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Public Works DEPARTMENT.

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Dated 27-10- 1870.

Not to be folded or roughly handled

No. 377. From the Acting Superintending Engineer, 1st Division, to the Acting Chief Engineer for Irrigation, dated Dowlaishweram, 9th June 1870, No 833

I HAVE the honour to forward, for your consideration, the accompanying original report and statements, together with the surveys of the reservoirs therein referred to, received from Captain Beckley, R E, the Executive Engineer on special duty, Ganjam, for perfecting the irrigation in that district from the Rooshkoolia river.

1 Estimate of the six reservoirs
1 Report
1 River Register of Rooshkoolia, Mahanuddy, for 1869 and 1870
1 Table of reservoirs in the Ganjam District
1 Copy of Collector's letter
1 Rain Register for 1869

Irrig Survey Section 3

2 It is no doubt a matter of very great regret that the registers of the flow of water in this river have not been maintained for many more years, but it is apparent from what we have, that, with reservoirs, a permanent supply of water can be maintained in the canals during the monsoon season to secure the maturing of the cultivation for one crop at least Further observation and experience are required to determine how much more the water can be utilized.

3. I am decidedly of opinion it would be the greatest mistake possible to omit the navigation part of the project, as the entire economical results likely to be obtained by the works are wholly dependent upon this. It is not at all necessary to have any particular classification of locks for the whole Presidency, this is merely creating a restriction of a very arbitrary character, and for no purpose The locks should be made suitable to the kind of boat it would be best to employ on the particular line of canals to be provided for any district, and not, in my opinion, taken from one system of navigation to be the design for all parts of the country. In the case of Captain Beckley's canals, I should say locks, 70×11, with single gates, would be the best arrangement to adopt, a boat, then, drawing three feet of water, would be able to convey from 20 to 25 tons of produce, and, with the available water-supply, regulated and distributed by reservoirs, it would be easy to keep from 4 to 4½ feet on the lock-sills, which is quite sufficient for good navigation in so small an area of country as has here to be provided for.

4. I agree with Captain Beckley, generally, as to the manner in which he proposes to carry out and construct the several works proposed by him It will be seen, that officer shows, it would not be expedient to increase the slope of the canal-bed, and as this would, moreover, interfere with the navigation, it would be highly objectionable I have not been able to go further into the matter, as the designs, etc., for the canals are not in this Office

5 As regards the rates in the estimates, I think it would be very unadvisable to put these down much in excess of those now prevailing, and that it is far better to have an understanding in a matter of this kind, whatever rates are allowed in the estimate are certain to be asked for by contractors, and executive officers would be put to great inconvenience, if any further rise were to take place from unforeseen circumstances

No I.

Estimate of Jallamara Reservoir on the Godahallow.

(1) *Between Contours* 224 *and* 189

			C ft	C yds
No I	Revetment	$\frac{76+190}{2}\times2\times816$ =	121,032 =	4,593⅓
	Bund	$\frac{15+190}{2}\times35\times816$ =	2,927,400	
	Bund, revetment		2,803,368 =	103,828⅔
No II	Revetment	$\frac{86+215}{2}\times2\times3,816$ =	656,352 =	24,309⅓
	Bund	$\frac{15+215}{2}\times40\times3,816$ =	18,153,600	
	Bund, revetment		17,497,248 =	648,046⅔
No III	Revetment	$\frac{63+165}{2}\times2\times1,000$ =	126,000 =	4,666⅔
	Bund	$\frac{15+165}{2}\times30\times1,000$ =	2,700,000	
	Bund, revetment		2,574,000 =	95,333⅓
No IV	Revetment	$\frac{25+80}{2}\times2\times922$ =	46,100 =	1,707⅓
	Bund	$\frac{10+80}{2}\times14\times922$ =	580,860	
	Bund, revetment		534,760 =	19,805⅓
No V	Bund	$\frac{6+26}{2}\times4\times760$ =	48,610 =	1,801⅓
No VI	Revetment	$\frac{104+258}{2}\times2\times590$ =	122,720 =	4,545⅓
	Bund	$\frac{18+258}{2}\times48\times590$ =	3,908,160	
	Bund, revetment		3,785,440 =	140,201⅓
	Puddle	$18\times12\times590$ = 127,440; $9\times10\times590$ = 53,100	180,540 =	6,686⅔

Abstract Estimate of Jallamara Reservoir on the Godahallow

(1) *Between Contours* 224 *and* 189.

					RS.	A	P
No. I.	103,828⅔	C yards of earth-work, at	0 2 3	per C yard	14,600	14	0
No II	648,046⅔	do	do 0 2 4	do	94,506	11	10
No III	95,333⅓	do	do 0 2 2	do	12,909	11	6
No IV	19,805⅔	do.	do 0 1 6	do	1,856	12	10
No V	1,801⅓	do.	do 0 1 0	do	112	9	5
No VI	140,201⅓	do	do 0 4 6	do.	39,431	10	8
	6,686⅔	do	puddle 1 0 0	do	6,686	10	8
	39,822⅓	do	rough stones 0 12 0	do	29,866	12	5
					1,99,971	13	4
Sluice and waste weir					25,000	0	0
Anicut and channel below					15,000	0	0
					2,39,971	13	4
Superintendence and sundries, at 10 per cent					23,998	2	8
					2,63,970	0	0
Land					1,05,600	0	0
Villages					20,000	0	0
				Total ..	3,89,570	0	0, say four lacs

Estimate of Jallamara Reservoir on the Godahallow

(2) *Between Contours* 234 *and* 189

			C ft	C yds
No I	Revetment	95×2×816 =	155 010 =	5,782⅔
	Bund	$\frac{18+243}{2}\times45\times816$ =	4,791,960	
	Bund, revetment		4,636,920 =	1,71,737⅓
No II	Revetment	106×2×3,816 =	808,992 =	29,962⅔
	Bund	$\frac{18+268}{2}\times50\times3,816$ =	27,284,400	
	Bund, revetment		26,475,408 =	980,570⅓
No III	Revetment	82×2×1,000 =	164,000 =	6,074⅛
	Bund	$\frac{15+215}{2}\times40\times1,000$ =	4,600,000	
	Bund, revetment		4,436,000 =	164,296⅛
No IV	Revetment	48×2×922 =	88,512 =	3,278⅔
	Bund	$\frac{12+132}{2}\times24\times922$ =	1,593,216	
	Bund, revetment		1,504,704 =	55,729⅓
No V	Revetment	24×2×760 =	36,480 =	1,351⅓
	Bund	$\frac{10+80}{2}\times14\times760$ =	4,78,800	
	Bund, revetment		442,320 =	16,382⅔
No VI	Revetment	124×2×590 =	146,320 =	5,419⅛
	Bund	$\frac{25+315}{2}\times58\times590$ =	5,817,400	
	Bund, revetment		5,671,080 =	210,040
	Puddle	$18\times12\times590$ = 1,27,440; $10\times9\times590$ = 53,100	180,540 =	6,686⅔

Abstract Estimate of Jallamara Reservoir on the Godahallow

(2) *Between Contours* 234 *and* 189.

					RS	A.	P
No I	171,737⅓	C yards of earth-work, at	0 2 6	per C yard	26,834	0	5
,, II	980,570⅓	do	do 0 2 10	do	173,642	11	6
,, III.	164,296⅛	do.	do 0 2 4	do	23,959	14	0
,, IV	55,729⅓	do.	do 0 2 0	do	6 966	3	6
,, V	16,382⅔	do	do 0 1 6	do	1,535	13	4
,, VI	210,040	do	do 0 4 8	do	61,261	10	8
	6,686⅔	do	puddle 1 0 0	do	6,686	10	8
	51,867⅔	do	rough stone 0 12 0	do	38,900	10	8
					30,000	0	0
Sluice and waste weir					15,000	0	0
Anicut and channel below					3,84,787	10	9
Superintendence and sundries, at 10 per cent					38,472	5	3
					4,23,260	0	0
Land					1,25,600	0	0
Villages					25,000	0	0
				Total ..	5,73,860	0	0, say 5 75 lacs.

No II

Estimate of the Soorada Reservoir on the Joranuddy, between Contours 300 and 270

			C ft	C yds
No I	Revetment	$54\times2\times620$	= 66,960	= 2,480
	Bund	$\frac{18+143}{2}\times28\times620$	= 1,397,480	
	Bund, revetment		= 1,330,520	= 49,278$\frac{1}{27}$
No II	Revetment	$86\times2\times1,416$	= 243,552	= 9,020$\frac{8}{9}$
	Bund	$\frac{18+218}{2}\times43\times1,416$	= 7,184,784	
	Bund, revetment		= 6,941,232	= 257,082$\frac{2}{3}$
No III	Revetment	$100\times2\times296$	= 59,200	= 2,192$\frac{16}{27}$
	Bund	$\frac{18+248}{2}\times30\times296$	= 1,968,400	
	Bund, revetment		= 1,909,200	= 70,711$\frac{1}{3}$
	Puddle ..	$18\times12\times296$ = 63,936; $9\times10\times296$ = 26,610	= 90,576	= 3,351$\frac{2}{3}$
No IV	Revetment	$54\times2\times713$	= 77,004	= 2,852
	Bund	$\frac{18+143}{2}\times28\times713$	= 1,607,102	
	Bund, revetment		= 1,530,098	= 56,670

Abstract Estimate of Soorada Reservoir on the Joranuddy

Between Contours, 300 and 270

							RS	A	P.
No I	49,278$\frac{1}{27}$	C yards	of earth-work, at	0	2	2 per C yard	6,673	2	1
No II	257,082$\frac{2}{3}$	do	do	0	2	6 do	40,169	2	8
No III	70,711$\frac{1}{3}$	do	do	0	4	0 do	17,677	12	5
	3,354$\frac{2}{3}$	do	puddle	1	0	0 do	3,354	10	8
No IV	56,670	do.	earth-work	0	2	0 do	7,674	1	0
	16,515$\frac{1}{27}$	do	rough stone	0	12	0 do	12,408	12	5
							87,957	9	3
Sluice							5,000	0	0
Waste weir							10,000	0	0
							102,957	9	3
Superintendence and sundries, at 10 per cent							10,292	6	9
							1,13,250	0	0
Villages							12,000	0	0
Land 2 $5\times640\times30$							48,000	0	0
						Total	1,73,250	0	0, say 1 75 lacs

No III

Estimate of Boradapilly Reservoir on the Rooshkoolia River

(1) Between Contours 226 and 191.

			C ft	C Yds
No. I.	Revetment	$82\times2\times1,642$	= 268,288	= 9,936$\frac{1}{27}$
	Bund	$\frac{15+205}{2}\times33\times1,642$	= 6,863,560	
	Bund, revetment		= 6,595,272	= 244,269$\frac{1}{3}$

			C ft	C yds
No II	Revetment	$72\times2\times940$	= 135,360	= 5,013$\frac{1}{3}$
	Bund	$\frac{15+180}{2}\times33\times940$	= 3,024,450	
	Bund, revetment		= 2,889,090	= 107,003$\frac{1}{3}$
No. III.	Revetment	$108\times2\times749$	= 161,784	= 5,992
	Bund	$\frac{20+270}{2}\times50\times749$	= 5,430,250	
	Bund, revetment		= 5,268,466	= 195,128$\frac{1}{27}$
	Puddle	$18\times12\times749$ = 161,784; $10\times9\times749$ = 67,410	= 229,194	= 8,488$\frac{1}{3}$
No IV.	Revetment	$77\times2\times538$	= 82,852	= 3,068$\frac{16}{27}$
	Bund	$\frac{15+190}{2}\times35\times538$	= 1,930,075	
	Bund, revetment		= 1,847,223	= 68,415$\frac{1}{3}$

Abstract Estimate of Boradapilly Reservoir on Rooshkoolia river

(1) Between Contours 226 and 191

							RS	A	P.
Nos I and IV.	312,685 C	yards	of earth-work, at	0	2	3 per C yard	43,971	5	3
No II.	107,003$\frac{1}{3}$	do	do	0	2	2 do	14,490	0	6
No. III	195,128$\frac{19}{27}$	do	do	0	4	0 do.	48,782	1	5
	8,488$\frac{2}{3}$	do	puddle	1	0	0 do	8,488	10	8
	24,010$\frac{17}{27}$	do.	rough stone	0	12	0 do	18,007	14	2
							1,33,740	0	0
Sluice and waste weir							25,000	0	0
Six miles of road and bridge							17,000	0	0
							1,75,740	0	0
Superintendence and sundries, at 10 per cent.							17,570	0	0
							1,93,310	0	0
Villages							20,000	0	0
Land 2 $75\times640\times40$ =							70,400	0	0
						Total	2,83,710	0	0, say 3 lacs.

Estimate of Boradapilly Reservoir on the Rooshkoolia

(2) Between Contours 236 and 191.

			C ft	C yds
No I	Revetment	$104\times2\times1,642$	= 341,536	= 12,649$\frac{8}{27}$
	Bund	$\frac{18+258}{2}\times48\times1,642$	= 10,876,608	
	Bund, revetment		= 10,535,072	= 390,187$\frac{8}{27}$
No II	Revetment	$90\times2\times940$	= 169,200	= 6,266$\frac{2}{3}$
	Bund	$\frac{18+233}{2}\times43\times940$	= 5,072,710	
	Bund, revetment		= 4,903,510	= 181,611$\frac{13}{27}$
No III	Revetment	$128\times2\times749$	= 191,744	= 7,101$\frac{17}{27}$
	Bund	$\frac{25+325}{2}\times60\times749$	= 7,864,500	
	Bund, revetment		= 7,672,756	= 284,176$\frac{4}{27}$
	Puddle	$25\times12\times749$ = 224,700; $9\times10\times749$ = 67,410	= 292,110	= 10,818$\frac{8}{9}$

			C ft	C yds
No IV	Revetment	96×2×538 =	103,296 =	3,825⅓
	Bund	$\frac{18+243}{2}$ ×45×538 =	3,159,405	
	Bund, revetment ..	.. ..	3,056,109 =	113,189⅓

Abstract Estimate of Boradapilly Reservoir on the Rooshkoolia

(2) *Between Contours* 236 *and* 191

						RS	A	P.
Nos 1 & IV.	503,377 $\frac{2}{27}$	C yds	of earth-work, at	0	2 6	per C. yd	78,652	10 8
No II.	181,611 $\frac{13}{27}$	do	do	0	2 4	do	26,484	15 0
No III	284,176 $\frac{4}{27}$	do	do	0	4 3	do	75,484	4 7
	10,818 $\frac{8}{9}$	do	puddle	1	0 0	do	10,818	14 2
	29,843 $\frac{5}{9}$	do	rough stone	0	12 0	do	22,382	10 8
Sluice and waste weir			..				30,000	0 0
Eight miles of road and bridge			...			.	23,000	0 0
							2,66,823	7 1
Superintendence and sundries, at 10 per cent			...		..		26,686	8 11
							2,93,510	0 0
Villages .			..				22,500	0 0
Land 35×640×40 =			...		..		89,600	0 0
			Total				4,05,610	0 0, say 4 25 lacs

Estimate of Boradapilly Reservoir on the Rooshkoolia

(3) *Between Contours* 246 *and* 191.

			C ft	C yds.
No. I.	Revetment ..	128×2×1,642 =	420,352 =	15,568$\frac{16}{27}$
	Bund .. .	$\frac{25+325}{2}$ ×58×1,642 =	16,666,300	
	Bund, revetment . ..	.. ..	16,245,918 =	601,701$\frac{7}{9}$
No II.	Revetment .	116×2×940 .	218,080 =	8,077$\frac{1}{27}$
	Bund ..	$\frac{25+290}{2}$ ×53×940 =	7,848,650	
	Bund, revetment	.. ...	7,628,570 =	282,539$\frac{17}{27}$
No. III.	Revetment	152×2×749 =	227,596 =	8,429$\frac{13}{27}$
	Bund	$\frac{25+375}{2}$ ×70×749 =	10,486,000	
	Bund, revetment . . .		10,258,404 =	379,940$\frac{8}{9}$
	Puddle {18×12×749=161,784 {10× 9×749= 67,410			
		——— =	229,194 =	8,488$\frac{2}{3}$
No. IV.	Revetment .	118×2×538 =	126,968 =	4,702$\frac{14}{27}$
	Bund	$\frac{25+300}{2}$ ×55×538 =	4,808,375	
	Bund, revetment		4,681,407 =	136,348$\frac{11}{27}$

Abstract Estimate of Boradapilly Reservoir on the Rooshkoolia

(3) *Between Contours* 246 *and* 191

						RS	A	P
Nos I & IV	738,050$\frac{5}{27}$	C yds	of earth-work, at	0	2 9	per C yd. =	126,852	6 0
No II	282,539$\frac{17}{27}$	do	do	0	2 8	do =	47,089	15 0
No III	379,940 $\frac{8}{9}$	do	do	0	4 6	do =	106,858	6 0
	8,488 $\frac{2}{3}$	do	of puddle	1	0 0	do =	8,488	10 8
	36,777$\frac{13}{27}$	do	of rough stone	0	12 0	do =	27,583	3 6
							3,16,872	9 2
Sluice and waste weir ..							35,000	0 0
10 miles of road and bridge						...	25,000	0 0
							3,76,872	9 2
Superintendence and sundries, at 10 per cent						...	37,687	6 10
							4,14,560	0 0
Villages .						...	25,000	0 0
Land 4×640×40 =							1,02,400	0 0
							5,41,960	0 0, say 5 5lacs

No IV

Estimate of Bulligutch Reservoir on the Rooshkoolia.

(1) *Between Contours* 271 *and* 231.

			C ft	C yds.
No I	Revetment .	40×2×820 =	65,600 =	2,429$\frac{17}{27}$
	Bund .. .	$\frac{10+110}{2}$ ×20×820 =	984,000	
	Bund, revetment .	...	918,400 =	34,014$\frac{22}{27}$
No II.	Revetment ..	80×2×2,889 =	462,240 =	17,120
	Bund	$\frac{15+215}{2}$ ×40×2,889 =	13,289,400	...
	Bund, revetment	.. ..	12,827,160 =	475,080
No III.	Revetment	94×2×658 =	123,704 =	4,581$\frac{17}{27}$
	Bund	$\frac{18+243}{2}$ ×45×658 =	3,197,880	...
	Bund, revetment	.. . .	3,074,176 =	113,858$\frac{16}{27}$
No IV	Revetment	112×2×339 =	75,936 =	2,812$\frac{4}{9}$
	Bund .	$\frac{18+283}{2}$ ×53×339 =	2,704,033½	
	Bund, revetment ..		2,628,097½ =	97,336$\frac{11}{18}$
	Puddle {18×12×339=73,224 {9×10×339=30,510			
		——— =	103,734 =	3,842

Abstract Estimate of Bulligutch Reservoir on the Rooshkoolia

(1) *Between Contours* 271 *and* 231.

						RS	A	P
No 1	34,014$\frac{22}{27}$	C yards	of earth-work, at	0	2 0	per C yard =	4,251	13 7
No. II	475,080	do	do	0	2 6	do =	74,231	4 0
No. III	113,858$\frac{16}{27}$	do	do	0	2 8	do =	18,976	6 3
No IV	97,336$\frac{11}{18}$	do	do	0	4 0	do. =	24,334	2 6
	3,842	do.	puddle	1	0 0	do. =	3,842	0 0
	26,943$\frac{13}{27}$	do	rough stone	0	12 0	do. =	17,707	12 5
							1,43,343	6 9

		RS	A.	P
Sluice and waste weir		25,000	0	0
3 miles of road and bridge		6,000	0	0
		1,74,343	6	9
Superintendence and sundries, at 10 per cent		17,656	9	3
		1,92,000	0	0
Villages		10,000	0	0
Land 1 5×640×40		38,400	0	0
		2,40,400	0	0 say 2 5 lacs

Estimate of Bulligutch Reservoir on the Rooshkoolia

(2) *Between Contours* 281 and 231.

			C ft.	C yds
No I	Revetment	61×2×820=	100,040 =	3,705$\frac{5}{27}$
	Bund	$\frac{15+165}{2}$×30×820=	2,214,000	...
	Bund, revetment		2,113,960 =	78,294$\frac{22}{27}$
No II	Revetment	107×2×2,889=	618,246 =	22,896
	Bund	$\frac{18+268}{2}$×50×2,889=	20,656,350	...
	Bund, revetment		20,038,104 =	742,152
No III	Revetment	117×2×658=	153,972 =	5,702$\frac{2}{3}$
	Bund	$\frac{18+293}{2}$×55×658=	5,627,545	..
	Bund, revetment		5,473,573 =	202,724$\frac{23}{27}$
No IV	Revetment	138×2×339=	93,564 =	3,465$\frac{1}{3}$
	Bund	$\frac{20+335}{2}$×63×339=	3,790,867	.
	Bund, revetment		3,697,303 =	136,937$\frac{4}{27}$
	Puddle	18×12×339=73,224 10× 9×339=30,510		
			= 103,734 =	3,842

Abstract Estimate of Bulligutch Reservoir on the Rooshkoolia

(2) *Between Contours* 281 and 231

						RS	A	P
No I.	78,294$\frac{22}{27}$	C. yards of earth-work, at	0	2 2	per C yard =	10,602	6	9
,, II	742,152	do	do	0 2 6	do	=1,15,961	4	0
,, III	202,724$\frac{23}{27}$	do.	do	0 2 9	do	= 34,813	5	6
,, IV	136,937$\frac{4}{27}$	do.	do	0 4 0	do.	= 34,234	4	7
	3,842	do	puddle	1 0 0	do	= 3,842	0	0
	35,771$\frac{5}{27}$	do	rough stone	0 12 0	do	= 26,828	6	2
Sluice and waste weir							30,000	0	0
4 miles of road and bridge							8,000	0	0
							2,64,311	11	0
Superintendence and sundries, at 10 per cent.							26,488	5	0
							2,90,800	0	0
Villages							12,000	0	0
Land 2×640×40							51,200	0	0
					Total ..		3,54,000	0	0, say 3 5 lacs.

