227 I d. 3. 86.
377 I. d. 5. 82

From P.W.C. No 7441

The Supg Engineer
I Circle

B.W. 2537 dt 28-9-86.

To

The Chief Engineer
P. W. Depart.

Sanctioned

Sanctioned

Date 15
Despd 17 September/86
Recd: 23.

Lieut
24/9/86

Lieu
27/9/86.

No 478. G.S.

B.W. 2537 dt 28-9-86.

Building for the East Engineers Office at Chicalda — Requests Sanction of Govt. to hire — at Rs 20 per month for until such time as the building lately purchased is thoroughly repaired.

With order

S. E. I Circle
E. I. C.
Exr. P. W. Accts
Exr. P. W. A
Despd 28-9-86

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SKETCH MAP
of
RUSHIKULYA PROJECT
SHOWING PROPOSED RESERVOIRS, ANICUTS, IRRIGATION & NAVIGATION CANALS.

SCALE 4 MILES TO AN INCH.

5 0 5 10 15 MILES

KOOLA

PROPOSED BAVANGONA RESERVOIR

RUSSELKONDA

GOOMSOOR

PILEPADA

MAHANUDDY RIVER

MAHANUDDY CANAL

RUSHIKULYA PROPOSED ANICUT (3 MILES 4 FURLONGS)

RUSHIKULYA RIVER

ASKA

SOORADA

PROPOSED SOORADA RESERVOIR

SHARGODAUD

GOORLA

INJILLY

RUSHIKULYA CANAL

44 MILES & 399 Yds

CHILKA LAKE

PALOOR

GANJAM

MUNSOORCOTAH

63 MILES 399 Yds

GOHALPUR

BERHAMPUR

BAY OF BENGAL

REFERENCES

- MAIN IRRIGATION CANALS.
- PORTION AVAILABLE FOR NAVIGATION
- BRANCH IRRIGATION CANALS.
- AREA TO BE IRRIGATED

	ACRES
MAHANUDDY CANAL	12.000
RUSHIKULYA CANAL	108.000
TOTAL	120.000

- COAST CANAL
- PROPOSED COAST CANAL.

Govt Lith: Departt
Chepâk June 1882

for Supt and Manager
Govt Lith: Dept

Chepâk
8 March 1882.

Executive Engineer
D Project Division.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Irrigation.

No. 8.

READ—the following Note on the Rushikulya Project* by C. VINCENT, Esq., Executive Engineer in charge of D. Project Division, dated 8th March 1882, No. 15, and endorsement by Colonel J. O. HASTED, R.E., Acting Chief Engineer for Irrigation, dated Ootacamund, 22nd April 1882, :—

1. I. PRELIMINARY REMARKS.—As a preliminary to other observations, it may be as well to state briefly the previous history of the project, and also, in the same connection, the circumstances as regards irrigation of the district it is designed to "protect" against the worst effects of scarcity or famine.

2. The Rooshkoolia, or, according to the authorised method of spelling, the *Rushikulya* river traverses Ganjam, which is the northernmost district in the Madras Presidency, and comprises an area of 8,500† square miles, of which 3,359 are in the Máliyá Hill Tracts, and 5,141 in the plains. The population, according to the Census of 1871, was 1,520,088, and according to the Census of 1881, 1,548,676. The district was severely visited by famine in 1865-66, the northern portion being the most affected. The famine was caused by the failure of the rains following upon two years of partial scarcity in 1863 and 1864. It is estimated that 60,000 persons perished, either of starvation or of diseases induced by privation.‡

† *Imperial Gazetteer.*

Chief Engineer's Memorandum, No. 2211, dated 29th September 1881.

‡ *Imperial Gazetteer.*

3. The total cultivated area in Ganjam in 1879-80 was 425,810 acres of first crop and 17,666 acres of second crop cultivation. Of this 214,816 acres of first crop and 9,886 of second crop were irrigated.§

§ Administration Report for 1879-80.

4. In circular No. 25 of 1866, the Government of India called for a report regarding irrigation projects in Madras, and certain special establishments were sanctioned in that year for the examination of such as appeared suitable. In Ganjam, although neither the Public Works nor Revenue authorities were actually cognisant of any schemes for the improvement of irrigation, yet it was considered probable that large reservoirs might be formed there at a comparatively small cost which would prove remunerative. Captain Beckley, R.E., was accordingly deputed in 1868‖ to examine the district, and the first report of the Chief Engineer for Irrigation on

‖ G.O., No. 1351, 1st May 1868.

* Revised in accordance with the instructions of the Chief Engineer for Irrigation.

the progress that had been made is contained in Proceedings of Madras Government, No. 247, dated 27th January 1869. Captain Beckley's attention was almost wholly confined in Ganjam to the examination of the Rushikulya Project, but the investigations regarding it were, from various causes, extremely protracted. He was employed on it continuously till the end of 1872,* sending in a general report on the whole scheme in September of that year; but, owing to deficient revenue information, the whole of the papers were not reviewed by the Chief Engineer for Irrigation till December 1875. The Chief Engineer's note, two reports from Major Beckley, and the detailed estimates are printed in Proceedings of Madras Government, No. 1293, dated 23rd May 1876. The Government, after considering these papers, determined that the project in its then state did not offer a prospect of a sufficiently remunerative return† to be recommended for sanction as a Loan Fund work, though it was said that it might in the future assume a more certain aspect of profit. All expenditure on it was therefore ordered to cease, though certain information regarding the cross-sections of the river and the levels of the subsoil water was directed to be collected. Owing to the press of other work, and to the numerous changes that have occurred in the Public Works Department since 1876, which resulted in Ganjam being removed from the sphere of Public Works operations from the early part of 1879 till October 1881, these orders have not received attention, and the circumstances as regards the project may therefore be said to be in precisely the same condition at present as when the Chief Engineer for Irrigation reviewed the papers in December 1875.

* Proceedings of Madras Government, No. 2686, dated 15th November 1872.

† Only 4 per cent. was then shown as the probable return on the expenditure.

5. II. DESCRIPTION OF PROJECT.—The project consists in utilising the waters of the small rivers Rushikulya and Mahánadi for the irrigation of a tract of country lying between the town of Aska and the sea. There were alternative proposals with regard to the works; the first being the construction of an anicut on the Mahánadi with a canal from it to the Rushikulya, so as to increase the supply of the latter, and an anicut on it where the Doab Canal runs in, with channels to the tract to be irrigated, and also the formation of two reservoirs on the principal affluent of each river. The alternative scheme dispensed with the anicut on the Mahánadi and the Doab Canal, one very large reservoir being formed instead on the Rushikulya itself. The relative advantages and disadvantages of the two schemes were thus summarised by Major Beckley:

First or Anicut Scheme. Advantages.

(1.) The Rushikulya Canal is a complete work and might be finished and yielding a revenue before a rupee was spent on the Mahánadi portion.
(2.) The water for irrigation would become available without any of its silt or fertilizing properties being lost.
(3.) Navigation would be extended for at least six months in the year from the Rushikulya to Goomsur.

Second or Reservoir Scheme. Disadvantages.

(1.) The whole must be completed before any portion of it becomes available.
(2.) Every thing will depend on the security of the reservoir.
(3.) A large proportion of the valuable fertilising silt will be deposited in the reservoirs.
(4.) In time the reservoir will become silted up.

On the other hand the reservoir scheme may claim the following

Advantages.

(1.) A more certain and larger supply of water.
(2.) A net increase of 25,000 acres in the irrigation.
(3.) A largely increased reserve available for second crop, and navigation ensured for the whole year.

The total cost of the two projects was approximately the same.

6. III. ANICUT SCHEME.—Government, however, in Proceedings of Madras Government, No. 1293, dated 23rd May 1876, decided in favor of the first project, and a somewhat more detailed description of this may therefore be now entered upon.

(1.) *Mahánadi Anicut and Canal.*—The site selected for the Mahánadi Anicut is a short distance above Goomsur close to where two rivers, the Loharanadi and Boodanur, join the Mahánadi. The latter joins the Rushikulya at Aska. The total area drained by the Mahánadi and its affluents down to the anicut site is about 900 square miles, on which the yearly rainfall varies between 35 and 60 inches. The maximum flood discharge is taken at 60,000 cubic feet per second. The anicut to be 600 feet long, with its crest 190 feet above M.S.L. The head sluice is designed with twelve vents, each 6 feet by 4 feet, or a total waterway of 288 square feet. The length of the canal to the Rushikulya is to be 19 miles 1,207 yards, of which the first 11·5 miles would have a bottom width of 35 feet, and the remainder a bottom width of 30 feet, the depth of flow being 6 feet throughout, the fall 6 inches in the mile, and the discharge 450 cubic feet per second. The depth of flow might, however, be increased if necessary to 8 feet, raising the discharge to 750 cubic feet per second. The canal will be navigable throughout, and will have a double tail lock. No head lock is considered necessary, as boats do not navigate the Mahánadi river. The velocity of flow in the canal will be about 1·2 feet per second.

The total estimate for this portion of the project amounts* to Rs. 2,84,430 under Works, the principal items being—

* Rates as in 1872.

	RS.
Anicut	22,560
Under-sluices	9,480
Head do.	10,140
Embankment	5,170
Canal	1,23,360

the remainder being for over-bridges and cross-drainage works. The total amount of drainage to be passed across the canal is 15,325 cubic feet per second, and this is provided for by thirty-one culverts.

