of cases, only be established in an imperfect and arbitrary manner, and though it would be possible to do this, the advantage to be got for the purpose now in view is not evident, and all that is aimed at could as well be obtained by exhibiting the whole revenue derived from irrigated land under a separate head. In many places a complete failure of the water would in practice involve a complete failure of the whole revenue of the irrigated land, whether the assessment were made in a consolidated rate or otherwise, and in fact the whole of the revenue derived from such lands is more or less completely dependent on the proper maintenance of the works which supply them with water. It is, therefore, substantially more correct to exhibit as proposed the *whole* revenue of irrigated lands, for the purpose of giving a fair indication of the amount of revenue dependent on irrigation, rather than the particular portion which may be critically regarded as due to the outlay of capital on the works. It will be plain that there is a real distinction between the objects for which the two sorts of account are prepared. The separate Revenue Account of works is to show the purely financial

result of each as an investment. The General Account is to exhibit the part of the revenue at stake in connexion with irrigation operations, and the aggregate charge which is incurred to obtain that revenue.

142. As regards Madras, the plan proposed would have the advantage of admitting the adoption of the figures given in the existing Revenue Accounts (which show separately the aggregate revenue derived from irrigated land) without change, as the basis of the new entry. The same remark will apply to all parts of India where there is a consolidated assessment of the revenue on irrigated land.

143. As regards the Provinces where there is a separate water-rate, the profits of irrigation are, as before remarked, not properly represented by the water-rate alone, and to obtain a just estimate of those profits a certain portion of the land Revenue would have to be added to the water-rates. In this case therefore it will also be simpler to follow the course suggested.

144. All that I need further say on this subject is to refer to the annexed forms of account which might usefully be rendered with a Provincial Revenue Report of Irrigation Works.

145. It will be convenient if I recapitulate the specific proposals now put forward in relation to the Irrigation Accounts:—

1st.—That the Accounts Branch of the Public Works Department should henceforth be made responsible for the exact preparation of all the Capital and Revenue Accounts of Irrigation Works. (Paras. 105 to 107; 117).

2nd.—That the outlay chargeable to Capital should be classified for all works in an uniform manner. (Paras. 112 to 113).

3rd.—That in the separate yearly Revenue Accounts of Irrigation Works, the income should be held to include all increase of land revenue actually obtained on irrigated lands, a corresponding share of the ordinary Revenue Establishment, proportionate to such increase, being at the same time shown as a charge. (Paras. 122 to 126).

4th.—That the increase of land revenue should be ascertained simply by deducting from the actual revenue on the irrigated lands from time to time the former revenue received before the irrigation began, or before the improvements charged to the Capital Account were brought into operation. (Paras. 127 to 130).

5th.—That in the General Annual Account of Revenues and Expenditure, the present head of *Land Revenue* be divided into two—*Land Revenue Ordinary* and *Land Revenue Irrigated*, and that the entire land revenue of irrigated land, together with all direct revenue derived from Irrigation Works, be credited under the latter head, and that all the corresponding charges be debited in like manner. (Paras. 138 to 141).

SIMLA,
2nd September, 1868.

R. STRACHEY, *Colonel, R. E.,*
Inspr. Genl. of Irrigation Works.

LIST OF PAPERS ANNEXED.

No.	DESCRIPTION.	NOS. AND DATES OF PAPERS.	SUBJECT.	PAGE.
1	Resolution by Govt. of India, P. W. D.	No. 675 C, dated 7th Aug. 1866.	Deputation of Colonel Strachey to Madras for the purpose of examining and reporting on matters connected with the Irrigation Works, and system of managing them in that Presidency	1
2	Despatch from Secy. of State.	No. 65, dated 25th Oct. 1866.	Suggesting that the enquiry on which it is proposed to employ Colonel Strachey should be extended to all the more important localities where irrigation is practised ...	1
3	Resolution by Govt. of India, P. W. D.	No. 1036 C, dated 18th Dec. 1866.	Requesting the Bombay Government to afford Colonel Strachey every facility in prosecuting his enquiries in that Presidency	2
4	Letter from Secy. to Govt., Fort St. George, P. W. D.	No. 1006, dated 12th April 1865.	Stating that the Madras Government is fully alive to the importance of accurately registering the results of the great Irrigation Works in that Presidency, and that a Return embodying these results is regularly prepared, and submitted to the Government of India	2
5	Ditto	No. 885, dated 22nd March 1867.	Forwarding Statement of Remunerative Works for the year 1865-66	2
6	Resolution by Govt. of India, P. W. D.	No. 1230 C, dated 18th Dec. 1865.	Reviewing the Statement of Remunerative Works in Madras for 1863-64...	3
7	Despatch from Secy. of State.	No. 48, dated 31st Aug. 1866.	Ditto ditto ditto ...	5
8	Memo. by Col. R. Strachey, R. E.	Dated 31st Jan. 1867.	Extension of Irrigation in Sindh	6
9	Ditto	Dated 17th April 1867.	Extension of Irrigation in Guzerat, Candeish and the Deccan	14
10	Note by ditto	Dated 1st Aug. 1867.	Contemplated operations in the Irrigation Department in the Punjab	20
11	Memo. by ditto	Dated 21th Jan. 1868.	Management of Inundation Canals in the Punjab ...	25
12	Ditto	Dated 22nd Feb. 1868.	Points calling for attention in the Revenue Survey of Mysore, with reference to the requirements of Irrigation Works, present and prospective	26
13	Resolution by Govt. of India, P. W. D.	No. 10 I, dated 1st Feb. 1868.	Deputation of Colonel Strachey to Madras to discuss with the Officers of that Government matters relating to the progress of Irrigation in India	30
14	Letter from the Secy. to Govt., Fort St. George, P. W. D.	No. 1185, dated 20th April 1868.	Submitting results of a conference held by the Inspector General of Irrigation Works, and certain Officers of the Madras Government, on the propriety of introducing an improved system of framing the Revenue Accounts of Irrigation Works	32
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Nos. 675 C, dated 7th August, 1866.

[No. 1.] *RESOLUTION,—By the Government of India, P. W. Dept.*

OBSERVATIONS.—In Public Works Department Resolution convening a Committee to report on matters connected with the Ganges Canal, the Governor General in Council remarked that the degree of success attainable in the construction of Canals and other Irrigation works, was due in a great measure to matters unconnected with engineering, depending on climate, soil, the system of agriculture, and the habits of the people, and observed that, as these, as well as engineering practice, differed materially in Northern and Southern India, it would conduce much to clearing up doubts and differences on the subject of Irrigation works, if Officers familiar with the system in Northern India were deputed from the North Western Provinces and the Punjab to report on the works in the Madras Presidency, and, similarly, if Officers from the south were sent from Madras to inspect and report upon the works in Northern India.

2. The Governments of Madras, the North Western Provinces, and the Punjab, were called upon for reports on the above suggestion. The Madras Government did not concur in the opinion that the success of Canals and other Irrigation works was due to other than engineering questions, and saw no advantage in establishing the system of inspection and cross-reporting suggested, being of opinion that the probable result would be criticisms and discussions which would occupy much time, and lead to no practical good.

3. The Government of the North Western Provinces also did not expect that any advantage would be gained by deputing an Officer from those Provinces to report on the Madras system of irrigation, and suggested that the reason why there was so little information as to the details of Madras irrigation, was the absence in that Presidency of an Irrigation Department in which the statistics of irrigation could be collected, arranged, collated, and interpreted.

4. The Punjab Government, without offering any opinion as to the advantage, or otherwise, of establishing the system of inspection and cross-report, states that not a single Officer of sufficient experience is available for deputation to Madras at present.

5. Notwithstanding these adverse opinions, the Governor General in Council is still of opinion that much advantage would be gained by the system of reporting indicated, and that it is especially desirable, in regard to the irrigation system of the Madras Presidency, if a report could be had which would enable the Government of India to arrive at more definite conclusions as to the causes which have conduced to make Irrigation works there so remunerative in many cases.

6. The want of an Officer of sufficient experience to undertake the necessary investigation, might often be the main obstacle to the carrying out of this object. An opportunity, however, now offers for deputing an Officer, perhaps, above all others, qualified for such a duty, in the return of Colonel R. Strachey, R. E., to India, which is expected in November or December next, and the Governor General in Council is of opinion that advantage should be taken of the opportunity to obtain reports on the Irrigation works of the Madras Presidency, regarding which more complete information would be most valuable.

7. Lieutenant-Colonel J. C. Anderson, R. E., of the Madras Public Works Establishment, has, as a Member of the Ganges Canal Committee, recorded a valuable Memorandum on the subject of the income derived from Irrigation works in Southern India, compared with the return from similar works in the North Western Provinces. But this important subject still requires further investigation, and the Governor General in Council is of opinion that it is very desirable to devote to it, for a time, the services of an Officer of Colonel Strachey's experience and ability.

8. It has accordingly been decided by the Governor General in Council, that instructions shall be issued to Colonel Strachey to report his arrival in India to the Government of Madras; and the Government of India will request the Governor in Council of Madras to do this Government the favour to afford Colonel Strachey every facility for examining and reporting upon all matters connected with the Irrigation works, and system of managing them, in the Madras Presidency.

No. 65, dated 25th October, 1866.

[No. 2.] *From—The Secretary of State for India,*
To—The Government of India.

I have received and considered in Council your Excellency's Despatch dated August 11th (No. 126), 1866, on the subject of the deputation of an Officer to report on the Irrigation system of the Madras Presidency, and I have also been in communication with Colonel Strachey on the subject.

2. Colonel Strachey has suggested that the investigation should not be confined to Madras, but that it would be useful to extend the enquiry to all the more important localities

where irrigation is practised, with a view to submitting a general method for common adoption, which should exhibit financial results, and relative economy of working and management, and at the same time be susceptible of application to local circumstances.

3. I concur with Colonel Strachey in the opinion that a wider enquiry than that suggested by your Excellency would be desirable, and have given that Officer the necessary instructions. He will leave England about the beginning of November, and land at Bombay.

4. The different Local Governments should be informed of the intention to employ Colonel Strachey on this service, with a view to their giving him the facilities he may require, and it should be understood that his enquiries imply no intention of any interference with the local administrative systems.

5. You will, of course, inform me of the limit you have placed to the duration of Colonel Strachey's employment on this service, and of the arrangements you have made with respect to his pay and allowances while so employed.

Nos. 1036 C., dated 18th December 1866.

[No. 3.] *RESOLUTION,—By the Government of India, P. W. Dept.*

RESOLUTION.—The Governor General in Council observes that it was the intention of the Government of India to depute Colonel Strachey to Madras alone, as it was thought specially desirable to obtain a report on the Irrigation system of that Presidency in order to arrive at some definite conclusion as to the causes which have conduced to make Irrigation works there so remunerative in many cases, and to ascertain whether the principles on which the works in Madras have been constructed are generally applicable to other localities.

2. Her Majesty's Secretary of State for India is, however, of opinion that it would be useful to extend the enquiry to all important localities where irrigation is practised, and has directed Colonel Strachey to proceed, in the first instance, to Bombay.

ORDER.—Ordered, that a copy of the papers above read be forwarded to the Government of Bombay with a request that the Governor in Council of that Presidency will do the Government of India the favour to afford Colonel Strachey every facility for examining and reporting upon all matters connected with the Irrigation works, and system of managing them, in that Presidency.

No. 1006, dated 12th April, 1865.

[No. 4.] *From*—COLONEL C. A. ORR, R. E., *Secy. to the Govt. of Madras, in the P. W. Dept.,*
To—Secretary to the Government of India, P. W. Dept.

In acknowledging the receipt of your letter* dated the 17th September last, with Resolution† by the Government of India which accompanied it, I am directed to state that the Madras Government are fully alive to the importance of accurately registering the results of the great Irrigation works in this Presidency, and that a Return‡ embodying these results has been regularly prepared and forwarded to the Government of India.

* No. 822 C—4570.
† „ 6568 C—3825.

‡ Statement of Remunerative Works. That for 1863-64 was forwarded with letter No. 554, dated 27th February 1865.

2. I am to explain that in giving the financial results of Irrigation works, it is not possible in this Presidency to enter into such detail as has been done in the Canal Reports of the North Western Provinces The revenue system which prevails here, and the difficulty of separating the water-rates from the land rental, together with the non-restriction of the quantity of water allowed for irrigation, render it impossible to do more than show the general financial result of the outlay upon each Irrigation work. In the return in question this result is exhibited by crediting each work with the *gross* revenue derived from it, and by debiting it with the entire cost of maintenance and repairs, as well as with interest at the rate of 4 per cent. upon the original capital sunk.

No. 885, dated 22nd March, 1867.

[No. 5.] *From*—COLONEL C. A. ORR, R. E., *Secy. to the Govt. of Madras, in the P. W. Dept.,*
To—Secretary to the Government of India, P. W. Dept.

In laying before the Government of India the Statement of Remunerative Works in this Presidency for the year 1865-66, I am directed to state that this Government are by no means satisfied as to the trustworthy nature of all the returns embodied therein. The difficulty of obtaining reliable information as to the increase of revenue which has resulted from carrying out any irrigational work is great, and this difficulty is considerably increased when,

as is in several instances the case in this Presidency, the works are mainly of old Native construction, their original cost being unknown, and the sums entered in the returns under the head of "Capital Outlay" representing the expense either of repairs necessary to restore the works to an efficient state, or of improvements and extensions executed of late years. The remarks of some of the Superintending Engineers, printed as Appendices to the Statement of Remunerative Works, will illustrate the difficulty which has been experienced in drawing up these returns.

2. In conclusion, I am directed to state that, as Colonel Strachey who has been deputed by the Government of India to inspect and report upon the irrigation works in the Presidency, may very shortly be expected here, this Government consider it advisable to defer for the present any further remarks upon the subject, and to submit to the Government of India in the shape in which it has hitherto been laid before them, the Annual Statement of Remunerative Works.

No. 1230 C, dated 18th December, 1865.

[No. 6.] *RESOLUTION,—By the Government of India, P. W. Dept.*

OBSERVATIONS.—With the earlier of the two letters above read, the Government of Madras submits a Statement of Remunerative Works in that Presidency for the year 1863-64, and in the latter letter it is explained that, owing to the revenue system which prevails in the Madras Presidency, the difficulty of separating the water-rates from the land rental, and the non-restriction of the quantity of water allowed for irrigation, it is impossible to do more than show the general financial result of the outlay upon each irrigation work, and that this result is exhibited by crediting each work with the gross revenue derived from it, and by debiting it with the entire cost of maintenance and repairs, as well as with interest at the rate of 4 per cent. upon the original capital sunk.

2. By adding up the items in the statement, it appears that the total outlay up to 30th April 1863 on the 22 works embraced in it, was Rs. 86,87,462, or £868,746. This it may be remarked is a small sum for the entire outlay on such works in the Madras Presidency.

3. The entire net result was as follows up to 30th April 1863:—

	Rs.	£
Net profit on 16 of the works	3,13,28,492 or	3,132,849
Loss on 6 of the works	2,81,315 or	28,131
Result on the whole net profit	3,10,47,177 or	3,104,718

being 357 $\frac{1}{3}$ per cent. on the entire outlay.

4. During the year 1863-64, the whole outlay of capital was only Rs. 6,56,691, or £65,669, while the amount of net income for the year was—

	Rs.	£
Net profit on 16 works	28,84,249 or	288,425
Loss on 6 works	81,211 or	8,121
Net profit on the whole	28,03,038 or	280,304

being on the whole outlay previous to the year in question no less than 32$\frac{1}{4}$ per cent. for the year.

5. The great Irrigation works in Madras have unquestionably been very profitable, but the very large profits noted above, makes it desirable that an endeavour should be made to obtain such a clear account of the profits of each work as will make intelligible the causes of the results set forth. This would enable the Government to judge whether a like result is probable from future outlay of the same kind.

6. It is believed that some of the works in question are not entirely original works initiated by the British Government, but partial restorations of ancient native projects, which, owing to much of the old work remaining uninjured, or little impaired, could be brought into use with little really new construction. The outlay for restoring them was comparatively small, and the profits accordingly high. But as the expenditure in the case of these and other works is set down as outlay on "original works and re-construction," it is likely to mislead, unless the fact of their being merely restorations of former works, of which much or certain portions of the ancient work remained, clearly noticed in the Returns, That is to say, instead of making use of the expression "original works and re-constructions, in such cases they should be set down simply as "restorations and improvements," or as the case may be; using the terms specially applicable, and not employing a general phrase for all cases.

7. For instance, the works on the Lower Coleroon in South Arcot, and on the Upper Coleroon in Tanjore, are, to a considerable extent, ancient works,* and of these the expenditure and income are given below:—

	Capital outlay.	Total net receipts to 30th April 1865.	Net receipts for 1863-64.
	Rs.	Rs.	Rs.
South Arcot	1,29,050	64,46,771	4,01,012
Tanjore	2,39,865	1,16,81,809	5,25,536
Total ...	3,68,915	1,81,28,580	9,26,548
Let these sums be taken from the entire aggregate of the return before given ...	86,87,462	3,10,47,177	28,03,038
And the result is	83,18,547	1,29,18,597	18,76,490
Per cent. on first Column ...		155¾	22½

Here the result of all these works excluding these two is still a very large profit, but no longer so astonishing as when the fact of these two sets of works being in some degree works of restoration is not taken into account.

8. Again, if the Godavery works are similiarly struck out, and separately considered, the result will be as follows:—

	Rs.	Rs.	Rs
Brought forward	83,18,547	1,29,18,597	18,76,490
Godavery	36,67,742	97,88,636	14,06,518
Balance ...	46,50,805	31,29,961	4,69,972
Per cent. on first Column ...		69$\frac{9}{10}$	10$\frac{1}{10}$

9. Thus, if the ancient works which have been restored, and the Godavery works are omitted, the average of the annual profit on the remaining works is reduced to 10 per cent, after payment of 4 per cent. interest, or really to 14 per cent.