No V.

Estimate of Bavancona Reservoir on a tributary of the Loharakundy

(1) *Between Contours* 150 and 105

			C ft.	C yds
No I	Revetment	84×2×358 =	60,144 =	2,227$\frac{5}{9}$
	Bund	$\frac{15+215}{2}$×40×358 =	1,646,800	.
	Bund, revetment		1,586,656 =	58,765$\frac{1}{27}$
No II	Revetment	106×2×826 =	175,112 =	6,485$\frac{17}{27}$
	Bund	$\frac{18+268}{2}$×50×826 =	5,905,900	.
	Bund, revetment		5,730,788 =	212,251$\frac{11}{27}$
No. III	Revetment	134×2×100 =	26,800 =	992$\frac{16}{27}$
	Bund	$\frac{18+333}{2}$×63×100 =	1,105,650	
	Bund, revetment		1,078,850 =	39,957$\frac{11}{27}$
	Puddle	18×12×100=21,600 10× 9×100= 9,000	= 30,600 =	1,133$\frac{1}{3}$
No IV.	Revetment	128×2×1,094 =	280,064 =	10,372$\frac{20}{27}$
	Bund	$\frac{18+318}{2}$×60×1,094 =	11,028,520	.
	Bund, revetment		10,748,456 =	398,090$\frac{26}{27}$
No V	Revetment	52×2×1,230 =	127,920 =	4,737$\frac{7}{9}$
	Bund	$\frac{18+143}{2}$×25×1,230 =	2,475,375	.
	Bund, revetment		2,347,450 =	86,942$\frac{16}{27}$

Abstract Estimate of Bavancona Reservoir on a tributary of the Loharakundy

(1) *Between Contours* 150 *and* 105.

						RS	A.	P.
No I	58,765$\frac{1}{27}$	C yards of earth-work at	0	2 2	per C. yard =	7,957	12	3
No II.	212,251$\frac{11}{27}$	do.	do.	0 2 8	do.	= 35,375	3	9
No III	39,957$\frac{11}{27}$	do	do.	0 3 6	do	= 8,740	10	11
	1,133 $\frac{1}{3}$	do	puddle	1 0 0	do	= 1,133	5	4
No. IV.	398,090$\frac{26}{27}$	do	earth-work	0 3 0	do	= 74,642	0	10
No. V.	86,942$\frac{16}{27}$	do	do	0 2 0	do	= 10,867	13	2
	24,816$\frac{5}{27}$	do	rough stone	0 12 0	do.	= 18,612	3	6
						1,57,329	1	9
Sluice and waste weir						15,000	0	0
						1,72,329	1	9
Superintendence and sundries, at 10 per cent						17,230	14	3
						1,89,560	0	0
Villages						15,000	0	0
Land 2×640×40						51,200	0	0
					Total ..	2,55,760	0	0, say 2 55 lacs

Estimate of the Bavancona Reservoir on a tributary of Loharakundy

(2) Between Contours 140 *and* 105, 10 *feet lower*

			C ft.	C. yds
No. I.	Revetment ..	38×2×288 =	21,888 =	820⅔
	Bund	$\frac{15+115}{2}$×20×288 =	374,400	
	Bund, revetment		352,512 =	13,056
No II	Revetment .	70×2×250 =	35,000 =	1,296⅝T
	Bund	$\frac{15+190}{2}$×35×250 =	896,875	
	Bund, revetment		861,875 =	31,921⅛T
No III	Revetment	109×2×100 =	21,800 =	807⅓T
	Bund	$\frac{18+283}{2}$×53×100 =	797,650	...
	Bund, revetment		775,850 =	28,735⅛T
	Puddle { 18×12×100 = 21,600 / 10×9×100 = 9,000			
		=	30,600 =	1,133⅓
No IV.	Revetment	104×2×1,094 =	227,552 =	8,427⅔T
	Bund	$\frac{15+265}{2}$×50×1,094 =	7,658,000	...
	Bund, revetment		7,430,448 =	275,201⅔
No V.	Revetment	71×2×876 =	124,392 =	4,607⅓
	Bund	$\frac{15+190}{2}$×35×876 =	3,142,650	
	Bund, revetment		3,018,258 =	111,787⅓
No VI	Revetment ..	26×2×500 =	26,000 =	962⅔
	Bund ...	$\frac{12+87}{2}$×15×500 =	375,250	..
	Bund, revetment		347,250 =	12,861⅓

Abstract Estimate of Bavancona Reservoir on a tributary of the Loharakundy

(2) Between Contours 140 *and* 105, 10 feet lower

							RS	A.	P
No I.	13,056	C yards of	earth-work, at	0	1	9 per C. yard	= 1,428	0	0
No II	31,921⅛T	do	do	0	2	2 do	= 4,322	10	9
No. III	28,735⅛T	do	do	0	3	0 do	= 5,387	13	6
	1,133⅓	do	puddle	1	0	0 do.	= 1,133	5	4
No IV.	275,201⅔	do.	earth-work	0	2	6 do.	= 43,000	4	5
No V	111,787⅓	do	do	0	2	2 do	= 15,137	13	10
No VI	12,861⅓	do	do	0	1	6 do	= 1,205	11	8
	16,922⅛T	do	rough stone	0	12	0 do.	= 12,691	11	6
							84,307	7	0
Waste weir and sluice							10,000	0	0
							94,307	7	0
Superintendence and sundries, at 10 per cent							9,432	9	0
							1,03,740	0	0
Villages							12,000	0	0
Land, 2×640×40=							51,200	0	0
						Total ..	165,940	0	0, say 1 66 lacs

No VI.

Estimate of Kollada Reservoir on the Mahanuddy.

(1) Between Contours 91 *and* 54

			C ft	C yds
No I	Revetment . .	46×2×570 =	5,244 =	194⅓
	Bund .	$\frac{10+135}{2}$×25×570 =	1,033,125	..
	Bund, revetment		.. 1,027,881 =	38,069⅓
No II	Revetment .. .	78×2×758 =	118,248 =	4,379⅝
	Bund ..	$\frac{15+215}{2}$×40×758 =	3,486,800	.
	Bund, revetment ..		... 3,368,552 =	124,761⅛T
No III	Revetment .	110×2×4,830 =	1,062,600 =	39,355⅝
	Bund	$\frac{20+295}{2}$×55×4,830 =	41,839,875	...
	Bund, revetment		40,777,275 =	1,510,269⅓
No IV	Revetment	184×2×300 =	110,400 =	4,088⅓
	Bund	$\frac{20+320}{2}$×60×300 =	3,060,000	.
	Bund, revetment		2,949,600 =	109,244⅓
No V.	Revetment .	98×2×332 =	65,072 =	2,410⅛T
	Bund	$\frac{15+265}{2}$×50×332 =	2,324,000	...
	Bund, revetment		2,258,928 =	83,664
No VI	Revetment	53×2×1,084 =	114,904 =	4,255⅓
	Bund . . .	$\frac{10+160}{2}$×30×1,084 =	2,764,200	
	Bund, revetment		2,649,296 =	98,122⅛T

Abstract Estimate of Collada Reservoir on the Mahanuddy

(1) Between Contours 91 *and* 54

							PS	A	P
No I	38,069⅓	C yards of	earth-work at	0	1	8 per C yard	= 3,965	9	5
No II	124,761⅛T	do	do	0	2	0 do	= 15,595	2	4
No. III.	1,510,269⅓	do	do	0	2	8 do	= 2,51,711	9	2
No IV.	109,244⅓	do	do	0	3	0 do	= 20,483	5	4
No V	83,664	do	do	0	2	8 do.	= 13,944	0	0
No. VI	98,122⅛T	do	do	0	1	9 do	= 10,732	1	6
	54,684	do	of rough stone	0	12	0 do	= 41,013	0	0
							3,57,444	11	9
.. ... .							5,000	0	0
Sluice							20,000	0	0
Waste weir ...							5,000	0	0
Puddling							3,87,444	11	9
Superintendence and sundries, at 10 per cent							38,755	4	3
							4,26,200	0	0
... ...							20,000	0	0
Villages							1,15,200	0	0
Land 6×640×30 = ...						Total .	5,61,400	0	0, say 5 6 lacs

Estimate of Kollada Reservoir on the Mahanuddy

(3) *Between Contours* 101 *and* 54

			C ft	C yds
No I	Revetment ..	73×2×760 =	110,960 =	4,109$\frac{17}{27}$
	Bund	$\frac{15+190}{2}$×35×760 =	2,726,500	
	Bund, revetment ..		2,615,540 =	96,871$\frac{23}{27}$
No II	Revetment . ..	107×2×758 =	162,212 =	6,007$\frac{23}{27}$
	Bund	$\frac{18+268}{2}$×50×758 =	5,419,700	...
	Bund, revetment		5,257,488 =	194,721$\frac{7}{9}$
No. III	Revetment	138×2×4,830 =	1,333,080 =	49,373$\frac{1}{3}$
	Bund	$\frac{20+345}{2}$×65×4,830 =	77,295,875	..
	Bund, revetment		75,962,795 =	2,813,436$\frac{23}{27}$
No IV.	Revetment	152×2×300 =	91,200 =	3,377$\frac{7}{9}$
	Bund	$\frac{20+370}{2}$×70×300 =	4,095,000	
	Bund, revetment		4,003,800 =	1,48,288$\frac{8}{9}$
No V.	Revetment	128×2×332 =	84,992 =	3,147$\frac{13}{27}$
	Bund	$\frac{18+318}{2}$×60×332 =	3,346,560	
	Bund, revetment		3,261,568 =	120,798$\frac{22}{27}$
No VI	Revetment	84×2×1,084 =	182,112 =	6,744$\frac{8}{9}$
	Bund	$\frac{15+215}{2}$×40×1,084 =	4,986,400	
	Bund, revetment		4,804,288 =	1,77,936$\frac{16}{27}$

Abstract Estimate of Kollada Reservoir on the Mahanuddy.

(3) *Between Contours* 101 *and* 54.

							RS.	A.	P.
No I	96,871$\frac{23}{27}$	C yards of	earth-work at	0	2 2	per C yard =	13,118	1	0
No II	194,721$\frac{7}{9}$	do.	do	0	2 9	do. =	33,467	12	10
No III	2,813,436$\frac{23}{27}$	do	do.	0	3 2	do. =	5,50,826	0	8
No IV	148,288$\frac{8}{9}$	do	do	0	4 6	do =	41,706	4	0
No V	120,798$\frac{22}{27}$	do	do	0	3 0	do. =	22,649	12	5
No. VI	177,936$\frac{16}{27}$	do	do.	0	2 6	do =	27,802	9	6
	72,761$\frac{1}{3}$	do.	of rough stone	0	12 0	do. =	54,571	0	0
Sluice and waste weir							7,50,141	8	5
Puddling							30,000	0	0
							5,000	0	0
Superintendence and sundries, at 10 per cent							7,85,141	8	5
							78,518	7	7
Villages							8,63,660	0	0
Land							25,000	0	0
							1,25,000	0	0
						Total. .	10,13 660	0	0, say 10 lacs

CHETTERPORE,
21*st May* 1870

(Signed) T BECKLEY, Captain, R E,
Executive Engineer on special duty, Ganjam

From the Executive Engineer on special duty, Ganjam, to the Superintending Engineer, 1st Division, dated Chetterpore, 21st May 1870, No 38

I HAVE the honour to forward surveys of reservoir sites that I have surveyed in connection with the Rooshkoolia Project, but will first supplement the information contained in former reports, and reply to certain questions raised by the Acting Chief Engineer for Irrigation.

2. I enclose River Register of Rooshkoolia and Mahanuddy complete for 1869 and 1870 The season has been very favourable with more than an average rain-fall Sections have been taken of the rivers at points where gauges are fixed, gauge posts are also placed lower down, thus the surface fall is known, these computed discharges are, of course, only approximately correct, the lower discharges being generally too great and the higher discharges too little, the principal sources of error are due to the sandy bed of the river being liable to constant changes and the velocities in broad shallow sandy bedded rivers being much retarded by the work done in transporting sand. There were moderate freshes in the Mahanuddy during the last ten days of June, and the two rivers contained far more than the requisite quantity of water during the months of July, August, September, October On the 15th November experiments by floats gave 160,000 cubic yards per hour to the rivers combined, on the 1st of December over 30,000, on the 15th of that month the quantity had diminished to 20,000, which was still more than sufficient for the sugar-cane cultivation

3 It is almost impossible to estimate even approximately the precise supply of water that it would be the most profitable and desirable to provide for the 140,000 acres of Government land that the proposed canal could irrigate, that for a considerable portion of these acres the quantity suggested by the Acting Chief Engineer as a minimum (namely, 1 cubic foot per second for 100 acres) is not absolutely essential in favourable years is proved by the fact that last year this land yielded rice-crops varying from indifferent to good without any water at all from the source we propose to create, and I think no one, acquainted with the country, would doubt but that whilst with the proposed canal the irrigated crops grown without it would have been perfected, fair crops would also have been obtained from the remainder of the land, in less favourable years the benefits from the canal unaided by reservoirs would be less widely distributed, but it would perform the highest duty in the worst years when irrigating the least extent of country, as by saving the crops on the low-lying land a famine, if not altogether prevented, would be much mitigated in severity to the people and cost to the State I am still of opinion, therefore, that the canal is a work that should be undertaken even were reservoirs inadmissible In designing the canal I should recommend that, both on the score of economy and practicability, we should bear in mind that we have only to supplement existing sources of irrigation, and accordingly full allowance be made for the usually ample rainfall, the numberless hill streams all more or less taken advantage of as irrigation channels, as also for the numerous tanks situated below the line of canal, and, in calculating the advantages that would be afforded by river channels, we must not overlook the fact that the first freshes bring down the sweepings of the hills, and, although something may be done by improved agriculture, there is probably no way of keeping up the fertility of the soil in India but by intercepting these first freshes Last year, the crops in the Ganjam District were good beyond precedent, and I believe this to be partly attributable to the land having been rested in previous bad seasons, there is a very general complaint among ryots that the soil is less fertile than formerly, the fact being that the proportion of arable to pasture or waste lands is yearly increasing.

4 In attempting to estimate the quantity of water per acre required, too much reliance must not be placed on the total amount of rainfall, which is about the same in the Madras and Ganjam Districts, but whilst in the former an attempt to grow rice, without artificial irrigation, would be justly regarded by the ryots as absurd, it has been so grown in the Ganjam District from time immemorial In considering the rainfall in connection with the proposed project, it is necessary to eliminate some of the rain-gauge tables, referred to by the Acting Chief Engineer in the 3rd paragraph of his memorandum Ganjam and Gopaulpore or Munsoorcotta have very little to do with the project; the lower portion of the tract of country to be irrigated is fairly represented by Berham-

pore and Chetterpore, the upper portion by Aska, the gauges at Russelcondah, Soorada, and Bulligada fairly representing the drainage area rainfall

5. With regard to existing irrigation, the Tahsildar of Goomsoor was asked for a list of irrigation channels, leading from the Mahanuddy between Goomsoor and Aska, on the 10th February 1870, and several applications have been made to him since, but no reply has been received If received, a list of these channels will be sent From my own knowledge of the country, I believe there is only one small channel from the left bank, there are several small channels from the right bank. The land they irrigate, however, will be commanded by the proposed canal, and even now is chiefly dependent on the Boary reservoir On the Rooshkoolia, between the proposed site of anicut and Aska, there is one small channel on the right bank belonging to the Daracotta Zemindar, the land hitherto irrigated by this will be supplied from the canal; there is one small channel on the left bank, but it commences above the anicut and will not be interfered with, in fact the present irrigation from the rivers is very insignificant and very imperfect Between Aska and the sea there is only one channel, namely, the Heeradara or Poorooshotapore channel which irrigates about 2,000 acres, but as this will still be supplied by the Bagoova river drainage, 350 square miles, and the Godahalow drainage, 400 square miles, besides other streams, the anicut above will not affect materially the irrigation from this channel

6 As regards navigation, I would earnestly recommend that, even if the canal is not made navigable by locks, etc, in the first instance, the works may be so designed that it may be made navigable hereafter It is not necessary that there should be the full depth of 6 feet to afford navigation, superior as a mode of transit, for the produce of the country, to the bandies mostly drawn by buffaloes, at a speed of about one mile per hour Numbers of the Chilka lake boats draw laden not more than 2 feet; the Rooshkoolia canal running 3 feet deep would require 41,500 cubic yards per hour, (311 cubic feet per second,) and this quantity, last year, could have been obtained direct from the river with only six days intermission, from June 20th to end of November, but if it has been determined that, on account of the irrigation, extensive reservoirs must be constructed, it is hardly worthwhile my attempting to show that a useful navigation might be maintained without their aid and without the aid of works that, at inconsiderable cost, could be constructed to regulate the surface fall according to the volume of water passing down the canal.

7. With reference to the Acting Chief Engineer's remarks on the details of the proposed works, I have the following information to give — The surface stones of the Rooshkoolia anicut will be large blocks, which would be more easily obtained than small stones I did not insert any groynes in the plan, considering that the best position for such works are often more rightly judged after the work has been partly constructed, the experience gained in the Kistna and Godavery seems to be that, unless very judiciously placed, they do harm, as, whilst destroying a portion of a cross current, they dangerously concentrate the power of the remainder The piers of the Dowlaishweram under sluice built of sandstone are only 3 feet thick, taking into consideration that the force of the current would here be very much less, and the stone very much harder and heavier, I thought 1 5 feet would suffice, that the cut stone work should not be more massive in these works than is essential to safety is important, not only on account of the extra costs, but also because the date of completion of the masonry works will probably be dependent on the quantity of cut stone required. I did not contemplate the necessity of closing the under sluices during high floods; the under sluices of the Kistna and Godavery anicuts are not even approachable during such floods, with one or even 2 feet of water on the weir I should not anticipate any difficulty in forcing down shutters if not made larger than 3 feet × 4 feet; the objection to a ramp or raising the piers seems to be that a very important part of the water-way would be blocked up The object in making the vents of the head sluice 5 feet high and only 4 feet broad was to keep the shutters within dimensions that would allow of their being raised and lowered at all times, without the extreme difficulty that is experienced with larger shutters, as stated the sluice would not pass the whole volume of water with a uniform flow, it would require a head of 1 25 inches, the difference of velocity in the river and channel being about 5,000 yards per hour, however, represents a head of about 5 inches* It would be the duty of the lascars, when more water was required, to raise a temporary bund on the

crest of weir, or the same object might be gained by an arrangement of shutters as used at Cuttack. If the cill of the head sluice is lowered to 7 feet below the crest of weir, it will be only 1 foot above cill of under sluices, and will give 1 foot additional cutting through the rock at Shargada, and if the fall of the canal be increased from 6 inches to 8 inches, the depth of the cutting will be increased another 2 feet, so that increasing the fall would not be an economical alteration, as it would not diminish the cost of embanking. I may here mention that, before contouring the line of canal at 6 inches per mile, I had stated my intention in my preliminary report I had also written to Colonel Anderson, R E, specially on the subject; so concluded that the 6 inches per mile fall had been approved.

8. The right bank of the Rooshkoolia near the proposed anicut site is very stable, being of the hardest rock I consider the site chosen the best even if the exit offered for the navigation canal by the Janimilly nullah be disregarded, if we go 300 yards, or *more* than one-sixth of a mile lower down, we lose another foot of level, the bed of the canal being thus lowered altogether 4 feet, the cost of the Shargada cutting would be most materially increased, and the area of land irrigated considerably lessened we should not either at the spot indicated by the Acting Chief Engineer have the advantage of a rock foundation for the head sluice and possibly for the under sluices as higher up. I am disposed to think that the length of the Mahanudly canal would be increased in length 300 yards instead of lessened, and the peculiar facilities offered to the navigation across the river would be lost, very little cutting would be requisite to render the whole length of proposed anicut effective in high floods, and the effectiveness of the whole would be of no moment in moderate floods In calculating rise due to construction of anicut I have entirely disregarded the water-way over that part embedded in the bank, and I must own I fail to perceive any inaccuracy in my calculation of an extreme rise of 2 feet; beyond question, the sharp bend affects the flow of the river, but does it not do so comparatively to a greater degree now than it would after the construction of the anicut? and the calculation of the rise that will be occasioned by anicut are based on the present actual sections and surface fall that have been fully affected by the bend alluded to. If the roadway is made as I proposed, M S L + 185 feet, it will be 6 inches above a flood of about 8 25 million yards per hour (61,875 feet per second), if raised to M S L + 188 feet it will be 6 inches above a flood of 12 5 million yards per hour (93,750 feet per second), the highest known flood being 5 25 million yards per hour (39,375 feet per second), a large tract of country must be flooded before this could occur

9 I note that locks on second-class canals are to be 105 feet × 15 feet Locks in the Cuttack District I understand vary in size, the most common being 100 feet × 17 feet.