7. (2.) *Bavancona Reservoir.*—The reservoir for the augmentation of the supply of the Mahánadi is to be formed opposite the village of Bavancona about $1\frac{1}{2}$ miles north of Russelkonda, and will be supplied by a channel from the Gulleri river which drains 170 square miles. The maximum depth of water in the reservoir is to be 60 feet, and it is to cover an area of 3,115 acres (about $4\frac{1}{4}$ square miles) and contain 2,457 millions cubic feet, of which at least 2,295 millions will be available for irrigation Major Beckley's design provides for a dam of earth with its crest 15 feet above M.W.L., thickness at top from 10 to 18 feet, with inside slope 2 to 1, and outside 3 to 1. There is to be a puddle wall in the centre and the inside slope is to be revetted. The admission of water to the reservoir being controlled by head works on the Gulleri river, only a very small surplus weir, costing Rs. 1,500, for the local drainage of 25 square miles is allowed for. The supply channel from the river will have a bottom width of 15 feet, and a velocity of discharge of about $3\frac{1}{3}$ feet per second. The time required to fill the reservoir with a minimum depth of flow of 6 feet will thus be about thirty-eight days.

The total of the reservoir estimate comes to Rs. 3,58,190, of which the cost of the

	RS.
Weir across Gulleri is	8,120
Head-sluice	6,710
Supply Channel	16,140
Dam	2,58,420
Sluice in do.	48,180
Land	3,790
The cost per million cubic feet of the capacity of the reservoir is ...	145·5
And that of the water available for irrigation is	156

These figures represent *works* charges only exclusive of land compensation. Adding one-third for the omitted items the figures would become Rs. 194·4 and Rs. 208 per million cubic feet respectively. To fill the reservoir once would require $\frac{2,457}{170} \times \frac{1}{3,097} =$ 4·65 inches draining off the whole basin.

8. (3.) *Rushikulya Anicut and Canal.*—The site selected for the Rushikulya Anicut is 600 feet below the confluence of the Janamalli Nullah with the Rushikulya. The area drained at that point is about 850 square miles, and the maximum discharge may be taken at 60,000 cubic feet a second with a velocity of 9·5 feet a second. The anicut is to be 6 feet high on well foundations, 4 feet broad at top, with a sloping apron 93 feet long. The head sluice to consist of 21 vents, each 6 × 4·5 feet, which will give a waterway of 567 square feet, that of the channel being 508 square feet.

There is to be a lock and lock channel 500 feet above the head sluice. The lock to be 75 feet long and 10 feet wide.

The main canal is to be 63¼ miles long, terminating near the village of Muttikella above Chetterpur Tampara. The ruling bed and surface fall is 6 inches per mile. The depth of flow to be 6 feet, down to 53 miles 1,093 yards, and from thence to the end 4 feet. The bottom width varies from 78 feet at the head to about 15 at the tail; side slopes 2 to 1. The discharge with a 6 feet depth of flow would be 900 cubic feet per second, but the depth of flow could be increased to 8 feet, giving a discharge of 1,715 cubic feet per second. The canal is to be navigable for 44¼ miles from the head. The velocity of flow will be about 1·6 feet per second. The cross-drainage amounts to 67,550 cubic feet per second, and this is provided for by 78 aqueducts or culverts; the principal cross-drainage work is an aqueduct of fifteen 30-feet arches across the Godahala river, to cost Rs. 68,860.

The total of the estimate amounts to Rs. 8,81,235, of which the principal items besides that above mentioned are—

	RS.
Anicut with under-sluices	27,840
Head-sluice	12,950
Lock and lock channel	5,720
Canal	3,88,000
Subsidiary channels	1,00,000

9. (4.) *Soorada Reservoir.*—The reservoir to increase the supply of the Rushikuly is to be formed by constructing a dam across the Joroonadi, ab out 1,000 yards above its junction with the Rushikulya, immediately below the town of Soorada, after which place it is named. The area drained by the Joroonadi is 250 square miles. The total length of the dam will be 3,604 feet, the width of the river at the site being 232 feet. Its height is to be 45 feet, and the contents of the reservoir 2,160 millions cubic feet. It is expected that the reservoir would be filled at least twice every year. The area covered by the reservoir at M.W.L. would be 4,777 acres or 7·14 square miles. The other details of the dam will be similar to those of the Bavancona reservoir dam. Some difficulty is anticipated in putting in the foundation where the dam crosses the river, as 18 feet of sand is found here, but there is hard soil below.

The head sluice is to have 10 vents each 2½ × 2 feet. The surplus weir to be 1,060 feet long with wing walls 30½ feet long. The maximum depth of flow over it to be 4 feet, with which head it will discharge 30,000 cubic feet a second, the maximum discharge of the river being not more than 22,500 cubic feet. The estimate for the reservoir amounts to Rs. 2,60,950, of which the principal items are—

	RS.
Dam	1,59,000
Head-sluice	28,700
Waste weir	23,710
Do. channel	24,080
The cost of storage capacity per million cubic feet is	120·5
Cost of water stored if filled twice per million cubic feet is :	60·25

Adding one-third as in the case of the Bavancona reservoir the figures become Rs. 161 and Rs. 80·5 respectively.

The depth of water draining from the basin required to fill the reservoir is 2·79 inches.

10. IV. COST OF PROJECT.—The total cost of the Anicut Project was estimated by Major Beckley at Rs. 20,60,000 made up thus—

	RS.
Works	15,25,000
Establishment, 25 per cent.	3,81,250
Direction, 5 per cent.	76,250
Tools and Plant do.	77,500
Total	20,60,000

but from this total the material items of land compensation and all indirect charges were omitted. The total for the scheme as arrived at by the Chief Engineer for Irrigation in 1875 when reviewing Major Beckley's reports is shown by the figures in ordinary type in the following table. The figures in Clarendon type denote the alterations now made, as subsequently explained, to make the estimate conform to present rules as regards percentages, &c. :—

ABSTRACT of Estimated Cost of Rushikulya Project.

Anicut Scheme.

Items.	MAHANADI SECTION. Canal.	MAHANADI SECTION. Reservoir.	RUSHIKULYA SECTION. Canal.	RUSHIKULYA SECTION. Reservoir.	Total.
I. Direct Charges.	RS.	RS.	RS.	RS.	RS.
1. Works	2,84,430	3,58,190	8,81,235	2,60,950	17,84,805
Do. (+ 5 per cent. for unforeseen expenses)	**2,98,651**	**3,76,100**	**9,25,297**	**2,73,997**	**18,74,045**
2. Establishment (at 30 per cent. on works)	85,329	1,07,457	2,64,370	78,285	5,35,441
Do. (at 23 per cent. on works)	**68,690**	**86,503**	**2,12,818**	**63,019**	**4,31,030**
3. Tools and Plant (at 8 per cent. on works)	22,754	28,655	70,498	20,876	1,42,783
Do. (at 5 per cent. on works)	**14,930**	**18,805**	**46,265**	**13,700**	**93,702**
4. Land compensation	(1) 19,332	(2) 45,000	(3) 88,277	(4) 30,000	1,82,609
Total, Direct Charges	4,11,845 / **4,01,603**	5,39,302 / **5,26,408**	13,04,380 / **12,72,657**	3,90,111 / **3,80,716**	26,45,638 / **25,81,386**
II. Indirect Charges.					
5. Capital abatement of Land Revenue.	(5) 17,359	(6) 40,000	(7) 1,08,031	(8) 20,000	1,85,390
6. Loss by Exchange	600	800	**1,800**	700	**3,900**
7. Leave and Pension Allowances	**10,990**	**13,841**	**34,051**	**10,083**	**68,965**
Total, Indirect Charges	17,359 / **28,949**	40,000 / **54,641**	1,08,031 / **1,43,882**	20,000 / **30,783**	1,85,390 / **2,58,255**
Total, Direct and Indirect	4,29,204 / **4,30,552**	5,79,302 / **5,81,049**	14,12,411 / **14,16,539**	4,10,111 / **4,11,499**	28,31,028 / **28,39,641**
Total of Sections	10,08,506 / **10,11,601**		18,22,522 / **18,28,040**		
Total for Project	28,31,028 / **28,39,641**				
Add for preliminary expenses	**59,700**				
Grand Total (round numbers)	* 28,91,000 / **28,99,000**				Difference **8,000.**

(1) 532·3 acres.
(2) 2,200 ,,
(3) 2,654 ,,
(4) 3,343 ,,
Total .. 8,729 Most of (2) and (4) is jungle or waste.

	RS.	A.	P.
(5) Revenue	694	6	0
(6) Lump sum.	..		
(7) Revenue ..	4,321	4	0
(8) Lump sum.	..		

* The total in round numbers taken by the Chief Engineer for Irrigation is Rs. 500 more.

11. V. LAND TO BE IRRIGATED.—From the reports of the Revenue officers it appears that there are about 109,544 acres of Government land available for irrigation, which could be supplied by the proposed works; to these may be added 10,000 acres of Zemindari land. The particulars of the area to be supplied and the probable revenue to be derived therefrom are shown in the following table, which is adapted from the figures submitted in 1875 by the Deputy Director of Revenue Settlement (Proceedings of Madras Government, Revenue Department, No. 5, of 4th January 1875).

PARTICULARS of the Area commanded by, Area to be cultivated under, and Increase of Revenue due to the Rushikulya Project.

Description of Land at present.	Area commanded by Project.	AREA THAT WILL BE CULTIVATED.				Total Revenue with Project, Columns 6 and 10.	Revenue without Project.	Difference Columns 11 and 12.	Remarks.
		Area.	Proportion of whole Area.	Rate per Acre.	Amount.				
1	2	3	4	5	6	11	12	13	14
	ACRES.	ACRES.		1st crop. Rs. A. P.	Rs.	Rs.	Rs.	Rs.	
I. Government Land—									
1. Wet irrigated ..	49,785	49,785	All	3 8 0	1,74,247½	2,32,330	1,49,355	82,975	
2. Wet rain-fed ..	18,586	18,586	All	3 8 0	65,051	75,893	23,233	52,660	
				Wet.					
3. Dry	31,003	20,668⅔	2/3	3 0 0	62,006	74,924	38,754	36,170	
4. Waste	10,250	1,025	1/10	2 8 0	2,562	6,662	960	5,702	
				2nd crop. Rs. A. P.					
				Dry.					
3. Dry		10,334⅓	1/3	1 4 0	12,918				
4. Waste		4,100	4/10	1 0 0	4,100				
Total ..	109,624	..	..	..	..	3,89,809	2,12,302	1,77,507	
II. Zemindari and Inam Lands ..	10,000	..	..	..	..	..	..	25,000	
Total Area ..	119,624	..	..	..	..	Total Increase ..		2,02,507	

Or say, in round numbers, 120,000 acres will yield a gross increase of revenue of Rs. 2,04,000, or an average increased rate of 1·7 rupees per acre.