10. It seems, then, that the key to understanding the profits of the Madras Irrigation works would be to obtain a clear analysis of the profits of the Godavery works. All that there is on record by way of analysis is, that the mode of reckoning the profit is to take the average annual land revenue of the Districts for the five years before the works came into use, and to deduct that from the present annual land revenue, the difference being taken as the profit on the works. In this manner it is said the works gain whatever there is in the way of increased production irrespective of the effects of irrigation, while they lose credit for other items of revenue not included in the *land* revenue which may, perhaps, be due to the works.

11. Thus for the Godavery we have—

	Rs.
Gross proceeds of all sorts for 1863-64	17,23,150
Maintenance and repairs	1,69,923
Net profit, not deducting interest	15,53,227

But to be satisfied about this, it is necessary to know how the sum of Rs. 17,23,150 is calculated. Is it all difference in land revenue, or are there other items of receipts directly

* That is to say new anicuts were constructed across the rivers, and certain new channels constructed by which to utilize more completely the existing net work of channels.

obtained from the use of the Canals? Of the difference of land revenue, is it difference of gross or net revenue; and if the latter, what charges does it bear? Is a share of the entire cost of the Civil establishment of the districts deducted, or if not, why should it not be?

12. Then, again, what are the charges included in the Rs. 1,69,923? Does this sum contain, in addition to the entire charges for repairs, the whole of the Engineer and Conservancy Establishment of the works, with all establishments for collecting any petty revenue, exclusive of the land revenue? Does it include a fair share of the cost of the superior establishments for controlling the Officers in direct charge of the works, and for the elaboration of the accounts?

13. Further, in order to test the amount of increase of land revenue that is due to the works of irrigation, it is necessary that there should be a comparison instituted between the growth of the revenue of the districts affected by the Godavery Works, and that in districts as nearly as possible similarly circumstanced in which no such works have been established, such as Vizagapatam immediately north of the Godavery District, and Nellore south of the Kistna District.

14. Again, it would be desirable to know whether the average revenue before the irrigation began was moral or not, and whether the revenue within any moderate interior period has been sensibly larger than the average taken as the standard of comparison in the Return. Next what was the actual area of wet and dry cultivation on which revenue was paid, and what the rates before the canal period, and what the corresponding figures for the last few years? It will probably be found that a very large proportion of the profits arises from an actual increase of total area under cultivation.

15. It is no doubt the case that much, if not all, the information mentioned as necessary is on record somewhere; but the object is to obtain it, in a succinct form with the returns, and put in a shape to bring out the reasons from the results which the returns give. If this be once done, the succeeding years return need not repeat the whole information, but only so much as is necessary to produce a connected series of reports following out the history of the works.

16. Leaving the Godavery, which may be regarded as the key and type for general enquiries to elucidate the whole subject, and turning to the remaining works, it is to be noticed that, though the *average* is a moderate profit of 14 per cent. before any payment of interest is deducted, the individual works differ very largely in their results. One realizes 118 per cent. per annum of profit, while others result in absolute loss. It would be very desirable to place on record in connexion with these reports the causes why one work is successful, and another a failure; and why one is astonishingly profitable, while others are only moderately so. Also something should be told of the measures of administration in progress, or in contemplation, and of the ultimate prospects of the works.

17. In fact of each of these 22 works there should be a succinct history shewing the stages it has gone through, and its present state and prospects, with the opinion of the Madras Government on the merits, or otherwise, of the administration. There doubtless is a system and science of management for Irrigation Works in Madras with special applications to each case. But it will be much more satisfactory if, while the working of this in each case is watched, as doubtless it is by the Madras authorities, there is also placed on record a detailed annual review of the proceedings during each year, and their results.

No. 48, dated 31st August, 1866.

[No. 7.] *From—The Secretary of State for India,*
To—The Government of India.

I have examined with interest the "Statement of Remunerative Works in the Madras Presidency," which was transmitted with your Excellency's Despatch of 18th December last. The document contains much valuable information, though the shape in which that information is submitted, is perhaps susceptible of improvement.

2. The works treated of are, with one exception, works of irrigation, and the return proposes to exhibit under separate headings, with respect to each individually the "outlay on construction," the annual "charges," and gross and net income; but an entry is made under the first heading, which should apparently have no place there, and the introduction of which occasions an error in the total. From original outlay on construction is deducted an annual one per cent. for deterioration for wear and tear, and only the difference is represented as the "balance of capital" invested in the work. But whether by this balance is meant the actual cost, or the present value of any work, it is likely to be equally misleading. An annual one per cent. will, after sufficient lapse of time, become by accumulation equal in amount to the original principal, so that, at the end of a hundred years from the date of its construction, every work would appear to have neither cost anything, nor as being any longer worth anything.

3. It would evidently be a preferable plan to enter under "outlay on construction," the whole amount so expended without deduction, to enter under "charges" nothing but cost

of maintenance and repairs (inclusive of course of cost of conservancy and other establishments with interest), and under income to deduct nothing from gross proceeds, but cost of maintenance and repairs similarly inclusive), leaving the remainder to appear as net returns.

4. If the statement had been framed in this manner, it would have shown Rs. 93,43,163, instead of Rs. 86,87,462, as the total outlay on the works included in it. Even the larger of these amounts is, undoubtedly, very small in comparison with the aggregate financial returns from the expenditure; but it is important to point out, as you have done, that among the works in question are some which are "not entirely original works initiated by the British Government," but only restorations or improvements of ancient native works. The distinction is a most material one, more especially in its bearing on the percentage of profits realized. Thus the whole outlay on the irrigation works on the Coleroon and Cauvery, in South Arcot and Tanjore, is set down at no more than Rs. 3,68,915, which, however, is really the cost of no more than new Anicuts, and new canals designed to utilize a previously existing and extensive net work of canals and natural rivers. The consequence is, that the income derived from the Cauvery and Coleroon works, being represented as profit upon only Rs. 3,68,915, appears to amount to between two and three hundred per cent. upon that sum, but the percentage would, of course, be very much smaller if it had been calculated upon the cost of construction and restoration, if it were possible to ascertain the former instead of on that of restoration only.

5. The abundant remunerativeness of some of the Madras works must not induce us to overlook the unremunerativeness of others. Some of them have been brilliant successes, but some have hitherto been comparative failures, and in every case the peculiar basis on which the returns are calculated, renders comparison between the irrigation works of Madras and those of any other part of India impracticable. In Madras, owing to the difficulty of separating the water-rates from the land rental, the practice would seem to be that of crediting an irrigation work with the whole difference between the amount of Government revenue at present yielded by the land under the influence of the work, and the amount yielded previously to the construction of the work. Elsewhere, as for instance, in the North-West Provinces, an irrigation work is credited, simply with the water-rate paid for the fields irrigated by it, and which, therefore, does not show the real effect of the works. Evidently no useful purpose can be served by comparing the combined land and water revenue in the one case with simple water revenue in the other. In order fairly to judge of the relative remunerativeness of work so differently circumstanced, a not unsuitable plan might be to ascertain the acreage irrigated by each, the amount of revenue which each acreage would yield if charged with the same water-rate, and the proportion which those amounts would bear to the outlay on their respective works. It might be useful to institute a comparison on this principle between individual canals in the Punjab and North-West, and those in the Madras Provinces.

6. Another subject for enquiry, not less interesting than that of the relative success of irrigation works in the Madras and in the other Presidencies, is the very various success observable among the Madras works themselves. The large difference in the results of different works has been alluded to above, and has also been noticed by your Government. One work is represented as yielding 118 per cent. of annual profits, while others result in actual loss. "It would," as you say, "be very desirable to have on record the causes why one work is successful, and another a failure, and why one is astonishingly profitable, while others are only moderately so." The purport in short, of the foregoing remarks, is to point out the desirableness of ascertaining first the exact measure of success achieved by irrigation works in Madras, and, secondly, the causes to which that success is due. If this were done, it would be much easier than at present to estimate rightly any special merits belonging to the Madras system of construction, and to determine in what situations and in what circumstances that system is applicable. To use your own words, your Government would then be enabled, when a certain outlay has been productive of certain results, "to judge whether like results would be probable from outlay of the same kind elsewhere." Much of the required information might be afforded by annual statements of remunerative works in Madras, somewhat different in form, and drawn upon a somewhat different principle, from those of the statement under review. Several useful alterations in both respects have, I observe, been suggested by you to the Government of Madras, and some of those indicated above might also perhaps be adopted with advantage.

Dated 31st January, 1867.

[No. 8.] *Memo. by* COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation, on the extension of Irrigation in Sindh.*

The rain-fall in Sindh is so small, that cultivation may be said to be almost impossible without the aid of irrigation in some form. The ordinary means of obtaining water for this purpose is to draw canals from the Indus. But it has been beyond the power of the people to maintain a supply of water in their canals, excepting during the season of the inundation, which corresponds to the rainy months of other parts of India, and to the agricultural khureef season. It follows that, as a rule, the cultivation of Sindh is limited to a khureef

crop; and the rubbee, or cold season crop, is less than one-tenth of the whole. Further, the produce of the khureef crops is in a great measure consumed in the country, supplying the food of the population and their cattle. The more valuable cereal grains and oil seeds are the produce of the rubbee crops, and from the causes that have been mentioned, the quantity of these is very small, and under existing circumstances is not likely to be increased to any sensible extent.

The cultivation dependent on the canals may be divided into two great classes:—*First*, that which can be carried on with water naturally flowing over the surface of the land, in Sindh termed *Moke*, and equivalent to *Tor* of the North-West Provinces; and *second*, that which requires the water to be artificially raised to lands, the surface of which is above the water-level of the canals, in Sindh called *Churkee*, and in the North-West *Dál*.

The moke cultivation is far less certain and less valuable than might at first sight appear likely, consequent on the almost entire absence of control over the level of the water in the canals. This level simply depends on the rise and fall of the river, and excepting in some few specially favourable cases, the risk of the cultivators in moke cultivation is very considerable, and the relative value as compared to churkee, greatly reduced.

The churkee cultivation is so called from being dependent on the use of the "churka," or Persian wheel, by which the water is lifted to the necessary level. It is probable that considerably more than one-half of the whole cultivated area is churkee land, and it is not likely that the average height to which the water has to be raised is less than 5 or 6 feet. It will be obvious that a very great expenditure of labour is requisite to lift water in this manner. Major Lambert, the Collector of Kurrachee, has got together a great number of estimates of the cost of this operation, and he reckons that it amounts, on the average of the whole Province, to about Rs. 15 an acre. It is wonderful how the country can support such a burden on its agriculture. The charge on the Sindhee peasant, over half of the Province, to place him in the position in which nature places the agricultural community of most countries without any cost, by means of the regular rain-fall, is not less than is paid in England as the whole amount of rent.

But besides these difficulties, others of hardly less importance arise from the rude manner in which the irrigation channels have been formed in the first instance. Want of stability in the heads of the main canals; obstruction of the channels by the deposit of silt, due to irregularities of inclination, or other causes; injuries to water-courses and adjacent lands from the breaching of embanked channels, ill-designed or constructed; submergence of lands by reason of the escape of water from canals, the supply in which has been in excess of the requirements for irrigation; injuries of various descriptions, arising from the Indus floods breaking into the water-courses and the irrigated lands: these are some of the more important defects to which the present system of irrigation is liable.

Till the present time, there has been hardly any application of engineering science to the improvement of this state of things, and the existing Canal Engineers are little more than superior Overseers of the annual canal clearances, under the direction of the Revenue District Officers. Some improvements, not without value, have been made from time to time in the rude system of canals which existed when Sindh first became a British Province, and in the Shikarpoor Collectorate, the supply of water has been sensibly increased with a corresponding distinct increase of cultivation and revenue. But, as a whole, the condition of the country and the people must be regarded as almost stationary; and that this should be the case seems quite sufficiently explained by the adverse combination of circumstances which have been mentioned.

The irregularity of the flow of the canals, and their rude character, often leads to a wasteful use of the water in Moke lands. The limitation of the quantity of water supplied by the canals, combined with the absence of rain, prevents the lands recovering itself after cropping, and induces a practice of long fallows of two or three years; this leads to very slovenly husbandry, the ground being seldom properly cleared of weeds and jungle. The heavy labour attendant on the raising of the water, restricts greatly the extent of land which might, under more favourable conditions, be tilled by the existing population. The almost complete absence of a rubbee crop, although the climate and the greater part of the soil is believed to be as favorable for its production in Sindh as in the North-West Provinces, deprives the cultivator of what, under a happier arrangement of water-supply, should be to him a source of great comparative wealth and absolute prosperity. The poverty and the stationary material position of the population, and the small amount of exportable produce which comes into the markets prevent the expansion of trade, opposes the growth of Kurrachee, the port of export, and starves the Railway which leads from the agricultural districts to this Port.

The obvious remedy for all these evils is to be found in the substitution of perennial, for the existing intermittent, irrigation canals, and of water delivered at the level of the surface, instead of at a level which requires that it should be lifted by animal power. If water could thus be given to the whole Province (excluding, of course, those parts which are sandy desert, and naturally incapable of culture), it would be but little, if at all, inferior in productive capacity to the best districts of India; and making allowance for all the barren regions, Sindh would yet remain one of the most important Provinces of the British territories.

And there is much reason to hope that such a remedy may be practically possible of application in the chief part of the culturable country. It will, of course, require very careful consideration before the needful works for carrying out such a change of system in the irrigation of the Province are put in hand; and at the present moment the only essential thing is to arrive at a conclusion whether the objects to be gained by success, and the prospect of such success are of that nature which should induce the Government to take the necessary steps to order further investigation, and to determine that the requisite works should be carried out if these investigations are satisfactory.

It may be assumed that there is no further need for discussing the character of the objects to be gained; their paramount importance is self-evident.

As to the prospects of success in accomplishing the ends in view, there are two principal lights in which the matter must be considered; *first*, the Engineering; and *second*, the Financial. It cannot be properly said in this case that such works as are suggested are strictly necessary to protect the country from famine. There is already sufficient safeguard against this extreme evil. What is sought is to improve the position of the population by greatly increasing the facilities for agriculture. The obligation on the State to do this, unless at all events there be no attendant increase of charge put on the general finances, can, perhaps, be hardly pressed with justice to the interest of the community as a whole; and it may fairly be accepted as a criterion by which to guide our action, that the work shall be distinctly profitable to the State. This point, therefore, will call for careful examination.

On the engineering question much need not be said beyond what will suffice, as *primâ facie* evidence, that the scheme as a whole is practicable. The Indus supplies what is virtually an unlimited quantity of water, and the levels of the country are known to be such as will admit of the easy formation of canals having the needful requisites. Nature has happily provided many spots which appear quite suitable for permanent heads for perennial canals, without involving the construction of very difficult or expensive works. Such are Rohree and the opposite bank of the Indus at Sukkur, Sehwun, Kotree, and Jurruck. At all these places solid rock formations occur on the river's bank, and the channel has, for a very long period, remained constant at these localities. Above Sukkur no rock occurs in the river bed, but there is no reason to doubt that a permanent canal head could be kept open where there is no rock, though at what cost, and with what general financial results, must depend on circumstances now unknown. On the whole, the facilities for canal construction in Sindh are singularly great.

The question has long been discussed, whether the large quantity of silt carried in suspension by the Indus would not be a cause of such obstruction to any perennial canal as would virtually make it useless. I regard such fears as quite chimerical, but it may be desirable to state briefly my reasons for saying this. First, it is a fact that many of the existing large inundation canals remain open permanently without sensible silt deposit. Next, where silt is deposited, it may unhesitatingly be attributed to the direct operation of causes which should not come into play in properly designed canals. In the existing canals, these deposits most frequently occur either near the mouth or at the extremity. In the first of these cases, the deposit is commonly the result of the erosive action of the river on its bank near the canal mouth. The water under these circumstances becomes abnormally charged with earthy and sandy matter as it enters the canal, and, as a matter of course, much of this is dropped shortly afterwards. When the canal mouths are free from such erosive river action, and the general slope of their beds is sufficient, they remain unobstructed. The obstruction of the lower extremity of the canals is the immediate result of deficient fall, and in many cases almost total stoppage of the current of water. These defects could not exist in properly designed channels. On the whole, the deposit of silt, wherever it occurs, is the result of irregular river action, or of irregular velocity within the canals. The result of the improved system would be to arrest the river action on its banks at the mouth of the canal, and to preserve the velocity of the water within the channels at a suitable uniform rate which should prevent the silt in suspension being deposited until it is carried out into the fields, or the very smallest of the water-courses. The increased height, at which the water-surface would be maintained in the canals, would materially assist in obtaining an improved velocity in the distributing channels; and the same result would be caused by the concentration of the supply into fewer and larger canals which would follow the suppression of some of the far too numerous cuts which have been formed in a state of society where there was no authority to exercise a proper control over the economical distribution of the water. It is the common belief that silt held in suspension is an absolute advantage to the cultivator if it can be distributed with the water over the surface of the land. If any deposit of silt should take place in the minor channels, in which the velocities are likely to be least, and the levels less under engineering control, it can be removed without sensible practical inconvenience, and with the least amount of labour.