10 The estimate for the iron girder bridge on the Aska and Soorada road is too low, the cost would not be under Rupees 12,000, as the road is only a district road. It would be better to build a masonry bridge for which the original estimate would be more than sufficient. As remarked by the Acting Chief Engineer the water-way has been diminished over the various aqueducts as is usually done, and for the usual reason, economy The head due to contraction in all, except the Shargada and Godahalow aqueducts, would be about an inch with a depth in canal of 6 feet, and this might be compensated for by giving, in addition to the 6 inches a mile fall, a drop of a little over an inch at each aqueduct, but I should not recommend this to be done, as it would be detrimental to navigation when the water was low, and it is to be considered that the reduction of velocity by these contractions of the channel will be about compensated on the whole for by the fact that the irrigation water will be drawn off under a head of 3 feet.

11. It is intended that the piers of all the works should be of the best material, namely, of hard heavy cut stone. I have not, therefore, considered that the piers need be of greater thickness than to afford a full bearing to the arches that they support, if this is determined to be an insufficient thickness, I should prefer the thickness to be increased throughout as, to my mind, a batter in bridge piers is unsightly, and the but end being in the water an unnecessary obstacle is offered to the current.

12 With reference to remark in paragraph 18 a reference to the plan and estimates will show that concrete has been allowed under all inverts.

13. If the piers of the Godahalow aqueduct are 5 feet thick there is, of course, no occasion to build them of cut stone, but I should prefer piers of cut stone 3 feet thick to more ponderous rubble masonry piers, as the river runs deep and rapidly, it is obviously of consequence not to obstruct the current more than is necessary, if the piers are thickened the apron must be increased in proportion. I believe that, in the majority of cases, the destruction of bridges may be rightly ascribed to the contraction of the water-way I had not intended it to be understood that the precise site for this aqueduct nor for any of the masonry works had been selected; a straight reach would, of course, have the preference, and it is very probable that a rocky foundation may be obtained

14. I note the Acting Chief Engineer's remarks regarding the inlets and outlets also that he considers width of weir apron must not be less than 1 3 feet × height of crest above them

15 The canal is not carried through the sand ridge at 65 66 miles to get rid of the surplus water, but to convey water for irrigation to Chetterpore and neighbourhood

16. It was an error allowing 60 feet span arch to carry Aska and Russelcondah road over canal, a 30-feet span arch would suffice I think that it would be better to widen the apron of the Mahanuddy anicut than to double the height of the cushion wall designed by me, which is 2 5 if doubled, the wall would be only one foot less in height than the anicut itself.

17 With reference to the 37th paragraph of Acting Chief Engineer's memorandum, I have to observe that the country on one side of the canal is tolerably thickly populated, but on the other side is mostly hill and jungle, frequent bridges therefore are not required, two not one only have been allowed, namely, at the Mahanuddy head sluice and Aska and Russelcondah road, probably a third would be useful near the Rooshkoolia.

18 I consider the scale of water allowances per acre, as set down in paragraph 27 of the Acting Chief Engineer's memorandum, altogether too high for this district, nearly all the water would be finally distributed by small channels, and if these are to carry at an average rate of 6 cubic yards per hour, whilst the main canal only carries 1 5, it appears to me that, whilst the land under the upper portion of the canal will get swamped, that dependent on the canal lower down will receive no irrigation

19 As remarked in paragraph 40 only the levels along the selected line were forwarded with plans and estimates of canal, but the preliminary report sent from this office, dated 28th October 1868, was accompanied by a map showing a number of other lines of levels

20. The rates for the earthwork are such as work could be easily done for in the Godavery District, where the daily cooly hire is higher than here, the rates for the masonry are considerably higher than those now in force I believe that, under competent management, the rates generally will be found sufficient, even if a still further raising of the rates on account of the magnitude of the work were inevitable, it would be better there should be a silent understanding on the subject, to put higher rates in the estimate would be simply doing at once what otherwise at the worst will be gradual and partial. A large number of stone cutters can be obtained in this district and from Vizagapatam, and some people must be taught

21. The Collector's attention has been drawn to paragraphs 30 and 31 of the Acting Chief Engineer's memorandum A copy of his letter in reply accompanies this report. When the Revenue surveys of the Goomsoor and Berhampore Talooks now in progress are completed, further information will be more easily obtained I do not myself argue that the people of this district will gladly avail themselves of canal water because people to the south do so, though I think it must be allowed that irrigated talooks are more prosperous than dry talooks, and we might fairly infer that people will avail themselves of the means of prosperity when placed within their reach. My argument is rather that we may reasonably expect a people, who throughout the district irrigate from the drainage channels will require little persuasion to use canal water, with its double blessing of enriching and saving trouble, that they will at first clamour to take the water without payment is to be expected, and it would be well if, as the Revenue survey progress, the people

Proceedings of the Madras Government, Public Works Department, 27th October 1870.

were taught to expect a somewhat increased rental Colonel Anderson, R E, remarked that it is hardly safe to reckon upon a higher kist than that already levied on irrigated lands Now it is difficult in this district to say what is the maximum rate I believe that on Government lands it seldom exceeds Rupees 3-8-0 per acre; the land under the Koratholy tank paying only an average of Rupees 3-2-9 is rich alluvial soil perfectly irrigated, the tank is never dry and receives the first freshes of the Godahalow with which it is connected by a channel, the supply in which is regulated by a head sluice with anicut across the river This land produces good crops even in famine years when the country around is desolate, and is, moreover, only 5 miles from the port of Ganjam whence much rice is exported I know of no reason why this land should not be rented as high, as inferior land in the Godavery District, namely, at Rupees 6 or less than one-fourth the value of the crop Against any theory that the Ooriyahs are naturally a less revenue paying people than Taloogoos, there is the fact that this propensity for paying low rents is confined to Government ryots, it is difficult to find out what Zemindary ryots pay practically, but it appears to be generally allowed that the Zemindar has a perfect right to half the grain produced, and that this is often taken either by himself or by the village renter On the lands under the Koratholy tank therefore instead of Rupees 3-2-9 he could take paddy to the value of Rupees 12, and green gram to the value of Rupees 2, we have no reason to doubt therefore that a fair irrigation cess may, with a little trouble, be exacted from the ryots who live in Government villages Although the Zemindar's cherished Revenue custom of taking half the grain may appear excessive, rice lands most certainly can bear the impost, as rice is sown or planted throughout the district wherever there is a chance of its growing It may, however, well be that this high rent is one reason why the people are, and always have been, averse to other cultivation, dry grains are only grown as a second crop, and where the paddy fields terminate the jungle commences, so that without a plentiful rainfall scarcity must arise

22 With reference to the Acting Chief Engineer's 39th paragraph there is nothing on record showing reasons in favour of anicuts above junction of the two rivers at Aska beyond my report, surveys, and levels. The report written in 1858 by Lieutenant (now Colonel) Rundall, R E, is doubtlessly known to the Acting Chief Engineer. Colonel Rundall's canal from Aska to Gopaulpore would have been over 40 miles long and more expensive than mine, in proportion to the length there would have been a 30-feet cutting through the ridge between Kookoodakundy and Chetterpore, and the main object of going higher up the river for the anicut site is to obtain a command over the summit of that ridge for the purpose of irrigating the slopes on either side, Colonel Rundall's canal would only have irrigated the low-lying country adjacent to the Rooshkoolia which is already fairly irrigated, he estimated the return at only half a lac per annum, but the realization of even this amount appears to have been doubted by the Collector, his rough estimate for this canal would have been altogether insufficient, doubtless Colonel Rundall knew that, in the year 1858, a larger project than the one he proposed would not have been even considered by Government In forming the scheme, I have endeavoured to make the canal irrigate as large a tract of country as was practicable, rather than to obtain a maximum rate of dividend on a smaller expenditure, though, I do not think that any smaller work would prove more remunerative, in this view I was emboldened by being told by Colonel Anderson, R E, to make the project as comprehensive as possible

23 In looking over the country for reservoir sites, I have been influenced by the following principles or opinions, namely, (1) that stone dams may be safely constructed up to 200 feet in height or more, but their suitability is much diminished, if not altogether destroyed, by the absence of a rock foundation, (2) earthern dams can hardly be safely trusted when first made for a greater depth of water than 50 feet, which may, however, be gradually increased to 75 feet There seems to be a difference of opinion amongst European Engineers as to whether a homogeneous bund or one with a stratum of puddle is preferable, I incline to the former myself wherever constructed, but especially in this country, as puddling to be anything better than a snare and delusion requires more constant and trustworthy superintendence than in this country would probably be devoted to

a work for many consecutive months though, of course, with any earthern bund of considerable height a dyke of puddle would often be absolutely necessary to secure a water-tight foundation, the embankment should, I consider, be allowed at least two rainy seasons to settle before called upon to bear the full pressure of the water, this could not be obtained for the portion across the river bed which would be constructed the last, and with extraordinary care.

24 I have inspected nearly the entire basin of the Rooshkoolia up to the foot of the hills, and it is unlikely that a favourable site for a reservoir of any size can have escaped me I find that the best, and indeed the only, sites are situated in broad valleys, as we approach nearer to the foot of the ghauts the main stream branches into numerous tributaries whose beds have great inclination, the intervening country being elevated and broken.

25 Eight sites in all have been partly surveyed and contoured, though probably one or two reservoirs will suffice for our requirements My estimates are rough, but I think adequate, at any rate sufficiently accurate for the purpose of comparing probable cost of the reservoirs one with another To make more detailed estimates much more careful examination of the sites would be requisite, and I should wish to be informed, somewhat in detail, of the kind of works that are the most likely to meet the approbation of the advisers of Government.

26 I will here make a few remarks as to the probable value of stored water. If we take land entirely dependent on the reservoir and rain, and allow an extreme quantity of 1 5 yards per acre per hour, we should require 1,080 × 5 from June 1st to end of October = 5,400, say including wastage 6,000, and the charge for this would be Rupees 1, we should be nearer actual practice if we allowed 1 yard per acre and charged Rupees 3 water-rate, this would give about 4,000 for Rupees 3 I think we may safely reckon 5,000 cubic yards worth Rupees 3-8-0 so far as the first crop is concerned, for the second crop the waste would be more, the yield less, and perhaps we cannot safely expect more than Rupees 2 per 5,000 cubic yards During the irrigation of the first crop, we may probably be able to distribute from 1½ to twice the capacity of reservoir, and in good years the reservoir would be full at the end of October, and the water available for the second crop.

27 Reservoir No I —In the valley of the Godhallow, the best and almost the only site for a reservoir is in the neighbourhood of Coolada cross sections, and contours 50 feet above river bed have been taken, one at Coolada and the second 2½ miles below Coolada, the latter gives the cheapest storage I do not, therefore, send the survey, etc, of the first The drainage area is 450 square miles, if we allow as available for storage ¾ × 60 inches in rainy years and ¾ × 30 inches in dry years, we shall have a maximum of 1,742 million cubic yards and a minimum supply of 580 million cubic yards I am doubtful as to the maximum discharge of this river; this would, of course, have to be carefully ascertained with reference to length of calingulah; probably 6 million cubic yards per hour might have to be allowed for. The Survey (No I) shows a contour of 224 + M. S. L embracing an area of 5 4 square miles, but, as this is the supposed permanent level, we must allow for an additional rise of 3 feet on crest of waste weir, the total area submerged would be 6 square miles, of which about ½ is cultivated, the rest jungle. If we estimate the former at Rupees 50 per acre, and the latter at Rupees 5, the whole belonging to the Chinnah Kimedy Zemindar, the value of the land becomes Rupees 105,600, possibly more than this would have to be paid; on the other hand ¾ of the land would be available for second crop, cultivation in the bed of these large reservoirs not being disadvantageous The villages are constructed of movable materials, such as wood, grass, mats, and compensation for them may be set down at Rupees 20,000 The water available for cultivation between the 224 — 189 contours, (*i e*, 35 feet,) is 70 million cubic yards, and the total rough estimate is 4 lacs, if we raise the bund 10 feet, however, and so have available for irrigation the volume of water between contours 234 and 189, or maximum depth of 45 feet, the storage becomes 140 million cubic yards, and the cost 5 75 lacs, and, of course, if raised still higher the water becomes still cheaper. I believe that, if desired, a rock foundation might be secured for a masonry wall at the deepest part of the dam; this site upon the whole appears worthy of further investigation, as it would be convenient for the supply of water to Berhampore and neighbourhood

28 I was very anxious to obtain sites for reservoir on the Shargada and Janimilly nullahs, so as to store the whole of the flow of these troublesome streams, but after devoting much time to investigating and surveying through thick jungle these water courses, I was not able to find any site on the Janimilly nullah, nor is the one surveyed on the Shargada nullah worthy of further consideration.

29 Reservoir No II —The only suitable site on the Joronuddy is where it joins the Rooshkoolia immediately below Soorada, the drainage area is 232 square miles, maximum supply 900 million cubic yards, minimum 300 million cubic yards Area of reservoir up to 300 feet + M S L., *i e*, highest level of storage, 5 14 square miles, allowing 3 feet above this as head of discharge over waste weir, total land submerged 5 5 square miles, of which 2 5 may be cultivated, the rest jungle, the land is Government, and we may allow Rupees 30 per acre for cultivated, and nothing for waste land, the total of the rough estimate is Rupees 1 75 lacs, the contents of this reservoir between 300 and 270 contours is 70 million cubic yards, this level could not be raised without flooding the town of Soorada, and topping the water-shed between the Joronuddy and Rooshkoolia, it is doubtful whether the weir ought to be at one end of the embankment or placed in the above-mentioned water shed, the sluice of this and all the reservoirs would best be constructed in the hill side and not in the embankment As if this reservoir be not constructed a bridge must be built at the site selected for the dam, in a detailed estimate for the work, credit should be taken for the cost of a bridge, say 20,000 Rupees, the width of the embankment being 18 feet at top would give a good roadway

30 Reservoir No. III —The first reservoir site on the Rooshkoolia is at Boradapilly at the 11th milestone on the Aska and Soorada road, the Rooshkoolia down to this point has a drainage area of 825 square miles, maximum yearly discharge 3,000 million cubic yards, minimum discharge 1,000 million cubic yards. The contents of a reservoir between Contours 226 and 191, (*i e*, depth 35 feet) would be about 100 million cubic yards, and the cost Rupees 2 84 lacs, say 3 lacs, if raised 10 feet the contents would be about 170 million cubic yards, and cost Rupees 4 06 lacs, say 4 25 lacs, if raised yet another 10 feet so that permanent highest level would be 246 + M S L and greatest depth of water available for irrigation 55 feet, the contents of the reservoir available for irrigation would be over 240 million cubic yards, and cost Rupees 5 42 lacs, say 5 5 lacs In the first case the land submerged would be 5 75 square miles, in the second about 7 square miles, and in the third about 8 25 square miles, the land is partly Zemindari, but not very valuable, some miles of the Aska and Soorada road would be submerged and have to be re-made along the margin of the lake, the sluice would probably best be tunnelled out of the rock upon the left bank, there is great facility for the waste weir over a low rocky ridge at C on the right bank I am inclined to consider this the most favourable of all the sites surveyed I have sounded the bed of the river to a depth of 10 feet, but found neither rock nor hard soil; if a good foundation were procurable, a masonry dam, 75 feet height, might be the best construction

31 Reservoir No IV —The next site is at Bulligutch opposite 16th mile stone on Soorada and Aska road The drainage of Rooshkoolia down to this point may be put down at 800 square miles, maximum yearly discharge 3,000 million cubic yards, minimum discharge 1,000 million cubic yards The contents of the reservoir between contours 271 and 231, greatest depth of water available for irrigation being 40 feet is 50 million cubic yards, and cost Rupees 2 4 lacs, say 2 5 lacs, if raised 10 feet with highest permanent level of 281 + M S L, the contents would be nearly 90 million cubic yards, and cost, Rupees 3 54 lacs, say 3 5 lacs In the first case the land submerged would be 3 25 square miles, in the latter case about 4 square miles, of which half would be cultivated, by this reservoir would be destroyed some miles of the Aska and Soorada road; the waste weir would have to be constructed at one end of the dam.

32 At Soorada there is a site for a reservoir that might be made in conjunction with the one estimated for on the Joronuddy, but I should not recommend it I have not inspected the country higher up than Pippalapunka nor carefully quite so far, there is but little chance, however, of a site

for even a third-class reservoir higher up than Soorada, as beyond that town the country is broken into high ridges and the slope of the channel beds become excessive

33 I have inspected the Loharakundy between 6 and 7 miles above Russelcondah finding nothing approaching a favourable reservoir site. I had not time to penetrate and survey the dense jungle higher up, it is improbable that if I had any site even for a third-class reservoir would have been discovered

34. Reservoir No V.—About 3 miles from Russelcondah, a reservoir site has been surveyed situated at Bavancona on a tributary of the Loharakundy The drainage area is only 20 square miles of hill country, the maximum yearly discharge therefore 78 million cubic yards, minimum yearly discharge 26 million cubic yards The contents of the reservoir between contours 150 and 105 greatest depth, 45 feet is 60 million cubic yards, and allowing 3 feet on weir 4 square miles of land would be submerged, cost Rupees 2 55 lacs. It is evident that the above is too large a reservoir for the drainage area, if we reduce the level 10 feet the high level being 140 and greatest available depth 35 feet the cubical contents of the reservoir would be 30 million cubic yards Area about 3 5 square miles, and cost Rupees 1 66 lacs This reservoir might perhaps be made still smaller with more economical results, probably a depth of 30 feet would be the best, there would be about 2,500 acres of land irrigable by this reservoir in addition to the land under the proposed canal.

35 Reservoir No VI —On the Mahanuldy a reservoir site has been surveyed near Kollada, the valley has also been inspected 7 miles above Kollada in the direction of Gullery, but no site discovered, in the neighbourhood of Gullery possibly a site for a third class reservoir might be found, but further investigation in these jungles would apparently have been wasting time In the direction of Kookoolah a tolerable site appears near Nunbai, about 5 miles above Kollada, and another about 2 miles higher up, about ½ a mile above Dologa, both sites much inferior to the one surveyed near Kollada in all respects except the value of land that would be submerged, I did not advance so high up as Kookoolabah, as in that neighbourhood, on account of the small volume of the streams and great slope of their beds, only small reservoirs are possible The drainage area affording water for this reservoir is 305 square miles, maximum yearly discharge therefore about 1,200 million cubic yards, minimum discharge 400 million cubic yards If the contour (94) showed in the survey be taken as the highest level of water, and the level of the useful supply be 3 feet lower, the contents of this reservoir will be 110 million cubic yards, submerged area 8 square miles, and cost Rupees 5 6 lacs. If we consider 94 contour as level of available supply, and 97 contour highest discharge level, the useful contents of reservoir would be 135 million cubic yards, submerged area about 8 5 square miles, and cost Rupees 6 5 lacs, if we take 101 contour as the level of available water the useful contents of the reservoir becomes 210 million cubic yards, submerged area about 10 square miles, cost about Rupees 10 lacs Under this reservoir there would be 10,000 acres to be irrigated independent of the canal.

36. I have inspected the whole of the valley of the Belloogoonta or Olsa river, there is no good site for a reservoir, the best being about 3 miles below Juggernathprasad There is nothing but wet cultivation in this valley, nearly the whole of which is dependent on local rains, the ryots talk feelingly of the last famine, and appear to be quite aware that their existence is very precarious. If each village was provided with an agricultural well, as water is usually found near the surface, this would provide somewhat of a safe-guard against starvation, but there are no such wells in the district. Water for sugar-cane cultivation is obtained from small pits dug in the sandy bed of river and raised in a pot tied on to the end of a pole. There are no bullock picottas so common in some districts Now, although we should generally fail when attempting to introduce European agricultural machines into India, there appears to be no good reason why an attempt should not be made to introduce the excellencies of one district into another district, where they have hitherto not been used because unknown

37 It is likely that the sum set down for land in these estimates might be exceeded, but it must be remembered that not only can three-fourths of the bed of the reservoir be cultivated or held for pasturage, but that, by these proposed irrigation works, cultivation throughout the district

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will encroach on the jungle At present the inhabitants of the most advanced or out-lying villages die in famine years I have had my tent pitched on the site of a village abolished by the last famine, the inhabitants of five of the houses are reported to have died, the survivors of the sixth house removed for a living elsewhere I understand the Zemindar is going to re-establish this village, but the next famine will abolish it again.