12. It will be observed that it is intended to derive the whole of the returns from the project by means of an increased consolidated assessment, and not by a water-rate on the lands irrigated. The Board of Revenue in their Proceedings, No. 1850, of 17th July 1874, printed in Proceedings, Madras Government, Revenue Department, No. 1061, of 22nd August 1874, make the following observations on this point.

"It is one of the greatest difficulties of revenue administration in Ganjam that the ryots place too much confidence in the rainfall, growing paddy which may fail, in which case there will be a famine, instead of dry crops which are almost sure to succeed. If the water-rate system of the Godávari and Kistna Districts is introduced, so that the ryots may take or refuse water as they will, very few of them will take it and pay for it ..... The Board are so strongly of opinion that not only the financial success of the project, but the welfare of this part of Ganjam, depend upon introducing a consolidated assessment for the lands irrigated by the project, that they think it needless to discuss what might be the result of assessing the land as dry, and imposing a separate water-rate."

The following remarks by the Government of India to the Secretary of State, (Proceedings, Madras Government, No. 1446, of 9th October 1876), refer to the same point:—

"The third point for discussion and settlement, viz., the proposal to levy a consolidated assessment instead of a water-rate, is very important and somewhat difficult. We understand that the system of imposing a consolidated assessment on irrigated land, under which the charge for water is included in the assessment (the whole of the Government demand and not only the charge for water being remitted when the water-supply fails), is the system in force in the greater part of the Madras Presidency. In the Godávari and Kistna Districts the plan of a separate water-rate has been introduced. But the opinion of the Madras Revenue officers generally is adverse to this system, and in the case of a recent extension of irrigation in Tinnevelly, we believe that the system of a consolidated assessment was adopted with the permission of Her Majesty's Government. Looking, moreover, to the difficulties which have attended the system of a separate water-rate in the districts of Orissa adjoining Ganjam, difficulties which have also been experienced to some extent in the Kistna District, the Madras Government may be justified in preferring a consolidated system; the latter being the system under which the whole of the present irrigated area in Ganjam, amounting to 164,834 acres, bearing an assessment of Rs. 4,77,747, is already assessed in that district.

13. VI. WATER-SUPPLY REQUIRED.—The theoretical irrigating duty of 1 cubic foot of water per second is 66⅔ acres in the Madras Presidency. At this rate 1,800 cubic feet per second would be required for the supply of 120,000 acres. The actual duty is usually somewhat higher than this; in the Godávari, for example, it is found that 1 cubic foot per second suffices for 74 acres. This is supposing that there is no existing supply. But in the case in point the supply to be derived is for the purpose of improving the present irrigation, and is not to be used throughout on land now wholly unirrigated. Referring to the table given in paragraph 11, it will be seen that the additional supply required is for about—

			ACRES.
One-third	of 49,785	acres	= 16,595
Three-fourths	of 18,586	,,	= 13,940
All	of 31,003	,,	= 31,003
,,	of 10,250	,,	= 10,250
,,	of 10,376	,,	= 10,376
or for 0·685	of 120,000	,,	= 82,164

In other words the average increased supply required is equivalent to 0·685 of the total supply required. That is, accepting the theoretical duty of 1 cubic foot of water per second, each cubic foot will supply here 97 acres, and according to the Godávari allowance each cubic foot will supply 108 acres; so that on the whole it may be assumed that 1 cubic foot per second will suffice for the supply of 100 acres in round numbers. At this rate 120,000 acres will require a supply of 1,200 cubic feet per second during the cultivating season. This may be taken as lasting from the middle of June to the end of November, half the full supply being required during the first half month and the last month. There are thus 123 whole days and 45½ days in all for which a full supply must be allowed, or together 145½ days, which is equivalent to a total supply of 15,085·44 millions of cubic feet.

14. VII. WATER-SUPPLY AVAILABLE.—Observations as regards the discharge in the rivers have only been made for a period of four years, 1868-1871 inclusive, and in these years the discharge is shown as varying very greatly. In the orders of Government, dated 23rd May 1876, further observations with regard to the discharge of the rivers were directed to be taken, but from causes already specified, this has not been done, and the question of supply, therefore, remains where it was.

For the above-mentioned period of four years, the registered rainfall and observed discharge are shown in the following table:—

Year.	Mahanadi (900 Square Miles).			Rushikulya (850 Square Miles).		
	Rainfall in Inches.	Discharge in Millions of Cubic Feet.	Equivalent in Inches draining from whole Basin.	Rainfall in Inches.	Discharge in Millions of Cubic Feet.	Equivalent in Inches draining from whole Basin.
1868	44·1	4,658	2·23	44·1	5,499	2·78
1869	59·585	45,012	21·52	59·585	36,495	18·48
1870	55·55	59,653	28·52	52·75	77,326	39·15
1871	43·7	16,310	7·89	42·05	6,964	3·52
Averages ...	50·734	31,408	15·04	49 621	31,571	15·98

	Rainfall in Inches.	Discharge in Millions of Cubic Feet.	Equivalent draining off.
Averages of two rivers.	50·177	62,979	15·51 inches

The average percentage draining off for these four years is 30·9 of the whole rainfall, but as the least observed discharge of the rivers is not one-tenth of the maximum discharge, obviously a very much longer series of observations is required before any reliable estimate of the average discharge by direct measurement can be framed.

15. But this points to another way of estimating the average discharge which might give a fairly accurate result, but of which I see no mention made in the papers. This is to take the figures for the average rainfall over the whole drainage basin, which are admitted to be fairly accurate, and to assume a certain proportion of the rainfall as draining away into the rivers. The proportion that does so drain away varies in different cases, principally according to the character of the soil and the physical features of the drainage basin. The drainage basin of the two rivers above the anicuts is about 1,750* square miles, and the average rainfall on it is put down at 47·74 inches. But as this refers to the hill tracts, the rainfall on which has only been observed for a limited period, *i.e.*, while Major Beckley was working there, it may perhaps be preferable to work upon the recorded figures for the rainfall in the plains. The average rainfall for Ganjam is 38 inches (Rainfall Map, page 7 of Part I of Report of the Famine Commission), and this may be safely increased to 40 inches for the basin of the two rivers. On this basis, and supposing that only 15 per cent. of the total rainfall drains away, which is probably well within the mark, the total discharge should be 24,394 millions of cubic feet, which is about two-fifths of the average discharge as given above,† and is very much less than the maximum discharge. If, therefore, the mean discharge thus calculated be accepted as the average discharge, the result will probably not be very far from the truth, and we may therefore take in round numbers 25,000 million cubic feet as the volume available for direct irrigation and storage. But as the whole of the rainfall is practically confined to the 5½ months

* Mahánadi	900
Rushikulya	850
	1,750

† Paragraph 14.

forming the cultivating season, it follows that the volume available is not the volume that can be utilised, for this is limited by the carrying capacity of the canals and the capacity of the reservoirs*. Much of the river discharge must, therefore, necessarily run to waste, for when the reservoirs are full only so much can be taken by the canals as is required by the irrigated area under them. Moreover the Mahánadi Canal having but little, (12,000 acres), direct irrigation, will only be required to furnish a supply when that in the Rushikulya Canal is deficient. These are important points, but the figures available show that the general conclusion that the water-supply is ample is not thereby invalidated. For instance, for 1871, when the average rainfall was about 43 inches, which is somewhat below the average†, the following are the statistics:—

* The reservoirs will contain 4,455 million cubic feet for irrigation if once filled.

† 40 inches has been assumed above to be on the safe side; 47·74 inches is the estimated average rainfall. Besides only 5·7 inches drained away in 1871, against an assumed average of 6 inches.

Periods.	Quantity required for Irrigation.	Quantity that can be supplied by the Rushikulya.	Additional quantity that can be furnished by the Mahánadi.	Total quantity that can be supplied.	Deficiency to be provided by Storage.	Surplus available for Storage.		Total Surplus.
						Rushikulya	Mahánadi.	
1	2	3	4	5	6	7	8	9
	MILLIONS C. FT.	MILLIONS C. FT.	MILLIONS C. FT.	MILLIONS C. FT.	MILLIONS C. FT.	MILLIONS C. FT.	MILLIONS C. FT.	MILLIONS C. FT.
Half June at half full supply	778	663	364	1,027.	..	550	1,089	1,639
July	3,214	1,400	1,382	2,782	432	577	4,414	4,991
August	3,214	780	1,400	2,180	1,034	49	1,327	1,376
September	3,110	1,308	1,614	2,922	188	219	2,805	3,024
October	3,214	507	146	653	2,561	280	..	280
November at half full supply	1,555	..	..	..	1,555	..	..	..
Total ..	15,085	4,658	4,906	9,564	5,770	1,675	9,635	11,310

An actual surplus of 5,540 million cubic feet would therefore have been available.

16. VIII. RETURN TO BE DERIVED.—In Proceedings of Madras Government of 23rd May 1876 it is stated that the estimated ultimate return will only be about 4 per cent. on the total outlay, including interest while the works are under construction; but this estimate now admits of considerable modification, tending to show that the works will, if executed within the estimated cost and bringing in the estimated revenue, regarding each of which assumptions there appears to be no reasonable ground for doubt, yield a very fair percentage of profit. In the accompanying statements, numbered 1, 2, and 3, the forecast regarding the project has been exhibited in the manner prescribed by the Government of India in Circular No. XVII of 1880. From Statement No. 1 it appears that the total Direct Charges to Capital will amount to Rs. 25,81,386, on which simple interest at 4 per cent. calculated in the authorised manner will amount to Rs. 5,31,724, it being assumed that the works will be completed in the tenth year after commencement.