I may here conveniently refer to a point which seems to call for special consideration in the formation of any project for improved irrigation works in Sindh. Where irrigation is introduced into a country for the first time, the arrangement of the minor distributing channels may be controlled by the Engineers almost as completely as that of the chief feeding lines of canal. But in Sindh, where all cultivation at present depends on irrigation, it seems almost obligatory to make use of the existing minor channels, if not exclusively, at least to the very utmost extent that is possible. The necessity for this will be apparent when it is remembered

that the whole fabric of property in land is, so to speak, built up upon the net-work of water-courses which supply the great essential for all cultivation. The inhabited and cultivated lands follow the lines of canal. Where the revenue settlement has been completed, it has been based on the supply of water by the existing channels. To do otherwise than continue to supply the water by these channels would not only call for a very great additional amount of labour for the excavation of the new water-courses, but would tend most seriously to disturb the tenures of land and everything connected with the agriculture of the country. The aim of the Engineers, therefore, should be to introduce water as early as possible, and with the least possible disturbance of the existing net-work of channels, on the improved system. It would be their business, at a later period, to weed out by degrees all the really objectionable features of the distributing channels first forced upon them. It will, of course, be possible that, in some cases, important modifications in supply channels may be unavoidable from the first, but so far as I am able to judge, these should be exceptions to the general rule as before stated. It is my belief that the adoption of this system will in all respects be the most desirable, whether regard be had to the interests of the cultivator; of the State as superior landlord; of the Exchequer in the matter of first cost and eventual speedy return; of the Engineers in obtaining a proper practical knowledge of the requirements of the country for its irrigation, and a gradual but complete power of control over the supply of the water in the most thrifty manner. It is necessary to bear in mind clearly that from the very conditions of the problem, our Engineers will come to the task imposed on them without a detailed practical knowledge of the exact requirements of the country in respect to water, and that their position, in the face of a population which has practised irrigation from time immemorial, is very different from what it might have been in a country into which canals were to be introduced for the first time.

The condition which for these reasons I regard as obligatory, of working the new system of irrigation through the existing distributing channels, it is almost needless to say cannot be productive of anything but saving of expense, time and labor; and under such an arrangement, the full benefit of the improved system will be obtained by the people and the State in a far shorter time than could be reasonably expected in a country new to irrigation, and requiring to be provided with distributing channels. One of the chief causes of the slow progress of irrigation from the Ganges Canal is understood to have been the want of minor distributing channels.

Of course it is impossible to offer an opinion of any value as to the probable cost of works such as have been spoken of, without first obtaining detailed designs and estimates. But without any precise knowledge of the exact cost, some useful light may be thrown on the financial part of the discussion by considering the probable return from an improved system of irrigation, and calculating the amount of capital which it would cover.

The total area of land under crops watered by the canals maintained by the Government in Sindh, is at present about 1,200,000 acres. The average combined charge for land revenue and water is about Rs. 2-4 per acre. It will certainly be a very moderate estimate if we reckon that, under a system of high level water-supply, permanently kept up, and completely under control, and additional charge of Re. 1 per acre might be made on land actually cropped under irrigation, raising the total charge to Rs. 3-4 per acre. In the North Western Provinces I believe that the average charge would be as much as Rs. 4-8, and in Madras it would be never less than Rs. 5, and often more. Next, it may be reckoned that for the khureef crop in Sindh, a constant flow of water of one cubic foot per second will water about 50 acres of land. This is considerably less than the corresponding area in Madras or the North-West, but allowance must be made for the larger quantity of water required in a country without rain. From actual observation in Sindh on one of the canals in the Hyderabad Collectorate, one cubic foot has been found to water 68 acres. On other canals a much smaller result was found.

If we then assume that, out of the existing area, one million acres could be brought under the improved system at 50 acres per foot, this would require a total water-supply for the whole Province of 20,000 cubic feet per second, which may be considered as equivalent to three canals, each as large as the Ganges Canal.

It will be remembered that the existing cultivation is exclusively khureef. With the perennial supply of water, a rubbee crop may be reckoned upon. Now the consumption of water for rubbee irrigation is much less than for khureef, and making a reasonable allowance as before for the want of rain in Sindh, one cubic foot of rubbee supply may be reckoned to irrigate 100 acres. Therefore the new rubbee crop will amount to two million acres.

The increase revenue will then be 1 Re. per acre on the old acreage, and Rs. 3-4 on the new acreage, that is—

	Rs.
1 million acres, at Re. 1	10,00,000
2 „ „ „ Rs. 3-4	65,00,000
Total ...	75,00,000

showing a total increase of revenue of 75 lakhs gross, or £750,000 yearly.

At the rates for land and water combined in force in the North Western Provinces, the total gross increase would be approximately—

	Rs.
1 million acres, at Rs. 2-4	22,50,000
2 „ „ „ 4-8	90,00,000
Total ...	1,12,50,000

showing a total of 112½ lakhs, or £1,125,000 yearly.

It will next be necessary to estimate the probable charges against this increase. For the canal maintenance and establishments, 12 annas per acre irrigated is not likely to be exceeded, judging by the results of the North Western canals; and even as small a charge as 8 annas an acre is likely to suffice. This charge, at the 12 annas rate, would amount on three million acres to 22½ lakhs yearly. Against this has to be set off the present charge for the same purposes, which may be taken at 3½ lakhs, leaving a net increase of charge of 19 lakhs. To this must be added, however, a sum to cover the additional charges connected with the realization of the increased land revenue. Taking the approximate rate of charge on this account as 10 per cent. on the revenue realized, the addition would be 7½ lakhs, or 11½ lakhs, according to the total rate realized from the land. Under the first hypothesis of a total maximum charge of Rs. 3-4 per acre, the net increase of revenue would be 48½ lakhs, and at the maximum rate of Rs. 4-8 per acre, it would be 86 lakhs. The former amount would be equivalent to 5 per cent. on about 9½ millions sterling; and the latter to 5 per cent. on 17 millions.

The inference that may be drawn from these calculations is, that if such an increase of cultivation as is spoken of can fairly be anticipated to follow the improved system of irrigation, it would, on the lower estimate, not be unprofitable to the State to spend 9½ millions on the requisite works, and on the higher 17 millions might be spent. Of course it is not for a moment implied that this gives any key to the actual outlay really likely to be necessary, and all that is desired is to show that, on a very moderate estimate of areas and rates of profit, there is *primâ facie* evidence that a large outlay of capital would be covered. It may be added that the Ganges Canal, which is acknowledged to be a very expensive work, is likely to cost when complete rather more than 3 millions sterling. It was before remarked that, to give such an extent of irrigation, as has been reckoned upon, a supply about three times that of the Ganges Canal would be required. On the standard of the Ganges Canal, therefore, the cost of the works might be taken at 9 millions, so that even at this very high rate of cost, the works would probably be remunerative. If an opinion on such a subject is to be hazarded in the present position of the question, it might perhaps not be unreasonable to consider the Ganges Canal standard fully one-third too high for the much more favourable circumstances of Sindh; and at such a rate, 6 millions sterling would be the whole sum needed, on which, at the lowest rate of income, a return of £485,000 yearly would be realized, being above 8 per cent. At the higher rate, the return would be £860,000, or 14 per cent.

I would repeat that it is to be understood that the above figures are only intended to show, on such data as can be got, the probably eventual operation of the improved system of irrigation. Time would be required both for the outlay of such large sums, and for the full realization of the entire profits; on the other hand there is every reason to suppose that considerably larger areas of cultivation, and considerably higher rates of charge, could eventually be attained. I conclude therefore that, on the whole, it is fair to anticipate that the interest on any amount of capital really required for such works would be covered by the returns at an early period, and that the prosecution of the proposed further investigations and the preparation of suitable projects and estimates, is entirely justified.

I have reckoned on a total cultivated area of 3 million acres, and it will be as well to show how far such an extent of land is likely to be available. I estimate that the entire area of the land that could be watered on the right bank of the Indus, between Sukkur and Sehwun, is 3½ million acres. On the left bank of the Indus, between Rohree and Hyderabad, the total area of British territory is about 2½ million acres. Together, this supplies 6 million acres, and rejecting one-fourth as an allowance to cover barren or unirrigable land, there would remain 4½ million acres irrigable. In the North Western Provinces, it is understood that about one-third of the culturable land is irrigated yearly in the best cultivated districts. But in Sindh, where the whole cultivation requires irrigation, a larger proportion must be taken, and it seems fair to assume that one-half may be irrigated at one time. This would allow of alternate years for fallow for all land, one crop only being taken in each year, which seems amply sufficient. In the area designated we should, on this basis, have 2¼ million acres irrigated yearly, leaving three-fourths of a million to be provided in the lower part of the Delta, and on both sides of the Indus above Sukkur, or by a larger amount of land under crop at one time. This additional quantity might very fairly be expected to be obtained from these sources.

As to the power of the existing population to extend the area of cultivation from 1 to 3 million acres, it may be said that the relief obtained by the cessation of the lifting

the water, will release a very large amount of labour which will be immediately available for extending the area under crop at one time. The money value of this labour may be taken at about Rs. 15 per acre on 500,000 acres, or Rs. 75,00,000. The saving of such an amount in labour, whether it is sufficient to meet the full demand for so large an increase of cultivation, as has been reckoned upon or not, must have a very great influence on the progress of the Province; and even if there be some exaggeration in the cost of this labour, it is almost certain that the real relief will be so great as to give an entirely different character to the agriculture of Sindh.

Although my visit to Sindh has been limited to a short period, and my means of forming sound opinions on matters of detail have, therefore, been restricted, it may be useful if I indicate generally the direction in which it has appeared to me that such investigations should be carried out. In doing this, however, it is fitting that I should disclaim any intention of doing more than offering suggestions for the consideration of the Officers who may be charged with such a duty, and placing in a somewhat more definite light the character of the operations which I regard as so desirable.

A project was prepared some years ago by Lieutenant-Colonel Fife, R. E., for a perennial high level canal to be drawn from the Indus at Rohree. For reasons which need not be referred to, no action has yet been taken on this scheme, though it was strongly supported by the present Governor of Bombay, who at that time was Commissioner in Sindh, much on the grounds which have been adduced in the earlier part of this Memorandum. This project, however, provided for a small supply of water only, 1,400 cubic feet per second, and was intended to be worked altogether apart from, and in addition to, the existing system of inundation canals. This indeed was a natural course to suggest at that time. Now, that opinion has so greatly changed as to the proper system of dealing with works of irrigation, and that more comprehensive views can be put forward with reasonable expectations of their receiving attention, such a project must be regarded as insufficient. I have discussed with Lieutenant-Colonel Fife the extension which might properly be given to this project so as to bring it into relation with such a general scheme of irrigation as that which I advocate. The conclusion to which I have come is, that this canal should carry about 7,000 cubic feet of water per second, and should supply the whole of the Hyderabad Collectorate as far as the Foolailee Channel. It should be so arranged as to throw water into all the canals now fed from the Indus between Rohree and the mouth of the Foolailee.

The Foolailee is so large a channel, and carries so large a body of water in the inundation season, and is in such good general condition, that it seems desirable to maintain it at all events for the present. The channels which now flow from its left or northerly bank will all be supplied from the new canal, and the water saved will go to increase the quantity available on the south. If needful, an additional head might be opened opposite to Kotree near Hyderabad, for the supply of the lower portion of the Delta, and a similar work could be constructed opposite Jarruck. It is probable that the canal from Rohree will give a sufficient supply of water for the rubbee cultivation throughout the Hyderabad Collectorate. It is questionable how far rubbee can be profitably raised in the lower part of the Delta, and it must be left for further investigation to show the precise form which should be given to the works for this portion of the Province. Both at Jurruck and Kotree, facilities exist for the formation of dams such as the Madras Anicuts, and, on the whole, there is nothing to prevent a very ample water-supply being given to the eastern half of the Delta.

On the left bank of the Indus, above Rohree, there is less apparent facility for improving the irrigation. There is no permanent bank, and the country is liable to heavy inundation. But there is no reason to question the practicability of maintaining a permanent canal head at some suitable point, or of protecting the country which is now flooded.

On the right bank of the Indus, above Sukkur, the conditions are more favourable than on the left bank, but there may be difficulty or expense in maintaining a permanent head. At Sukkur there is a very favourable locality for a canal head to supply the region between Sukkur and Sehwun, at which place the alluvial plain of Sindh is cut off by the hills which there abut directly on the Indus. It seems probable that a single large canal, of about the same size as that proposed for the left bank, *viz.*, to discharge 7,000 cubic feet per second, would supply the whole area of the Shikarpoor and Kurrachee Districts between Sukkur and Sehwun. The water-supply in this part of the Province is at present much more ample than in Hyderabad; but from the absence of a proper engineering control over the supply, considerable danger is incurred of serious floods, and as a fact, injury from this cause is too frequent. From the strong slope of the surface towards the west, the extremities of the distributing channels in many places require to be embanked, and this having been carried out without a proper system of levels, and without due attention to the precautions required under such circumstances, much waste of water and injurious flooding of land takes place.

On the east, or left bank of the Indus, the land is generally so high as to require the natural fall of the surface to be economized to secure a satisfactory slope for the distributing channels. Here the first object of the Engineers will doubtless be to bring in the main supply at an improved level as early as possible. This being done, the existing channels will be capable of doing greatly increased irrigating duty, and their thorough re-arrangement may be carried out by degrees afterwards.

On the right, or west bank, I am inclined to think that attention is at once required to the main distributing channels; and that by placing these in a position of proper efficiency as regards their levels, having due regard to their eventual character as channels to carry a high level supply, great immediate improvement could be secured. The fall from the Indus to the south-west is so great, moreover, that real danger of a serious nature is incurred by leaving the main channels open from the river without engineering control. The success which is claimed for some of the canals made by the District Revenue Officers, and particularly that called the Forwah, is undoubted; but it would be a great misfortune if, from the want of efficient power of control over the water entering such cuts, calamitous flood were to happen, and there is every appearance of such an event being at least possible. The head sluice of the Forwah is in a very critical condition, and if it were carried away, it would not be easy to save Larkhana from a damaging flood, if the result was not something of a much graver sort, such as a large portion of the Indus breaking out over the country in that direction.

The country between Sehwun and Jurruck is hardly susceptible of perennial irrigation from the Indus, and calls for no further comment.

The western Delta, so far as it may be found to require improved irrigation, can readily be supplied from Kotree or Jurruck. It is from this quarter also that it is probable that Kurrachee must look for a fresh water-supply of the abundance which seems requisite for a town and port of the importance which it is likely to assume. I see no engineering difficulty in the way of sending down a copious supply of fresh water into the Garra Creek from Jurruck or Kotree, and thence carrying it, by help of a weir, across the Mulleer River to Kurrachee. By avoiding all expenditure that was not essential for such an object, it could, I think, be attained for an outlay not incommensurate with its importance, but of course exact surveys and estimates alone can test speculations of this nature.

It only remains for me to refer briefly to the extreme eastern Districts of Sindh, Thurr and Parker, These now receive a limited supply of water during the inundation by an old channel called the Narra, fed by a new head constructed by our Engineers, drawn from the Indus at Rohree. A new canal has also been excavated from the end of this old channel, and is known as the Mitrow Canal. From various causes, this canal has not been so successful as could have been desired, or was anticipated. The efficient source of these causes of want of success will, I think, be sufficiently found in the absence of a proper professional administration for irrigation operations in Sindh; and the removal of this defect will, I have no doubt, be very soon followed by the application of all needful remedies to the shortcomings of the Mitrow Canal. There are some other minor channels leading from the Narra, lately dug, which have already done much good in extending cultivation, and there should be no great difficulty or expense in considerably adding to the supply of water thrown into these districts, either by the Narra Channel, or from the surplus of the new main Hyderabad Canal, or from the Foolailee, or some new channel taken from the Indus near Hyderabad.

I shall now proceed to make some observations as to the fiscal system which seems likely to be best suited to the condition of things which would exist were the proposed irrigation works carried out. The question at once arises, whether the whole of the State demand should be levied in one sum as at present, or whether a separate water-rate should be levied: and if so, under what sort of system and with what objects? At first sight there is an appearance of simplicity in the present system which recommends it as preferable to the confessedly artificial plan of levying a separate water-rate where, as a fact, cultivation is not possible without irrigation. But further reflection seems to me to show that, in truth, the land revenue is fixed on a perfectly artificial system, and that when a settlement of the revenue has been made, the charge on this account no longer, so to speak, represents agricultural facts, but is a deduction from them. So long as the land revenue is directly based on the actual produce of any field under cultivation, such cultivation being impossible without water, to separate the charge for the water must of course be quite an arbitrary proceeding. But as soon as the land revenue becomes an average or estimated sum, which will satisfy the Government as a composition for a term of years, it is just as easy and simple to separate this into two parts, as to take it in one sum, if there be any sufficient cause for doing it. The question therefore, is, whether there is such a cause; and I think it will readily be shown that the system of making the separate charge for water, which has been adopted in other parts of India, should eventually be followed in Sindh also.

If the supply of water were unlimited, there would be no reason for controlling or checking its use. But this not being the case, and the value of the water being so great, it becomes very important that no waste should be allowed; that the available supply should be distributed equitably, having regard to the area of land under cultivation, and prescriptive rights of priority of enjoyment; and that the State which supplies the water at the general expense of the country, should receive in payment for it a fair sum to cover the actual cost of maintenance and the interest on capital, and to provide a reasonable profit in aid of the general resources of the State. Now the introduction of systematic irrigation is essentially a tentative process. It is only by

experience that it can be ascertained how much water is required for the several qualities of land and crop, and what is its value; and the first duty of the Irrigation Engineer is to endeavour to ascertain these points. For the former purpose, he measures the irrigated area and finds out what extent can be watered by a given volume of water. In like manner, in fixing and apportioning the charge for the use of water; it is almost essential to begin by a calculation based on the area of land irrigated. In a more advanced stage it becomes possible to make compositions at fixed sums, or to regulate the charge according to the volume of water actually supplied; but, practically, neither of these courses can be adopted with advantage until sufficient experience has been gained, under a system of crop measurement, of the actual wants of the lands to be watered, and of the value of the water as supplied for irrigation.

On the introduction of improved irrigation in Sindh, it will thus be necessary to ascertain the actual areas irrigated: *first*, to get data for calculating the proper irrigation duty of the water; and *second*, to apportion the increased charge fairly. Even if the increased charge was levied simply as an increased lump-sum of land revenue, it must in detail be arrived at by a consideration of the actual area cultivated with the improved water-supply. And this will hold good whether the Revenue Settlement has been made or not.