38 I am inclined to consider that the reservoirs, the construction of which present the greatest advantages, are those of Boradapilly and Kollada I believe, however, the former might be capable of supplying all our wants, and that, if about 7 lacs be set down for reservoir, we should be justified in assuming that the 140,000 acres might easily, including the second crop, pay an average rental of Rupees 6, the estimate for the whole project becomes

		Lacs.
Weirs and channels	...	13 2
Reservoirs	...	6 8
	Total	20
Revenue of 140,000 acres	6 Rupees =	8,40,000
Deduct Present revenue	2,35,000	
Deduct Repair and management sundries	65,000	
		3,00,000
		5,40,000

eventual rate of interest on outlay 27 per cent

39 The survey and report on the still-water canal between Aska and Ganjam will be sent separately as altogether independent of the Irrigation Project

40 The survey of the southern portion of this district has been commenced with the view of irrigation from the Vumsadara and Chicacole rivers

Table showing the computed discharges of Rooskoolia and Mahanuddy rivers at Aska

Month and date.		Rooskoolia Discharge.	Mahanuddy Discharge.	Total	Remarks.
August 1868	15th	107,151	20,430	127,581	
	16th	107,151	79,920	187,071	
	17th	43,776	75,480	119,256	
	18th	43,776	70,400	114,176	
	19th	43,776	58,050	101,826	
	20th	43,776	28,050	71,826	
	21st	43,776	28,050	71,826	
	22nd	23,000	18,000	41,000	
	23rd	23,000	18,000	41,000	
	24th	20,000	18,000	38,000	
	25th	9,707	28,050	37,757	
	26th	9,707	28,050	37,757	
	27th	17,885	22,650	40,535	
	28th	38,570	4,675	43,245	
	29th	152,400	83,808	236,208	
	30th	1,437,051	192,249	1,629,300	
	31st	576,639	165,980	742,619	
September 1868	1st	191,754	102,080	293,834	
	2nd	149,265	87,740	237,005	
	3rd	128,000	86,268	214,268	
	4th	128,000	77,832	205,832	
	5th	111,771	68,256	180,027	
	6th	65,975	71,552	137,527	
	7th	65,975	66,900	132,875	
	8th	91,640	62,490	154,130	
	9th	512,528	47,640	560,168	
	10th	652,775	75,072	727,847	
	11th	230,640	105,896	336,536	
	12th	238,700	117,612	356,312	
	13th	205,143	112,840	317,983	
	14th	139,140	161,320	300,460	
	15th	179,064	207,328	386,392	
	16th	145,260	126,440	271,700	
	17th	334,960	90,272	425,232	
	18th	274,296	112,840	387,136	
	19th	180,000	126,440	306,440	
	20th	180,000	112,840	292,840	
	21st	216,030	75,118	291,148	
	22nd	184,600	81,880	266,480	
	23rd	125,680	126,440	252,120	
	24th	219,450	88,320	307,770	
	25th	128,000	92,004	220,004	
	26th	102,300	75,636	177,936	
	27th	256,990	143,260	400,250	
	28th	143,010	210,600	353,610	
	29th	333,375	210,600	543,975	
	30th	216,030	154,000	370,030	
October 1868.	1st	178,250	132,980	311,230	
	2nd	168,120	126,440	294,560	
	3rd	269,940	137,900	407,840	
	4th	244,860	313,760	558,620	
	5th	119,600	219,150	338,750	
	6th	124,200	156,420	280,620	
	7th	107,085	131,760	238,845	
	8th	93,960	131,760	225,720	
	9th	93,960	122,000	215,960	

Table showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Continued)

Month and date		Rooskoolia Discharge.	Mahanuddy Discharge	Total	Remarks.
October 1868	10th	73,000	91,430	164,430	
	11th	76,000	77,832	153,832	
	12th	57,200	75,480	132,680	
	13th	57,920	70,400	128,320	
	14th	79,875	65,700	145,575	
	15th	79,875	65,700	145,575	
	16th to 31st	. .	...	100,000 (about)	The sandy bed of the river altering it was impossible to calculate discharge correctly after October, 15th.
November 1868	6th	. ...	.. .	10,000	Accurately gauged, but at this period bunds had been thrown across all rivers in the district
	28th	..	.	2,000	Accurately gauged, bunds across all rivers above
Dec 1868	.	..	.	... . .	Very little.
Jan 1869	.	. ...	.. .	....	Do.
Feb 1869		. ..	... .	.. .	Do.
March 1869	From 1st to 15th	...	. .	. ... .	Do
	16th				
	17th				
	18th				
	19th			From 100,000 to 150,000	This fresh was measured.
	20th	. ...	..... .		
	21st				
	22nd				
	23rd				
	24th				
	25th to 31st	... ..	... . ..	... .	None.
April 1869	..	... . .	.....	... . .	None, except one small fresh
May 1869	..	... . .	. . ..	....	
June 1869	1st	... . .	....	... .	
	2nd	. ... ..	. ... .	. .. ..	
	3rd	. ... .	. . . .	. ... .	
	4th	. ...	. . ...	. ... ..	
	5th	. ..	...	....	
	6th	.	.. ..	.. .. .	
	7th	... . .	. . ...	....	
	8th	... .. .	...	....	
	9th	.....			

Table showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Continued)

Month and date		Rooskoolia Discharge	Mahanuddy Discharge	Total.	Remarks
June 1869	10th	.....	.	. ..	
	11th	...	. .. .	..	
	12th	.. .	. ..	. . .	
	13th	.. ...		.....	
	14th	. .	..	... ...	
	15th	...	. . .	. . .	
	16th	...	..		
	17th		. . ..	... .	
	18th	... .	... .	. . . .	
	19th	. . .	...	..	
	20th	. .	127,080	127,080	
	21st	.. .	159,225	159,225	
	22nd	. . . .	92,260	92,260	
	23rd	.	81,000	81,000	
	24th	55,500	73,500	129,000	
	25th	194,400	65,100	259,500	
	26th	102,000	65,100	167,100	
	27th	....	165,015	165,015	
	28th	. ...	81,550	81,550	
	29th	. .	65,100	65,100	
	30th	.. ..	56,052	56,052	
July 1869	1st	. . .. .	75,072	75,072	
	2nd	.	37,052	37,052	
	3rd	... ..	24,480	24,480	
	4th	. .	8,415	8,415	
	5th	.	3,920	3,920	
	6th	. ..	2,775	2,775	
	7th	..	2,220	2,220	
	8th	.. . .	15,300	15,300	
	9th	39,300	7,480	46,780	
	10th	155,115	26,376	181,491	
	11th	155,115	25,748	180,863	
	12th	151,470	222,000	373,470	
	13th	202,860	284,400	487,260	
	14th	145,800	214,600	360,400	
	15th	94,800	159,850	254,650	
	16th	68,200	147,200	215,400	
	17th	68,200	75,072	143,272	
	18th	59,940	72,800	132,740	
	19th	39,300	72,800	112,100	
	20th	24,565	77,280	101,840	
	21st	11,730	75,900	87,630	
	22nd	9,880	69,000	78,880	
	23rd	9,880	35,400	45,280	
	24th	10,480	24,480	34,960	
	25th	9,880	70,720	80,600	
	26th	7,140	665,660	672,800	
	27th	45,400	510,900	556,300	
	28th	45,400	330,720	376,120	
	29th	52,200	325,360	377,560	
	30th	248,080	341,320	589,400	
	31st	402,360	354,200	756,560	
August 1869	1st	421,290	993,010	1,414,300	
	2nd	358,680	671,960	1,030,640	
	3rd	539,720	649,060	1,188,780	
	4th	462,210	547,400	1,009,610	

Table showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Continued)

Month and date.		Rooskoolia Discharge	Mahanuddy Discharge	Total	Remarks
August 1869	5th	560,700	649,060	1,209,760	
	6th	389,760	313,760	703,520	
	7th	499,550	434,920	934,470	
	8th	443,750	1,692,000	2,135,750	
	9th	666,000	1,691,940	2,285,940	
	10th	816,270	1,417,640	2,233,910	
	11th	480,250	1,192,480	1,672,730	
	12th	833,000	487,014	1,320,014	
	13th	781,500	408,800	1,190,300	
	14th	611,250	348,740	989,990	
	15th	891,250	499,660	1,390,910	
	16th	966,000	481,400	1,447,400	
	17th	581,250	261,960	843,210	
	18th	358,680	267,120	625,800	
	19th	1,537,490	696,700	2,033,190	
	20th	1,750,320	1,481,920	3,232,240	
	21st	833,000	1,494 600	2,327,600	
	22nd	570,400	1,626,240	2,196,640	
	23rd	443,750	1,698,840	2,142,590	
	24th	462,000	1,682,560	2,114,560	
	25th	448,610	1,521,520	1,970,130	
	26th	208,600	1,163,880	1,372,480	
	27th	295,400	366,220	661,620	
	28th	579,000	1,626,900	2,205 900	
	29th	1,337,490	1,452,500	2,789,990	
	30th	2,138,940	805,200	2,944,140	
	31st	1,474,650	1,579,920	3,054,570	
September 1869	1st	550,310	1,100,000	1,650,310	
	2nd	2,675,610	5,500,000	8,175,610	
	3rd	1,310,260	5,500,000	6,810,260	
	4th	836,910	4,500,000	5,336,910	
	5th	104,160	1,650,880	1,755,040	
	6th	248,160	1,031,680	1,279,840	
	7th	559,650	511,000	1,070,650	
	8th	411,600	436,600	848,200	
	9th	445,470	458,500	903,970	
	10th	536,520	619,180	1,155,700	
	11th	438,960	458,500	897,460	
	12th	310,100	425,500	735,600	
	13th	605,850	334,960	940,810	
	14th	667,080	1,457,940	2,125,020	
	15th	406,800	1,125,720	1,532,520	
	16th	347,160	283,020	630,180	
	17th	305,900	283,020	588,920	
	18th	925,020	1,220,120	2,145,140	
	19th	410,200	768,600	1,178,800	
	20th	387,150	971,360	1,358,510	
	21st	836,910	1,504,160	2,341,070	
	22nd	1,513,800	1,239,000	2,752,800	
	23rd	720,000	817,000	1,537,000	
	24th	568,750	721,020	1,289 770	
	25th	576,500	625,820	1 202,120	
	26th	558,600	458,500	1,017,100	
	27th	481,490	313,760	795,250	
	28th	478,020	334,960	812,980	
	29th	339,900	277,300	617,200	
	30th	522,900	577,680	1,100,580	

Table showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Continued)

Month and date		Rooskoolia Discharge	Mahanuddy Discharge	Total	Remarks
October 1869	1st	374,640	298,920	673,560	
	2nd	441,750	453,260	895,010	
	3rd	1,022,900	1,078,520	2,101,420	
	4th	874,335	1,380,880	2,255,215	
	5th	579,000	1,297,200	1,876,200	
	6th	483,750	1,164,000	1,647,750	
	7th	2,334,950	1,339,200	3,674,150	
	8th	871,530	1,224,810	2,096,340	
	9th	716,100	1,177,500	1,893,600	
	10th	509,040	1,339,200	1,848,240	
	11th	429,000	1,421,460	1,850,460	
	12th	506,880	1,637,010	2,143,890	
	13th	392,110	949,980	1,342,090	
	14th	1,499,070	1,188,880	2,687,950	
	15th	836,350	1,260,540	2,096,890	
	16th	753,000	963,600	1,716,600	
	17th	677,120	622,050	1,299,170	
	18th	576,450	492,560	1,069,010	
	19th	757,900	775,200	1,533,100	
	20th	513,660	696,000	1,239,660	
	21st	486,675	589,300	1,075,975	
	22nd	445,470	391,140	836,610	
	23rd	393,240	321,180	714,420	
	24th	407,160	327,540	734,700	
	25th	704,375	313,760	1,018,135	
	26th	1,835,800	1,489,620	3,325,420	
	27th	1,865,950	1,489,620	3,355,570	
	28th	1,114,470	1,405,800	2,520,270	
	29th	633,490	1,349,250	1,982,740	
	30th	909,850	1,106,600	2,016,450	
	31st	839,110	527,220	1,366,630	
November 1869	1st	649,440	247,800	897,240	
	2nd	534,000	216,720	750,720	
	3rd	478,020	186,780	664,800	
	4th	388,440	132,000	520,440	
	5th	361,920	155,100	517,020	
	6th	286,760	127,370	414,130	
	7th	185,000	115,000	300,000	
	8th	113,470	64,800	178,270	
	9th	163,350	87,360	250,710	
	10th	163,350	87,360	250,710	
	11th	140,800	64,170	204,970	
	12th	140,800	64,170	204,970	
	13th	115,150	64,170	179,320	Rooskoolia Area 44 yards 3,000 yards V S 132,000 yards D Mahanuddy Area 27 yards 2,000 yards V S 54,000 yards D Total discharge 186,000. Observed on the 15th.
	14th	115,150	64,170	179,320	
	15th	115,150	53,820	168,970	
	16th	115,150	44,620	159,770	
	17th	90,900	44,620	135,520	
	18th	90,900	44,620	135,520	
	19th	75,140	36,000	111,140	
	20th	75,140	36,000	111,140	
	21st	57,750	30,600	88,350	
	22nd	39,200	25,200	74,400	
	23rd	39,200	25,200	74,400	
	24th	39,200	21,195	60,395	
	25th	39,200	21,195	60,395	
	26th	40,160	21,195	61,355	

Table showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Continued)

Month and date		Rooskoolia Discharge.	Mahanuddy Discharge	Total	Remarks
November 1869	27th	40,160	16,675	56,835	
	28th	40,160	16,675	56,835	
	29th	40,160	16,675	56,835	
	30th	40,160	16,675	56,835	
December 1869	1st	Area 9 72 yards 2,000 yards V. 19,440 yards D.	Area 9 yards 2,400 yards V. 21,600 yards D	41,040	Observed on the 1st
	2nd				
	3rd				
	4th				
	5th				
	6th				
	7th				
	8th				
	9th				
	10th				
	11th				
	12th				
	13th				
	14th				
	15th		Area 2 6 yards 1,500 yards V 3,900 yards D	19,308	Observed on the 16th.
	16th	Area 9 yards. 1,712 yards V. 15,408 yards D.			
	17th				
	18th				
	19th				
	20th				
	21st				
	22nd				
	23rd				
	24th				
	25th				
	26th				
	27th				
	28th				
	29th				
	30th				
	31st				
January 1870	1st				
	2nd				
	3rd				
	4th				
	5th				
	6th				
	7th		Area 1·5 yards 1,500 yards V 2,250 yards D	8,850	Observed on the 9th.
	8th	Area 3 3 yards 2,000 yards V. 6,600 yards D			
	9th				
	10th				Very little
	11th				
	12th				
	13th				
	14th				
	15th				
	16th				
	17th				
	18th				
	19th				
	20th				
	21st				

ble showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Continued.

Month and date		Rooskoolia Discharge	Mahanuddy Discharge.	Total	Remarks
January 1870.	22nd				Very little
	23rd				
	24th				
	25th				
	26th				
	27th				
	28th				
	29th				
	30th				
	31st				
February 1870	1st				No running stream
	2nd				
	3rd				
	4th				
	5th				
	6th				
	7th				
	8th				
	9th				
	10th				
	11th				
	12th				
	13th				
	14th				
	15th				
	16th				
	17th				
	18th				
	19th				
	20th				
	21st				
	22nd				
	23rd				
	24th				
	25th				
	26th				
	27th				
	28th				
March 1870.	1st				No running stream.
	2nd				
	3rd				
	4th				
	5th				
	6th				
	7th				
	8th				
	9th				
	10th				
	11th				
	12th				
	13th				
	14th				
	15th				
	16th				
	17th				
	18th				

Proceedings of the Madras Government, Public Works Department,
27th October 1870.

Table showing the computed discharges of Rooskoolia and Mahanuddy, etc —(Concluded)

Month and Date		Rooskoolia Discharge	Mahanuddy Discharge	Total	Remarks
March 1870	19th				No running stream.
	20th				
	21st				
	22nd				
	23rd				
	24th				
	25th				Flood in Rooskoolia, about an average of 100,000 yards per hour for four days
	26th				
	27th				
	28th				
	29th				
	30th				
	31st				

CHETTEPORE,
21st May 1870.

(Signed) T BECKLEY, Captain, R E,
Executive Engineer on Special duty, Ganjam

Table of Reservoirs surveyed in the Ganjam District

No	Names	Contents in cubic yards	Water available for irrigation, first crop, in cubic yards	Value at Rupees 3-8-0 per 5,000 cubic yards	Estimate cost of Rupees	Interest by first crop	Water in good year available for second crop	Value at Rupees 2 per 5,000 cubic yards	Interest from first and second crops
		M C YDS	M C YDS	RS	LACS		M C YDS	RS.	
I	*Jellamarah*	70	110	77,000	4	19 2	70	28,000	26 2
(1)	Between contours 224 and 189 ..	140	210	147,000	5 75	25 5	140	56,000	35 3
(2)	Do do 234 and 189 .								
II.	*Soorada*	70	100	70,000	1 75	40	70	28,000	56
	Between contours 300 and 270 ...								
III.	*Boradapilly*	100	200	140,000	3	46 6	100	40,000	60
(1)	Between contours 226 and 191...	170	340	238,000	4 25	56	170	68,000	72
(2)	Do. do 236 and 191 .	240	480	336,000	5 5	61	240	96,000	78 5
(3)	Do do 246 and 191 ..								
IV	*Bulligutch*	50	100	70,000	2 5	28	50	20,000	36
(1)	Between contours 271 and 231 .	90	180	126,000	3 5	35 4	90	36,000	45 6
(2)	Do do 281 and 231 .								
V.	*Bavancona*	60	50	35,000	2-55	13 7	20	8,000	16 8
(1.)	Between contours 150 and 105 .	30	40	28,000	1 66	16 8	20	8,000	21 6
(2)	Do do 140 and 105 ..								
VI	*Coolada*	110	165	115,500	5 6	20 6	110	44,000	28 4
(1)	Between contours 91 and 54 ..	135	200	140,000	6 5	21 5	135	54,000	29 8
(2)	Do. do 94 and 54 ..	210	300	210,000	10	21	210	84,0 0	29 4
(3)	Do do 101 and 54 ..								

N B—M stands for Million.

CHETTERPORE,

(Signed) T BECKLEY, Captain, R E,

From the Acting Collector to the Executive Engineer on special duty, Aska, dated Chetterpore, 17th February 1870, No. 157.

In reply to your letter of the 10th instant, No. 294, I have the honour to inform you that not only will the compilation of the information asked for by Major Mullins take up considerable time, but it will entail an immense labour on the Talook and Village officials, who are at present engaged in the preparation of accounts connected with Jummahbundy I would, therefore, suggest the advisability of confining the information to the area actually cultivated, and the collections and remissions during the last three years It will, I think, be sufficient if the ayacut be shown only for the last year The Zamindars, whose villages are situated within the dotted lines shown in the sketch received with the letter under reply, will, I am certain, not be willing to render us the required assistance, should they, however, profess their readiness to do so, they have not the means of supplying reliable information

2. The same may be said of the Mohery Khandum of the Berhampore Talook, which was never measured.

3 Moreover, in the sketch above referred to, all the villages that may be commanded by the canal are not shown. To find them out will be also a matter of some difficulty.

Rain Register of the under-mentioned Stations for the year 1869.

Months		Ganjam.	Chetterpore.	Munsoorcotta	Berhampore	Russelcondah	Russelcondah by Mr. Lever	Aska	Total.	Average.
1		2	3	4	5	6	7	8	9	10
Jan	1869 .	1 70	3 65	68	25	05	15	145	.345	049
Feb	,, ...	90	1 37	1 67	1 10	2 27	6 20	54	6 99	·998
March	,, ..	1 30	0 15	0 50	·30	0 49	·80	1 665	15 175	2 167
April	,, ..	30	96	1 38	·15	09	·57	·225	3 765	·537
May	,, ...	4 35	4 85	5 90	5 40	6 20	5 80	·915	4·365	623
June	,, .	7 10	5 75	6 10	9 70	8 10	8 22	3 910	36 41	5 201
July	,, ..	3 17	3 98	10 82	9 40	14 1	14 225	10 98	55 95	7 992
Aug.	,, .	10 60	11 85	9 89	8 10	14 46	13 65	14 925	70 62	10 088
Sept	,,	7 90	11 82	12 53	15 10	8 18	9 2	7 35	75 90	10 842
Oct	,,	.		·12	·20	.	...	7 5	72 23	10 318
Nov.	,, .			40	..		..	...	32	·045
Dec	,, .							...	.40	057
		37 32	43 78	49 99	49 70	53 94	59 585	48·155	342 47	48 924

CHETTERPORE,
21*st May* 1870.

(Signed) T. BECKLEY, Captain, R E,
Executive Engr on Special Duty, Ganjam

No 378. *Note by the Acting Chief Engineer for Irrigation.*

Since the Order of Government of the 8th February last, No. 441, was passed on the Rooshkoolia project, the Superintending Engineer has submitted a further report by Captain Beckley, containing some additional information, as also the results of his examination of the country in search of reservoir sites.