The total of these two amounts is Rs. 31,13,110. The ultimate net returns from the project will, it is calculated, amount to Rs. 1,44,312, which is equivalent to 4 63 per cent. on the Direct Capital outlay.

The maximum net return is expected to be reached in the thirteenth year after the commencement of the works, and the total is obtained in the following way:—

(1.) Rs. 15,000 are assumed as the ultimate direct receipts in the Public Works Department, derived from navigation tolls, grass-rents, &c.

(2.) Rs. 2,04,000 are the ultimate receipts in the Revenue Department, being the average increased assessment (Rs. 1·7 per acre), to be derived from the 120,000 acres which the system will irrigate.

(3.) Annas 8 per acre, or Rs. 60,000 a year, are taken as the maintenance charges in the Public Works Department.

(4.) The revenue collection charges are taken at 7·2 per cent. on the revenue, which is the accepted average in the Madras Presidency.

The total ultimate receipts thus amount to Rs. 2,19,000 and the charges to Rs. 74,688, leaving the net receipts at Rs. 1,44,312 as above stated.

17. The reasons for the more favorable forecast that can now be made as regards the project than was the case in 1876 when the same data for calculation existed, lie in the altered regulations on the subject which have recently been prescribed.

In the first place, the payments on account of land compensation are excluded from the total on which the percentages for Establishment and Tools and Plant are calculated.

In the second place, the percentage for Establishment is fixed at 23 per cent. on the Works outlay.

In the third place, the interest during construction is calculated on direct charges only.

In the forecast statements the Tools and Plant charges have been taken at 5 per cent. on Works, $2\frac{1}{2}$ being for General and $2\frac{1}{2}$ for Special Plant.

18. IX. CONCLUDING REMARKS.—From a consideration of the foregoing summary there can be no question as to the project being fairly remunerative ultimately, though the percentage (4·63) which, it has been stated, would be realised, is perhaps somewhat less than would be necessary to allow the project to be classed as Productive. It is not at all improbable, however, that the actual return on the Capital expenditure would be higher than is now estimated. In the first place, 5 per cent. has been allowed for unforeseen works to meet any increases found to be necessary on account of alterations, additions, or changes in rates. That these increases would be large is not however probable, as the estimates were prepared leisurely and carefully. They are now in a complete state with all plans, &c., in the office of the Chief Engineer for Irrigation and only await the necessary review. In the second place, ten years have been assumed as the period the works would take to complete, and the charges on account of interest are sensibly increased by adopting so long a limit. There would be no difficulty, supposing funds available, in completing the project in six years. But even admitting 4·63 per cent. as the maximum probable return, there can still be no question that the works are required. It has been stated in the preliminary remarks how small a portion* of the district is irrigated, and even of this portion only part can be assumed to be really protected against famine, for of the existing irrigation more than half† is effected by means of tanks, which would naturally be dry in dry years. It has also been shown how grievously famine has, on more occasions than one, affected the district, and how much therefore some measures of protection are required. That a beginning of distinctly protective works from the Famine Fund can be made with a work so remunerative as the one now under review is therefore a subject for congratulation.

19. This note is accompanied by a sketch map illustrative of the project and by a classified abstract estimate.

CHEPAUK,
8th March 1882.

(Signed) C. VINCENT,
Executive Engineer,
D. Project Division.

* Not more than about 1/16 of the plains portion.

	ACRES.
† Total irrigated area	214,816
Estimated river irrigation (Proceedings of the Madras Government, No. 685 I., of 11th October 1881).	100,000
Balance under tanks ...	114,816

ENCLOSURES.

PARTICULARS of Estimated Debits to Capital (excluding Interest) up to Date of Completion of Works and Opening of Revenue Account.

[Form No. 1 of Circular from Government of India, No. XVII, P.W., of 1880.]

Year.	Direct Charges.				Indirect Charges other than Interest.				Grand Total without Interest.
	Works.	Establishment.	Tools and Plant.	Total.	Capitalized Abatement of Land Revenue.	Loss by Exchange on Payments in England.	Charges for Leave and Pension Allowances.	Total.	
1	2	3	4	5	6	7	8	9	10
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS
First	50,000	11,500	2,500	64,000	..	..	1,840	1,840	65,840
Second	1,36,000	23,000	5,000	1,64,000	37,000	1,000	3,680	41,680	2,05,680
Third	3,36,000	69,000	15,000	4,20,000	37,000	1,400	11,040	49,440	4,69,440
Fourth	3,36,000	69,000	15,000	4,20,000	37,000	1,000	11,040	49,040	4,69,040
Fifth	3,36,000	69,000	15,000	4,20,000	37,000	400	11,040	48,440	4,68,440
Sixth	2,63,609	51,750	11,250	3,26,609	37,390	100	8,280	45,770	3,72,379
Seventh ..	1,75,000	40,250	8,750	2,24,000	..	..	6,440	6,440	2,30,440
Eighth	1,50,000	34,500	7,500	1,92,000	..	..	5,520	5,520	1,97,520
Ninth	1,50,000	34,500	7,500	1,92,000	..	..	5,520	5,520	1,33,520
Tenth	1,24,045	28,530	6,202	1,58,777	..	..	4,565	4,565	1,13,115
Total ..	*20,56,654	4,31,030	93,702	25,81,386	1,85,390	3,900	68,965	2,58,255	28,39,641

(1) * Works .. .. .. RS. 18,74,045
Land Compensation .. .. 1,82,609 divided among second, third, fourth, fifth, and sixth years.

Total .. 20,56,654

(2) Establishment percentage only charged on Works outlay.
(3) Tools and Plant charges 5 per cent. on Works ($2\frac{1}{2}$ for General and $2\frac{1}{2}$ for Special Plant).
(4) The following is the estimated progress of the works:—

Year.	Work.
First	Rushikulya Anicut.
Second	Do. Canal.
Third	Do. do. and commencement of Soorada Reservoir.
Fourth	Continuation of do. and construction of Mahánadi Anicut.
Fifth	Completion of Soorada Reservoir and commencement of Mahánadi Canal.
Sixth	Do. do. do. of Bavancona Reservoir.
Seventh	Continuation of Mahanadi Canal and Reservoir.
Eighth	Completion of do. and construction of head-works for Mahánadi Reservoir.
Ninth	Subsidiary channels, &c.
Tenth	Completion of all works.

SUMMARY of the Net Estimated Direct Charges to Capital Account and Simple Interest up to Date of Completion of Works and Opening of Revenue Account.

[Form No. 2 of Circular from Government of India, No. XVII, P.W., of 1880.]

Year.	Debits to Capital.	Sum on which Interest is calculated.			Simple Interest at 4 per Cent. on Column 5.
		Debits to end of previous Year.	Half Debits during Year.	Total Columns 3 and 4.	
	RS.	RS.	RS.	RS.	RS.
First	64,000	...	32,000	32,000	1,280
Second	1,64,000	64,000	82,000	1,46,000	5,840
Third	4,20,000	2,28,000	2,10,000	4,38,000	17,520
Fourth	4,20,000	6,48,000	2,10,000	8,58,000	34,320
Fifth	4,20,000	10,68,000	2,10,000	12,78,000	51,120
Sixth	3,26,609	14,88,000	1,63,304	16,51,304	66,052
Seventh	2,24,000	18,14,609	1,12,000	19,26,609	77,064
Eighth	1,91,000	20,38,609	96,000	21,34,609	85,384
Ninth	1,92,000	22,30,609	96,000	23,26,609	93,064
Tenth	1,58,777	24,22,609	79,389	25,01,998	1,00,080
Total ...	†25,81,386	...	...	...	†5,31,724

† Together Rs. 31,13,110, on which Rs. 1,44,312, the net earnings due to the works (*vide* Form 3), equals 4·63 per cent.

ESTIMATE of Growth of Irrigation and Revenue Receipts and Charges.

[Form No. 3 of Circular from Government of India, No. XVII, P.W., of 1880.]

Year.	Area irrigated by Project at end of Year.	Revenue Receipts and Charges.									
		Revenue due to Works.					Charges against Revenue Account.			Net Earnings due to Works.	
		Direct Receipts.			Share of enhanced Land Revenue or Indirect Receipts.*	Total Columns 5 and 6.	Maintenance Charges, Public Works Department (at 8 annas per acre irrigated).	Collection charges, Revenue Department, at 7·2 per cent. on Revenue.	Total.	Including enhanced Land Revenue.	Excluding enhanced Land Revenue.
		Public Works Department.	Revenue Department.	Total.							
1	2	3	4	5	6	7	8	9	10	11	12
	ACRES.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.
Fifth ..	40,000	..	..	..	68,000	68,000	20,000	4,896	24,896	43,104	—24,896
Sixth ..	50,000	..	..	..	85,000	85,000	25,000	6,120	31,120	53,880	—31,120
Seventh ..	60,000	1,000	..	..	1,02,000	1,03,000	30,000	7,344	37,344	65,656	—36,344
Eighth ..	70,000	2,000	..	1,000	1,19,000	1,21,000	35,000	8,568	43,568	77,432	—41,568
Ninth ..	80,000	4,000	..	2,000	1,36,000	1,40,000	40,000	9,792	49,792	90,208	—45,792
Tenth ..	90,000	6,500	..	4,000	1,53,000	1,59,500	45,000	11,016	56,016	1,03,484	—49,516
Eleventh ..	100,000	9,000	..	6,500	1,70,000	1,79,000	50,000	12,240	62,240	1,16,760	—53,240
Twelfth ..	110,000	12,000	..	9,000	1,87,000	1,99,000	55,000	13,464	68,464	1,30,536	—56,464
Thirteenth.	120,000	15,000	..	15,000	2,04,000	2,19,000	60,000	14,688	74,688	1,44,312	—59,688

* This is the increase of revenue due to the works—*vide* paragraph 12. The heading is misleading.