Moreover, where the settlement has been made on the basis of the old condition of irrigation, and an improvement in this takes place, it will not be possible with equity to make a *pro rata* addition to the whole revenue, because it will not follow that all the land will be benefitted for every year of the residue of the term, or for any one year. It is only after experience shall have shown what is a fair average estimate for one year with another of the benefits of the new system, that the water-rate could be brought under settlement with the land revenue.

It seems, therefore, almost an obligatory measure that, in all settled villages, during the period of transition at least, a separate water-rate shall be taken on the recokoned actual irrigated area. Now, before the new canals are completed, the whole of Sindh will almost certainly have come under revenue settlement, and therefore the separate water-rate will practically everywhere become necessary.

It further appears desirable that, following the practice of the North Western Provinces, the increased charged for the improved water-supply shall be borne by the cultivator as distinguished from the zemindar. The existing land revenue being in fact that proportion of the rental received by the zemindar from the cultivator, which custom assigns to the State, it appears proper to leave this unchanged until the cultivator's rental is raised. It is probable that in Sindh, as in the North-West, the improvement of the irrigation will not at all of necessity lead to the direct increase of the cultivator's rental. Where, for instance, the customary rental is a certain share of the produce, the profits of the cultivator might be greatly increased by reduction of the cost of irrigation without any important change taking place in the produce, which alone regulates the zemindar's interest in the process. Here the cultivator would receive the whole benefit, and should bear the whole charge. Where rents and zemindar's profits practically become increased as a secondary result of these improvements, it will be just that the Government should participate in the increased profits according to the customary rule of the country, and under the terms of any revenue settlement from time to time existing.

In connexion with the matters last discussed, it may be convenient to say a few words on the subject of the Sindh *huccaba*, or rate to cover the cost of canal clearance. As a fact, no such rate is levied, excepting from Jagheerdars, and the *huccaba* for revenue paying lands is only distinguished from the land revenue proper by being arbitrarily separated in the Collector's accounts. Before the British occupation of Sindh, the usual custom was, that the zemindars cleared the canals by their own cultivators, the Government making a small allowance of grain to the work-people, and paying for the supervision, but at the same time taking a corresponding small portion of the produce, under the name of *huccaba*, in addition to the regular land revenue. When Sindh became British, the revenue in kind was commuted into a money payment, and the practice of clearing the canals by unpaid labour was also discontinued, the Government in lieu fixing the money land revenue rate at such an amount as covered the estimated cost of clearance by paid work-people. Of course, this was done in a rough and approximate way. Subsequently, when it was pointed out that, under this system, the Jagheerdars got their canals cleared at the expense of Government, it was ruled that they should be required to pay 3 annas per beegah (about half an acre) to make good this charge for all land irrigated by them from canals cleared by Government; and at the same rate, a separation was made in the Collector's accounts of the nominal *huccaba* from the land revenue.

Under a later arrangement, this nominal *huccaba* rate has been ordered to be transferred from the Imperial to the Local Fund income, the charge for the canal clearances at the same time being made a local charge. Obviously, the sole financial effect of this measure is to make a permanent contract with the Sindh Local Funds for canal clearances at the rate of 3 annas per Sindh beegah irrigated. It will suffice if I here briefly state my opinion, that such a system is even now needless and objectionable, and that it would be quite inapplicable to

the condition of things that would exist, were a proper irrigation adminstration established in the Province. That the apparent necessity for such a measure should have been conceived to exist, seems to me the result of misconceptions and defects of administrative system, which I may take another opportunity to explain.

It remains for me to refer to one other consideration which should receive serious attention when adopting a policy of providing Sindh with permanent irrigation at a high level. I refer to the grave responsibility which will rest on the State to maintain the works in proper efficiency. Any want of attention to the water-supply of a country so completely without rain, and so thoroughly dependent as it would become on a highly artificial system of irrigation, will be calamitous. A country thus placed is in a position as critical as one in which the entire surface is preserved from the irruption of the sea by dykes.

The conclusion to be adopted in the face of this responsibility should certainly not be that on this account such works should not be undertaken, but that every possible precaution should be adopted to guard against accidents. And having regard to the character of the risk, and to the present comparatively small amount of the population of Sindh, it seems unsafe to trust to the ordinary supply of labor that could be obtained in the open market to meet all possible emergencies that might arise after such a canal system as I have contemplated had come into operation. Whether for effecting clearances of the channels, or repairing breaches in the embankments, or carrying out any other really essential work, the administration should have the power, under suitable check, of commanding the labour of the entire community to effect what was necessary in behalf of the general interests. If a conscription or an enrolment of the whole number of able-bodied citizens is legitimate for the defence of a country against an armed enemy of the State, how much more legitimate is the exercise of a similar power for the protection of the whole community from the most frightful calamity that can befall it—a general drought and famine. If the tremendous character of such visitations had been estimated at their proper value, some of the blackest pages in the history of the British Administration in India would have had no place there; and it would be inexcusable indeed, if, in the face of the lesson which has been lately read to us in Cuttack, any proper precaution was omitted when attemping to deal with the irrigation of a whole Province. A law having such an intention as is here contemplated, exists, I think, in Madras; and something of this nature should be introduced in Sindh simultaneously with the resolution to prosecute the new system of works.

Dated 17th April, 1867.

[No. 9.] *Memo. by* COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation, on the extension of Irrigation in Guzerat, Candeish, and the Deccan.*

For the satisfactory treatment of the subjects which I propose to discuss, namely, how the extension of irrigation in the chief Districts of the Bombay Presidency may best be accomplished, it is first necessary to obtain a clear conception of the exact end in view, and of the general conditions under which any Engineering operations designed to effect that end will have to be carried out.

2. It is, as I understand, the present desire of the Government to do what is practicable for the provision of the means of irrigation in all parts of India, to such an extent at least as shall protect the country from the consequences of seasons of extreme drought; and, so far as Bombay is concerned, the practical question now for consideration therefore is, what steps shall be taken for giving effect to this policy in that Presidency?

3. If we except Sindh, regarding which I have already recorded my opinions, very little has yet been done in this direction in the Provinces of Bombay. Within the last few years, it is true, the great importance of irrigation has been more clearly felt, and such measures as were at the time possible have been taken for the prosecution of investigations having in view the preparation of projects for works of this class. But from the nature of the system under which funds were available for these purposes, the scope of the operations of the Public Works Officers has been greatly restricted, and their efforts have been directed to securing the readiest means of utilizing the most accessible sources of water-supply, rather than to seeking for a method of providing water for the Districts which most required it, or were most likely to be benefitted in an important degree by irrigation works.

4. In saying this, I should perhaps add that nothing is further from any intention than to impute any blame; so far from it, that I have no doubt that what has been actually done was, under the circumstances, the right thing to do, and that the works which have already been begun, will form the best possible centres from which to proceed in carrying out the far broader policy which has now happily been adopted.

5. The great characteristics of the seasons and of the natural water-supply, are generally similar in all the three Provinces, Guzerat, Candeish, and the Deccan, to which these remarks are intended to apply. The rain-fall is for agricultural purposes confined to the monsoon months, that is, from June to September. There is either no cold-weather rain, or its amount is so trifling as to have no importance whatever. The culturable lands everywhere lie in the proximity of mountains of only moderate elevation, the natural drainage of

which supplies no permanent streams of importance. Exceptionally, very small perennial rivulets are met near the chief mountain ridges, and a limited area of land is already irrigated from such sources. The larger rivers are commonly torrents of very fluctuating magnitude during the rainy months, and almost dry after Christmas. The beds of these rivers at the same time are most frequently cut so deep below the surface of the country, as to make it difficult to bring the water from them for the purposes of irrigation.

6. The absolute quantity of water which is available in the form of rain on the neighbouring hills, or of flood-water passing down the rivers, is, however, very ample to meet all possible wants of the country, if it can only be suitably stored and diverted; but, under the circumstances that have been just stated, the task of providing anything approximating to a permanent supply of water is likely to be much more difficult and costly than would have been the case if any permanent streams naturally existed. The provision of irrigation becomes, therefore, to a greater extent than elsewhere a financial question, and the problem to be solved is mainly how to supply the water so as to yield a profit, or at all events not to lead to a charge on the finances.

7. Again, as there are no permanent streams of magnitude, there is no distinctly obvious or unquestionable plan to adopt for accomplishing what is desired; and after the first specially convenient localities for works have been occupied, and the available small permanent supply of water has been exhausted, a sort of difficulty arises as to what should be done next, and as to the way of determining how or where the reservoirs, dams, or canals, some combination of which must be resorted to, shall be constructed.

8. It appears to me that the proper way to proceed under these circumstances is entirely to invert the order in which such enquiries have hitherto been made. Instead of proceeding from a given water-supply, or a given convenient site for works, and thence seeking for the land to be irrigated from them, and for the means of reaching that land with irrigating channels, the more proper course would appear to be to begin from the land requiring irrigation, and having considered in each District what area has to be provided for, and in what localities, to seek how the needful water can best be obtained. This method of going to work may at first seem somewhat more troublesome, and may have an appearance of entering upon a task of very great magnitude; but it has in fact already become in some measure necessary from the acknowledged difficulty of finding exceptionally favourable sites, and from the very limited quantity of the permanent water-supply. So long as we were satisfied with turning to account any specially convenient source of supply, the old way of going to work was quite legitimate and sufficient; but having given up the old way of viewing matters, and having determined to provide water where it is wanted rather than where it is readily procurable, it is no longer possible to trust to exceptional sites, and the question must be faced how to obtain water for specific tracts of land which require irrigation, under the specific conditions which in each case affect the actual available natural drainage area, or rain-catchment basin, from which the water must come.

9. On such a system the first question for the Engineers will be to ascertain the quantity of land to be irrigated in the several localties, which will commonly be strictly limited in extent by natural boundaries of hills or rivers. It will then be necessary to settle some arbitrary proportion of the whole area which shall, if possible, be provided with water. It cannot be expected that the whole area could ever be irrigated even if water could be found for it. Some land will remain fallow; some crops will not require water, or a very little will suffice for them; the agricultural population now existing will not be able for some time at least to convert more than a moderate area of dry into irrigated cultivation. Moreover, having regard to the intention of the Government to extend the benefits of irrigation as widely as possible, and as soon as possible, it will manifestly be preferable to give a certain moderate proportion of irrigation to all Districts before attempting to push to the utmost the provision of water in any one District.

10. The exact proportion of the whole cultivated area to be supplied with water at the outset, must in each case be left to be determined on a consideration of the relative facility of giving the supply, and the urgency of the demand for protection from drought, or the probable capacity for making early and full use of the water. It is, however, probable, I believe, that about one-fourth of the entire area, or one-third of the cultivated area, might be found a fair proportion to adopt at first under average circumstances. In a District of peculiarly small rain-fall, a larger proportion might be deemed proper if it could be obtained without serious difficulty.

11. Having approximately estimated the extent of land to be watered, the next step would be to ascertain the probable character of the cultivation; and with reference to the nature of the crop, and the amount of natural rain-fall, to calculate the quantity of water required to be artificially provided at the various periods of the agricultural seasons. This will give a general indication of the extent and character of the works that will be needed. Where the distinction between the Rubbee and Khurreef crops is plainly marked, the necessity for making special provision for each will, of course, appear. Where the variation of temperature between the coldest and the hottest months is not so great as to lead to the sharp separation of the agricultural seasons, a corresponding modification in the manner of supplying the water will be possible. Here the capacity of the land for producing crops

without rest, will furnish almost the sole standard of the maximum demand for water, while in the former case the periodicity of the seasons will introduce a limitation of the demand of equally great importance.

12. It may be said, and with much truth, that there will be considerable difficulty in thus estimating the quantity of water required for the irrigation of a tract of land, and that it may even be impracticable to do it in a very trustworthy manner. It is unfortunately the case that in few parts of India has such attention been paid to the detailed working of irrigation, as to have furnished really satisfactory data relating to the area of various descriptions of crop that can be sufficiently irrigated by a given quantity of water. But approximate results have been obtained, and it is to be hoped that the attention of all Engineers in charge of works of irrigation will henceforth be directed to the point, and that our information on the subject will continue to improve in the future.

13. I would add that a knowledge of this matter, the proper irrigating duty of a given volume of water, is not only of importance in aiding the projectors of new works, but is of equal value to those who have charge of the works that are completed. It must obviously be one of the principal objects of the administrative Officers in charge of irrigation works, to extend to the utmost the benefits to be derived from the water, and this can only be fully accomplished by ascertaining that the greatest possible area is watered by the smallest quantity of water which will give a good crop, It may be true that it will be difficult to adjust exactly the balance between the water-supply and the area irrigated, and that no precise rules can ever be laid down on such a point ; but it is practically certain that, unless special attention is paid to this adjustment, the maximum advantage to the country will not be derived from the available supply of water which is as essentially limited as the demand is unlimited.

14. After these general observations, I shall proceed to offer a few remarks on the special character of the principal Districts of Bombay with regard to the provision of irrigation.

15. The Concan is geographically the narrow belt of country between the Western Ghâts and the sea. The rain-fall is every where heavy, and the cultivation during the monsoon is almost always successful. It is not doubtful that the agriculture could be much benefitted by the improvement of the control over the water-supply during the monsoon ; or that, by the aid of dams and reservoirs, cold weather and hot weather crops could be raised in much greater breadth and abundance than at present. But the necessity for artificial aids to cultivation is much less in this region than elsewhere, and it is probable that progress should be obtained where it is more needed before taking up the improvement of the Concan. It must not be overlooked, however, that the proximity of the city of Bombay will give greatly increased value to improved cultivation in these Districts, and the policy of affording the means of irrigation during the dry season to the country within easiest reach of the Bombay market, is worthy of careful attention, not only in the interest of the producers, but of the consumers also. All that can be done to secure a plentiful and cheap supply of food for man and beast in a city like Bombay, will well repay the trouble devoted to it.

16. Passing on to Guzerat, it will be found that the rain-fall gradually diminishes in abundance as we proceed northward from Bombay ; so far as I could learn, it is about at Bulsar that such a reduction of rain has taken place as to indicate that irrigation would be certainly most beneficial. Beyond the Nerbudda, the rain-fall approximates in quantity to that of the upper part of the North Western Provinces between the Ganges and Jumna, and though I am not aware that any severe drought has ever been felt in this part of Guzerat, there seems no question that the rain-fall is often so short as to cause much loss to the cultivators. In Northern Guzerat the conditions of temperature are such as to establish fully the distinction between a Khureef and Rubbee crop; in the southern parts of the Province the climate is more tropical, and the cultivation of temperate cereals ceases.

17. Though several large rivers traverse Guzerat, the permanent supply of water in none of them is important. Further, they flow for the most part in very deep beds, and bring down floods of vast amount in the rainy season. I would not say that such permanent streams as they afford may not be utilized at a cost which will pay, but the difficulties to be overcome will be great. It seems probable that some of the smaller streams which run in beds less depressed below the surface of the country, would be found to yield a sufficient supply of water during the monsoon months, and for the Khurreef crop. What would be required for the Rubbee in the cold weather and hot dry months must, under any arrangement, be mainly obtained from reservoirs ; and it is at first sight likely that the small permanent supply of the largest rivers will, in most cases, be so difficult to obtain possession of, that it must be rejected. The sort of arrangement, therefore, which seems most suitable is to divert the monsoon supply of some of the smaller streams, making up the required quantity of water, if necessary, by combining several of them, or by drawing something from one of the larger rivers ; and to arrange reservoirs within the hills in which the streams rise, or outside of them, if suitable sites can be found, which shall be able to discharge into the irrigating channels fed from the monsoon waters. In one or two cases, the Taptee and Saburmuttee for instance, it may be possible to deal with the larger rivers without incurring too great expense, and the Engineers employed on the preliminary investigations to be taken up in Guzerat will no doubt first look to these as affording the groundwork for practical projects which can be brought into a shape fit for execution at an early period.

18. It may be noticed that there exist in Guzerat small irrigation dams, constructed some years ago by the late Major Fulljames, on one of the smaller rivers, on a very inexpensive plan, which have been used with much success. They are placed at intervals along the stream, and are closed and opened in succession so as to divert the flood-waters in turn to the lands on the banks. For a small and very intermittent supply, such an arrangement seems very suitable, but it is probable that it would be better to form an entirely new artificial irrigating channel, with a single dam at its origin, in all cases where the supply could be maintained pretty constantly, and was tolerably abundant.

19. I had the advantage of speaking to Major Prescott of the Settlement Department regarding the prospects of irrigation in Guzerat. I understood him to consider that there was an almost indefinite scope for the application of irrigation to the cultivation as now carried on, both in the Khurreef and the Rubbee seasons, and that the land would on an average very readily pay as much as Rs. 4 per acre on an irrigated crop in addition to the present Settlement rates. The large population, and the very careful character of the existing agriculture, afford strong grounds for expecting that the benefits of irrigation would be very quickly taken advantage of in this Province.

20. The physical characteristics of Candeish and the Deccan are sufficiently alike to admit of my speaking of them together. In Candeish and the northern portions of the Deccan, there is distinct Rubbee cultivation ; further south, the Division of the seasons is less marked, and the crops are more generally tropical. In both Provinces, the cultivated lands commonly lie in comparatively flat-bottomed valleys, traversed by streams mostly dry from December to June, and closed in on both sides by steep hills. Along the summit of the Western Ghâts, the rain-fall is heavy, but it rapidly diminishes as we proceed eastward, and in some regions the average fall is as little as 10 inches, or still less. Even in those valleys closest to the Ghâts, few of the streams maintain anything but a very small stream in the dry months, and the largest of the rivers hardly bring down 100 cubic feet per second after February. The rivers usually flow in deep beds from 50 to 100 feet below the edge of the cultivated plain which they traverse, the slope of their beds being from 2 to 5 feet per mile. The cultivated lands rise rapidly from the central stream to the hills on either side, with an inclination from 10 to 50 feet per mile, and are much scoured through by transverse nullahs and hollows.