2. The project is not yet sufficiently matured to admit of its submission to Government, but it will be convenient to review the information which has been

collected by Captain Beckley, and to show, as far as may be, the probable value of the project, and what is still necessary to enable Government to decide whether it should be submitted to the Government of India for sanction.

3. I propose, therefore, to consider here the features presented by the project as regards—

First.—The water-supply and the arrangements proper in connection therewith.

Secondly —Such details of the project as appear to require notice.

Thirdly.—The probable cost of the works and the returns to be expected from the scheme.

4. The data for estimating the water-supply available are still very imperfect, and as yet the information given regarding the position and circumstances of the area to be irrigated is insufficient to enable a clear idea of the best way of dealing with the supply to be formed. A part of the supply is to be drawn from the Mahanuddy, and, of the discharge of the Mahanuddy canal, a portion will no doubt be utilized in the irrigation of the Doab, and the rest will be carried on to the Rooshkoolia and then taken into the canal from this latter river.

Water-supply.

Captain Beckley's report of the 11th September 1869, paragraph 37, gives 5,000 acres as the area in the Doab, but it is not clear upon what data this conclusion is based.

5. In paragraph 3 of the memorandum printed in the order of Government quoted at the beginning of this note, it was mentioned that the highest duty which should be assigned to a cubic foot of water per second should be the irrigation of 100 acres. This duty is 50 per cent. higher than that allowed in districts to the south of Ganjam. Captain Beckley appears to think that the quantity of water named is capable in Ganjam of irrigating a larger area. He alludes to the great difference between the climate of Ganjam and that of the Southern Districts, and mentions that, whereas in the latter rice cultivation without artificial irrigation is impracticable, in the former it has been so carried on from time immemorial. It must be remembered that the chief value of the scheme will be in securing fair average crops in adverse seasons, when consequently the ordinary existing sources of water-supply would either fail altogether or be greatly diminished, and when, therefore, nearly the whole area under the canals would be entirely dependent upon the additional or new supply, which it is proposed to provide. The rain-fall register, submitted with Captain Beckley's letter, gives an average of 48 92 inches for 1869 at the six stations at which the rain-fall has been recorded, and the average would not be materially altered by taking those stations* only which this officer considers to fairly represent the tract of country to be irrigated. June to October are the monsoon months, and they correspond with the season for cultivation The rain-fall differs but little in quantity from that of Madras, and in the absence of any direct evidence as to the supply of water

Letter No. 38, paragraphs 3 and 4.

* Chetterpore ..	..	..	..	43 78
Berhampore ...	..	..	.	49 70
Aska	.	...		48 15
				141 63
				47 21

required to bring rice crops to maturity in Ganjam, it would not, I think, be prudent to calculate upon a higher duty than 50 per cent in excess of the irrigating power of a cubic foot a second in other districts. Taking, then, 100 acres to the cubic foot per second, the area intended to be watered being 140,000 acres, the average supply must be 1,400 cubic feet a second. Elsewhere it has been considered necessary that variations in the supply should be compensated for within periods of ten days each, but here it will probably suffice if the whole total supply required be made available within fifteen day periods, or in other words, if the short supply of some of the fifteen days be made up by a corresponding excess during the remainder of the period.

6 In order that it may clearly be understood what the rivers can do, and how far they must be supplemented by storage reservoirs, it will be advisable to prepare statements showing for the Mahanuddy canal in—

Column 1, The dates of the several fifteen day periods
" 2, The supply required for cultivation in each period.
" 3, The quantity available in the river within the maximum capacity of the canal
" 4, The quantity deficient in canal and to be provided for by storage.
" 5, The quantity surplus in the canal and available for the Rooshkoolia canal
" 6, The quantity surplus in the river and available for storage.

Similarly for the Rooshkoolia canal should be shown in—

Column 1, 2, 3, } As for Mahanuddy canal.
" 4, Quantity available from Mahanuddy canal
" 5, Total available within maximum capacity of the canal.
" 6, Quantity deficient in canal to be provided for by storage
" 7, Quantity surplus in river and available for storage.
" 8, Quantity (if any) which must be stored in rivers not falling into the Rooshkoolia above the anicut.

A maximum discharge has been spoken of for these canals, and this maximum may be taken at 50 per cent in excess of the ordinary full supply, or, for the—

Mahanuddy canal $450 + 225 = 675$ cubic feet a second.
Rooshkoolia canal $950 + 475 = 1{,}425$ " "

The proportions may require modification with reference to the areas under the two canals respectively, and the above supposes that $\frac{2}{3}$ths of the whole area will be irrigated from the smaller canal or in the Doab, and $\frac{1}{3}$ths from the larger canal. If nearly the whole of the cultivation be under the Rooshkoolia canal its ordinary capacity should be $\frac{\text{acreage}}{100} =$ cubic feet per second, and its maximum capacity 50 per cent additional.

7. The tables of computed discharges of the rivers will enable a rough approximation to be made of the irrigating power of the rivers, and of the extent to which their supply must be economized or supplemented by reservoirs; they commence with August 1868. The season will here be taken as extending from

the 16th June to the end of November, and it may be supposed that for the first fifteen days, and for the last thirty days, of the season, half a full supply will suffice, for the seed-beds in the former period, and for the smaller area requiring water in the latter. Then the total supply to be provided per acre will be—

16th to 30th June	15 × 24 × $\frac{3}{4}$	= 240
July ..	31 × 24 × $1\frac{1}{3}$	= 992
August	31 × 24 × $1\frac{1}{3}$	= 992
September	30 × 24 × $1\frac{1}{4}$	= 960
October ..	31 × 24 × $1\frac{1}{3}$	= 992
November ..	30 × 24 × $\frac{2}{3}$	= 480
	Total cubic yards	4,656

against 6,000 cubic yards, the ordinary allowance for the first crop in other districts The total supply required in each month for the whole area, and the quantity available, are shown below, as also the surplus in the rivers in excess of the maximum of 2,100 cubic feet a second, or 280,000 cubic yards an hour, which the canals have been supposed to be capable of carrying, namely, 90,000 for the Mahanuddy and 190,000 for the Rooshkoolia canal, the figures denote millions of cubic yards and decimal parts of a million —

Periods	Quantity required for Irrigation	Available within capacity of canals		Total available	Deficiency to be provided for by storage	Surplus available for storage		Total surplus
		Mahanuddy	Rooshkoolia			Mahanuddy	Rooshkoolia	
Latter half of June	33 60	20 325	8 340	28 665	4 93	4 405	0 105	4 51
July	138 88	43 015	42 571	85 586	53 30	61 589	6 799	68 38
August	138 88	44 640	94 240	138 880	.	678 530	447 450	1125 98
September	134 40	43 200	91 200	134 400	..	808 930	366 710	1175 64
October	138 88	44 640	94 240	138 880	.. .	677 083	501 330	1178 41
November	67 20	21 600	45 600	67 200		29 949	69 920	99 87
Totals .	651 84	217 420	376 191	593 611	58 23	2260 486	1392 314	3652 79

The above is for the year 1869 and, from August to the end of the season, the rivers, with the exception of one day in September, were discharging more water than the canals would require, and therefore the ordinary full supply* only has been taken, and the balance entered as available for storage. Similar particulars for the part of the season of 1868, for which records were kept, are given below .—

* 1 Cubic foot per second per 100 acres

Periods	Quantity required for Irrigation.	Available within capacity of canals		Total available	Deficiency to be provided for by storage	Surplus available for storage		Total surplus.
		Mahanuddy.	Rooshkoolia			Mahanuddy	Rooshkoolia	
17 days in August .	76 16	18 278	26 578	44 856	31 31	4 277	39 208	43 48
September ..	134 40	43 200	91 200	134 400	...	35 459	55 928	91 38
October .	138 88	30 122	40 537	109 059	29 82	15 926	3 235	19 16
		38 400	}					
November ...	67 20	4 320		4 320	62 88	..	..	..
Totals	416 64		...	292 635	124 01	55 662	98 371	154 02

Captain Beckley, in paragraph 30 of his letter, states the drainage basin of the Rooshkoolia, a little above the anicut site, to be 825 square miles, and that of the Mahanuddy may be estimated from paragraphs 34 and 35 to be about 450 square miles Rivers of this class are dependent upon what may be termed local rain-fall ; considerable freshes are of short duration, and the quantities discharged vary greatly from day to day On the whole, however, the above particulars give a fairly favourable view of the rivers, and probably in the hill country, in which they take their rise, the rains are less liable to total or nearly entire failure than in the plains in which it is proposed to turn their waters to some account It is not practicable on the data available to form a reliable opinion as to the amount of storage which would be likely to suffice to render the cultivation secure, but it is probable that, when returns for a series of years are forthcoming, it will be found that if reservoirs capable of holding one-third of the total quantity required, or, say, 250 millions of cubic yards, be provided, the supply in the canals will be capable of being maintained throughout the season, even in years which are much less favourable than the average, while in good years one-third of this quantity would perhaps be sufficient.

8. Under these circumstances it appears to me that a tentative arrangement will be the best The development of irrigation will be the work of some years, and it would not, therefore, be economical to provide storage for the whole ultimate area at once. I would therefore propose that, in the first instance, one or two reservoirs of moderate dimensions be constructed, and it will be preferable to select sites for these rather on considerable tributaries of, than on, the principal rivers It must be remembered that 100 millions of stored water must be taken as the equivalent of 75 millions drawn direct from the river, in order to allow for evaporation and wastage en route to the canals On the other hand, if the drainage basin be large in proportion to the quantity to be stored, it may be assumed that the tank will be re-filled after a portion of its contents has been drawn off, and perhaps therefore the practical capacity of such a reservoir may be without risk assumed at one and a half times its nominal contents. The Soorada site on the Joronuddy, a tributary of the Rooshkoolia, and falling into the latter river about 12½ miles above the proposed anicut, appears to me very suitable, as far as the information at present available will enable a judgment to be arrived at, for affording a moderate supplemental supply to the scheme of irrigation. The site is described in paragraph 29 of Captain Beckley's report, and the particulars may be thus summarized .—

Area of catchment basin	†232 square miles.
Depth of water proposed	30 feet
Area of water spread ...	5·14 square miles.
Maximum area liable to submergence with 3 feet on waste weir	5 50 do.
Capacity .	70 millions cubic yards.
Estimated cost	1,75,000 Rupees.

† I make the area a little over 250 square miles

The storage here then would be at the rate of 400 cubic yards for the rupee if once

filled each season, and 600 cubic yards if an additional half-supply were received and utilized. The Joronuddy rises in the hills S. S. W. of Soorada, and, according to the atlas sheet, its head waters are at a distance of 22 miles from its junction with the Rooshkoolia, the reservoir site being but little above that junction. In moderately good seasons the supply of the tank might be expected to amount to 8 inches draining off the whole area, or about one-sixth of the rain-fall, and this would amount to 172 millions of cubic yards, of which it has been assumed that 70+35 = 105 millions would be stored and used In bad seasons probably the tank would be just filled. The maximum discharge to be provided for at the waste weir of the reservoir would perhaps be six inches of drainage from the whole catchment basin, less half the capacity of the reservoir, in the 24 hours, and if so, the length of the waste weir, with 3 feet going over, would require to be 1,680 feet. The actual maximum discharge should be ascertained from flood marks, or information obtained from villagers, coupled with longitudinal and transverse sections of the river. Captain Beckley allows 10,000 Rupees for the waste weir, which does not seem likely to be enough, unless a very favourable site be discoverable, and the sluice will perhaps cost 10,000 instead of 5,000 Rupees, as it must be capable of passing a large body of water, and will require to be provided with small openings for use when the tank is full, and with large vents for passing the required discharge with a small head. The detailed plans show that the length of the bund at top would be 3,675 feet, the level of the top 313 against 300 for full tank, and 303 for maximum water level. I think that the maximum level might be taken at 305, and that 5 feet of water might be allowed to pass over the waste weir during the few hours that extreme floods would last, and the length of the weir would then be reduced to less than one-half that required with a depth of 3 feet. Captain Beckley should, however, use his discretion, with reference to the circumstances of the site and of the materials available, in determining the maximum depth to be allowed on the crest of the weir. On cross Section No 3 of the bund, Captain Beckley has shown the arrangement of puddle core estimated for by him. In any case the puddle wall should be carried up a few feet above maximum water level, and I have shown in red pencil two arrangements, either of which may be adopted. In the one case the wall occupies the centre of the bund, its top is 3 feet broad and 3 feet above maximum water level, and each face has a batter of 1 in 6. In the other case the bottom and top thicknesses are similar, and the upper surface is placed parallel to, and 6 feet below, the interior slope of the bund, so as to have that thickness of soil between the revetment and the puddle. The revetment should be bedded against a layer, about foot thick, of clayey gravel, ordinary laterite gravel is a good material.

D = 29,335 cubic feet per second = 3·92 millions of cubic yards an hour
The formula D = 75,000 $M^{\frac{1}{2}}$ gives 2·976 millions of cubic yards an hour.

Say, 750 cubic feet a second

The datum used is mean sea level.

about In the case of this reservoir the capacity is 1 million of cubic yards for basin, every 3¼ square miles, or every 11 millions of square yards of catchment assume so that a drainage of 3⅓ inches will be needed to fill it. It may be d, I think, that this reservoir may be constructed in a thoroughly efficient

manner within two lacs of rupees, and the moderate depth is an advantage, inasmuch as it lessens the risk of failure.

9. I do not contemplate the early construction of another reservoir, but it may be necessary hereafter to provide one for the cultivation under the Mahanuddy canal, and it may be useful, therefore, to make a few remarks on the two sites, Nos. 5 and 6, which have been surveyed, and which, of the six, would alone serve for this cultivation. No. 5, or the Bavancona site, is, whether the higher or lower contour be taken, expensive in proportion to the capacity; in the one case the storage would be at the rate of 235 cubic yards, and in the other 181 cubic yards per rupee. The catchment basin, 20 square miles, also is very small, and only in extremely favourable seasons would the tank fill if made of the larger capacity, seeing that 1 million of cubic yards would have to be obtained from every one-third of a square mile, or every 1·03 million square yards of catchment basin or, in other words, 36 inches of drainage would be needed, while on the other hand, the smaller tank could not be expected to fill every year. This site may therefore, I think, be rejected as unsuitable.

10. Site No. 6 at Koolada, on the Mahanuddy, has been examined for three different capacities, namely:—

For a depth of 27 feet with a capacity of 110 millions cubic yards.
" 30 " " " 135 " "
" 37 " " " 210 " "

In the first the storage would be at the rate of 196 cubic yards per rupee; in the second cubic yards 208; and in the third, or largest, cubic yards 210 per rupee. The catchment basin is reported to be 305 square miles, so that for the smallest reservoir 1 million cubic yards would have to be obtained from every 2·77 square miles, or 8·58 millions square yards of catchment basin, equivalent to a drainage of about 4¼ inches, for the intermediate size, 1 million cubic yards would be derivable from every 2·26 square miles, or 7 millions of square yards of catchment basin, equivalent to a drainage of 5½ inches; while for the largest capacity 1·45 square miles, or 4½ millions square yards, would have to yield a million cubic yards, and the equivalent drainage would be 8 inches. The high cost of storage at this site is due to the length of the bund, which is at top 8,050 feet for the lowest capacity, and to the low level of the ground between the hills. In the estimate Rupees 20,000 are allowed for a waste weir, but nothing is said in the report (paragraphs 35 and 36) regarding a suitable site being available. On the whole I do not think that it will be economically practicable to construct a reservoir in this locality, because the storage would not be cheap, the smallest capacity estimated for is probably larger than will be required for the Mahanuddy canal cultivation, while a smaller capacity would be likely to be proportionately more expensive, and would absorb too small a portion of the average drainage. Captain Beckley does not speak favourably of the country through which the Mahanuddy and its tributaries flow, but it may yet be possible to discover a site for a reservoir capable of containing 40 or 50 millions of cubic yards, with a catchment basin above of from 120 to 160 square miles, and giving a storage rate of from 250 to 300 cubic yards the rupee.

11. Though not immediately required, it may be well to consider whether reservoir site No. 1, on the Godahallow, is likely to prove a good position for future storage requirements. Any supply stored here would be additional to that derived from the rivers whence the canals are intended to take off, and this would be some advantage. I have not been able to lay down the position very accurately on the atlas sheet, for Captain Beckley (paragraph 27) speaks of Jellamurra being about 2½ miles below Colady, whereas, on the printed map, the former village is about 2 miles above the latter However the bund site would appear to be near the village called Ambagom on the atlas sheet. Captain Beckley estimates the area of the catchment basin at 450 square miles, but I think this is a mistake, and that 240 miles approximate to the actual area The drainage basin is fairly well situated among the hills, though it is perhaps hardly as well circumstanced as that of the Joronuddy for the Soorada site. Perhaps a capacity of 90 millions would be the largest which it would be advisable to give with reference to the area of the catchment basin The site has been surveyed for two capacities—

First.—With a depth of 35 feet and capacity of 70 millions cubic yards.

Second.— ,, ,, 45 ,, ,, 140 ,, ,,

In the first case the storage would, according to the approximate estimate, be at the rate of 175 cubic yards the rupee, and in the second at 243 cubic yards a rupee. Neither of these is particularly favourable, but the latter would do very well were the drainage basin as large as Captain Beckley has supposed it to be. Perhaps with a capacity of 90 millions the storage rate would be 200 cubic yards a rupee, and supposing the quantity of water utilized to be only 90 millions annually, instead of probably 135 millions, the net quantity distributed would be 67½* millions, and at 4,656 cubic yards per acre this would suffice for 14,500 acres. The cost of the reservoir would be about 4½ lacs, so that the storage per acre would cost 31⅛ Rupees, which is not unreasonable. I would recommend, therefore, that this site be worked out in detail for a water-level at about 229, if efficient arrangements for a waste weir at that level can be made. It may be remarked that in this, and all cases, the possibility of making due provision at a reasonable cost for the discharge of surplus water must govern, to a great extent, the selection of sites, and determine the exact level of the water surface.

* 100 millions stored = 75 millions direct irrigation

12. The plans and estimates of the canal works have not been submitted in a revised form with reference to my memorandum of the 20th December last, No 320, but most of the points noticed are referred to in Captain Beckley's letter. It was pointed out that apparently it would be necessary, in order to keep the cost of the project within moderate limits, to give up the idea of making the canal one of navigation as well as irrigation. Captain Beckley (paragraph 6) strongly recommends that, even if locks be not given in the first instance, the canal may be so designed as to admit of its being hereafter adapted to navigation At the

Details of the project

end of paragraph 7 he mentions that at least down to Shargada, a distance apparently of 12 miles, it would not be economical to increase the fall from 6 to 8 inches a mile. Not having the longitudinal and cross sections of the canal I cannot examine into this in detail, but it is a matter which could easily be worked out, and of course the result of allowing the maximum fall which the soil is adapted to admit of, must be considered for the whole length of the canal, and not only for that part above the cutting On side-long ground a higher velocity would reduce the cost of carrying any given quantity of water There can be no doubt, however, of the benefit to the community which facilities for navigation would confer, and, if the additional cost of making the canal navigable will not reduce the gross returns per cent below 10, it would be advisable to provide for navigation, and probably, if this be done, the ryots would be able to pay an additional water-rate of 8 Annas an acre, which would be a light tax for enabling produce to be carried to market at a cost which, compared with land carriage, would be almost nominal. Second-class locks would, with the weirs connected with them, cost about 2,500 Rupees a foot of lift. The canal at its head will be about 169 feet above mean sea level, and its length will be between 67 and 68 miles, so the fall, to 4½ feet below mean sea level to be disposed of by locks would be 140 feet, and the cost 3½ lacs. Four annas an acre on 140,000 acres would yield 10 per cent. on that sum, so that there would be little doubt of 8 Annas an acre covering all expenses connected with navigation.

13. Captain Beckley's explanations regarding the site selected for the Rooshkoolia anicut show it to be unobjectionable, and apparently superior to either of the sites lower down which were suggested by me. The roadway of the head-sluice should not be less than 4 feet above the maximum ascertained flood-level The sill of this work should be placed at such a level as will, when the water in the river is flush with the crest of the anicut, give, with the canal running full, the head required to generate the velocity needed to discharge a full supply Velocity of approach in the river should be disregarded, it is a variable quantity, and, with the under-sluices open, it often is, in the direction of the head-sluices, inappreciable, while with the supply in the river just equal to the draught of the canal it may be inconsiderable The remarks in paragraph 9 of this Office Memorandum, No 320, on some of the details of the anicut, should be attended to in framing the estimates. The exact arrangement of groynes will have to be determined as the works progress, but groynes will be necessary, particularly close to the under-sluices, and provision should be made for them, as also for a bank of quarry rubbish between the groynes, and for similar material under the anicut apron

Paragraph 8.