CLASSIFIED ABSTRACT ESTIMATE of the Rushikulya Project in the Ganjam District.

Sub-head.	Mileage.	Names of Works.	Amount of Estimate.	Total.	Remarks.
		DIRECT CHARGES.	RS.	RS.	
		I.—WORKS.			
		(1) *Head Works.*			
		Mahánadi Section.			
B. Land ...	...	83·5 acres of land for the channel from the Gulleri river.	75,000		
		3,115 acres of land for the Bavancona reservoir.			
		Land for Soorada reservoir.			
				75,000	
C. Works ...	...	Weir across the Gulleri river ...	8,120		
		Under-sluices to do. ...	3,870		
		Gulleri river L.B. embankment.	730		
		Gulleri river channel head sluice.	6,710		
		Do. earthwork ...	16,140		
		Do. aqueduct ...	2,080		
		Do. under-tunnel.	3,030		
		Bavancona reservoir dam ...	2,58,420		
		Do. head sluice ...	48,180		
		Do. weir	4,410		
		Do. channel above and below weir.	2,710		
		Do. waste weir channel.	3,790		
		Goomsur anicut	22,560		
		Under sluices to do. ...	9,480		

Classified Abstract Estimate of the Rushkulya Project in the Ganjam District—*cont.*

Sub-head.	Mileage.	Names of Works.	Amount of Estimate.	Total.	Remarks.
		DIRECT CHARGES—*cont.*	RS.	RS.	
		I.—WORKS—*cont.*			
		(1) *Head Works*—cont.			
		Mahánadi Section—*cont.*			
		Loharanadi river R.B. embankment. Gulleri river L.B. embankments.	5,170		
		Rushikulya Section.			
		Soorada reservoir dam ...	1,59,000		
		Do. bank from Roman Catholic Chapel to waste weir.	8,590		
		Do. head sluice	28,700		
		Do. supply channel ...	1,510		
		Do. do. weir	3,310		
		Do. waste weir	23,710		
		Do. do. channel ...	24,080		
		Do. coffer dam	12,050		
		Rushikulya anicut	21,040		
		Under sluices to do. ...	6,800		
		Rushikulya river R.B. and L.B. embankments. Janamalli nullah L.B. embankment.	1,450		
				6,85,640	
K. Buildings...	...	Buildings in connection with Goomsur anicut.	1,500		
		Do. Rushikulya anicut	7,000		
				8,500	
		Total (1) Head Works ...	...	7,69,140	
		(2) *Main Canals and Branches.*			
		Mahánadi Canal.			
B. Land ...	...	532·3 acres of land	19,332		
				19,332	
D. Regulators.	0	Head sluice	10,140		
				10,140	
F. Other Cross.	0·66	Under tunnel, 3 arches 15′ span.	6,020		
(1) Drainage works.	1·25	Do. 2 „ 10′ „	3,160		
	2·00	Do. 4 „ 15′ „	7,070		
	3·0	Do. 1 arch 10′ „	1,990		
	3·5	Do. 3 arches 10′ „	5,030		
	4·75	Do. 1 arch 15′ „	2,620		
	5·25	Do. 3 arches 15′ „	6,020		
	5·5	Do. 1 arch 10′ „	1,990		
	6·0	Do. 1 „ 10′ „	1,990		
	6·75	Do. 1 „ 15′ „	2,620		
	7·25	Do. 1 „ 15′ „	2,620		
	8·0	Do. 1 „ 10′ „	1,990		
	8·75	Do. 1 „ 10′ „	1,990		
	9·25	Do. 1 „ 15′ „	2,620		
	10·25	Do. 1 „ 10′ „	1,990		
	11·25	Do. 2 arches 15′ „	5,160		
	12·75	Do. 1 arch 15′ „	2,540		

Classified Abstract Estimate of the Rushikulya Project in the Ganjam District—*cont.*

Sub-head.	Mileage.	Names of Works.	Amount of Estimate.	Total.	Remarks.
		DIRECT CHARGES—*cont.*	RS.	RS.	
		I—WORKS—*cont.*			
		(2) *Main Canals and Branches*—cont.			
		Mahánadi Canal—*cont.*			
	13·5	Under tunnel, 1 arch 15′ span.	2,540		
	14·75	Do. 1 „ 15′ „	2,540		
	15·25	Do. 1 „ 15′ „	2,540		
	16·25	Do. 1 „ 10′ „	2,340		
	18·75	Do. 1 „ 15′ „	3,050		
	19·5	Do. 1 „ 10′ „	1,900		
G. Bridges ...	3·75	Accommodation bridge 45′ span.	2,600	72,330	
	8·25	Do.	2,600		
	11·5	Bridge at Condrally	3,100		
I. Navigation Works.	19·7	Double lock	10,870	8,300	
	19·7	Do. lock weir	4,550		
L. Earthworks.	...	Mahánadi canal	1,23,360	15,420	
	19·7	Lock weir channel	930		
M. Plantations.	...	Planting trees	1,000	1,24,290	
O. Miscellaneous.	...	Minor Works	3,000	1,000	
				3,000	
		Total, Mahánadi Canal ...	...	2,53,812	
		Rushikulya Canal.			
B. Land ...	...	Compensation for land ...	88,277	88,277	
D. Regulators.	...	Head sluice	12,950	12,950	
F. Other Cross. (1) Drainage Works.	2·0	Under tunnel 2 arches 10′ span.	4,660		
	4·25	Do. 1 arch 15′ „	3,350		
	5·0	Do. 1 „ 14′ „	3,350		
	6·0	Do. 1 „ 14′ „	4,180		
	6·75	Do. 1 „ 15′ „	3,350		
	7·25	Do. 1 „ 15′ „	3,350		
	8·0	Do. 1 „ 15′ „	4,090	...	Includes 1 under bridge.
	9·0	Do. 1 „ 15′ „	3,280		
	9·5	Do. 1 „ 15′ „	3,910		
	10·0	Do. 1 „ 15′ „	3,280		
	12·75	Do. 2 arches 10′ „	4,480		
	13·25	Do. 1 arch 10′ „	2,300		
	14·0	Do. 1 „ 10′ „	2,300		
	14·5	Aqueduct 9 arches to Shergadda nullah.	17,810		
	15·25	Under tunnel 1 arch 15′ span ...	3,870		
	17·0	Do. 1 „ 15′ „ ...	3,080		
	17·75	Do. 1 „ 10′ „ ...	2,200		
	18·5	Do. 1 „ 10′ „ ...	4,230	...	Do.
	18·75	Aqueduct 15 arches Godahala river.	68,860		

Classified Abstract Estimate of the Rushikulya Project in the Ganjam District—*cont.*

Sub-head.	Mileage.	Names of Works.	Amount of Estimate.	Total.	Remarks.
		DIRECT CHARGES—*cont.*	RS.	RS.	
		I.—WORKS—*cont.*			
		(2) *Main Canals and Branches*—cont.			
		Rushikulya Canal—*cont.*			
	19·5	Under tunnel 1 arch 10′ span.	4,230		
	20·0	Do. 1 „ 10′ „	2,200		
	21·0	Do. 1 „ 15′ „	3,020		
	22·0	Do. 1 „ 10′ „	2,200		
	23·0	Do. 1 „ 15′ „	3,020		
	23·5	Do. 1 „ 10′ „	2,200		
	24·75	Do. 4 arches 10′ „	6,410		
	25·75	Do. 1 arch 15′ „	3,020		
	26·5	Do. 1 „ 10′ „	2,200		
	27·0	Do. 2 arches 15′ „	5,230		
	27·5	Do. 1 arch 10′ „	2,200		
	28·0	Do. 1 „ 15′ „	3,020		
	29·0	Do. 1 „ 15′ „	3,750	...	Includes 1 under bridge.
	29·75	Do. 1 „ 15′ „	3,020		
	30·75	Do. 2 arches 10′ „	4,310		
	31·25	Do. 1 arch 10′ „	2,160		
	32·5	Do. 1 „ 10′ „	2,160		
	33·0	Do. 2 arches 10′ „	4,230		
	34·0	Do. 1 arch 15′ „	3,670	...	Do.
	34·75	Do. 1 „ 15′ „	2,930		
	36·0	Do. 1 „ 15′ „	2,810		
	37·25	Do. 1 „ 15′ „	2,810		
	38·75	Do. 1 „ 15′ „	2,810		
	40·5	Do. 1 „ 15′ „	2,750		
	41·75	Do. 1 „ 15′ „	2,750		
	46·5	Do. 1 „ 15′ „	2,220		
	48·5	Do. 1 „ 10′ „	1,660		
	52·0	Do. 1 „ 15′ „	2,800	...	Do.
	52·5	Do. 1 „ 10′ „	1,660		
	58·5	Do. 1 „ 15′ „	2,220		
	60·0	Do. 1 „ 15′ „	2,220		
	51·75	Do. 1 „ 15′ „	2,220		
	...	Minor drainage works ...	10,000	2,50,040	
G. Bridges ...	...	Bridge on Aska and Soorada road.	5,100		
	2·5	Bridge for Daracotta road ...	4,000		
	10·0	Accommodation Bridge ...	3,930		
	12·5	Bridge for Aska and Ichápur road.	4,890		
	14·25	Accommodation bridge ...	3,930		
	17·25	Do. do. ...	3,930		
	22·75	Do. do. ...	3,930		
	26	Do. do. ...	3,930		
	31	Do. do. ...	3,930		
	39·75	Bridge Aska and Berhampur.	4,890		
	48	Accommodation Bridge ...	2,640		
	53·75	Bridge for Jagganadhapur and Purushottapur road.	3,380		
	57·0	Accommodation Bridge ...	2,640		
	59·75	Bridge on Trunk Road No. 6 ...	3,380	54,500	