21. This arrangement of the surface makes it peculiarly difficult to obtain the means of irrigation. The longitudinal slope of the valleys is so small, that a canal must be carried a great length before it rises from the level of the river-bed to the level of the country to be watered. When sites are sought for reservoirs, excepting on the main rivers, the slopes of the country are so strong, that a very high and costly dam is necessary to give a large capacity for storage. If dams are placed across the main rivers, they suffer under the disadvantage of requiring waste weirs of capacity enough to discharge the entire river supply, for the quantity of water that could be retained by the largest possible dam is probably not more than one-tenth part of the whole volume of water passing down the river. Further, a dam so constructed will have the serious defect of stopping the whole of the silt brought down by the river while only a small portion of the water is utilized.

22. The irrigation works that have hitherto been executed in the Deccan and Candeish have principally been dams across streams having a small permanent supply, with canals leading from the dams of such capacity as to utilize the minimum discharge of the stream, or something slightly in excess of it. The more ancient works of this character in Candeish, in the western part of which such dams known as Bundaras are frequent, are of very small size ; though, so far as they go, they are extremely valuable. The works lately undertaken by the Public Works Department are on a larger scale than any of the old Native works, but still are of small dimensions compared to the works of the Madras Deltas, or the North-West Provinces. Till now, nothing has been settled as to the best means of extending the utility of any of these works by connecting them with reservoirs. The Engineers have not come to any conclusions as to the safest and most economical system of storing water, and this very important subject has not yet passed from the stage of discussion and speculation into that of fact.

23. The result of the information that I have obtained from the Officers who have been employed on these works, and chiefly from Lieutenant-Colonel Fife, whose attention has long been directed to these important but difficult problems, may be briefly stated, not in any dogmatic spirit, but rather with a view to assist further discussion and research on the part of the many intelligent Engineers engaged in this branch of their profession. It appears, then, that the first step should probably be to derive from one of the principal streams a sufficient supply of monsoon water to provide for the wants of each locality during the rainy months. The means of doing this would be found by going backwards from the land to be irrigated along the most convenient line for a canal until a sufficient supply of water was met with, either in a single stream, or in several streams. Suitable dams and escape weirs would then be formed on these streams, and canals led from them. These canals, in the comparatively long course which must be given them in order to bring them up to a proper level to command the cultivated lands, will cross many minor side streams, the water flowing down which might be drawn into the irrigating channel so far as it was required. In this manner, a fairly continuous supply of water may probably be furnished for most parts of the country from July to September

which will therefore suffice for the satisfactory maturing of one crop at least. To prolong the supply into the cold weather and dry hot weather, so far as the conditions of the agriculture of the District required (this being determined on the general principles already explained), recourse would then be had to reservoirs to be formed along the line of irrigating channel. Such reservoirs might either be formed by damming up lateral lines of drainage of minor extent, or by throwing the surplus waters brought down from some river having an ample monsoon supply into some suitable basin or reservoir. So far as it was practicable, every reservoir should store the entire volume of water brought down into it from the drainage basin on which it was formed, or the river from which it was fed, so as to avoid to the utmost the necessity for a waste weir, and at the same time to reduce to the utmost the relative quantity of silt thrown down in the reservoir. I may add that the above method of proceeding is substantially that which is followed in those Districts of Madras and Mysore where the physical conditions of the country are most like those of the Deccan.

24. With a view to the satisfactory progress of the preparation of designs for works under these circumstances, I am strongly impressed with the probable advantange of obtaining, as early as possible, such a general knowledge of the exact levels of the surface of any District which it is proposed to irrigate, as will suffice to form a skeleton contour map. Such a system of levels might be got by levelling up the chief water channels, and making cross-sections at fixed intervals, which cross lines should be again combined with a longitudinal line along the water-shed between two neighbouring streams. I entirely discredit the power of the eye in estimating the relative levels of the surface of gently sloping ground broken up by hills, and the more exact the knowledge that can be obtained of the form the surface at a moderate outlay, the better will it be for all the subsequent operations of the Engineer. With the help of Native Surveyors, such a net-work of levels might, I feel satisfied, be obtained at every small cost. All experience shows the great waste of power and time that arises from isolated levelling operations where a complicated system of irrigating channels has to be worked out, and the greatest care should be taken to start any newly organized Irrigation establishment with a thorough perception of the necessity for keeping all its levelling records in the most perfect order and in such a form that every new line of levels shall be a permanent addition to the fixed knowledge of the Department.

25. As to the prospects of remunerative return from irrigation in these Districts, Colonel Francis, the Settlement Commissioner, considers that the additional sum that can be realized is likely to be quite as much as that already mentioned for Guzerat, namely, Rs. 4 an acre for an average crop. Colonel Francis is strongly impressed with the great importance of doing what is possible to give irrigation as early as possible to the dry zone of the Deccan, which is a band running parallel to the line of Ghâts, and at a distance of about 20 or 30 miles to the east of them, along which the rain-fall seldom exceeds 10 inches. It is, I believe, a constant, and probably an essential, charateristic of Districts of small rain-fall, that much in proportion as the absolute fall is small, so the variations are great, and the risk of severe drought great also. The attention of Colonel Fife has already been given to the supply of water to a portion of this dry region about Indapoor, and it may be hoped that a project will be soon matured which will serve as a model on which to frame future schemes of a like nature.

26. I have not the returns of Candeish irrigation by me for reference, but the general results show a satisfactory growth both of the area irrigated and of the revenue received by the State. So far as I can learn, however, a somewhat more complete responsibility should be put upon the Engineers for the proper maintenance of the Candeish works, and the line of the duty of the Revenue and Engineer Departments should be more precisely defined. The Engineers should, I conceive, be made fully responsible for all that concerns the works and the water-supply, and though, of course, they would be bound to attend strictly to all the implied or written engagements of the Government with the cultivators for the maintenance of the works, they should not be liable to the interference or control of the Revenue Officers in such matters. The Engineer should be regarded as the final authority in respect to the works and the water-snpply, as the Collector should be in respect to all matters of revenue. Regular inspections should be made of all the works, and all questions as to repairs and maintenance should be dealt with by the Engineers, and not by the Revenue Offiers. The extent of the irrigation should be watched by the Engineer, and comparisons instituted between the results of various works having varying supplies of water. All matters affecting the revenues coming to the knowledge of the Engineer should be brought to the notice of the Collector by the Engineer; the Collector, in like manner, informing the Engineer of anything appearing to call for attention in the management of the works. In short, the Engineers in charge of the irrigation should be placed in the position of an Administrative Department, acting concurrently with the Revenue Authorities in respect to their special duties, and fully responsible before the Government both for the maintenance and the active development of irrigation in the Districts in which they were placed. I understand that Colonel Francis has recently been paying special attention to the condition of the Candeish works, and it might be suggested that the results of his enquiries may give occasion for considering further the general scope of these remarks.

27. In connection with this portion of the subject, I may further observe that I am under the impression that a proposal has been made in some quarter to the effect that, on the

completion of any new irrigation work, the cultivators should be required to make use of the water, and should be charged for its use whether they desired to have the water or not. I cannot avoid expressing in the most distinct manner my own disapproval of any such procedure, and I feel assured that the Government of India would much prefer to leave the utilizing of the water, and the full realization of the returns from irrigation, to take place by a regular and natural spontaneous growth. It is almost certain that the demand for water will in a very few years far exceed the power of supplying it, and there is much danger of committing great injustice by attempting to force the introduction of irrigation prematurely. To bring about any sudden change in the practice of agriculture by anything like compulsion, would be a dangerous step, to say the least of it. To argue that, because the Government has spent money on these works mainly to benefit the cultivators, it has therefore acquired the right to compel the cultivators to use water at its own price, for the proposal to which I have referred pretty much comes to that, is to take up a position utterly indefensible, and contrary to every principle of good government. I cannot say that I have any cause to suppose that the Government of Bombay has entertained such a proposal as this, and in the case of the new canal drawn from the Girna in Candeish, the option of using the water or not has, I understand, been left entirely to the cultivators. But the objections to attempting to force on the practice of irrigation, though dictated, no doubt, by a good motive, are to my mind so great that I have thought it necessary to draw attention to the matter at the risk of combating a view which was not at all likely to receive any support.

28. I understand that it is the established practice of the Revenue Department in the Bombay Territory to make a separate special charge, in addition to the land revenue proper, for the use of water derived from all irrigation works. For the reasons I have already given in my Memorandum regarding irrigation in Sindh, I consider that this course is almost essential where irrigation is introduced on land previously cultivated without irrigation, and already under Revenue Settlement, and the ordinary practice in Bombay conforming to this view, no further remarks are necessary on this point.

29. I cannot avoid reference to another topic closely bearing on the financial scope of all irrigation works. I have been given to understand that there is not one of the larger irrigation works now in progress in Candeish and the Deccan on which the actual expenditure will not probably exceed the estimate by something like 50 per cent. It is obvious that, so far as the purely financial interests of the State are concerned, it is a matter of no importance whatever whether such an excess of cost be justified by administrative considerations, or not. The only financial justification that can be accepted is that the works will, notwithstanding their increased expense, still give a proper return from improved Revenue. How far such a result may in the actual cases in hand be obtained, I cannot say, nor, perhaps, is it in one sense very important. But it is impossible to exaggerate the importance of the Disbursing Department engaged in operations such as those now under consideration obtaining the thorough and continued confidence of the Financial Department through which the needful capital for executing the works is to be provided. It has already been asserted by many persons, that the alleged profits from irrigation works are illusory or fictitious, and it behoves all those who believe the contrary to see that no exaggeration of possible profits shall ever be used as an argument in favour of executing a work, that no under-estimate of first cost shall ever swell the anticipated profit, and that no laxity of management shall tend to reduce the actual profit below the estimated amount on the faith of which the work was sanctioned. It is merely a question of time how long an unsafe financial system can go on without detection; and it is very certain that if, from any cause, alleged profits from projected works are found to be habitually overstated, the Government will be forced, in defence of its financial safety, to exercise increased rigour in the scrutiny of projects, and diminished freedom in the supply of funds for construction.

30. It will not be out of place if I also draw attention to the importance of making all new irrigation works undertaken in these Districts subservient, as far as possible, to purposes of communication. Wherever it is possible, the canals should be constructed so as to be fit for navigation, and in designing all the masonry works, attention should be paid to this. Also it will in many cases, if not in all, be possible at a very small additional cost to make roads along the banks of the principal lines of irrigating channel. Such roads are of very great importance to the irrigation establishments, as they facilitate easy access to the works and the irrigated Districts, and it will in all cases be worth while considering whether such additional outlay as might be necessary for making the bank of the canal a convenient road for ordinary traffic, will not be well applied.

31. A few words may be said in conclusion as to the system that might best be followed in extending the action of the Public Works Department as now constituted, so as to bring it, as soon as possible, into a condition of progressive activity, such as the high importance of the early extension of irrigation fairly demands. I understand that the Government of Bombay has already obtained the sanction of the Government of India to the appointment of a separate Chief Engineer for Irrigation Works for the Bombay Presidency. Under this Officer the operations in Sindh will naturally form a distinct section of the administration. In that Province, the practice of irrigation is so fully established, that there will be no probability of much difference of opinion arising as to the general direction in which the Engineers should extend their action after the main questions at issue as to the expediency of constructing permanent canals are once settled. In the Deccan,

Candeish, and Guzerat it is otherwise. Here the existing works are few and scattered, and of those lately undertaken, not one is yet brought into full operation. It at the same time naturally happens that very few of the Bombay Public Works Officers have experience in the designing or management of irrigation works. Under these circumstances, it would seem likely to be the best course to strive to extend the provision of irrigation by regarding those places where the Engineers are now actually constructing irrigation works as centres from which to advance. The Officers now employed on these works who have already acquired some experience, could be supplied with additional assistance, and encouraged to prepare projects for the extension of the utility of the works now in hand, or for the provision of irrigation to other Districts in their immediate vicinity. In Guzerat, one or two additional special Surveying Officers could usefully be employed, no works of this sort having hitherto been taken up there. To assist the Chief Engineer in supervising the preparatian of the new projects, and to prepare for the means of properly controlling the operations of the department when greater activity of construction becomes possible, two Superintending Engineers, one for Guzerat and Candeish, and one for the Deccan, would seem to be desirable. Such an expansion of the establishments would not lead to important present outlay, and would open the way for the more vigorous action of a strong and expanding separate irrigation administration, through the operation of which alone can such progress be secured as shall fully come up to the expectations that may now justly be formed as to the early general extension of irrigation in all parts of India.

Dated 1st August, 1867.

[No. 10.] *Note by* COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation Works, on the contemplated operations in the Irrigation Department in the Punjab.*

In March 1866 the Government of India addressed a Circular to all Governments, making enquiry as to the existence of any projects for works of irrigation which might be taken up within the next few years, and also as to the direction in which further investigations should be prosecuted. The Punjab Government has now replied to this enquiry.

The consideration of the subject was delayed in this Department till Colonel Crofton could discuss the various proposals made by him with myself. This having now been done, I proceed to submit to the Government of India the following observations on the measures which are advocated by the Lieutenant Governor of the Punjab.

The basis of the Lieutenant Governor's proposals is a Memorandum by Colonel Crofton, in which he reviews the existing works of irrigation in the Punjab Provinces, and the projects now in view. It will be convenient to follow Colonel Crofton in his Memorandum.

1.—*Western Jumna Canal.*

There are already several important projects under preparation for the improvement of this, the oldest of all our Irrigation Works in Upper India. The chief of these projects may be noticed here.

First, the construction of a permanent dam on the Jumna to give complete command over the canal supply. This work will also serve a like purpose for the Eastern Jumna Canal. This project is in hand; there is no question as to the necessity for this work.

Second, improvements in the channel between the head and the bifurcation of the Delhi branch. The precise character that should be given to this part of the scheme of works is still undecided. The original idea was to abandon the old line of canal, and dig a new one to the west of the old, avoiding the low ground through which this old line runs. This proposal has been objected to by the Government of India and Secretary of State on account of the large outlay it would involve, and in the extreme form in which it was first put forward, it may be considered as no longer open to discussion. On the other hand, I must be allowed to say that such a summary discarding of the whole idea as seems to be contemplated in the last Despatch of the Secretary of State on the subject, cannot be upheld. It will be *necessary* to do something, and what is necessary should not be delayed till other works which have no relation to this part of the scheme of improvement are completed.

I will as briefly as possible say why something is *necessary*. Above Kurnaul a certain amount of re-arrangement of the canal will be rendered essential by the formation of the new dam on the Jumna. From this dam the old channel will require improvement down to Dadoopoor, at which place the canal becomes an artificial cut, and leaves the old branch of the Jumna in which its upper course is taken. From Dadoopoor, to Indree the existing canal channel seems to be all that is needed with some small improvement.

If, as seems most propable, an arrangement is found to be practicable and expedient for taking off from the Jumna a supply of water during the monsoon months, to be passed down to the Sirsa quarter, the existing canal will have to be enlarged as far down as Indree, near which it is likely that the new branch would have its head.

Below Indree it is a question whether to make an entirely new line as far as Rair, the head of the Delhi Canal, or to complete the improvements between Indree and Kurnaul already partly done, and to deal with the portion of the canal below Kurnaul only in the

way of re-construction. The portion of the canal near Kurnaul is a disgrace to our administration, and has been for years past. It creates most pestilential swamps which must be got rid of, unless we are content to perpetuate this abominable nuisance, which has been talked about for the last 25 years, during which period no serious attempt has been made to abate it. For my own part I distinctly reject all share in any counsels which tend to delay in meeting this most crying evil. I most fully admit the great importance of doing what has to be done with the most scrupulous regard to economy, and I am ready to sacrifice all thought of elegance or congruity for the purpose of avoiding any considerable outlay which is really not needed to secure efficiency. But it is impossible for me to affirm with too great positiveness the moral obligation which rests on our Government to put an end with all possible speed to the discreditable condition of the large tracts of land along the Western Jumna Canal, which are converted into swamps of the most pestilential nature, not only destructive to the health and life of the population, but occupying in a manner far worse than uselessly some of what might be the very best lands. It is very doubtful from the peculiar position of the canal below Kurnaul, whether any adequate remedy for the defects of this part of the channel can be got better than by making a new bed for it. It is possible that economy may be secured by taking the new cut from Indree, and combining the channel for the existing supply with that needed for the new canal before referred to, as proposed to carry a monsoon supply to the westward. These points are under the consideration of the Engineers, and the whole subject will be reported on when the investigation is complete.

Third, the provision of an escape channel from the head of the Delhi branch. This project has already come up, and will be disposed of immediately.

Fourth, the drainage of the whole of the irrigated districts along the Delhi and Rohtuk Canals. The projects for this operation are in a forward state, I am happy to say, and at last it seems likely that action will really be taken to get rid of the swamps in these districts which have for years been a standing reproach to our canal administration like those on the upper part of the canal before referred to.

Fifth, the re-arrangment of the distributing irrigation channels, and the consolidation of the outlets from the main lines on canal into rajbuhas. This also is in progress.

These comprise the main points hitherto taken up. But I would strongly urge the early consideration also of the advantage to be obtained from rendering the chief part of this system of canals navigable.

I think that there can be doubt that the line from Delhi to Kurnaul, and the branch to Hansi or Hissar, should be made navigable as early as possible. From this line of navigation a canal would join into the Sutlej Canal in the neighbourhood of Puttiallah, and thence a communication got with the Sutlej and the Punjab. The communication with Delhi must be settled in connexion with the project for the dam below Delhi. Above Kurnaul there will probably be no serious difficulty in making the canal navigable also, though for purpose of internal trade, it will probably be a less important matter than opening the lower parts which pass through the most productive districts, and go to the largest towns.