14. With regard to the dimensions to be given to the piers of under-sluices, bridges, aqueducts, and similar works, Captain Beckley is quite right in considering that cut-stone piers, where the material is much harder and heavier than the sand-stone of the Godavery Delta works, need not be of the thickness usually allowed for less dense stone. This officer has not, however, stated what the stone to be used is, and, unless he has experimented upon it, it will not be prudent to

run the risk of failure by reducing the dimensions too much. Under any circumstances, $2\frac{1}{4}$ feet piers for 30 feet arches, as in the design for the Godahallow aqueduct, would seem to be out of proportion, and could not be approved without a full demonstration of their sufficiency. It is very essential that piers should (paragraph 11) afford a full bearing to the arches they support, but this is not all that is required of them, and they should be amply strong enough to sustain the weight they are to carry, to resist the pressure of water increased by accumulation of drift, and the blows of trees coming down the rivers, etc. I think that it will not be advisable to provide cut-stone in work for which rubble masonry is a suitable material, and particularly so where the stone is hard and therefore, it may be supposed, not easily worked. It is not easy to estimate the cost of cut-stone work or the time required for its execution, unless considerable experience on large works with the stone to be used is available. Captain Beckley should consider, therefore, this point, and take care to keep work of this description within perfectly safe limits.

15. With regard to the contraction of water-way at aqueducts, with a view to diminish cost (paragraph 10), the instructions contained in this Office Circular, No. 14 of the 28th May 1869, are as applicable to aqueducts carrying navigable canals, as to bridges over such works.

16. The scale of maximum discharges for minor channels, given in paragraph 27 of my memorandum No. 320, is applicable to districts where 2 cubic yards per

Captain Beckley's paragraph 18

acre per hour is the average consumption. In Ganjam two-thirds of those quantities may suffice. The object of the arrangement has been explained in Circular Memorandum No. 27 of May 1870 Of course if all the minor channels were carrying on the average a much larger quantity per acre than the main canal, the lower cultivation would get none; the average is intended to be equal, but the actual supply of small areas at different times does not approximate to the average, but varies between wide limits, one of which is, no water at all, and the other many times the average consumption.

17. Captain Beckley, at the end of paragraph 16, supposes that were the depth of the water-cushion of the Mahanuddy anicut doubled, the cushion-wall would be only 1 foot lower than the main wall of the dam. He has forgotten that the floor of the cushion might be lowered instead of raising the cushion-wall. As before

No 320, paragraph 34

pointed out, the cushion may be omitted altogether if a suitable apron be provided.

18. Regarding the maximum depth of water to be allowed in reservoirs with earthen bunds and other details of works of this class, I may mention that, so far, it does not seem probable that sites for

Paragraphs 23, 24, and 25 of Captain Beckley's Report.

very deep reservoirs will be available; if sites for reservoirs of moderate depth, *i e*, under 50 feet deep, and allowing of water being stored at a cost not exceeding one rupee for 200 cubic yards can be found, it will be better to make use of such sites rather than to construct deeper tanks even at a somewhat less cost. On the other hand, facilities for disposing of surplus water, the occupation of waste instead

Proceedings of the Madras Government, Public Works Department, 27th October 1870.

of cultivated lands, and possibly the opportunity of using water-power for the excavation and deposition of soil, might make it advisable to prefer deep to comparatively shallow reservoirs Sixty feet depth of water should be considered a maximum where the earthen bund would have to be constructed by manual labour, and it is perhaps not probable that the dam requisite for this depth could be carried out unless facilities existed for passing freshes under the embankment, or under the hills on the flanks, during the time of construction If the whole or a considerable part of the dam were capable of formation by the silting process, the case would be different, and a depth of 100 feet of water might be retained without any serious risk of failure. Captain Beckley will be furnished with such information as is available regarding the construction of bunds by water, in order that he may, when

Proceedings, Madras Government, No 2,093, dated 28th June 1869
Do No. 3,800, dated 1st December 1869
Do ,, 2,430, ,, 10th October 1870

examining the parts of the rivers among the hills, ascertain whether small streams of water could be led to any bund sites at a level sufficiently high to admit of their being used to excavate and deposit silt of high specific gravity. I can hardly gather from the papers connected with the reservoir sites, which Captain Beckley has examined, whether that officer has sufficiently considered the means available for disposing of surplus water. Localities in all other respects favourable may be altogether unsuitable from the absence of facilities for this purpose, and it will frequently be unadvisable to expend time and labour in running contour or other levels over the basin, unless it has first been ascertained that a good position for a waste weir is available. In shallow reservoirs the difficulty of discharging surplus, though it may be considerable, need not be insuperable, but where any great fall has to be overcome, it is generally economically essential that the escape weir should be built on rock. Usually also it is difficult to construct an efficient escape at either flank of the bund, unless the hill side at full tank-level has a slope sufficiently gentle to afford the required space, and unless the sub-soil is rock or so rocky as to allow of the water running down it without erosion, and with at most a training wall to guide the outfall to the point where the water may be allowed to re-enter the river channel. A detached saddle is the preferable situation for the discharge of surplus water and, where such a saddle with a sub-soil of hard material can be found at, or about, the required level, it should be selected for the escape weir. These remarks touch after all upon but a few of the many considerations which must be taken into account in determining, from a preliminary examination of the valleys of rivers, which parts afford the best chance of working out a reservoir project possessing all that is necessary to efficiency. At one place there may be a short length of bund, but no facilities for the temporary or permanent discharge of water; at another all that is required in this respect, but no, or an insufficient quantity of, good soil, at a third, the climate may be too unhealthy to make it prudent to undertake work, the success of which is often greatly dependent upon the possibility of carrying out punctually predetermined arrangements I think, therefore, the best plan would be for the Executive Engineer to ask for advice, officially or demi-officially, whenever any matters of difficulty may be met with, for it is far from easy to give beforehand such detailed instructions as would dispose of any considerable portion even of the principal points which need to be

attended to. It is comparatively simple to determine the best arrangements at any given spot where it may be considered necessary to construct a tank, but here, in Ganjam, what is required is the solution of a far more complex problem, namely, the selection of the best sites available over a great extent of country with reference to—

1*st*—A sufficient but not too superabundant supply.

2*nd*.—Economy of storage.

3*rd*—Facilities of construction and of disposal of surplus water.

4*th*—Security, and economy of maintenance.

5*th*—Situation with respect to the canals to be supplied, so that the regulation of the discharge from time to time may be managed without difficulty

19. The last subject to be considered in this note is the aspect of the project as regards the probable returns to be expected from the outlay required.

Outlay and Returns.

The revenue information is as yet very imperfect: it will be seen from the letter, as per margin, from the Collector of Ganjam to the Executive Engineer, that the former officer wished to limit the revenue statistics to the past three years, and that he considered that there would be many difficulties in the way of furnishing, in a complete form, the details asked for in paragraph 30 of my memorandum, No 320, of the 20th December last. A further memorandum on this subject to the Superintending Engineer, 1st Division, is submitted with this note, and it seems requisite that no time should be lost in making such investigations into the probable revenue returns which may be expected from the irrigation of the tract of country commanded by the proposed canals, as will afford the fullest obtainable data for estimating the financial results of the outlay which the execution of the project would involve.

No 157, 17th February 1870

No. 185, 22nd August last.

20. The information at present available is very limited. In paragraph 37 of Captain Beckley's report, of the 11th September 1869, it is shown from "the Collector's accounts" that of the 140,000 acres proposed to be irrigated, and of this a large portion appears to be irrigated at present imperfectly,

			Present Revenue.
20,000	acres are assessed at Rupees	3	60,000
50,000	,, ,, at ,,	2	1,00,000
50,000	,, ,, at ,,	1½	75,000
20,000	,, ,, yield no revenue.		
			2,35,000

Captain Beckley supposed the average assessment with improved irrigation would be 4 Rupees an acre, which is equivalent to the bare water-rate in the Godavery

and Kistna Deltas, and probably with navigation added, Rupees 4½ an acre would not be too high. In that case the returns would be—

140,000 acres at Rupees 4½			= 6,30,000
Deduct maintenance at 8 Annas an acre (11		70,000	
per cent. on revenue) .. .		2,35,000	3,05,000
Do. present revenue		...	3,25,000
Net returns			

With regard to the cost of the works, Captain Beckley's original estimates amounted, including establishments, to . . 13 2 lacs

And probably when revised they will amount to .. .. 15 lacs

Cost of Soorada reservoir for 70 millions of cubic yards, say	2 lacs	
Establishment	½ ,,	2 5 ,,

The storage then would be at the rate of 280 cubic yards per rupee, cost of 180 millions of additional storage, which may ultimately be required, at 250 cubic yards per rupee . 7 2 ,,
0 3 ,,
25 0 ,,
Contingencies
Grand Total

On this sum the anticipated net returns amount to 13 per cent.

21. After giving the project, as a whole, careful consideration, I am of opinion that there is very strong *prima facie* evidence for believing that a system of irrigation, capable of conferring great benefits upon a considerable tract of country, and of yielding as large a return upon the outlay required as will suffice to pay interest on the capital expenditure, and at the same time increase the resources of the State, can be worked out in connection with the Mahanuddy and Rooshkoolia, and the result of the investigations, so far as they have at present been carried, is such as, I think, to make it desirable to ask the Government of India to sanction the charge to Loan Funds of the cost of the establishments thereon employed from the commencement of the current official year.

(Signed) J. MULLINS, Major, R E.,
Acting Chief Engineer for Irrigation.

OOTACAMUND,
9th September 1870.

No. 379. ORDER THEREON, 27th October 1870, No. 2,553.

IRRIGATION, No. 23.

THE Government are glad to learn from the papers submitted by the Acting Chief Engineer for Irrigation, that the investigations in Ganjam, in connection with a system of irrigation to be supplied from the Mahanuddy and Rooshkoolia, afford good reason for believing that it will

be practicable to carry out a scheme, which will be of material benefit to the part of the Ganjam District within its influence, and which will at the same time be sufficiently remunerative.

2. A reference to the papers marginally noted show that the Secretary of State subsequently to the famine of 1866 has repeatedly urged the importance of the improvement of the system of agriculture in Ganjam by works which will tend to secure fair crops over the area which they are designed to irrigate. The outlines and principal features of a comprehensive but prudent scheme have now been embodied. No time should be lost in completing the plans and estimates and in prosecuting such further enquiries as may be requisite to present the project in a form capable of being submitted to the Government of India as a remunerative loan work.

G O, No 3,048, dated 8th November 1866, Revenue Department
G O, No 9, dated 4th January 1867, Public Department.

3. The Government approve of the Acting Chief Engineer's proposal to construct, in the first instance, one moderately sized reservoir to supplement the direct irrigation from the river, and His Excellency in Council thinks that, only by such tentative measures as those suggested, can the real wants of the country in the absence of records of river discharges for a long series of years, be provided for without running the risk of incurring unnecessary expenditure by the formation of reservoirs in excess of the immediate or perhaps ultimate wants of the area to be irrigated Though estimates for more than one reservoir will not at present be required, Captain Beckley should be instructed, when he has completed the work needed for the submission of his scheme for sanction, to investigate such additional sites as may be advisable with a view to the ultimate formation of reservoirs capable of storing together about 250 millions of cubic yards, and in doing so he should give consideration to the remarks of the Acting Chief Engineer on the subject of the principal points to be attended to, and he should obtain from time to time from that officer such further instructions as he may require.

4. These papers will be communicated to the Revenue Department in order that the Collector of Ganjam may be requested to prepare the revenue information required in support of the project, and in elucidation of its probable effect upon the revenue. In order that all doubtful points also may be definitively settled with as little delay as possible, His Excellency in Council thinks that a report on the rates of assessment which the Collector may propose to recommend for the several classes of land, should be submitted for the consideration of the Board of Revenue as early as may be practicable, leaving details of areas and cultivation, etc., for a series of years to follow in due course The importance which the Secretary of State, and this Government also, attach to measures for the amelioration of the circumstances which render the naturally fertile district of Ganjam liable to severe and periodical visitations of famine makes it desirable that every effort should be made in the Revenue and Public Works Departments to get this project completed as early as practicable.

5. The *prima facie* evidence in favour of this scheme of irrigation is, the Government consider, sufficiently strong to make it highly probable that it will be

Proceedings of the Madras Government, Public Works Department,
27th October 1870.

carried out from Loan Funds, and the Government of India will therefore be requested to sanction the charge to those funds of the cost of the Public Works establishment employed upon the preparation of the project, with effect from the commencement of the current official year.

Ordered that the following letter be sent :—

(Here enter No. 2,554, dated 27th October 1870.)

(True Extract.)

Colonel, R.E.,

Secretary to Government.

To the Acting Superintending Engineer, 1st Division.
,, , Chief Engineer for Irrigation.
,, Revenue Department.

Ex1 S. T. Augustin.

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PUBLIC WORKS DEPARTMENT,
FORT ST GEORGE, 27*th October* 1870.

No. 380.

No. 2,554

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
PUBLIC WORKS DEPARTMENT.

IRRIGATION, No. 24

SIR,—I am directed to transmit for the consideration of the Government of India a copy of the Proceedings of this Government under date the 27th October 1870, No 2,553, on the subject of a proposed scheme of irrigation from the Mahanuddy and Rooshkoolia rivers in Ganjam which has for its object, so far as the scope of the project extends, the prevention of those periodical famines which have been attended not only with great suffering and loss of life among the people, but also with a heavy cost to the State.

2. The Secretary of State has, I am to point out, repeatedly urged upon this Government the adoption of measures such as are contemplated in this scheme, and His Excellency the Governor in Council hopes at no distant date to be able to lay before the Government of India a complete project supported by full information on revenue details In the meantime I am, in drawing attention to the evidence in favour of the feasibility, and remunerative character, of the scheme, to solicit the sanction of His Excellency the Governor-General in Council to the charge to Loan Funds from the commencement of the current official year, of the cost of the establishment employed upon the preparation of the project. That establishment at present consists of—

	Cost per Month RS	A.	P.
1 Executive Engineer, 1st Grade.	893	10	0
1 Surveyor	150	0	0
1 Estimator	50	0	0
1 Draughtsman	20	0	0
1 Do.	15	0	0
1 Surveyor	75	0	0
1 Do	50	0	0
3 Lascars at 7 Rupees	21	0	0
9 Do. at 6 Rupees	54	0	0
Total	1,328	10	0

It may however be advisable, with a view to hasten the completion of the plans and estimates, to increase the strength of the Executive Engineer's office for a short time, and I am therefore to request permission to add to the monthly charge,

for a period not exceeding six months, such extra establishment, within a total cost of 250 Rupees a month, or 1,500 Rupees altogether, as the Executive Engineer may show to be required.

I have the honour to be,
Sir,
Your most obedient servant,

Colonel, R.E.,

Secretary to Government.

Exd S. T. Augustin.

26 Dec. Plan supplied 12-2-71

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Memorandum.

Requested ~~for reference~~ the undermentioned papers

Capt Beresford. Certain Plans
Est. Estimate.

Office of the Chief Engr for Irrigation, P. W. Department. 14 Feb 1871

Asst Clerk

To The Registrar of the

Special Executive Engineers
Office Chillerpore 21st May
1870

No. 38.

From Captain J. Buckley R.E
Executive Engineer Ore
Special Duty Ganjam

To. Major J. F. Fischer R.E
Superintending Engineer
1st Division

Sir, I have the honour to forward
Surveys of Reservoirs sites that I have
surveyed in Connection with the Rooshoolia
Project but will first supplement the
information Contained in former Reports
and reply to Certain questions raised by
the Acting Chief Engineer for Irrigation.

2. I enclose Riven register of Rooshoolia
and Mahanuddy Complete for 1869 & 1870.
the Season has been very favourable
with more than an average Rainfall.
Sections have been taken of the Rivers
at

points where gauges are fixed; gauges posts are also placed lower down thus the surface fall is known; these Com=puted discharges are of Course only ap=proximately Correct, the lower discharges being generally too great and the higher discharges too little; the principal Sources of Error are due to the Sandy bed of the river being liable to Constant Changes and the velocities in broad shallow Sandy bedded rivers being much retarded by the work done in transporting Sand.

5 There were Moderate freshes in the Mahanuddy during the last 10 days of June and the two Rivers Contained far more than the requisite quantity of water during the months of July, August, September October, on the 15th November Experiments by floats gave 160,000 C. ozars per hour to the rivers Combined, on the 1st of December over 30,000, on the 15th of that month the quantity had diminished to 20,000 which

was

was still more than sufficient for the Sugar Cane Cultivation.-

3. It is almost impossible to Estimate even approximately the precise supply of water that it would be the most profitable and desirable to provide for the 140,000 Acres of Government land that the proposed Canal Could irrigate; that for a Consider=able portion of these Acres the quantity suggested by the Acting Chief Engineer as a Minimum (Vizt. 1 C. ft. per second for 100 Acres) is not absolutely Essential in favourable Years is proved by the fact that last Year this land girlded rice Crops varying from indifferent to good without any water at all from the source we propose to Create, and I think no one acquainted with this Country would doubt but that whilst with the proposed Canal the irrigated Crops grown without it would have been perfected; fair Crops would also have been obtained from

from the remainder of the land; in less favourable years the benefits from the Canal unaided by Reservoirs would be less widely distributed, but it would perform the highest duty in the worst years when irrigating the least Extent of Country as by saving the Crops on the low lying land a famine if not altogether prevented would be much Mitigated in severity to the people and Cost to the State - I am still of opinion therefore that the Canal is a work that should be undertaken even were Reservoirs inadmissible -

In designing the Canal I should recommend that both on the score of Economy and practicability we should bear in mind that we have only to supplement Existing Sources of Irrigation and accordingly full allowance be made for the usually ample rainfall, the numberless hill streams all more or less taken advantage of as irrigation Channels as also for the numerous tanks situated below the lines of Canal and in Calculating the advantages that would be afforded by River Channels we must not overlook the fact that the first freshes bring down the sweepings of the hills and although some thing may be done by improved agriculture there is probably no way of Keeping up the fertility of the soil in India, but by Intercepting these first freshes: last year the Crops in the Ganjam District were good beyond precedent and I believe this to be partly attributable to the land having been rested in previous bad seasons, there is a very general Complaint among Ryots that the soil is less fertile than formerly the fact being that the proportion of Arable to pasture or waste lands is yearly increasing

In attempting to Estimate the quantity of water per Acre required too much reliance must not be placed on the total Amount of rainfall which is about the same in the

the Madras and Ganjam Districts but whilst in the former an attempt to grow rice without artificial irrigation would be justly regarded by the Ryots as absurd it has been so grown in the Ganjam District from time immemorial; in Considering the rainfall in connection with the proposed project it is necessary to eliminate some of the Rain gauge tables referred to by the Acting Chief Engineer in the 3rd para of his memo, Ganjam and Gopalpore or Berhampore and Chellerpore have very little to do with the project, the lower portion of the tract of Country to be irrigated is fairly represented by Berhampore & Chellerpore, the upper portion by Aska, the gauges at Russelcondah. Soorada and Bulligada fairly representing the drainage area Rainfall.