Classified Abstract Estimate of the Rushikulya Project in the Ganjam District—*cont.*

Sub-head.	Mileage.	Names of Works.	Amount of Estimate.	Total.	Remarks.
		DIRECT CHARGES—*cont.*	RS.	RS.	
		I.—WORKS—*cont.*			
		(2) *Main Canals and Branches*—cont.			
		Rushikulya Canal—*cont.*			
H. Escapes ...	37	Surplus weir 15′	1,270		
	43	Do.	1,270		
	44	Do.	1,270		
	44·25	Double weir	3,380		
	53·75	Surplus weir 15′	1,270		
	53·75	Single weir	1,440		
	56·75	Surplus weir 10′	740		
	63·25	Do.	740		
				11,380	
I. Navigation Works.	...	Lock	4,320		
		Lock channel	1,400		
				5,720	
L. Earthwork...	...	Rushikulya canal	3,88,000		
				3,88,000	
M. Plantation.	...	Planting trees	2,500		
				2,500	
O. Miscellaneous.	...	Minor works	1,875		
				1,875	
		Total Rushikulya Canal		8,15,242	
		Total (2) Main Canals and Branches. ...		10,69,054	
		(3) *Distributaries.*			
		Rushikulya Canal.			
C. Works ...	...	Irrigation sluices	40,500		
				40,500	
L. Earthwork.	...	Irrigation channels	72,000		
				72,000	
		Total		1,12,500	
		Mahánadi Canal.			
C. Works ...	...	Irrigation sluice	3,000		
				3,000	
L. Earthwork.	...	Do. channels	6,500		
				6,500	
		Total		9,500	
		Total (3) Distributaries		1,22,000	

Classified Abstract Estimate of the Rushikulya Project in the Ganjam District—*cont.*

Sub-head.	Mileage.	Names of Works.	Amount of Estimate.	Total.	Remarks.
		DIRECT CHARGES—*cont.*	RS.	RS.	
		I.—WORKS—*cont.*			
		(4) *Drainage and Protective Works.*			
L. Earthwork.	...	Catch-drain above Rusihkulya Main Canal.	5,480		
Do. ...	...	Catch-drain above Mahánadi Canal.	1,740		
				7,220	
		Total ...	...	19,67,414	
		Add 5 per cent. for unforeseen works excluding Land Compensation.	...	89,240	
		Total Works ...	...	20,56,654	
		Establishment	...	4,31,030	
		Tools and Plant	...	93,702	
		Total Direct Charges ...	...	25,81,386	
		INDIRECT CHARGES.			
		Capitalisation of the abatement of Land Revenue.	...	1,85,390	
		Loss by Exchange	...	3,900	
		Leave and Pension Allowances.	...	68,965	
		Total Indirect Charges ...	...	2,58,255	
		Grand Total without Interest...	...	28,39,641	

Endorsement, No. 34 I.

Submitted for orders.

2. The Rushikulya Project was submitted to Government in December 1875 and approved in G.O., No. 1293, dated 23rd May 1876, with the remark that the time had not yet come for undertaking it. It has, however, since been referred to as a Protective Work, and in G.O., No. 1729 W., dated 14th July 1881, it is mentioned as a Project that has only to be put into shape for submission to the Government of India, and the work of putting it into shape was allotted to the D Project Division.

3. Mr. Vincent, the Officer in charge of the D. Project Division, has prepared the accompanying Note on the Project while working in the Office of the Chief Engineer for Irrigation and has submitted it to Colonel Mullins, at whose suggestion some amendments have been made. The estimates and statements are now complete and in a fit state to be submitted, and it is suggested that the Project should be recommended for sanction as a Protective Work, as, although the forecast of revenue shows that a return of 4·28 per cent. will be received on completion of the Project, yet the water-supply being drawn from rivers which do not, like the principal sources of irrigation in the Presidency, receive the drainage of the Western Ghâts, cannot be considered absolutely certain.

4. Every feature of the Project has been so carefully worked out and commented on that it is unnecessary to give here a detailed account of each. The plans and

estimates have been left as originally designed and approved, but alterations in detail, which must always be necessary when some time has elapsed between the works being designed and the estimates being sanctioned will be made before the works are commenced.

5. The general features of the Project are briefly described in paragraph 4 of G.O., No. 1293, 23rd May 1876, under four heads. The estimate as now revised is as follows under these heads :—

	RS.
1. Anicut across the Mahánadi and channel to the Rushikulya ...	3,17,983
2. Reservoir near Bavancona to increase supply of Mahánadi ...	4,21,100
3. Anicut across the Rushikulya and channel, 63¼ miles in length.	10,13,574
4. Reservoir near Soorada to increase supply of Rushikulya ...	3,03,997

6. The total of the estimates is thus—

Works	20,56,654
Establishment	4,31,030
Tools and Plant	93,702
Total Direct Charges ...	25,81,386
Indirect Charges ...	2,58,255
Total Direct and Indirect Charges ...	28,39,641

The area to be brought under cultivation is 120,000 acres, which, it is estimated, will be taken up in thirteen years, the works being completed in ten years ; the increase of revenue due to the works, after deducting maintenance charges, will then be Rs. 1,44,312, or 5·1 per cent. on the Capital outlay including indirect charges.

If to the proposed Capital outlay as given above the charge for interest during the construction of the work is added, viz., Rs. 5,31,724, the estimate inclusive of all charges will be Rs. 33,71,365, and the return will then be 4·28 per cent.

No. 9.

ORDER—dated 8th May 1882, No. 377 I., Public Works.

With these papers the Rushikulya Project in the Ganjam District, which was approved by Government in 1876, is resubmitted with the forecast statements required by the Government of India in their Circular XVII of 1880.

The charges are—

	RS.
Works	20,56,654
Establishment	4,31,030
Tools and Plant	93,702
Total Direct	25,81,386
Indirect	2,58,255
Interest during construction	5,31,724

The anticipated return from the cultivation of 120,000 acres is Rs. 1,44,312, equivalent to 5·1 per cent. on the Direct and Indirect Charges together, or 4·28 per cent. on the charges including interest. The works are expected to be completed in ten years and the cultivation to be fully extended in thirteen years.

2. The Project thus promises to be remunerative ; but, considering the fact that the rivers from which supply of water is derived are likely to be affected by a failure of the monsoon rains, the Right Honorable the Governor in Council considers that the Project cannot properly be classed as a Productive Public Work, but as a

Protective Work it is worthy of prosecution, and he resolves therefore that it be forwarded to the Government of India with the recommendation that it may be sanctioned as a Protective Public Work.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Superintending Engineer, First Circle.
" Chief Engineer for Irrigation.
" Examiner of Public Works Accounts.
" Revenue Department.

Exd. C. Howarth and J. W. Fischer.
Spare Copies

IRRIGATION.
ACCOUNT.

Govt. of {1882} Madras.

PUBLIC WORKS.

Dated May, 8th.

Recd. *Encl.*

G.O., 8th May 1882, No. 377 I.

MAY.

Nos. 8-9.

Rushikulya Project.

Rushikulya Project in the Ganjam District.—Note by the Chief Engineer for Irrigation, together with forecast statements on the —, forwarded to the Government of India with the recommendation that the Project may be sanctioned as a Protective Public Work.

INDEX TO NOTES OF INSPECTION BY THE CHIEF ENGINEER FOR IRRIGATION, FEBRUARY 1886, GANJAM DISTRICT, I CIRCLE

	Paras.
Injelly anicut and head-sluice	1
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Jahada anicut	2
Rushikulya canal	3
Head-quarters at Dowgam	4
Suradá reservoir	5
Russellkonda reservoir	6
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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Irrigation.
Account.

Read—the following paper :—

Notes of Inspection by the Chief Engineer for Irrigation, Rushikulya Project, Ganjam District, I Circle, February 1886.

Injelly Anicut and Head-sluice.—It is two years since it was directed that proper shutters with screw gearing should be put to the head-sluice, and they are not yet fixed ; but it is said that the shutters and screws are ready to be put up. The parapets have been coped with dressed stones which have been very unnecessarily levelled on both sides ; the stone is soft, but good enough for the purpose.

The anicut is in fair order, and the Portland cement pointing, which was referred to in last notes of inspection, has stood very well. The apron wants pointing in places.

The under-sluice shutters appear not to be worked ; they are in one piece lifted by two rings, through which, it is presumed, that a bamboo is put for lifting ; it is doubtful whether four men could lift a shutter when water is level with the crest of the anicut, which is the time at which the shutters should be raised. It is evident that they have not been worked properly, as there is a great accumulation of silt in front of the sluices which extends to the mouth of the head-sluice channel. The water register was called for and was incomplete, no record having been entered apparently for several months. It is thus evident that the instructions given in previous notes have not received attention and that this important work has been neglected. The Superintending Engineer will issue such orders as may be necessary to ensure the work being properly attended to and the instructions now given carried out.

A yearly repair estimate must be prepared and carried out each year during the dry weather.

The under-sluice shutters must be made to work properly, and arrangements must be made to ensure their being worked at proper times.

The accumulation of silt in front of the under-sluices must be entirely removed. This may be done by the grass being entirely removed from the surface and sides by the lascars and the silt loosened and washed through the under-sluices during floods.

A proper register of water must be maintained, showing level of water above and below anicut and head-sluice, and recording the dates and hours during which the under-sluice and head-sluice shutters are raised.

The anicut lascars' sheds must be repaired and the lascars made to live in them or be dismissed.

The head-sluice shutters must be properly fixed before next irrigation season.

The channel for some distance below the head-sluice has apparently been widened, but little or no information is available regarding the rest of the channel. It should be examined by the Executive Engineer and arrangements made for maintaining it in good order throughout.

The circumstances of the irrigation under the channel should be investigated and proper arrangements made for its regulation.

Rushikulya Project.