I would also refer to a point incidentally noticed by Colonel Crofton, the expediency of restricting the irrigation on some parts of the canal, chiefly the Delhi branch, and the transfer of the water to other parts of the line, probably in the direction of Rohtuk. I have already expressed my general views on the necessity for a revision of the actual distribution of water on the older canals, and what Colonel Crofton suggests is in fact quite the same thing. The occasion of the falling in of the last settlement two or three years hence in the Paniput District, will give a good opportunity of disposing of this question in a satisfactory manner.

2.—*The Delhi and Goorgaon Works.*

These works are now managed in connexion with the Delhi Division of the Western Jumna Canal. They are by no means in a satisfactory position, and call for more attention, which it may be hoped they will before long receive from Colonel Crofton.

3.—*The Sutlej Canal.*

The consideration of this project is still going on. The point which now has to be decided is the precise locality at which the canal shall be taken from the Sutlej. Surveys have recently been made on which the question may most probably be settled within a month or so. This being done, there is nothing to prevent the final surveys and designs being put in hand, on which actual operations would be begun. In the course of the coming cold season it may probably be possible so far to settle the general scope of the project as to begin the actual marking out of the main canals, preparatory to obtaining possession of the land and setting to work.

4.—*The Baree Doab Canal.*

Before this canal can be brought into complete operation, it is necessary to reduce the excessive slope of the upper portions. But before any final plan for doing this is settled, it is important to ascertain whether it may not be possible to add to the supply drawn from the Ravee by taking a second head from the Beas. To determine the exact nature of the works, the quantity of water to be carried by the canal must first be settled, and a decision relative to the Beas supply is, therefore, needed before progress in the existing channel improvement can be got.

It may be noted that the Baree Doab Canal was designed to carry a much larger body of water than is secured by the Ravee cold-weather supply. The question naturally arises therefore why should not the largest possible volume be passed down into the dry regions below Lahore during the rainy months? The main difficulty is in the excessive slope already alluded to. But the general importance of giving the largest possible monsoon supply has, I think, not yet been sufficiently appreciated, and the special attention of the Engineers should be given to the subject. I believe that Colonel Crofton is fully sensible of the importance of this, and that enquiries are being made with a view to obtaining data as to the available water-supply in various canal feeding rivers in the Punjab for monsoon irrigation.

The question of navigation has not been seriously taken up in relation to the Baree Doab Canal. It is very necessary to do this. The first desideratum would seem to be to give water communication *viâ* Lahore, between the Ravee and the Sutlej. The canal leading to the latter river should be placed conveniently with respect to the navigable line leading from the new Sutlej Canal. The navigation should be connected with Umritsur certainly. It should probably be completed to the head of the canal to the Madhopoor Workshops to facilitate the transport of stores and work. If there is any serious difficulty in making the canal navigable to Madhopoor, I should question the propriety of extending the Workshops, and this point should be considered at once. The increased cost of land carriage would almost certainly out-balance any advantage got from the superior cheapness of water-power over steam-power for driving machinery.

5.—*The Inundation Canals.*

Till now little has been done in the way of bringing these works under proper engineering control. They are for the most part still much in the same condition as that in which they were when the Punjab was annexed, and this means that they have remained unimproved for centuries, and though eminently useful, are exceedingly rude and incomplete works.

It is, I believe, a great error to think, as is often the case, that this class of canal is very economical. From the ordinary uncertainty of the supply of water, the returns are low, and from the nature of the works the outlay for clearances is heavy, and the risk of entire stoppage of the supply of water great. It seems to me that there is no reason to doubt that by proper arrangements the utility of these works could be greatly increased, and the supply of water be much better maintained and kept under control, while the cost of them was reduced. It may not be possible, as a rule, to improve them to such an extent as to make them deliver a permanent stream of water, but a very great step would be taken if a satisfactory monsoon supply could be secured under proper control. This much I feel satisfied could be got without any very expensive works. The discussion of the probable means of improving these canals would be out of place here, and I need only add that I entirely concur in the opinions expressed by the Lieutenant Governor of the Punjab and Colonel Crofton that they call for improved supervision and management, and are likely to be a very valuable resource to the country. It seems to me probable that a very large area of the country on the right bank of the Sutlej, below Ferozepoor, and as far as Mooltan, could be irrigated without any very serious expense by means of a canal taken from the Sutlej near Ferozepoor. I should think that the construction of a permanent dam, as proposed by Lieutenant-Colonel Anderson, would not be required for a monsoon canal taken from the river at this point. But the exact facts are of course essential before any useful proposals can be put forward, and the necessity for surveys and levels urged by Colonel Crofton is beyond question. These general remarks apply equally to all the inundation canals in the Punjab, whether derived from the Sutlej, Chenab, or Indus.

I should add before leaving the subject of these canals that I am thoroughly impressed with the necessity that exists for placing their management entirely in the hands of the Irrigation Officers, and relieving the Revenue Officers of all concern with them beyond seeing that the revenue is collected, and bringing to notice any requirements that they may think of importance. Until a complete responsibility rests on the Engineers for the entire management of these works, and their being brought into a thorough state of efficiency, and being made to pay a satisfactory revenue, matters will not be as they should. At present the Engineers merely help in maintaining the works on their old imperfect basis, and cannot be looked upon as responsible for radical improvements. This condition of things is manifestly objectionable.

6.—*Projects for new Canals from the Chenab, Jhelum, and Indus.*

A year or two back a first attempt was made to begin an investigation into the best means of taking a canal from the Chenab, but it was not carried through. It seems probable that there will be no particular difficulty in taking a canal from this river above Sealkote, and Chiniout is named as another likely place for a satisfactory head. It is stated that the population of the lower parts of the Rechna Doab, the tract between the Ravee and Chenab, is very scanty, and the cultivation small in quantity; and it seems to be thought by Colonel Crofton that this tract should receive the available water in preference to the more favourably situated districts nearer the Himalaya, which generally have fair seasons. I confess to having considerable doubts on this point, and as the question is one which must be argued on general principles, I will state my own conclusions on it, so that the subject may be more fully gone into.

There is a disposition on the part of many people, if not of most, to consider that, as a rule, the available means of irrigation should be devoted to the regions where there is the greatest absolute scarcity of rain, to the more or less complete exclusion of more favoured tracts. Now I question the justice of this conclusion. To take an extreme case, if we go into a district absolutely devoid of rain, and cut off from irrigation, we shall find an absolute desert. To reserve water to such a country, while there was plenty of well-peopled and well-cultivated land on which the water could be quite as profitably applied, to say the least of it, would, without doubt, be wrong. Now, as the natural supply of water gradually becomes better, population and cultivation increase also. But where the supply is very small and precarious, the population is small also, and nomadic, or very easily moved. Also such a population is not essentially dependent on cultivation for support, it takes to other industries, often including the robbery of richer neighbours. As we get further from the total desert, we at length arrive in districts, where, in the ordinary run of years, the cultivation is satisfactory, and a large population can be supported. But at intervals more or less distant these tracts will be liable to a failure of the natural rain-fall as complete as that which is the normal condition of the real desert. Then it is that the great suffering caused by drought is developed. The population is so large that any serious deficiency in the food supply becomes calamitous, and by its habits is so fixed that it cannot remove to other places where food is to be got, and is further incapable of finding any occupation by means of which to support life.

The first object of our Irrigation works should, in my opinion, be to protect this region which skirts the true desert tracts. It will not suffice to dole out the supply of water with such parsimony as shall just admit of the existence of a few human beings over the largest area. What is incumbent on us is to give protection to the best of our power to the population, which often will be very dense, of the tracts subject to periodical droughts, but which, under ordinary circumstances, are prosperous enough.

So far, therefore, from beginning with the region most akin to mere desert in our attempts to prevent the worst effects of famine, we should, in my estimation, take exactly the opposite course. Famine will be the worst where the population is largest and least accustomed to drought, and our first consideration should be to provide security against such a failure of crops as would cause famine in these districts.

So far as I am able to judge, this result will be best obtained by allotting to all districts which we regard as liable to a failure of the ordinary rain, such a supply of water as shall secure completely, say one-third or one-fourth of the culturable area. This distribution should be made, beginning with the best cultivated, and therefore most, populous districts, and supplying them in preference to poorer regions with less cultivation and a more sparse population.

This conclusion may at first appear somewhat paradoxical, but I have no hesitation in affirming that it cannot be controverted. It will certainly be far better for any country to have one-half of its surface completely protected from drought under the worst circumstances, and in a state of considerable prosperity generally, than to have its entire area partially supplied with water, and so made capable of general cultivation, but at the same time be left to periodical droughts of an extreme character. To extend cultivation and population beyond what can be protected in the *worst* season, will be to increase and not to diminish the evils of the situation. This is a case in which our action must be regulated not by average results, but by an extreme result. If we leave the population to die of starvation in one year, it will overthrow all the good they have derived from 50 years' previous prosperity.

I therefore conclude that our first business will everywhere be to take up the best cultivated and peopled districts, and from them to go on to the less favourably situated. It will, of course, be understood that I refer to such districts as are liable to extreme drought, but I feel pretty certain that in this category is included almost every portion of the Punjab and North Western Provinces lying outside of the Himalaya. For these reasons I do not look upon proposals to enter upon projects for canals to go into the desert parts of the Punjab as of pressing importance, and consider that attention should first be given to the wants of the districts where cultivation already exists, and where there is a population sufficient to take full advantage of any means of irrigation provided.

With the reservations implied in the above remarks, I quite concur in the propriety of making, as soon as practicable, suitable investigations into the best means of obtaining a supply of water for irrigation from all the rivers which traverse the Punjab. In any projects for irrigation canals, the importance of making lines of navigation should be carried in mind. A line of this sort from the salt-mines at Pind Dadun Khan to Lahore, whence communication would be given to the eastward, would be of the greatest importance to the salt revenue and salt consumer as supplying the cheapest possible mode of transport.

The value of permanent means of irrigation in the Districts west of the Indus would be very great in a political, as well as a fiscal sense. Everything which will add to the wealth of the population, and security of obtaining a means of existence must conduce to the confirmation of habits of order and peace. In this point of view it seems probable that attention should also be given to the irrigation in the Peshawur Valley and the Yusufzaie country.

There is no such powerful agent in the cause of civilization as money. The possession of money derived from honest labour, and the knowledge that the means of procuring it in this way were fully secured, would assuredly produce a very beneficial effect on the border races.

7.—Irrigation in the Kangra Valley.

Although the minor channels in the Kangra Valley are not referred to in the Memorandum of Colonel Crofton, I notice them, because I do not doubt that much good could be accomplished by their being placed under engineering supervision. I am aware that it will be said of these works, as it is said of all similar works managed entirely by the people themselves under the general control of the Revenue Officers, that they do very well as they are. But I cannot admit that this is any sufficient argument for abstaining from making them better, and I must distinctly affirm that the art of skilled Engineers is as certain of producing beneficial results in this case as any other.

This concludes all that I have to say on the general subjects discussed by Colonel Crofton. As to the specific proposals made, the following remarks are offered :—

The essential requirement is Engineers to undertake surveys. At the present time there is, I believe, not a single person available for such duty, while the Punjab Government ask for not less than 16 Officers and 23 Native Surveyors in addition to existing establishments. Although I do not doubt that the Officers asked for could be usefully employed, it is probable that progress could be made with a smaller number. But it is not easy to say how any help can be given.

The best chance seems to be in allowing the Punjab Government to try to obtain the services of a few persons who are qualified for Survey duties for a limited time, and as a temporary arrangement, if such can be found willing to accept service on these terms. If possible, Military Officers should be permitted to accept this employment. It would be understood to be outside of the regular Public Works Department, and the offer might be made for a year only to begin with. During the next year we shall see what help we are to get from England, and the necessities of the case can be re-considered hereafter.

If this were agreed to, it might be settled that to begin with eight Officers, of whom two might receive salary as Executive Engineers, 4th class, and six as Assistants, might be taken by the Punjab Government if they could find them from 15th October next for one year, or any shorter period. It will be best to leave the selection to the Punjab Government probably; and with the assent of the Military Department and His Excellency the Commander-in-Chief, perhaps Military Officers might be invited to send in their names.

If this attempt to get Surveyors prove successful, the number might be added to hereafter if thought necessary.

As to the Native Surveyors, the Punjab Authorities should be desired to take in hand the training of a suitable number, probably twelve might do to begin with. It might be suggested to the Punjab also whether European Surveyors might not perhaps be got from the Roorkee Soldier class. Under proper supervision, these men should be useful.

The only other point is the giving an Assistant to the Chief Engineer for Irrigation. This I think should be agreed to. There is much laborious calculation, &c., involved in the working out irrigation projects, which is alone quite enough to justify such an appointment. This being approved, the Lieutenant Governor might be told to make his own selection when a qualified Officer can be found.

For all these additions to the establishments, formal sanction must be asked, stating rates of salary, &c.

As to the order in which the proposed works should be carried out, the first thing to be remarked is, that everything possible should be done to secure early progress with the Sutlej Canal, and that all other works should yield to this.

Having provided for this, and for any additional help required for the Western Jumna Canal Surveys and the Baree Doab, the next thing to take up should be the Inundation Canals, and probably the Sutlej series first. Last of all would come the Chenab Project, and probably it may be necessary to postpone this until more Engineers are available.

I shall explain in a separate note on the establishments of the Western Jumna and Baree Doab Canals, that I advise the re-arrangement of the Executive charges on these canals, so as to make them suitable for the normal administrative business, *without* the additional special works to be taken up. For these special works it will, I think, be better to form a separate special divisions, or sub-divisions, having nothing to do with the canal administration, and solely devoted to the execution of the works. Whatever is needed in this way must be specially asked for from time to time by the Punjab Government. The arrangement will admit of a reduction of one division on each of the canals, which will give a few Officers for the special works, though, perhaps, not altogether enough.

The suggestion that an additional Superintending Engineer should be appointed for the Inundation Canals is rather premature just now. But it may properly be brought up again when the Survey operations have been actually put in hand to such an extent as to indicate the early commencement of additional works of this character.

Dated 24th January, 1868.

[No. 11.] *Memo. by* COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation Works.*

The Secretary of State makes enquiry as to the meaning of certain expressions used in a Memorandum drawn up by me on the contemplated operations in Irrigation in the Punjab.

The remarks in question had reference to the Inundation Canals of the Punjab. I said—"I am thoroughly impressed with the necessity that exists for placing their management entirely in the hands of the Irrigation Officers, and relieving the Revenue Officers of all concern with them, beyond seeing that the revenue is collected, and bringing to notice any requirements that they may think of importance" (see last para. of Section 5 of my Note of 1st August 1867.

It is asked—"What are the precise duties from which it is proposed to relieve the Revenue Officers?"

The reply is, that the management of this class of Canal has remained till quite lately, very nearly in the condition in which things were found when the Punjab was first taken possession of by the British Government. The works are very primitive, and can hardly be said to be under engineering control in a professional sense. The water comes into them as the rivers rise, and is distributed according to long established custom, with very little supervision or interference on the part of anybody. The payment for the use of the water is made in the land revenue in a lump sum, in some cases the landholders also paying a share of the cost of the clearance when it is needed. The Public Works Officers employed on these canals are mainly engaged in supervising the periodical clearances, and no serious attempt has yet been made to establish the irrigation from these canals on a scientific basis.

Under such a system, the practical manager of the canals is the District Officer, who settles all questions that arise in relation to them, excepting the merely mechanical operation of removing the silt deposits, which accumulate in them, and paying for the removal.

Precisely the same sort of system holds in Sindh, where the so-called Canal Engineer is a mere subordinate to supervise the clearances.

Something analogous also takes place in other parts of the Punjab, notably in the Kangra and Peshawur Districts, where there is a good deal of irrigation from small channels not under engineering control.

In Madras also a similar practice exists in the older irrigated districts. In Tanjore, the Engineers have no sort of concern in the management of the water in the canals derived from the Cauvery. In the new works from the Godavery and Kistnah it is otherwise, the Engineers having the complete control of the water and its distribution.

In Mysore and Bombay the same thing happens

My position is that the complete responsibility for the management of all Irrigation Works should be placed upon Engineers having proper knowledge of the art of irrigation, and that, till this is done, the country cannot obtain the full advantage from such works. It should become the exclusive duty of the Irrigation Department to see that all available resources for irrigation are made the most of, both in the interests of the landholder and of the State. To leave such matters to the supervision of uninstructed Revenue Officers, whose time is greatly occupied by the details of district, revenue, and judicial business, may have been necessary in the first commencement of our rule, and may yet be more or less unavoidable in many cases. But so long as it continues to be done, we must admit that the arrangement is provisional, and tolerated only because of the practical impossibility of establishing a satisfactory system everywhere at once.

The progress of our administration in this respect will certainly go on in the manner in which it goes on in other matters. At first a single Officer with large powers roughly carries on the government of a large district in all branches of business. By degrees one special branch after another is taken out of his hands and given to some special Officer. So long as Engineers properly qualified cannot be got, the Revenue Officer is the best Canal Superintendent, and often a very good one. But the time comes when the wants of the country call for the division of labour, and in my opinion, in respect to all the more important works of irrigation, the time has now come for establishing the principle I have already enunciated.

Therefore it is rather to impose "precise" duties on the Engineers, and to relieve the District Revenue Officers of a general, but rather indefinite, responsibility that my suggestions tend. Of course such a change can only be carried out as a part of an improved system of management generally; and the observations on which the Secretary of State has commented have possibly been somewhat misunderstood, and been thought to have a more specific intention than was really the case.

I think this is all that I need now say on this matter.

Para. 3 of the Secretary of State's letter will be dealt with when the Punjab Government sends up its proposals for remedying the evils of the Canal near Kurnaul. Para. 4 has been settled already by the Government of India.

Dated 22nd February, 1868.

[No. 12.] *Memo. by* COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation Works, on points calling for attention in the Revenue Survey of Mysore, with reference to the requirements of Irrigation Works, present and prospective.*

The following remarks and suggestions are made after some conversations on the subjects discussed with Mr. Bowring, Major Sankey, and the Deputy Superindendent of Colar. I have thought that it might be convenient to record them in a formal manner, so that the Commissioner might take any official notice of them which seemed to him desirable.