5 With regard to Existing irrigation the Shasildar of Goomsoor was asked for a list of Irrigation Channels leading from the Mahanuddy between Boad and Aska on the 10th February 1870 and several applications have been made to him since, but no reply has been received; if received a list of these Channels will be sent: from my own knowledge of the Country I believe there is only one small Channel from the left bank, there are several small channels from the right bank the land they irrigate however will be Commanded by the proposed Canal and even now is chiefly dependent on the Boary Reservoir: On the Koorkootia between the proposed site of Anicut and Aska there is one small Channel on the right bank belonging to the Daracotta Zemindary the land hitherto irrigated by this will be supplied from the Canal there is one small Channel on the left bank but it Commences above the Anicut and will not be interfered with as

Last

fact the present irrigation from the Rivers is very insignificant and very imperfect. Between Attock and the Sea there is only one Channel viz. the Heeradara or Poorooshotapore Channel which irrigates about 2000 acres but as this will still be supplied by the Bagroo a river draining 350 Square Miles and the Gondalow draining 400 Square Miles besides other streams, the Ancicut above will not affect Materially the irrigation from this Channel.-

6. As regards Navigation I would Earnestly recommend that even if the Canal is not made Navigable by Locks &c. in the first instance the works may be so designed that it may be made Navigable hereafter. It is not necessary that there should be the full depth of 6 ft. to afford Navigation Superior as a mode of transit for the produce of the Country to the bandies mostly drawn by bullocks at a speed of about two miles per hour. Numbers of the Chilka Lake boats draw laden not more than 2 feet, the Rookhodia Canal running 3 ft. deep is would require $\frac{41,500 \text{ C.ft per hour}}{311 \text{ C.ft per second}}$ and this quantity last year could have been obtained direct from the river with only six days intermission from June 20th to end of November but if it has been determined that on account of the irrigation Extensive Reservoirs must be Constructed, it is hardly worth while my attempting to shew that a useful Navigation might be maintained without their aid - and without the aid of works that at inconsiderable Cost could be Constructed to regulate the Surface fall according to the volume of water passing down the Canal.-

7. With reference to the Acting Chief Engr's remarks on the details of the proposed works. I have the following information to give. The Surface stones of the Rookhodia Ancicut

Anicut will be larger blocks which would be more Easily obtained than small stones. I did not insert any groins in the plan Con= =sidering that the best positions for such works are often more rightly judged after the work has been partly Constructed by the Experience gained in the Kristna and Godavary seems like that unless very judiciously placed they do harm as whilst destroying a portion of a Cross Current they dangerously Concentrate the power of the Remainder: the piers of the Dowlai= =swarum Undersluice built of Sand stone are only 3 ft thick taking into Consideration that the forces of the Current would here be very much less and the stone very much harder and heavier. I thought 1.5 ft would suffice; that the Cut stone work should not be more Massive in these works than is Essential to safety is important not only on Account of the Extra Cost but also because the date of Completion of the Masonry works will probably be dependent on the quantity of Cut stone required. I did not Contemplate the Necessity of Closing the Undersluices during high floods, the Undersluices of the Kristna and Godavary Anicuts are not even approach= =able during such floods, with one or even 2 ft of water on the weir I should not anti= =cipate any difficulty in forcing down shutters if not made larger than 3' x 4', the objection to a ramp or raising the piers seems to be that a very important part of the waterway would be blocked up: The object in making the vents of the Head sluice 5' high and only 4 ft broad was to keep the shutters within dimensions that would allow of their being raised and lowered at all times without the Extreme difficulty that is Experienced with larger shutters; as stated, the sluice would not pass the whole volume of water with a uniform flow it would require a head of 1.25 inches, the difference of velocity in the River and Channel being above 5000 gallons per hour however represents a head of about 5 inches

It

It would be the duty of the Lascars when more water is required to raise as tempo-
rary bund on Crest of weir-or the same object might be gained by an arrangement of Shutters as used at Cuttack: if the Sill of the Head Sluices is lowered to 7 ft. below the Crest of Weir it will be only 1 foot above Sill of undersluices and will give 1 foot additional Cutting through the Rock at Shargada and of the fall of the Canal be increased from 6" to 8" the depth of the Cutting will be increased another 2 ft. so that increasing the fall would not be an Economical alteration as it would not diminish the Cost of Embanking. I may here mention that before Contouring the line of Canal at 6" per mile I had stated my intention in my preliminary report I had also written Colonel Anderson R.E. Specially on the Subject, & Concluded that the 6" per mile fall had been approved.—

8 The right bank of the Roorkee hear the proposed Anicut site is very stable being of the hardest rock. I consider the site Chosen the best even if the Sill offered for the Navigation Canal by the Jamnee Nullah be disregarded, if we go 300 yards or more than $\frac{1}{6}$ of a mile lower down we lose another foot of level, the bed of the Canal being thus lowered altogether 4 ft. the Cost of the Shargada Cutting would be much Materially increased and the area of land irrigated Considerably lessened, be- sides should not either at the spot indicated by the Acting Chief Engineer have the advantage of a rock foundation for the Head Sluices and possibly for the Undersluices as higher up. I am disposed to think that the length of the Mahanuddy Canal would be increased in length 300 yards instead of lessened, and the peculiar facilities offered by the Navigation across the river would be lost; very little

little Cutting would be requisite to under-
the whole length of proposed Anicut Effective
in high floods, and the Effectiveness of the
whole would be of no moment in moderate
floods. In Calculating rise due to Construction
of Anicut I have entirely disregarded the
waterway over that part Embedded in
the Bank and I must own I fail to
perceive any in accuracy in my Calculation
of an Extreme rise of 2 ft.; beyond question
the sharp bend affects the flow of the river
but does it not do so Comparatively to a
greater degree now than it would after
the Construction of the Anicut? and the
Calculation of the rise that will be
occasioned by Anicut are based on
the present Actual Sections and surface
fall that have been fully affected by
the bend alluded to. If the roadway is
made as I proposed M. S. Lt 185 it will
be 6" above a flood of about $\frac{8.25 \text{ Million cubic feet per hour}}{61875 \text{ ft per second}}$
if raised to M. S. Lt 188 it will be
above

six inches above a flood of $\frac{12.5 \text{ Million cubic feet per hour}}{93750 \text{ ft per second}}$
the highest known flood being $\frac{8.25 \text{ Million cubic feet per hour}}{39375 \text{ ft per second}}$
a large tract of Country must be flooded
before this Could occur.-

9. I note that Locks on 2nd Class Canals
are to be 105' x 15'. Locks on the Cuttack
District I understand to any in size
the most Common being 100' x 17'-

10 The Estimate for the Iron girder bridge
on the Atka and Soorada Road is too low,
the Cost would not be under Rs 12,000 as
the road is only a District road. It would
be better to build a Masonry Bridge for
which the original Estimate would be
more than sufficient. As remarked by
the Acting Chief Engineer the waterway has
been diminished over the various Aque-
ducts as is usually done and for the usual
reasons Economy; the head due to Contraction
in all Except the Shargada & Godahalow
Aqueducts would be about an inch
with

with a depth in Canal of 6 ft. and this might be Compensated for by giving in addition to the 6" a mile fall a drop of a little over an inch at Each aqueduct but I should not recommend this to be done as it would be detrimental to Navigation when the water was low and it is to be Considered that the reductions of velocity by these Contractions of the Channel will be about Compensated on the whole for by the fact that the irrigation water will be drawn off under a head of 3 feet.

11. It is intended that the piers of all the works should be of the best Material. Viz. of hard heavy Cutstone. I have not therefore Considered that the piers need be of greater thickness than to afford a full bearing to the Arches that they support, if this is determined to be an insufficient thickness I should prefer the thickness to be increased throughout as

as to my mind a batter in bridge piers is unsightly and the But-end being in the water an unnecessary obstacle is offered to the Current.

12. With reference to remark in para 18 a reference to the plan and Estimates will shew that Concrete has been allowed under all inverts.

13. If the piers of the Godahallow Aqueduct are 5 ft. thick there is of Course no occasion to build them of Cutstone but I should prefer piers of Cutstone 3 ft thick to more ponderous Rubble Masonry piers, as the river rises and rapidly it is obviously of Consequence not to obstruct the Current more than is necessary; if the piers are thickened the apron must be increased in proportion. I believe that in the Majority of Cases the destruction of Bridges may be rightly ascribed to the Contraction of the waterway. I had not intended it to be understood that the precise site for this Aqueduct nor for any of the Masonry works had been selected; a straight reach would of course have

have the preference and this very probable that a rocky foundation may be obtained

14. I note the Acting Chief Engineer's remarks regarding the Inlets and Outlets also that he considers width of Weir apron must not be less than 1.3 ft. × height of Rock above them.

15 The Canal is not carried through the Sand ridge at 65.66 Miles to get rid of the Surplus water but to convey water for irrigation to Chetterpore and Neighbourhood.

16 It was an Error allowing 60 ft. Span Arch to Carry Aska and Russelcondah Road over Canal a 30 ft. Span Arch would suffice. I think that it would be better to widen the Apron of the Mahamiddy Anicut than to double the height of the Cushion wall designed by me which is 2.5. if doubled, the wall would be only one foot less in height than the Anicut itself.

17. With reference to the 37th para of Acting Chief Engineer's Memo I have to observe that the Country on one side of the Canal is tolerably thickly populated but on the other side is mostly hill and jungle, frequent bridges therefore are not required; two not one only have been allowed viz. at the Maha = nuddy Head Sluice and Aska & Russelcondah road probably a third would be useful near the Roosikoolia.

18. I consider the scale of water allowances per acre as set down in para 27 of the Acting Chief Engineer's Memo altogether too high for this District Nearly all the water would be finally distributed by small Channels and if these are to Carry at an average rate of 6 C.ft. per hour whilst the main Canal is only Carries 1.5. It appears to me that whilst the Land under the upper portion of the Canal will get swamped that dependent on the Canal lower down will receive no irrigation

19 As remarked in para 40 only the levels along the Selected line were forwarded with plans and Estimates of Canal but the preliminary report sent from this Office dated 28th October 1868 was accompanied by a Map shewing a Number of other lines of

of levels.-

20. The rates for the Earthworks are such as work could be easily done for in the Godavary District where the daily Coolie hire is higher than here; the rates for the Masonry are Considerably higher than those now in force; I believe that under Competent Management the rates generally will be found sufficient, even if a still further raising of the rates on account of the Magnitude of the work were inevitable it would be better there should be a silent understanding on the subject, to put higher rates in the Estimate would be simply doing at once what other wise at the worst will be gradual and partial: A large number of stone Cutters Can be obtained in this District and from Vizagapatam and some people must be taught.-

21. The Collector's attention has been drawn to paras 30 & 31 of the Acting Chief Engineer's Memo a Copy of his letter in reply accompanies

this report When the Revenue Surveys of the Goomsoor and Berhampore Talugs now in progress are completed, further information will be more easily obtained. I do not myself argue that the people of this District will gladly avail themselves of Canal water because people in the South do so, though I think it must be allowed that irrigated Talugs are more prosperous than dry Talugs and we might fairly infer that people will avail themselves of the means of prosperity when placed within their reach. My Argument is rather that we may reasonably Expect a people who throughout the District irrigate from the drainage Channels, will require little persuasion to use Canal water with its double blessing of Enriching and Saving trouble; that they will at first Clamour to take the water without payment is to be expected and it would be well if as the Revenue Survey progress the people were taught to Expect a somewhat increased

increased Rental- Colonel Anderson RE remarked that it is hardly safe to Recko upon a higher Rate than that already levied on irrigated lands, How it is difficult in this District to say what is the Maximum rate, I believe that on Government lands it seldom Exceeds Rs. 3-8- per acre the land under the Korathoty tank paying only an average of Rs 3-2-9 is rich alluvial soil perfectly irrigated by the tank is never dry and receives the fresh freshes of the Godavery through which it is Connected by a Channel the supply in which is regulated by a Head Sluice with Anicut across the River, this land produces good Crops even in famine years when the Country around is desolate and is moreover only 5 Miles from the Port of Gangaum whence much rice is Exported; I know of no reason why this land should not be rented as high

high as inferior land in the Godavary District Viz at Rs 6 or less than ¼ of the Crop; against any theory that the Goriyahs are naturally a less Revenue paying people than Taloogoos, there is the fact that this prosperity for paying low rents is Confined to Government Ryotage it is difficult to find out what Zemindary Ryots pay practically but it appears to be generally allowed that the Zemindar has a perfect right to half the grain produced and that this is often taken either by himself or by the Village renter: On the lands under the Korathoty tank therefore instead of Rs 3-2-9 he could take paddy to the value of Rs 12 and green grain to the value of Rs 2 we have no reason to doubt therefore that a fair irrigation Cess may with a little trouble be Exacted from the Ryots who live in Government Villages. Although the Zemindar's Cherished Revenue Custom of taking half the grain may appear Excessive

Rice

rice lands most Certainly Can bear the
impost as rice is sown or planted throughout
the District wherever there is a chance of it
growing; it may howeve[illegible] be that this
high rent is one reason why the people are
and always have been averse to other cultivation
Dry grains are only grown as a second Crop
and where the paddy fields terminate the
Jungle Commences, so that without an
plentiful raingall Scarcily any harvest.

22. With reference to the Acting Chief
Engineer's 39 $\frac{6}{11}$ para, there is nothing on
record shewing reasons in favour of
Anicuts above Junction of the two Rivers
at Ashta beyond my report Surveys and
levels. The report written in 1858 by
Lieutenant (now Colonel) Rundall R.E.
is doubtless by known to the Acting Chief
Engineer. Colonel Rundall's Canal from
Ashta to Gopaulpore would have been
over 40 Miles long and more Expensive
than mine in proportion to the length
there would have been a 30 ft. Cutting
through

through the ridge between Kookoodakinny
and Chellerpore and the main object of going
higher up the River for the Ancient Sites is
to obtain a Command over the Summit
of that ridge for the purpose of Irigating
the slopes on either side; Colonel Rundall's
Canal would only have irrigated the
low lying Country adjacent to the Roorkolia
which is already fairly irigated. The Estimate
the returns at only $\frac{1}{2}$ a Lac per Annum but
the realisation of even this Amount appears
to have been doubted by the Collector - his
rough Estimate for this Canal would
have been altogether insufficient; doubt-
less Colonel Rundall knew that in the
year 1858 a larger project than the ones
he proposed would not have been even
Considered by Government. In forming
the scheme I have endeavoured to make the
Canal irrigate as large a tract of Country
as was practicable rather than to obtain
a Maximum rate of dividends or as
smaller

Smaller Expenditure, though I do not think that any smaller work would prove more remunerative; in this view I was emboldened by being told by Colonel Anderson R.E. to make the project as Comprehensive as possible.—

23 In looking over the Country for Reservoir sites I have been influenced by the following principles or opinions viz (1) that stone dams may be safely constructed up to 200 feet in height or more; but their suitability is much diminished if not altogether destroyed by the absence of a rock foundation (2) Earthern dams can hardly be safely trusted when first made for a greater depth of water than 50 ft. which may however be gradually increased to 75 ft. there seems also a difference of opinion Amongst European Engineers as to whether a homogeneous bund or one with a stratum of puddle in preferable, I incline to the former myself where ever Constructed but

but Especialy in this Country as puddling does anything better than a square mud dam requires more Constant and trustworthy Superintendence than in this Country would probably be devoted to a work for many Consecutive months: though of Course with any Earthern bund of Considerable height a dyke of puddle is would often be absolutely necessary to secure a water tight foundation; the Embankment should I Consider be allowed at least two rainy seasons to settle before Called upon to bear the full pressure of the water this Could not be obtained for the portion across the river bed which would be Constructed the last and with Extraordinary Care.

24. I have inspected nearly the entire Course of the Rooskoolia up to the foot of the Hills and it is unlikely that a favourable site for a Reservoir of any size Can have Escaped me: I find that the bed and indeed

indeed the only sites are situated in broad valleys
as one approaches the area of the
Ghauts the main streams branches into
numerous tributaries whose beds have great
inclination the intervening Country being
elevated and broken -

25. Eight sites in all have been partly
surveyed and Contoured though probably
one or two Reservoirs will suffice for our
requirements - My Estimates are rough but
I think adequately accurate for the purpose of Comparing
probable Cost of the Reservoirs one with
another - To make more detailed Estimates
much more Careful Examination of the
sites would be requisite and I should
wish to be informed some what in detail
of the Kind of works that are the most
likely to meet the approbation of the
advisers of Government -

26. I will here make a few remarks
as to the probable value of stored water

if we take land entirely dependent on the
Reservoir and Rain and allow an Extreme
quantity of 1.5 Yards per acre per hour we
should require 1080 x 5 from June 1st to
End of October = 5400 say including Wastage
6000 and the charge for this would be
Rs 4 per acre should the heavy actual practice
is we allowed 1 Yard per acre and charged
Rs 3 water rate this would give about
4000 for Rs 3. I think we may safely
reckon 5000 Cubic Yards worth Rs 3-8-0 so
far as the 1st Crop is Concerned; for
the 2d Crop the water would be more
the yield less and perhaps we Cannot
safely Expect more than Rs 2 per 5000 Cubic Yds
During the irrigation of the 1st Crop we
may probably be able to distribute from
1½ to twice the Capacity of Reservoir and
in good Years the Reservoir would be
full at the End of October and the water
available for the 2d Crop -

Reservoir No I

27. On the valley of the Godahallow the

Reservoir is in the Neighbourhood of Coolada
Cross Sections and Contours 30 ft. above
River bed have been taken over at Coolada
and the Second 2½ Miles below Coolada
the latter gives the Cheapest Storages I
do not therefore send the Survey Vol. of
the finish. The drainage area is 150 Sqr.
Miles, & we allow as available for storage
¾ × 60 inches in rainy years and ½ × 30 inches
in dry years we shall have a Maximum
of 1742 Million Cubic Feet and a Minimum
supply of 580 Million Cubic Feet; Quite double
ful as to the Maximum discharge of this
River this would of course have to be
Carefully ascertained with reference to
length of Calingulah probably 6 Million
Cubic Feet per hour Right-hand Bank allowed for.
The Survey (No 1.) shows a Contour
of 224 ft R. L. Embracing an area
of 5.4 Square Miles but as this is the
supposed permanent level we must
allow

allow for an additional Rise of 3 feet
on Crest of waste weir & the total Area
Submerged would be 6 Square Miles
of which about ½ is Cultivated the rest
Jungle, if we Estimate the former at
Rs. 50 per Acre and the latter at Rs. 5 the
whole belonging to the Chinnah Kimedy
Zemindar the value of the Land becomes
Rs. 105,600, possibly more than this would
have to be paid for the other hand ¾ of the
Land would be available for Second
Crop, Cultivation in the bed of these large
Reservoirs not being disadvantageous.
The Villages are Constructed of Moveable
Materials such as wood, grass, Mats, and
Compensation for them may be set down
at Rs. 20,000. The water available for
Cultivation between the 224 – 189 Contours
(i.e. 35 ft.) is 70 Million Cubic Feet and the
total Rough Estimate is to Raise the Bund 10 ft. however and to
have available for Irrigation the

Volume

volumes of water the barrage Contours 234 and 189 or Maximum depth of 45 ft. the storage becomes 140 Million Cubic Yards and the Cost 5.75 Lacs and of Course if raised still higher the water becomes still cheaper;
I believe that if desired a rock foundation might be secured for a Masonry wall at the deepest part of the dam; this site upon the whole appears worthy of further investigation as it would be convenient for the supply of water to Berhampore and Neighbourhood.

28. I was very anxious to obtain sites for Reservoir on the Shangada and Jeeminilly Nullahs so as to store the whole of the flow of these troublesome streams but after devoting much time to investigating and Surveying through thick jungles these water courses, I was not able to find any site on the Jeeminilly Nullah nor is the one Surveyed on the Shangadda Nullah worthy of further Consideration.

29

Reservoir No. II

29 The only suitable site on the Jora Nuddy is where it joins the Rooshikoolia immediately below Soorada: the drainage area is 232 Square Miles Maximum Supply 900 Million Cubic Yards Minimum 300 Million Cubic Yards. Area of Reservoir up to 306 ft. M.S.L. i.e highest level of Storage, 5.14 Square Miles allowing 3 ft. above this as head of discharge over waste weir total land submerged 5.5 Square Miles of which 2.5 may be Cultivated the rest Jungle, the Land is Government and we may allow Rs. 30 per Acre for the Cultivated and Nothing for waste land the total of the Rough Estimate is Rs. 1.75 Lacs the Contents of this Reservoir between 300 and 270 Contours is 70 Million Cubic Yards this Level Could not be raised without flooding the Town of Soorada and stopping the watershed between the Jora Nuddy and Rooshikoolia - this doubtful whether

whether the Weir ought to be alone Bank of the Embankment or placed in the above mentioned water shed, the choice of this and all the Reservoirs would best be Constructed in the Hill side and not in the Embankment - As if this Reservoir be not Constructed a Bridge must be built at the site selected for the Dam; in a detailed Estimate for the work Credit should be taken for the Cost of a Bridge say 20,000 Rs the width of the Embankment being 18 ft at top would give a good roadway -

30 The first Reservoir site on the Roos: (Ex Koolia wal Boradapilly at the 11th Mile stone on the Ashtea and Soanada road) the Roos Koolia down to the point has a drainage area of 825 Square Miles - Maximum yearly discharge 3000 Millions Cigars, Minimum discharge 1000 Millions Cigars. The Contents of a Reservoir between Contours 226 and 191 (ie depth 35 ft) would be about 100 Millions Cigars and the Cost Rs 2.84 Lacs Say 3 Lacs if raised 10 ft the Contents would be about 170 Millions Cigars and Cost Rs 4.06 Lacs Say 4.25 Lacs if raised 20 ft another 10 ft so that permanent highest level would be 246 + M.S.L and greatest depth of water available for Irrigation 55 ft the Contents of the Reservoir available for Irrigation would be over 240 Millions Cigars and Cost Rs 5.42 Lacs Say 5.5 Lacs - In the first Case the Land submerged would be 5.75 Square Miles in the second about 7 Square Miles and in the 3rd about 8.25 Square Miles. the Land is partly Zemindary but not very valuable some Miles of the Ashtea and Soanada road would be submerged and have to be removed along the margin of the Lake. the Sluices would probably best be tunnelled out of the Rock upon the left bank; there is great facility for the Waste Weir over a low rocky Reservoir No III

ridge at C on the right bank. Dam
inclined & Concrete this the most favour-
-able of all the sites surveyed. I have
Sounded the beds of the Reservoir to a depth
of 10 ft on hard foundation rock near
hard soil. If no good foundation
were procurable a Masonry Dam 75 ft
high might be the best Construction -

31 The next site is at Balligatch Reservoir No IV
opposite 16th Mile stone on Soorada and
Attara road. The drainage of 800 Square
down to this point may be put down at-
discharge 5000 Cubic feet Maximum
discharge 1000 Million Cigars. The
Contents of the Reservoir between Contours
271 and 231 greatest depth of water
available for irrigation being 40 feet
is 50 Million Cigars and Cost Rs 2.4 lacs
say 2.5 lacs. if raised 10 ft with highest
permanent level of 281 + M.S.L. the Contents
would be nearly 90 Million Cigars and
Cost Rs 3.5 lacs say 3.5 lacs. In the first
Case the land submerged would be in
3.25 Square miles in the latter Case about
4 Square miles of which half would be
Cultivated by the Reservoir would be
deducted some miles of the Attara and
Soorada road & the water shed would
have to be Constructed at one end of the
Dam -