2. *Jahada Anicut.*—In the last instructions sent on the subject of the site to be selected for the anicut, it was stated that the site about one-third mile below the sanctioned site should be selected. Since then the bed of the river has been more thoroughly examined, and it has been found that if the anicut is built at the first selected site, the head and under sluices can be founded on rock, while if the anicut is built lower

down, the under-sluices will be on clay and the head-sluices be partly on rock and partly on clay. The effect also of placing the anicut lower down the river will be to lose two feet of head. For these reasons, it seems advisable to build the anicut at the first selected site. The ground was thoroughly examined, and the line of the anicut was laid down on the site plan and pointed out on the ground to the Executive Engineer. A very considerable quantity of rock will have to be removed by blasting, in order to build the head-sluice and lock, but all the stone can be used on the work and the necessity for foundations will be obviated, so that there will be no extra expenditure entailed thereby. The lock chamber cut to join the lock to the canal below the head-sluice will apparently be entirely in rock and will only need to be 15 feet wide throughout. The roadway will have to be taken over the lock by a bridge over the upper chamber, and it was calculated that this could be done by giving a very moderate gradient to the road between the lock and head-sluice.

The anicut can be constructed in accordance with instructions referred to in memorandum No. P—15 G.W., dated 17th April 1885; there is an unlimited supply of stone close at hand, and a better opportunity of constructing an anicut by throwing in stone until a solid foundation on which to build the face wall is obtained cannot be found. A commencement should be made at once in throwing in the stone, as the head-sluice site is at present encumbered with large stacks of stone. For the first season it will be sufficient to carry the stone across the existing bed of the river and for a little distance beyond the margin on the north bank.

A good deal of blasting has already been done under the supervision of overseer T. Sundrum Pillay, who has had experience in this work. A large quantity of dynamite has been indented for, and instructions were given that a proper magazine should be constructed on the small hill above the site of the work. On no account should the dynamite or fuze be stored in a thatched shed.

The rock, being blasted, is intensely hard, and is found quite unworkable with a chisel; as the work is to be constructed with rough stone, this is of no great consequence; but if stone cutters cannot eventually be found to cut the stone for coping of anicut, the work must be coped as suggested by Captain Dorward, R.E., with a block of Portland cement concrete.

The site for the anicut being now finally settled, the head of the canal can be cut out at once.

A rest-house, one room and two bath-rooms, stone in chunam, with thatched roof, has been completed.

3. *Rushikulya Canal.*—The excavation of the canal is in progress for 10 miles, and fully two-thirds of the work in this distance is done. One under-tunnel in the 7th mile has been completed, and six other under-tunnels are in course of construction. The tunnels are built of rough stone set in soorkhi mortar, which, though not very handsome in appearance, is good work, and, when the men are more experienced, can be made to look well. The arches are being turned with concrete, which on being picked up seemed good, though rather a large proportion of mortar had been allowed. The proper proportion for the stone should be ascertained by careful experiment before any more arches are turned. It is not clear that sufficient care is being taken in the selection of clay for soorkhi. Some bricks were being pounded, which were certainly made of too sandy soil. Good clay is available in many places apparently, and care must be taken to select the clay to be built. It is understood that several experiments were made by Captain Dorward, R.E., to ascertain the proper proportions of lime, sand and soorkhi; but these have been lost sight of apparently, and the specimens were not forthcoming. It is essential that the Executive Engineer should satisfy himself that the best proportions are being used.

The earthwork is in all stages of progress along the line; in some places almost completed, the banks having been in parts sectioned. Additional height has been allowed to bring the bank to proper section after settlement, but apparently sufficient care has not been taken to slope the top of the bank to the rear to carry off rain water. The side slope $1\frac{1}{2}$ to 1 will generally do, but the soil varies very much in character, and it may be necessary to alter the general rule in cases where very light soil is met with. The same applies to width of berms to be allowed; one yard may be sufficient

in stiff soil, but in light soil more will be required, and perhaps it will be advisable to lay down, as a general rule, that the berms should be two yards wide. Demarcation stones have been put down all along outside the banks to show the land taken up, but it was noticed that in several cases sufficient margin had not been allowed outside the toe of the bund.

Sufficient ground should be taken up to allow of subsequent clearing which may be necessary, and it is considered that in cultivated land which is valuable, we should have a clear margin of not less than 10 feet, and in other land 15 feet.

The sites of bridges were visited, iron work for three girder bridges had been obtained, and materials for the bridges will now be collected. Two bridges are allowed with only about three-fourth mile between them for roads in the Dhárákót estate, and the Executive Engineer suggests that one bridge would meet all the requirements. The subject was discussed with the Collector, who is now in charge of the estate, and it was decided that one bridge near the temple would be sufficient.

The revised plans of the Godahallow aqueduct were examined and generally approved, some suggestions being noted on the plans, the levels of the work may now be considered settled, the floor of the aqueduct at upper end being fixed at M.S.L. + 152·5. This will fix the level of the Sharagodan cutting, the heaviest part of the canal work, which must now be cut out to dimensions sufficient to carry the full supply with the fall available. The velocity through the aqueduct is not to exceed 3 feet per second. Arrangements should be made to commence this part of the work at once and to get the line marked out up to the Godahallow aqueduct, and, if labor is likely to be available, beyond the aqueduct for some distance.

The arrangements proposed by the Executive Engineer of cutting out the channel from the under-tunnels, so as to allow a clear run-away for the water instead of passing it through an inverted syphon, is approved generally; but in some instances, where valuable cultivated land would have to be taken up for the outfall channel, the tunnels should be left as syphons.

There are about 1,500 men on the work, most of them apparently from neighbouring villages, though about 200 come from Ganjam and others from Parlákimedi. The men who come from a distance do not, as is usual in more southern districts, bring their families with them, and consequently they work for a time and then return home for a few days. The rates allowed are very fair, being much the same as in the deltas, and a good workman can earn 4 annas a day, while a cooly can be hired for the day for 2 annas. There are no good contractors at present on the work, all being done under petty contractors, or by gangs, the headman of whom is paid. The prevalence of high prices in parts of the district may attract more labor to the works, but there are certainly difficulties in the way of getting labor here which do not exist in the southern districts. Temporary Assistant Engineer Venkatareddi Naidu is an energetic officer, and it is hoped he will be able to induce more people to come to the work.

4. *Head-quarters at Dowgam.*—The buildings here have been completed and are sufficiently good and have been well built apparently. The doors and windows however appear rather slight. The site is a very good one, though, as only one well has been sunk which is said to give not very good water, water has to be brought from a little distance. The Executive Engineer considers that it will be necessary to add another room to the office, which is a substantial tiled building, when the Rushikulya office is transferred from Berhampore, which is now proposed. It is very evident that one Executive Engineer cannot visit works in Chicacole and Parlákimedi, which may be 100 miles from his head-quarters, and pay sufficient attention to such very important works as are now in progress on the Rushikulya project. The project runs through the Goomsur and Berhampore taluks, and therefore the works in these taluks can well be supervised by the Rushikulya division officer, as also three small zemindaries which are more or less affected by the project and the works in which have been handed over to this department by the Court of Wards. It is proposed therefore that the Rushikulya division should for the future consist of the project, the Goomsur and Berhampore taluks, the Chinna Kimedi, Dhárákót and Bodoogooda zemindaries, with head-quarters at Dowgam, which is a good central position and also close to some

important project works. The Ganjam division, which would then be reconstituted, would consist of the Chicacole taluk, the Parlákimedi, Urlám and Jarada zemindaries, with head-quarters at Chicacole. The expenditure in Parlákimedi alone is likely to be between one and two lakhs per annum, and besides irrigation works of some extent, the palace building and all roads will be under our charge.

The buildings at Dowgam will therefore become of importance as the head-quarters for some years to come of the division, and care must be taken that the native houses which will now be built in the neighbourhood are properly disposed, and that trees are planted and cared for. Several baniyan and other trees have been planted, but from having been put down at a wrong season, or neglected after planting, nearly all are dead.

5. *Suradá Reservoir.*—A good deal of work has been done on the reservoir bund between the river and the hill towards the town of Suradá, the soil for the most part is very good, and it was before decided that this being the case, it would be unnecessary to have any puddle wall. Much of the material is in fact puddle as it is, and, being well watered and rammed in thin layers, ought to be quite impervious to water; it was noticed, however, that some pits were being dug in sandy soil which is quite unsuited for a bank which will have 30 to 40 feet of water against it. This must be prevented, and then the bund will do if continued as at present. The iron rammers in use are hardly suitable, it will be economical to use rammers having a larger surface, and if flat iron rammers are not procurable, heavy wooden ones with the ends bound with hoop iron should be used.

Part of the bank which was thrown up last year is now covered with grass, and bushes are beginning to grow on it; these should be rooted out at once and all vegetation kept off the bank. Surface soil with grass roots in it should also not be used in making the bank.

A pulsometer is being used to raise the water on to the bank, but what will be wanted as the bank increases in height will be a powerful pump with a delivery hose which can be moved about to different parts of the surface as it is rammed.

The last part of the bank to be undertaken will of course be that across the existing course of the river, and here we are working rather in the dark; borings have been made through the sand in the river-bed with a pricker and not with a regular boring machine; these show that for a distance of 50 or 60 feet nothing but sand has been met with, for a depth of about 28 feet firm clay is then said to be met with. At this point therefore the bund will have to be 80 feet high, and the depth of water 65 feet; the construction of an earthen dam under the circumstances will be rather a hazardous proceeding, and it seems matter for consideration whether it will not be advisable to construct a masonry dam at this portion. The left bank of the river is high and steep and is said to be of hard natural soil; the masonry dam could therefore be built into this, and the earthen dam well revetted round it. On the right bank the ground rises gradually to the hill, and on this rising ground a head-sluice to supply the river has to be built; the masonry dam would naturally end at the sluice, and the small portion between the sluice and the hill could be made of earth; there is not at present the information available to enable a decision to be arrived at as to the advisability of constructing a masonry dam; and it is thought that, considering the length of time work has been in progress here, necessitating lengthened visits on the part of the officers concerned, more should have been done to enable the point to be finally decided. A proper boring machine must now be obtained, and the whole site of the dam across the river-bed must be carefully bored over, the depth of sand ascertained, the quality of the clay and the stratum which it overlays. If then it is found that there is a sufficiently solid foundation on which to construct a masonry dam, a rough estimate of its cost can be made, and a decision on the subject come to. No time should be lost in carrying out these instructions.