2. The Revenue Survey no doubt already distinguishes the lands as "not irrigated," "irrigated from ordinary tanks," "irrigated from tanks fed from rivers," and "irrigated from channels derived from rivers." These distinctions seem desirable.

3. The distinction between "wet and garden" land would, I think, be better re-placed by a division into "one crop" and "two crop" land. It is not desirable to recognize a crop assessment if it can be avoided, and the basis of any charge for water should, as far as possible, be the quantity of water used rather than the character of the crop raised. No doubt in practice the crop does, to a great extent, regulate the quantity of water required, and so far rates determined by the crop are equivalent to rates determined by the quantity of water. But it seems objectionable to do anything which seems to maintain the idea that the nature of the produce regulates the Government demand on land.

4. In order to admit of the future extension of irrigation without disturbing the settlement, and with due regard to the fair claims of the Government, it seems expedient to distinguish, in the case of all irrigated land between the rate due on the land as dry, and the rate due on the water. I am under the impression that this is now done by the Bombay Revenue Surveyors, to some extent at all events.

5. In each case the water-rate would be arrived at by a comparison of the relative value of thoroughly irrigated land, and of dry land of equal fertility and convenience of position.

6. The water-rate should be reckoned by reference to a maximum rate, which would represent the full value of irrigation of a complete sort. For one crop land, this might amount to Rs. 4 per acre for tank irrigation, and Rs. 5 for river irrigation, and, perhaps, double those rates for two crop land. I do not intend to offer any opinion as to the precise sum to be fixed however, and these figures have been named as indicating what I gather might be reasonable. I understand that the river irrigation is actually more valuable than tank irrigation, also it is more costly to the Government, as the works cost more to maintain.

7. Possibly, the higher rate should be charged for tanks fed from rivers, the supply being more certain.

8. The water-rates fixed by the Settlement would allow for the annual fluctuations of the rain-fall as indicated by past experience, and no remissions would be claimable on account of such variations.

9. The maximum wate-rate should, as far as possible, be made uniform for the same Talook or District, and an absolute maximum rate might probably be prescribed. The very high rates which are actually paid in some cases are quite exceptional, and if irrigation is extended, it would most likely be impossible to maintain such rates. It is plain that the tendency of the increase of irrigated cultivation must be to add to the quantity of irrigated produce, and to reduce its money value, making the maintenance of very high special rates less and less possible.

10. It must be specified in every case what is the liability of the Government in respect to the maintenance of the Irrigation Works. I understand that the ordinary practice now is, that the Government maintains the chief works. It is probable that, under the old system of the Native Government, the ryots provided the needful labour more or less completely, but I believe that this obligation has been allowed to fall into disuse of late years, and that it can now hardly be re-asserted.

11. In the case of tanks, where there is no specific agreement to the contrary, I should therefore propose that the obligation on the Government to maintain the main bund and masonry works should be recognized, the whole cost of the distributing channels and of the distribution and control of the water being borne by the cultivators with the help of whatever service Inams or Village allowances now exist.

12. The Settlement might determine more precisely the scope of the duties of such Inamdars or Village servants, and it should be made a clear rule that, if those duties were not performed to the satisfaction of the Government, the persons who neglected them would be liable to be ousted, and other persons might be appointed, or other arrangements made for the performance of the duties at the cost of the ryots, if the village Inams or allowances did not supply a sufficient fund.

13. If, under any exceptional circumstances, the cost of the maintenance of a channel from a tank was borne by the Government, the higher water-rate should be charged to meet the extra cost to the State.

14. The same general principles should be followed in the case of channels supplied from rivers. The anicuts and regulating works, the main supply channel with its masonry works, would be provided and maintained at the cost of the Government; all the minor distributing channels would be formed by the ryots, and the duty of managing the supply to the village lands would fall on them also; the Government regulating at its cost the supply in the main channels.

15. Where existing custom places the maintenance of the main channels or works in the hands of a special Inamdar or Village servant paid by fees or allowances (if this ever is the case), I think that the arrangement should either be terminated absolutely, or at all events declared to be terminable at the discretion of the Government under any arrangement thought fair. For the proper management of irrigation channels, the persons employed to patrol and regulate the supply must be directly under the orders, and in the pay of the Managing Officer, and it would be quite impossible to secure anything like discipline or order with a body of men holding Inams, &c., instead of receiving money wages, and being liable to summary dismissal for misconduct.

16. It may be true that the time has not yet come for taking up thoroughly the control of the channels, but the needful powers should now he taken, so that by degrees an efficient system may be introduced.

17. The above observations relate to the general considerations which seem to call for special attention in conducting the survey. I next shall refer to the arrangements under which the settlement for a fixed term of years will be made.

18. For the effectual preservation of the fair claims of the Government to an increase of revenue with any increase of irrigation, certain precautions will be necessary:—

19. First, it should be within the discretion of the Government to retain in its own hands the management of all the larger irrigation works, and to adopt a system under which the benefits of irrigation are strictly paid for according to the actual advantages given to the ryots. This would be done by charging a special water-rate on the actual area irrigated, or supply of water given, either year by year, or for short terms, so that any reasonable increase of rate might be made in the future. Experience has shown that, for the satisfactory management of irrigation works, measures must be taken for ascertaining the actual acreage year by year. This being necessary in an administrative point of view, the data on which to reckon the charge for water are given, and the system of making an annual charge readily follows.

20. But this plan is of course only suited to the larger class of works, and would be utterly inapplicable to the minor tanks which supply so large a proportion of the irrigation of Mysore. It would, therefore, be desirable to make a rule by which special orders should be obtained from the Commissioner as to the mode of management to be followed in all the larger tanks before the settlement is completed. Perhaps an area of from 300 to 500 acres might be regarded as the limit beyond which direct Government management might be feasible.

21. For the minor tanks, no doubt, the settlement should go on just as though there were no distinction made between irrigated and unirrigated lands. All that should be done in these cases is to secure to the Government the means of adding fairly to the assessment if the water-supply is unprovided after settlement of the revenue.

22. The assessment, with the separation of the water-rate, at once permits of this being done. After any improvement has been made, it will be ascertained what land has had its facilities for irrigation improved, and an addition will be made to the Revenue on this account according to the survey rates. For instance, if in a holding of 50 acres, 30 acres are assessed at dry rates, 10 acres at the maximum water-ate, and 10 acres at half the maximum water-rate; and that an improvement is made by which the 10 acres first assessed at the half water-rate are fully irrigated, and 15 acres of the former dry land are three-quarters irrigated, then the 10 acres will be charged the full water-rate, or a half rate more, and the 15 acres will be charged a three-quarter water-rate which before only paid the dry rate.

23. After an improvement, the actual extension of irrigation might be tested for, say three years, and on the results so obtained a new settlement made to continue to the end of the existing general settlement, or for any shorter period thought proper.

24. In the event of an improvement on a large scale, the Government must of course have the power to take up the management itself, as in the case of a restored work, or an altogether new work. Also any second improvement would be dealt with in like manner; no second settlement interfering with the right of Government to increase the water-rate for further improvements.

25. With reference to the minor tanks another consideration arises. It will be extremely difficult, if not quite impossible, for the Government to undertake to make all improvements which are desirable under its own agency. Two cases may arise in connection with minor improvements. First, that the ryots will themselves provide the whole sum of money or labour necessary; and second, that they will provide a portion of it.

26. If the ryots provide the whole cost, and effect a complete restoration of a work wholly useless now, the following plan is suggested as suitable. That the ryots should

agree to maintain the work at their own cost, and on failure, things to go back to their former position. That the land irrigated from a tank thus restored, should be charged only half the ordinary water-rate, and that this advantage should be perpetual. Thus on the expiry of the existing settlement, the new assessment would deal with the dry rates like those of all other lands, but the water-rates would not be increased to a higher rate than half the maximum.

27. If the ryots provide only part of the money, or make an improvement to a work already partially in use, then a corresponding reduction might be made in the water-rate on the additional area irrigated till the end of the current settlement only, after which the work would be treated like a common Government tank. Thus, if the ryots supplied half the money, the reduction would be one-fourth of the water-rate, and so on.

28. In all cases the Government would reserve to itself the right of determining what works could be made over to ryots, and in what cases the Government should carry out operations itself. Also due care should be taken to see that no danger to other works is likely to arise from any work handed over to ryots.

29. Next, it is important to arrange for the transfer from the Government to the ryots of the obligation to maintain all the smaller tanks. The necessity for the Government taking up the petty repairs of the multitude of tanks which exist in Mysore, is a very great difficulty, which should, as far as possible, be got rid of.

30. Therefore it might be declared that the Government should have the power of requiring the ryots to undertake the maintenance of all minor tanks under some such system as the following :—

31. The average cost of maintenance should be ascertained in each case, referring to the actual expenditure for the last six or eight years, and giving any fair moderate increased sum which was thought right. This sum would be deducted from the assessment in consideration of the ordinary repairs being carried by the ryots.

32. The works would be inspected from time to time, under suitable arrangements by the Revenue and Irrigation Officers, and when any neglect was observed, notice would be given to the ryots to make good the defects in a reasonable time. If this was not done, the work would be carried out by the Government, and the actual cost, with an addition of 25 per cent. to cover the expenses of Government, would be levied from the ryots, the payment being enforced, if necessary, as though the sum due were an arrear of land revenue.

33. Suitable powers should be given to some one among the ryots who should be named to superintend the repairs, to admit of his obtaining the needful labour, or contributions of money from the body of the cultivators. Either the deduction allowed from the revenue would be made over to him, or he should have special facilities for obtaining a summary decision in case of any individual ryot refusing or neglecting to bear his share of the work.

34. The obligation to maintain works improved at the cost of the ryots, as before proposed, should be enforced under the same system.

35. The failure of any ryot, or body of ryots, to act fully up to their obligations in relation to tank maintenance, should justify the Government in breaking the settlement, or any agreement come to, as to a reduced water-rate being levied.

36. If the ryots anywhere decline to carry out the improvement of a small tank, or object to enter into an arrangement for maintaining it, as just explained, the Government may entrust the work to any one ready to take it up, and such a person should receive the advantageous terms that would have been given to the ryots, or the powers necessary to levy the needful contributions for repairs, as the case might need. A farmer or contractor thus introduced should have an absolute title to retain his farm or contract for any term of years agreed to by Government, or till the end of the existing settlement. Then the ryots might take up their ordinary position on paying the farmer compensation for the improvements made at his cost.

37. This disposes of the matters calling for notice in relation to the minor works which the Government would not care to manage in detail. For the larger works and the river channels some further remarks will be made.

38. As before observed, under a system of direct management, a knowledge of the actual area irrigated from time to time must be considered essential. To ascertain this, it will be necessary to have a detailed record of the area of all fields, and the Survey should therefore extend its computations and records to the fields, and not stop at the Survey Numbers. It will also be necessary to provide for the Survey and record of the new fields formed from time to time as irrigation extends, and also for changes in boundaries. Experience shows that this is requisite, and provision should be made for it in the case of all the larger works.

39. Although I consider that it is necessary for the Government to reserve its right of increasing the water-rate on irrigated land from time to time, yet it may, perhaps, be thought expedient, on the first indroduction of the survey and new assessment, deal with the land-

holders occupying lands irrigated from river channels on terms, as nearly as can be, the same as those given to ryots having tank irrigated lands. Therefore it may be wished to settle the water-rate for the channel irrigated lands for 30 years in the first place, and to leave the claim to increase the water-rate in abeyance for the present as regards lands *now* irrigated. For any lands which may be brought under irrigation after the settlement is made, there could be no reason for making any such provision, and for these the right of Government to raise the water-rate at discretion should be affirmed, it being understood that the rate would not be changed oftener than at the end of five years from the last fixing of charge.

40. If a settlement be made thus for 30 years on channel irrigated land, or land under the largest class of tanks, it should, I think, only be allowed when nearly all the irrigable land is now under cultivation and irrigated, or when such lands are in a compact block. It would be very inconvenient to have lands on which a yearly water-rate would be charged, mixed up with others on which the water-rate was fixed for 30 years of the settlement.

41. Also no such settlement should be made unless the total water-rate charged amounted to the maximum rate on the whole area, less say 20 per cent. If this be not the case, it would show that the irrigation was so likely to be unprovided as to lead to considerable alterations in the assessment in the future under the system already explained as applicable to extension of tank irrigation, for this of course would also apply to improvements in the irrigation of settled lands under channels.

42. If these concessions were not thought necessary, however, all the lands under channels or large tanks, which it was intended to bring under direct Government management, might be settled for 30 years, so far as the dry assessment went, and for five years as regards the water-rate. It would then be optional with the Government to introduce at any time any system of charge for the water which was thought best, and to substitute it for the Survey water assessment at the end of the 5 years, or any further time that was convenient, the Survey rates being meanwhile extended till the new system was ready.

43. So far as my experience enables me to form an opinion, I am inclined to think that the proper course to follow in the assessment of water-rates on irrigated lands would be somewhat as follows :—

44. To ascertain as exactly as possible, from year to year, the actual area irrigated under the several crops. At the same time to ascertain the quantity of water applied to the irrigation; to define by degrees the supply given to separate villages or plots of land; and to limit the quantity by a fixed sluice, to what experience shows to be needed for the lands.

45. When a complete control has been established on the distribution of the water, and a fair knowledge has, by actual experience, being got of the average irrigated area, to make a contract agreement with the land-holders that they shall pay a fixed lump-sum for each fixed opening, irrespective of the actual area irrigated. Such a contract to be for five years on a somewhat reduced rate, an allowance of 20 per cent. on the full maximum rates would seem fair.

46. By following up such a system, the Government would be in a position to extend constantly, and as far as possible, the useful effect of the available water-supply, and at the same time to take fair advantage of the natural increase of rates which might be fairly hoped for with general increased prosperity of the country. The terms of the contracts might be increased beyond five years if experience showed it to be desirable; but at present, I think, that five years is quite enough.

47. The rules under which the water-rate would be charged would provide for any special adjustments, either for failure of crops or single waterings of special crops, or special rates of any sort. As a rule, there should be no reduction of rates unless the supply was so far short as to cause sensible deterioration in the crop, and perhaps three-fourths of a full supply might be about the limit.

48. To carry out such a system, it would be clearly necessary that the distribution of the water in the irrigating channels should be under the full control of the Officer in charge of the works. The first principles which should regulate the distribution of the water would be, that the available supply should be considered applicable to all the lands irrigable in equal proportions, without admitting of any priority of claim on account of position, &c. The intention should be to extend the advantages of irrigation to the largest possible area of land.

49. To accomplish this, the Irrigation Officers should have power to make any needful change in existing arrangements, it being left to every individual who considered that he had been injured by such a change, to appeal to the Revenue Officers, and on proving his case, he being allowed a proper compensation by a reduction of his revenue assessment or otherwise.

50. It would of course be proper to take all due care that attention should be paid to objections before changes were carried out, and a system of appeal and supervision under superior authority should be established to prevent the inferior irrigation agents doing what was objectionable in these or other matters.

51. Certain police powers should also be given to the Irrigation Officers to admit of the summary stoppage of all irregularities in connexion with the water-supply. Experience has everywhere proved that, to be effectual, the repression of offences of this class must be exercised on the spot, and in a summary way.

52. The only other point which seems to call for notice is the position of Inamdars, or persons holding lands under Government in any special manner in relation to irrigation. It is very desirable that the rights of all such persons should be defined exactly.

53. If an Inamdar holds irrigated land, the equivalent water-rate on that land should be recorded. It cannot equitably be held that he has any right to any water-supply better than that which he now has, and if an improvement is made, he is fairly liable to assessment for the advantage which is not part of his Inam. In practice, the only way of defining the water-supply will be by stating the equivalent money water-rate, which will at once afford a ready means of comparison with the adjacent ryots' holdings.

54. The liability of Inamdars to share in the cost of maintenance should, in like manner, be distinctly recorded. I understand that, on the revision of the titles of Inamdars, it may be possible to induce them generally to assent to share the cost of maintenance of works now kept up by Government from which they benefit.

55. If so, it will of course be an advantage. I further need only remark that the exact nature of the liability should be defined in such a way as to prevent all question hereafter as to the precise mode of estimating it.

No. 10 I, dated 1st February, 1868.

[No. 13.] *RESOLUTION,—By the Government of India, P. W. Dept.*

Resolution.—The Madras Government, in June last, forwarded for sanction by the Government of India a project for the extension of the Irrigation Works supplied from the Pennair Anicut in the Nellore District. For reasons explained to the Madras Government, the Governor General in Council found himself unable to give sanction to the project until further explanations were afforded. The Government of Madras has subsequently expressed a hope that an additional report, more recently sent up, will satisfy the Government of India that the project is sound, and the works will now be sanctioned.

2. His Excellency the Governor General in Council has observed with much satisfaction that the Government of Madras has at once cordially responded to the request that projects of the class under consideration shall henceforth be sent up for the consideration of the Government of India in a more complete form, and His Excellency in Council trusts that no delay will in future arise in dealing with proposals for the execution of new projects for Irrigation Works in the Madras Presidency.

3. In the present case it seems to His Excellency in Council that the best way of disposing of the questions on which further information has been desired by the Government of India, will be to depute the Inspector General of Irrigation Works to Madras to go into the project personally with the Engineers of the Madras Government, under the provisions of the Circular Resolution (No. 60, dated 2nd July 1867), describing the powers and duties assigned to the Inspector General of Irrigation. This course would have been adopted sooner, but Colonel Strachey has been detained by other duties which he could not conveniently quit.