The line of the rest of the bund beyond the hill has been marked out and was inspected; there will here be no considerable height of bank, and the work is being reserved for execution in the wet weather when there will be difficulty in digging pits in the low ground.

The tail drop on the channel leading from the reservoir sluice to the river has been nearly completed, the masonry is rough, but the mortar seems good, the concrete in the floor of the water cushion was examined and found to be very hard.

The site for the escape was also examined and the designs for two drops which will be necessary there; these were approved, and the lowering of high portions of ground can be commenced and material collected for the construction of the drops.

A rest-house has been built here, also an Overseer's house and store; they are all sufficiently good buildings and well built.

At the time of our visit there were about 500 coolies on the work, besides those employed on watering and ramming. Some of the labor had come from a distance, but here also the men had come without their families and will not stay continuously. It is not the custom in this part of the country for the women to leave their homes for work, and if we cannot get tank-diggers from a distance, we shall probably have to put up with the spasmodic work of the male population. It would appear, however, that the subject has not received the amount of personal attention from the sub-division officer that it deserves, and the arrangements were too much in the hands of the overseer.

6. *Russellkonda Reservoir.*—A considerable amount of work has been done here on the bund on the left of the nullah this year and last year. The last year's work was overgrown in the same way as the old work at Suradá, and orders were given that all roots and grass should be most carefully removed from the bund. The soil here, of which the bund is being made, is much inferior to that at Suradá, and unfortunately at the highest part of the bund surface soil has been thrown up which does not appear sufficiently good to stand the pressure. After careful consideration, it has been determined that a puddle wall will be necessary in the centre of the bund for its whole length. The top of the puddle will be at M.W.L., the wall will be 5 feet wide with a batter on each side of 1 in 12 to ground level when it will decrease with the same batter till it is carried down into firm soil. Good clay for the puddle must of course be procured and it must be looked for immediately, the sub-division officer should, it is thought, have investigated this subject when called upon to make the calculations for the revision of the estimates. The work is not being carried out altogether in a satisfactory way. A young overseer is in charge, and he would seem to have been left too much alone, and that he wanted guidance was evident from the way in which the layers of the earth being thrown up had been levelled and smoothed before being watered and rammed. There was a great waste of labor in breaking clods and levelling, and the remarks made with reference to the ramming at the Suradá reservoir apply with equal force here. More supervision on the part of the officer is needed, every detail of the work being carefully studied by him on the spot; too much is left to the overseer.

It was ordered that, in addition to the puddle wall above referred to for the whole length of the bund, a trench should be dug half way between the puddle wall and inside toe of the bund to ground level, at as steep a slope as the earth will stand, and filled with puddle; this trench need only extend the length of the low ground in front of the bund, but no more pits must be dug in this low ground. The rule which has been laid down, of 40 feet being left between the toe of the bund and the first pit, may be well as a general rule, but special circumstances may require its relaxation.

It seems probable that, if good gravelly soil could be found in sufficient quantity near the hill at either end of the bund, it would probably answer to run the earth down to the bund by a tramway; at all events this should be investigated; it is very probable a tramway will pay for this, as also for the conveyance of the puddle which it seems must be brought some distance. Pumps also would save a great deal of labor in carrying up water from the pits below the bund for consolidating the new earth. Altogether there is a great need of good management here. The clay for puddle must first be found, excavation for puddle wall being commenced at once, and the wall commenced as early as possible. In carrying it up care must be taken that the surface of the puddle must never be left without a small margin on the edges being made and water left standing on the surface. Until the investigations now referred to have been undertaken, there is no possibility of revising the estimate accurately.

A rest-house has been built here in what seems to be a very odd position, it is behind the hill on which the bund abuts and cut off by the hill from the work; as the reservoir is barely a mile from Russellkonda, no rest-house seems to have been necessary

but a good shed on the work where the sub-division officer could have sheltered during the heat of the day while superintending the work. Overseer's quarters are being built; the works are of the same description as those at Suradá.

The designs for the drop weirs from the reservoir into the river were approved, but too much work must not be undertaken with an inexperienced overseer.

7. *Sub-divisions.*—The arrangements of the sub-divisions as at present do not appear satisfactory. One Assistant Engineer, Mr. Wood, is in charge of both the large reservoirs which are separated by a rough 19 miles of country almost impassable to carts or indeed to horses in wet weather (two and-a-half days have to be wasted in going either way) and Assistant Engineer Venkatareddi Naidoo has the Rushikulya canal, of which only 10 miles are in progress, and weir at head. Under proposed arrangements several miles more of this canal have to be marked out and commenced, this will fully occupy his time, and it seems impossible to give him more to supervise. It has been suggested that another Assistant Engineer should be sent who should be placed in charge of the Suradá reservoir, and the Assistant Engineer now in charge of Russellkonda reservoir could then take up the Goomsur anicut and the Mabandi canal which should now be started.

8. *Machinery.*—There are at present the following machines on the Rushikulya works:—

One pulsometer pump with engine.
One steam mortar do.
Three hand mortar mills.
Two fire engines with hose.
Two centrifugal pumps, 8″ without engines.
Two three-ton portable cranes.
One boring apparatus.

and the following are expected:—

One six-horse-power engine.
One pile diving machine.
One steam mortar mill with engine.

Pumping machinery must now be much used, and the six-horse-power engines are not sufficiently powerful to work 8-inch pumps to the best advantage. Two twelve-horse-power engines should be procured, possibly they may be transferred from some other division. The six-horse-power engine now coming out would then be available to work and the pulsometer which the Government will be asked to allow us to purchase; the price according to Calcutta list is Rs. 700.

The boring apparatus requires piping; 50 feet of pipe should be indented for at once from the stores.

For the Goomsur anicut a tramway to the quarries is necessary. Two-and-a half miles of rail is wanted and about 20 trucks. Some may be available at Cauvery and Vennár regulators and Sangam. Inquiries will be made on the subject, and the rails and waggons supplied. Wooden sleepers can be procured at very low rates close at hand and wood for constructing truck platforms and sides.

For the Russellkonda reservoir, it will be advisable to have a light tramway for conveyance of clay for puddle and possibly earth for the bank. If not otherwise employed the mile of Decauville's tramway which was in the stores should be sent up.

The allowance in the project for tools and plant is Rs. 94,000, of which about Rs. 39,000 will have been spent when the machinery now coming out has been paid for; there will therefore be a balance of Rs. 55,000 which will suffice for purchase of tramways and engines.

Chepâk,
24th February 1886.

(Signed) J. O. HASTED, Colonel, R.E.,
Chief Engineer for Irrigation.

No. 36 I.

Submitted for the information of Government.

Chepâk,
24th February 1886.

(Signed) J. O. HASTED, Colonel, R.E.,
Chief Engineer for Irrigation.

To the Joint Secretary to Government,
Public Works Department, Irrigation Branch.

Order—dated 8th March 1886, No. 227 I., Public Works.

Communicated to the Superintending Engineer, I Circle, for information and guidance.

2. The Superintending Engineer will see that due attention is paid to the directions of the Chief Engineer for Irrigation in future.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Superintending Engineer, I Circle.
" Chief Engineer for Irrigation.
" Examiner, Public Works Accounts.
" Revenue Department.

Exd. A. F. Aaron.
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R279N

IRRIGATION. 1 MAR
ACCOUNT. 88

Govt. of {1886} Madras.

PUBLIC WORKS.

Dated March, 8th.

Recd. *Encl.*

G.O., 8th March 1886, No. 227 I.

MARCH.

Rushikulya Project Division

Notes of inspection by the Chief Engineer for Irrigation of the —, communicated to the Superintending Engineer, I Circle.

No. 4784 A.

FROM

THE SUPERINTENDING ENGINEER

FIRST CIRCLE.

TO

THE CHIEF ENGINEER P. W. Department-
~~FOR IRRIGATION.~~

DOWLAISHWARAM, 15 September 1886
Dupd. 17-9-86.

SIR,

I have the honor to inform you that the Executive Engineer Ganjam Dn. has hired a building at Chicacole for the Division Office at Rs. 20 per -mensem from 26 May 1886 and to request you will be good enough to ob-tain the sanction of Government to the same until such time as the build-ing lately purchased under the author-ity given in Irrigation Chief Engineer's telegram* dated 29-3-86 is thoroughly repaired.

I have the honor to be,
Sir,
your most obedient Sv.

C. Stuart
Supr. Engr. 1st Circle.

M.E.I.
Please put up any papers you may have— D.P.
23-9-86.

* Copy of telegram put up.

MRJ.
23/9
JK

327 I d. 3-86.
377 I. d 5-82

From P.W.C. No. 7441

The Supg Engineer
I Circle

To

The Chief Engineer
P. W Depart.

B. No. 2537 H dy 28-9-86.

Sanctioned

Sanctioned

Dated 15
Despd 17 September/86
Recd: 23.

24/9/86

Sec
27/9/86.

No. 478. G.T.

B. No. 2537 H dy 28-9-86.
Rw
23/9/86

Building for the Asst Engineers Office at Chicacole — Requests Sanction of Govt. to hire — at Rs. 20 per month ~~for~~ until such time as the building lately purchased is thoroughly repaired.

Witte order

S. E. I circle ✓
E. I. C.
Exr. P. W. Accts ✓
Exr. P. W. A.
Despd 28-9-86

Exr
30/9
11/10