4. The Governor General in Council remarks that it will certainly conduce to the speedy termination of any discussions that may arise between the Government of India and Local Governments, on professional or technical subjects in relation to Irrigation Works, to bring them to a point by personal communication between the local professional Officers and the Inspector General of Irrigation Works. It is believed that most frequently all differences of opinion will thus be speedily reconciled in a manner which will be acceptable both to the Local Government and the Government of India; and the Governor General in Council would, so far as is possible, adopt such a method of settling differences for the future.

5. The visit of Colonel Strachey to Madras at the present time may, in the estimation of the Government of India, also be taken advantage of for considering, in communication with the Officers of the Madras Government, some other matters which are of much present importance in relation to the progress of irrigation in India.

6. The first of these refers to the system to be followed in framing the Revenue Accounts of Irrigation Works, so that they may exhibit results which shall be comparable for all parts of India.

7. It will be remembered that the main object of Colonel Strachey's visit to Madras and Bombay last year was to obtain data on which to make proposals for effecting the above purpose. Colonel Strachey has expressed an opinion, in which the Governor General in Council fully concurs, that it will be a more satisfactory way of proceeding, in attempting to accomplish the end in views, that he should discuss the subject personally at Madras with a few selected Revenue and Engineer Officers who have a full knowledge of the requirements of the Madras Works, and endeavour to arrange a plan which might be submitted with a joint recommendation from them all, for the approval of the Madras Government. By conducting

such a discussion at Madras it would probably be possible to settle, in a few days, to the satisfaction of all parties, what otherwise would require a very tedious and difficult correspondence.

8. The Governor General in Council recognizes the fact that the extent of irrigation at Madras is much greater than in other Provinces of India, and, therefore, that the requirements of its system of Revenue and Irrigation and administration must be considered as of primary importance in any conclusions adopted. It is believed that no serious difficulty will arise in arranging a plan which shall fairly meet all the essential wants of all parts of the country, and the Government of India trust that the present proposal will be acceptable to His Excellency the Governor of Madras in Council, and will lead to an early settlement of this important question.

9. The next subject relates to the exhibition, in the annual accounts of the Empire of the revenue derived from Irrigation Works under a new separate head, distinct from Land Revenue and Public Works, under one or other of which the income is now shown, the system in different Provinces varying without much reason.

10. In adopting this change, the plan that has been accepted for the last few years, in respect to the Forest revenues, might be followed, and it is thought that it would, for several reasons, be productive of sensible advantages, accompanied, as it naturally would be, with a corresponding separate exhibition of the charges for Irrigation Works, which constitute the set-off against the revenues.

11. With a growing expenditure on Irrigation Works, it will become yearly more important to show, in a distinct and tangible form, on the face of the annual accounts, the results of this expenditure on the Revenue and Charge of the year. The re-action of such a distinct preception of the true importance of this class of works, on their administrative control, would also probably prove of much value. The large income which would be shown to be due to irrigation (and this particularly applies to Madras), would indicate in an unmistakable manner the necessity for making all needful grants for the maintenance of the works which secure that income.

12. The frequent complaints which have arisen in past years as to the insufficient grants for such purposes, would almost certainly soon cease in the face of the facts which such an account would exhibit in an incontrovertible form. At the same time the immediate juxtaposition of the Charges and Revenue would afford a ready and most useful check on the economical management of the Irrigation Department, and would constantly keep in view the necessity for strict frugality, and indicate where the administration was best conducted, so far as financial considerations were concerned.

13. It is not to be disguised that some difficulty may be found in settling how such a plan shall be carried out. But the questions will probably be chiefly on matters of detail, and there seems no reason for doubting that a such a close approximation to the true facts may be attained in the separation of the Irrigation Revenue and Charges from those due to other sources, as shall secure the real ends in view.

14. In close connection with these questions arises a third, *viz.*, how it may best be possible to assist the improvement or restoration of the numerous minor Irrigation Works in the Madras Provinces, with due regard to financial considerations.

15. The Governor General in Council has deemed it necessary, on financial grounds, to limit closely the application of funds obtained by loan to certain classes of works. Under the rules laid down on this subject, the prosecution of such minor works, as have now been referred to, from money obtained by loan could only be authorized under special arrangements. It would be satisfactory to the Government of India to find that some plan of operations could be devised, which should place at the command of the Madras Government, for the improvement of these minor works, whatever funds were really essential for the purpose; and the visit of the Inspector General of Irrigation Works to Madras might be taken advantage of to consider this point also. Colonel Strachey is fully conversant with the views which the Government of India has adopted in relation to the financial control to be exercised in the application of borrowed money to Irrigation Works, and it is highly probable that any plan in which he concurred, and which met the approval of the Government of Madras, would at once be accepted by the Governor General in Council.

16. If during Colonel Strachey's visit to Madras the Government of Madras should desire to ask Colonel Strachey to communicate with their Officers on any other subject relating to Irrigation, he will be instructed to comply with any requisition so to do.

17. It is the wish of the Government of India that any discussions which may take place between the Officers of the Government of Madras and the Inspector General of Irrigation, shall be entirely regulated as desired by His Excellency the Governor of Madras in Council; and though the Governor General in Council hopes that the Madras Government will acquiesce in the consideration of the subjects referred to in this Resolution in the manner suggested, yet, should any decided objection arise, it is left to the full discretion of the Government of Madras to act as it thinks best in respect to all of them.

No. 1185, dated 20th April, 1868.

[No. 14.] *From*—COLONEL C. A. ORR, R. E., *Secy. to the Govt. of Madras, in the P. W. Dept.*,

To—Secretary to the Government of India, P. W. Dept.

I am directed to acknowledge the receipt of the Proceedings of the Government of India of the 1st February 1868, No. 101, wherein this Government are advised of the deputation to Madras of the Inspector General of Irrigation Works for the purpose of considering, in communication with the Officers of this Presidency, the propriety of introducing an improved system of framing the Revenue Accounts of Irrigation Works, with a view to the exhibition of that revenue in the annual accounts of the Empire under a separate and distinct head, and of determining the mode in which it may best be possible, with due regard to financial considerations, to assist the improvement or restoration of the numerous minor agricultural works in the several districts.

2. Recognizing the extensive scale on which irrigation is carried on in this Presidency, the Government of India point to the great importance of the requirements of its system of revenue and irrigation administration being thoroughly considered in order to the arrangement of a plan which shall meet all essential wants, and be applicable to other parts of India. To give effect to the proposal for the separation of the Irrigation revenue and charges, from those due to other sources, in the annual accounts the Government of India suggests the adoption of the plan now followed in respect to the Forest revenues, which, while conclusively demonstrating the wants of the works that secure the income exhibited in those accounts, would at the same time afford a ready and useful check on the economical management of the Irrigation Department. Finally, taking into consideration the restrictions which are imposed by existing rules on the appropriation of money obtained by loan, it is suggested that some plan should be devised, whereby this Government would have at their command whatever funds may be essential for the improvement of Minor Agricultural Works.

3. Agreeing in opinion with the Government of India that these important matters could best be arranged by personal communication between the Officers of this Government and the Inspector General of Irrigation Works, His Excellency in Council requested Mr. J. D. Sim, as a Member of the Board of Revenue, and the Chief Engineer for Irrigation, to associate themselves with Colonel Strachey for the purpose of discussing and reporting on the points adverted to in paras. 6 to 15 of the Orders of the Government of India.

4. The results of the conference held by these Officers on the questions remitted for their consideration, will be found recorded in the accompanying Memorandum dated the 15th February 1868. The various subjects treated of in that Memorandum were discussed with the collective Board of Revenue, who, it is stated, unanimously concur in the views and recommendations of the Committee.

5. On the first of the points above-mentioned, *viz.*, the propriety of introducing an improved system of framing the Revenue Accounts of Irrigation Works, the Committee, assuming that no objection would be raised in the Financial Department to the introduction of additional heads of Account, give it as their opinion that the proposed separation of the Irrigation Revenue from the general Land Revenue of this Presidency would best be attained by the sub-division, both on the credit and debtor side of the Account, of the present head "Land Revenue" into "Land Revenue, Ordinary," and "Land Revenue, Irrigated." The latter will include the whole income derived from irrigated lands when levied in a consolidated rate, and the whole land revenue, as well as the water-rate on such lands when the latter is separately charged, as also the miscellaneous items of income derived from Irrigation Works, which, together with the water-rate, will then be excluded from Public Works income. The Committee state that the charges to be entered under "Land Revenue, Irrigated," should be those noted in the margin, and that the revenue and charges under "Land Revenue, Ordinary," should include all sums not entered under "Land Revenue, Irrigated," which now fall under "Land Revenue."

The cost of all new works constructed from revenues, and all outlay for repairs and maintenance.

A proportionate charge for the Public Works Establishments employed on construction and maintenance, and all special establishment charges incurred for the works.

A proportionate charge for the cost of the Land Revenue Establishments, with any special charges of a like description.

The interest on the special grants obtained by loan applied to the construction of new works.

6. The assent of the Board of Revenue to the separation of the Irrigation Revenue from the general Land Revenue, has been given on the distinct understanding that such separation is under no circumstances to be followed by the transfer of the duty of collecting that revenue from the Revenue Authorities to the Public Works Department.

7. Looking to the growing expenditure on agricultural works, and to the large grants which it is probable will hereafter be made available from borrowed capital for the extension of irrigation in this Presidency, this Government fully recognized the necessity and importance of recording in a distinct form in the annual accounts the results of the irrigation outlay on the revenue and charge of each year. Concurring, however, in the opinion of the Board of Revenue, that a change in the system under which the Irrigation Revenue is collected in this

Presidency is neither necessary nor desirable, I am to say that His Excellency in Council agrees to the change recommended by the Committee on the assurance that the proposed separation of the Irrigation Revenue is to be carried out solely as a Financial or Budget arrangement, and to be confined to the accounts.

8. Adverting to para. 12 of the Committee's Memorandum, this Government consider that no change should be made in the mode of dealing with income derived from Navigation on Canals of Irrigation, and they have accordingly directed that such receipts should continue to be credited in the accounts of the Public Works Department.

9. The principle to be followed in reckoning the profits of Irrigation Works, as explained in paras. 18 to 20 of the Committee's Memorandum, as well as the form of Revenue Account appended to the Committee's Report, and the classification of the main heads of income and expenditure proposed by Colonel Strachey, and agreed to by the Chief Engineer for Irrigation, are approved of by this Government, and I am to state that the Board of Revenue have been requested to take measures, in communication with the Accountant General and the Controller of Public Works Accounts, for giving effect to the changes under notice, and that instructions have been issued to the latter Officer to arrange for the maintenance of special Revenue Accounts for the classes of Irrigation Works referred to in para. 25 of the Committee's Memorandum.

10. With regard to the manner in which it may best be possible to provide for the requirements of minor Irrigation Works in the Districts of this Presidency, the Committee propose, and this Government strongly recommend, that the minimum cost of works to be undertaken from money obtained from loan should be reduced from Rs. 1,00,000, as originally fixed, to Rs. 25,000. This arrangement will provide the means of carrying out improvements on a class of very useful works, which, in this Presidency, are both numerous and generally of a highly remunerative character. With respect to the allowance to be made from the general revenues for agricultural works, the Government concur in opinion with the Board of Revenue, that the grant of about 15 lakhs for Ordinary Irrigation new works and repairs in 1868-69, should be increased in future years to twenty lakhs, the additional assignment being made available, at the discretion of this Government, for either minor new works or repairs; and as it will be absolutely impossible to diminish the allotments under other heads of service to make up the amount, His Excellency the Governor in Council trusts that an extra grant to the required extent will hereafter be made, pending the adoption of an improved system for providing for the repair and maintenance of minor irrigation works; a subject which will receive the early consideration of the Governor in Council.

[No. 15.] CLASSIFICATION OF WORKS.

A. Temporary Works, to maintain and regulate supply.

B. Cost of land—
- *a.* Main Canals and Branches.
- *b.* Distributing Channels.

C. Masonry Works.
1. *Main Canals and Branches*—
   - *a.* Dams and regulating works.
   - *b.* Falls and Weirs.
   - *c.* Aqueducts and works to divert or pass drainage across the Canal.
   - *d.* Escapes.
2. *Distributing Channels*—
   - *a.* Head Sluices and regulating works.
   - *b.* Falls and Weirs.
   - *c.* Aqueducts.
3. *Drainage works* to provide for the surface drainage of lands traversed by the Canals.
4. *Supply of Tanks*, including waste weirs, inlets, and sluices of such tanks.
5. *Road Bridges*, not being combined with works for other purposes—
   - *a.* Main Canal and Branches.
   - *b.* Distributing Channels.
6. *Navigation works*, mainly or essentially designed for navigation.
7. *Mills and application of water-power.*
8. *Buildings*, for Offices, Establishments, Stores, Workshops, &c.

D. Earth-Works.
1. *Main Canals and Branches*—
   - *a.* Excavation of bed.
   - *b.* Embankments or protection of banks.

In first construction, where embanked channels are formed in connexion with excavated beds, they would fall into Class *a*, it being intended that Class *b* should apply to channels formed by embanking natural river beds, and to works for the protection of the banks of such channels.

In maintenance, all clearances would fall under Class *a*, and the protection or repair of banks under Class *b*.
   - *c.* Diversions of drainage crossing the Canal.
   - *d.* Escape Channels.

2. *Distributing Channels*—
   - *a.* Excavation. } as above explained.
   - *b.* Embankments. }
3. *Drainage*, for surface drainage of lands traversed by the Canal.
4. *Supply of tanks*—
   - *a.* Embankments for Reservoirs.
   - *b.* Channels of supply or escape.
5. *Navigation channels*, restricted as in the case of the masonry works.
6. *Mills and application of water-power*; channels to supply such works.

E. Navigation plant.
1. Steamers.
2. Boats.
3. Stores and other plant.

F. Machinery for Mills, &c.

G. Miscellaneous.
1. *Tools and Plant.*
2. *Surveys and experiments.*
3. *Contingencies*, not properly chargeable to any individual work.

[No. 16.] CLASSIFICATION OF ESTABLISHMENTS AND CHARGES FOR COLLECTION.

A. General.

1. *Direction*—
   - Engineering.
   - Office.
   - Account.
2. *Executive*—
   - Engineering.
   - Office and Accounts.
   - Water Regulation.
3. *Medical.*
4. *Survey.*

B. Revenue.
1. *Share of Land Revenue Establishments.*
2. *Special Canal Establishments.*
3. *Fees and allowances on collections.*

C. Navigation.
1. *General control.*
2. *Working locks.*

(and any others necessary).

D. Mills and Machinery.

(When necessary).

E. Plantations.

F. Compensations and Remissions.
1. *Free grants.*
2. *Short supply.*
3. *Flooding.*
4. *Other causes.*

In each case charges for contingencies would appear under the head in connexion with which they arose.

[No. 17.] REVENUE ACCOUNT OF THE CANAL FOR THE YEAR 1867-68.

EXPENDITURE.			RECEIPTS.			
1.—*Maintenance and repairs of works.*			1.—*Irrigation.*			
Temporary works			Land Revenue on irrigated area			
Masonry „						
Earth-work			*Deduct—*			
Navigation plant			Land Revenue on irrigated area before construction of works			
Mill machinery			Less charges of collection, &c.			
Total ...			Net deduction ...			
2.—*Establishments.*			Gross increase of land revenue from irrigation			
General			2.—*Special water-rates* ...			
Revenue						
Navigation						
Mills						
Total ...			Total Irrigation ...			
3.—*Plantations*			3.—*Produce of land and plantations*			
4.—*Compensations and Remissions*			4.—*Navigation*			
			5.—*Water-power*			
Total expenditure ...			6.—*Miscellaneous*			
Balance profit —— per cent. on Capital						
Grand Total ...			Grand Total ...			

Memorandum of Interest and current charges remaining unpaid from income.				*Memorandum of Capital Account.*			
	INTEREST AT FIVE PER CENT.	CURRENT CHARGES.	TOTAL.		WORKS TOOLS AND PLANT, AND CONTINGENCY.	ESTABLISHMENTS.	TOTAL.
Former balance brought forward				Former outlay brought forward			
Add for the current year				Outlay for the year 1867-68 ...			
Total ...							
Deduct or add for the current year ...							
Deduct net profit ...							
Balance not discharged				Total ...			

(N. B.—This account would cease when all arrears of current charges and interest are paid off.)

[No. 18.] ACCOUNTS TO ACCOMPANY THE ANNUAL PROVINCIAL REVENUE REPORT.

No. I.—General Cash Account of the Irrigation Branch, Public Works Department, North Western Provinces.

DR.			CR.		
To Balance			By Outlay chargeable to Irrigation Capital Account		
Cash			„ Outlay chargeable to Irrigation Revenue Account		
&c.			„ Outlay chargeable to other Accounts..		
To Receipts			Total ...		
P. W. Grant			By Balance		
Realizations of revenue &c. ...			Grand Total ...		
Grand Total ...					

No. II.—General Capital Account, Irrigation Department, North Western Provinces.

DR.			CR.		
To Balance			By sum written off to Revenue		
„ Outlay, Canal A			Canal A		
„ B &c. ...			„ B		
			Total ..		
			By Balance		
Grand Total ...			Grand Total ..		

No. III.—General Revenue Account of the current year , Irrigation Department, North Western Provinces.

DR.			CR.		
To Cash for charges of the year ...			By Demand for the year		
Canal A			Canal A		
„ B			„ B		
To Capital transfers					
Total ...					
Balance Profits					
Grand Total ...			Grand Total ...		

No. IV.—General Account of Demands and Realizations of Revenue, Irrigation Department, North Western Provinces.

DR.			CR.		
To Balance outstanding			By Realization for past years		
„ Demand for the year ...			„ „ current years		
Canal A			„ Remission written off...		
„ B			Total ...		
			Balance, past years ...		
			„ current years ...		
Grand Total ...			Grand Total ...		

Report on Irrigation Works in India; more particularly having reference to the mode of exhibiting their financial results. By COLONEL R. STRACHEY, R. E., *Inspector General of Irrigation Works.*

Dated 2nd September, 1868.

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