32. At Soorada there is a site for a
Reservoir that might be made in Conjunction
with the one Estimated for on the Jora-
-Buddy but I should not recommend it.
I have not inspected the Country higher
up than Pipplapentia nor Carefully
quite so far, there is but little Chance
however of a site for even a 3rd Class
Reservoir higher up than Soorada as
beyond

beyond that Town. the Country is broken into high Ridges and the slopes of the Channel heads become precipitous—

33. 8th from inspected the Lohara Kuroly Arbusen Causy Mile above Russelcondah finding nothing approaching a favourable Reservoir site. I had not time to penetrate and survey the dense Jungle higher up, it is improbable that if I had any site, even for a 3rd Class Reservoir would have been discovered.—

Reservoir No. V

34. About 3 Miles from Russelcondah a Reservoir site has been surveyed situated at Bavaneona on a tributary of the Lohara Kuroy. The drainage area is only 20 Square Miles of Hill Country the Maximum yearly discharge therefore 78 Million Cigars Minimum yearly discharge 26 Million Cigars. The Contents of the Reservoir between Contours 150 & 105 greatest depth 45 ft. is 60 Million Cigars

Reservoir No. VI

35. On the Mahanuddy a Reservoir site has been surveyed near Kollada the valley has also been inspected 7 Miles above Kollada in the direction of Gullery but no site discovered, in the neighbourhood of Gullery possibly a site for a 3rd Class Reservoir might be

and allowing 3 ft. on weir 4 Square Miles of land would be submerged Cost Rs 2.55 lacs. It is evident that the above is too large a Reservoir for the drainage area if we reduce the level 10 ft. the high level being 140 and greatest available depth 35 feet the Cubical Contents of the Reservoir would be 30 Million Cigars - Area about 3.5 Sq. Miles and Cost Rs 1.66 lacs. This Reservoir might perhaps be made still smaller with more Economical results probably a depth of 30 ft. would be the best - there would be about 2500 Acres of land irrigable by this Reservoir in addition to the land under the proposed Canals

ber found but further investigations in these jungles would apparently have been wasting time: in the direction of Kookoo=labah a tolerable site appears near Kunkai about 5 miles above Kollada and another about 2 miles higher up about ½ a mile above Dologa. both sites much inferior to the ones surveyed near Kollaida in all respects except the value of land that would be submerged. I did not advance so high up as Kookoo=labah as in that neighbourhood on account of the small volumes of the streams and great slopes of their beds only small Reservoirs are possible. The draniage area affording water for this Reservoir is 305 Square miles Maximum yearly discharge therefore about 1200 Million C. yards Minimum discharge 400 Million C. yards. If the Contour (94) shewed in the Survey be taken as the highest level of water and the level of the useful supply be 3 feet lower the Contents of this Reservoir will be 110 Million C. yards Submerged Area 8 Sqr Miles and Cost Rs 5.6 lacs. If we consider 94 Contour as level of available supply and 97 Contour highest discharge level the useful Contents of Reservoir would be 135 Million C. yards: Submerged area about 8.5 Square miles and Cost Rs 6.5 lacs. If we take 101 Contour as the level of available water the useful Contents of the Reservoir becomes 210 Million C. yards Submerged area about 10 Square miles Cost about Rs 10 lacs: Under this Reservoir there would be 10,000 acres be irrigated independently of the Canal.—

36. I have inspected the whole of the valley of the Bellogonda or Elsa River there is no good site for a Reservoir the best being about 3 miles below Jaggernathpra where there is nothing but wet Cultivated

in this valley nearly the whole of which is dependent on local rains the ryots talk jokingly of the last famine and appear to be quite aware that their existence is very precarious, if each village was provided with an agricultural well as water is usually found near the surface, this would provide some what of a safe guard against starvation, but there are no such wells in the district; water for Sugar Cane Cultivation is obtained from small pits dug in the Sandy bed of River and raised in a pot tied on to the end of a pole, there are no bullock picottas so Common in some districts; Now although we should generally fail when attempting to introduce European agricultural Machines into India there appears to be no good reason why an attempt should not be made to

to introduce the excellencies of one District into another District where they have hitherto not been used because unknown.

37. It is likely that the sum set down forward in these Estimates might be exceeded but it must be remembered that not only Can-$\frac{3}{4}$ths of the bed of the Reservoir be Cultivated or held for pasturage but that by these proposed irrigation works Cultivation throughout the District will encroach on the jungle at present the inhabitants of the most advanced or outlying villages die in famine years; I have had my tent pitched on the site of a village abolished by the last famine the inhabitants of five of the houses are reported to have died, the survivors of the 6th houses removed for a living

Elsewhere

elsewhere; I understand the Zemindar is going to re-establish this village but the next famine will abolish it again -

38. I am inclined to Consider that the Reservoirs the Construction of which present the greatest advantages are those of Boradapilly & Hollada I believe however the former might be Capable of supplying all our wants and that if about 7 lacs be set down for Reservoirs we should be justified in assuming that the 140,000 acres might easily including the second Crop pay an average rental of Rupees 6 the Estimate for the whole project becomes -

Weirs & Channels	13.2 lacs
Reservoirs	6.8 lacs
Total	20 lacs

Revenue of 140,000 acres 6 Rs = 8.40,000

Deduct	Present Revenue 2,35,000	
	Repairs & Management 65,000	
	Annual Charges	3,00,000
		5,40,000

Annual rate of interest on outlay 27 per Cent. -

39. The Survey and report on the Utilization Canal between Astra & Gayaan as also Canal between Astra & Gayaan will be sent separately as altogether independent of the Irrigation Project -

40. The Survey of the Southern Portion of this District has been Commenced with the view of irrigation from the Punnadara and Chicacole Rivers -

I have the honour to be
Sir
Your most obed.t Servant
J. Buckley. Captain RE
Executive Engineer on
Special duty Gayaan

Rec.d
Khan Sing
Esq.r

Jersey

The Executrix Exor-
Genl for Duty Gayer

To the Supervisor
Division

Date 21st May 1870
Dep 3
P.D. 3811/70

Returns Duty &
and Estimates of the
proposed Reserve
in Connection with
the Irrigation proposed
in North Province -

Sun. 29. Oct/71 O.S. 3503-45

Table showing the Compared discharges of Rockhokia and Brahamaddy rivers at Asaba

August 1868.

Month & Date	Rockhokia discharge	Brahamaddy discharge	Total	Remarks
15th	107,157	20,430	127,581	
16	107,157	79,920	187,071	
17	43,776	75,480	119,256	
18	43,776	70,400	114,176	
19	43,776	58,050	101,826	
20	43,776	28,050	71,826	
21	43,776	28,050	71,826	
22	23,000	18,000	41,000	
23	23,000	18,000	41,000	
24	20,000	18,000	38,000	
25	9,707	28,050	37,757	
26	9,707	28,050	37,757	
27	17,885	22,650	40,535	
28	38,570	4,675	43,245	
29	152,400	83,808	236,208	
30	1,437,051	192249	1,629,300	
31	576,639	165,980	742,619	

Table shewing the Computed discharges of Rooskoo
and Mahanuddy Rivers at Astea

Month & Date	Rooshkolia discharge	Mahanuddy discharge	Total	Remarks.
1	191,754	102,080	293,834	
2	149,265	87,740	237,005	
3	128,000	86,268	214,268	
4	128,000	77,832	205,832	
5	111,771	68,256	180,027	
6	65,975	71,552	137,527	
7	65,975	66,900	132,875	
8	91,640	62,490	154,130	
9	512,528	47,640	560,168	
10	652,775	75,072	727,847	
11	230,640	105,896	336,536	
12	238,700	117,612	356,312	
13	205,143	112,840	317,983	
14	139,140	161,320	300,460	
15	179,064	207,328	386,392	
16	145,260	126,440	271,700	
17	334,960	90,272	425,232	
18	274,296	112,840	387,136	
19	180,000	126,440	306,440	
20	180,000	112,840	292,840	
21	216,030	75,118	291,148	
22	184,600	81,880	266,480	
23	125,680	126,440	252,120	
24	219,450	88,320	307,770	
25	128,000	92,004	220,004	
26	102,300	75,636	177,936	
27	256,990	143,260	400,250	
28	143,010	210,600	353,610	
29	333,375	210,600	543,975	
30	216,030	154,000	370,030	

September 1868.

Table shewing the Computed discharges of Rooskoolia
and Mahanuddy Rivers at Astea

Month & Date	Rooskoolia discharge	Mahanuddy Discharge	Total	Remarks.
1	178,250	132,980	311,230	
2	168,120	126,440	294,560	
3	269,940	137,900	407,840	
4	244,860	313,760	558,620	
5	119,600	219,150	338,750	
6	124,200	156,420	280,620	
7	107,085	131,760	238,845	
8	93,960	131,760	225,720	
9	93,960	122,000	215,960	
10	73,000	91,430	164,430	
11	76,000	77,832	153,832	
12	57,200	75,480	132,680	
13	57,920	70,400	128,320	
14	79,875	65,700	145,575	
15	79,875	65,700	145,575	
16 to 31	"	"	100,000 about	The sandy bed of the River altering it was impossible to Calculate discharge Correctly after October 15th
6th	"	"	10,000	Accurately gauged but at this period bunds had been thrown across all rivers in the District.
28th	"	"	2000	Accurately gauged - Bunds across all rivers above.

November 1868.

Table shewing the Computed discharges of Rookhokia and Mohaunadoly Rivers at Attia

Month & Date	Rookhokia discharge	Mohaunadoly Discharge	Total	Remarks
January 1869	"	"	"	Very little
February 1869	"	"	"	little
March 1869	From 1st to 15th "	"	"	little
	16			
	17			
	18		From 100,000 to 150,000	Like fresh was measured
	19	"	"	
	20			
	21			
	22			
	23			
	24			
	25			
	26 to 31	"	"	"
April 1869	"	"	"	None.
May 1869	"	"	"	None. Except one small fresh.

Table shewing the Computed discharges of Rookhokia and Mohaunadoly Rivers at Attia

Month & Date	Rookhokia discharge	Mohaunadoly Discharge	Total	Remarks
December 1868	"	"	"	Very little

Spl Executive Engrs Office Chittagong 21 May 1870.

J. Buckley Asstt Engr RE
Executive Engineer Dy Supt
Dy Gangaw

Table shewing the Computed discharges of Roostkoolia and Mahanuddy Rivers at Attka

June 1869.

Month & Date	Roostkoolia discharge	Mahanuddy discharge	Total	Remarks
1	"	127,080	127,080	90,000	37,080
2	"	159,225	159,225	90,000	69,225
3	"	92,260	92,260	90,000	2,260
4	"	81,000	81,000	87,000	
5	55,600	73,500	129,000	90,000	39,000
6	194,400	65,100	259,500	90,000	169,500
7	102,000	65,100	167,100	90,000	77,100
8	"	165,015	165,015	90,000	75,015
9	"	81,550	81,550	87,000	
10	"	65,100	65,100	65,100	
11	"	56,052	56,052	65,052	
			1,382,892	913,702	

Table shewing the Computed discharges of Roostkoolia and Mahanuddy Rivers at Attka

July 1869.

Month & Date	Roostkoolia discharge	Mahanuddy discharge	Total	Remarks
1	"	75,072	75,072	
2	"	37,052	37,052	
3	"	24,480	24,480	
4	"	8,415	8,415	
5	"	3,920	3,920	
6	"	2,775	2,775	
7	"	2,220	2,220	
8	"	15,300	15,300	
9	39,300	7,480	46,780	
10	156,115	26,376	181,491	
11	155,115	25,748	180,863	
12	151,470	222,000	373,470	
13	202,860	284,400	487,260	
14	145,800	214,600	360,400	
15	94,800	159,850	254,660	9,14,460 2,550 0
16	68,200	147,200	215,400	
17	68,200	75,072	143,272	
18	59,940	72,800	132,740	
19	39,300	72,800	112,100	
20	24,565	77,280	101,840	
21	11,730	75,900	87,630	
22	9,880	69,000	78,880	
23	9,880	35,400	45,280	
24	10,480	24,480	34,960	
25	9,880	70,720	80,600	
26	7,140	665,660	672,800	
27	45,400	510,900	556,300	
28	45,400	330,720	376,120	
29	52,200	325,360	377,560	
30	248,080	341,320	589,400	
31	402,360	354,200	756,560	

Table shewing the Computed discharges of Rookoolia and Mahanuddy Rivers at Attka.

August 1861

Month & Date	Rookoolia discharge	Mahanuddy discharge	Total	Remarks
1	421,290	993,010	1,414,300	
2	358,680	671,960	1,030,640	
3	539,720	649,060	1,188,780	
4	462,210	547,400	1,009,610	
5	560,700	649,060	1,209,760	
6	389,760	313,760	703,520	
7	499,550	434,920	934,470	
8	443,750	1,692,000	2,135,750	
9	666,000	1,619,940	2,285,940	
10	816,270	1,417,640	2,233,910	
11	480,250	1,192,480	1,672,730	
12	833,000	487,014	1,320,014	
13	781,500	408,800	1,190,300	
14	641,250	348,740	989,990	
15	891,250	499,660	1,390,910	
16	966,000	481,400	1,447,400	
17	581,250	261,960	843,210	
18	358,680	267,120	625,800	
19	1,337,490	696,000	2,033,490	
20	1,750,320	1,481,920	3,232,240	
21	833,000	1,494,600	2,327,600	
22	570,400	1,626,240	2,196,640	
23	443,750	1,698,840	2,142,590	
24	462,000	1,682,360	2,144,360	
25	448,610	1,521,520	1,970,130	
26	208,600	1,163,880	1,372,480	
27	295,400	366,220	661,620	
28	579,000	1,626,900	2,205,900	
29	1,337,490	1,452,500	2,789,990	
30	2,138,940	805,200	2,944,140	
31	1,474,650	1,579,920	3,054,570	

Table shewing the Computed discharges of Rookoolia and Mahanuddy Rivers at Attka.

54

September 1861

Month & Date	Rookoolia discharge	Mahanuddy discharge	Total	Remarks
1	550,310	1,100,000	1,650,310	
2	2,675,610	5,500,000	8,175,610	
3	1,310,260	5,500,000	6,810,260	
4	836,916	4,500,000	5,336,916	
5	104,160	1,650,880	1,755,040	
6	248,160	1,031,680	1,279,840	
7	559,650	511,000	1,070,650	
8	411,600	436,600	848,200	
9	446,470	458,500	903,970	
10	536,520	619,180	1,155,700	
11	438,960	458,500	897,460	
12	310,100	425,500	735,600	
13	605,850	334,960	940,810	
14	667,080	1,457,940	2,125,020	
15	406,800	1,125,720	1,532,520	
16	347,160	283,020	630,180	
17	305,900	283,020	588,920	
18	925,020	1,220,120	2,145,140	
19	410,290	768,600	1,178,890	
20	387,150	971,360	1,358,510	
21	836,910	1,504,160	2,341,070	
22	1,513,800	1,239,000	2,752,800	
23	720,080	817,000	1,537,080	
24	568,750	721,020	1,289,770	
25	576,300	625,820	1,202,120	
26	558,600	458,500	1,017,100	
27	481,490	313,760	795,250	
28	478,020	331,960	812,980	
29	339,900	277,300	617,200	
30	522,900	577,680	1,100,580	

Table shewing the Computed discharges of Rooskoolea and Mahanuddy Rivers at Attka

Month & Date	Rooskoolea discharge	Mahanuddy discharge	Total	Remarks.
1	374,640	298,920	673,560	
2	441,750	453,260	895,010	
3	1,022,900	1,078,520	2,101,420	
4	874,335	1,380,880	2,255,215	
5	579,000	1,297,200	1,876,200	
6	483,750	1,164,000	1,647,750	
7	2,334,950	1,339,200	3,674,150	
8	871,530	1,224,810	2,096,340	
9	716,100	1,177,500	1,893,600	
10	509,040	1,339,200	1,848,240	
11	429,000	1,421,460	1,850,460	
12	506,880	1,637,010	2,143,890	
13	392,110	949,980	1,342,090	
14	1,499,070	1,188,986	2,689,950	
15	836,350	1,260,540	2,096,890	
16	753,000	963,600	1,716,600	
17	677,120	622,050	1,299,170	
18	576,450	492,560	1,069,010	
19	757,900	775,200	1,533,100	
20	543,660	696,000	1,239,660	
21	486,675	589,300	1,075,975	
22	445,470	391,140	836,610	
23	393,240	321,180	714,420	
24	407,160	327,540	734,700	
25	704,375	313,760	1,018,135	
26	1,835,800	1,489,620	3,325,420	
27	1,865,950	1,489,620	3,355,570	
28	1,114,470	1,405,800	2,520,270	
29	633,490	1,349,250	1,982,740	
30	909,850	1,106,600	2,016,450	
31	839,410	527,220	1,366,630	

October 1851

Table shewing the Computed discharges of Rooskoolea and Mahanuddy Rivers at Attka

Month & Date	Rooskoolea discharge	Mahanuddy discharge	Total	Remarks
1	649,440	247,800	897,240	
2	534,000	216,720	750,720	
3	478,020	186,780	664,800	
4	388,440	132,000	520,440	
5	361,920	155,100	517,020	
6	286,760	127,370	414,130	
7	185,000	115,000	300,000	
8	113,470	64,800	178,270	
9	163,350	87,360	250,710	
10	163,350	87,360	250,710	
11	140,800	64,170	204,970	
12	140,800	64,170	204,970	
13	115,180	64,170	179,320	Rooskoolea
14	115,150	64,170	179,320	Area 44 gauze
15	115,150	53,820	168,970	3000 yds B.S.
16	116,150	44,620	159,770	132,000 yds D.
17	90,900	44,620	135,520	Mahanuddy
18	90,900	44,620	135,520	Area 27 gauze
19	75,140	36,000	111,140	2000 yds B.S
20	75,140	36,000	111,140	54,000 yds D.
21	57,750	30,600	88,350	Total discharge 186,000
22	39,200	25,200	74,400	
23	39,200	25,200	74,400	
24	39,200	21,195	60,395	
25	39,200	21,195	60,395	
26	40,160	21,195	61,355	
27	40,160	16,675	56,835	
28	40,160	16,675	56,835	
29	40,160	16,675	56,835	
30	40,160	16,675	56,835	

November 1851

Observed on the 15th

Table shewing the Computed discharges of Rooskoolia and Mahanuddy Rivers at Atoka.

Month & Date	Rooskoolia Discharge	Mahanuddy Discharge	Total	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16	Area 3.3 gauge	Area 1.5 gauge		
17	3000 gal Velocity 1500 gal Velocity		2.850	Observed at the 9 P.M.
18	6,600 gal Discharge 2250 gal Discharge			
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

January 1870

Very little.

Table shewing the Computed discharges of Rooskoolia and Mahanuddy Rivers at Atoka.

Month & Date	Rooskoolia Discharge	Mahanuddy Discharge	Total	Remarks
1	Area 9,772 gal	Area 9 gauge		
2	2000 gal V.	2400 gal V.		
3	19,440 gal A.	21,600 gal A	11,040	Observed at the 1st.
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16	Area 9 gauge	Area 6 gal		
17	1712 gal V	1500 gal V		
18	15,408 gal A	3900 gal A	19,308	Observed at the 16
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

December 1869.

Apl. Executive Engr's Office Chittagong 21 May 1870.

J. Buckley Captain R.E. Executive Engineer 2nd Sub Divy Chittagong

Table shewing the Computed discharges of Rooekoolia and Brahamdoy Rivers at Aseka

Month & Date	Rooekoolia discharge	Brahamdoy discharge	Total	Remarks
March 1870				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

Remaining Steam.

Do

Flood in Rooekoolia about an average of 100,000 cusecs per hour for 4 days.

Fld. in Executive Engr's Office Cherrapoonjee 21 May 1870

J. Buckley Captain R.E. Executive Engineer on Special Duty Cacharee

C.B. 38 111 24
Survey Office 27th Feb 1871

Rivers Regulation
Ft Rose Rocks and
Bru Kamindeh Jheels
1869 and 1870.

No 1

Estimate of Excavation in the Godahallow

(1) Between Cutlines 224 and 189

		C. ft.	C. yds
No I	Rectangle $76 \times 2 \times 816$	= 124,032	= 4,593 7/9
	Bund $\frac{151 + 190}{2} \times 35 \times 816$	= 2,927,400	
	Bund − Rectangle	= 2,803,368	= 103828 4/9
No II	Rectangle $86 \times 2 \times 3816$	= 656,352	= 24,309 1/3
	Bund $\frac{151 + 215}{2} \times 40 \times 3816$	= 18,153,600	
	Bund − Rectangle	= 17,497,248	= 648,046 2/9
No III	Rectangle $63 \times 2 \times 1000$	= 126,000	= 4,666 2/3
	Bund $\frac{151 + 165}{2} \times 30 \times 1000$	= 2,700,000	
	Bund − Rectangle	= 2,574,000	= 95,333 1/3
No IV	Rectangle $25 \times 2 \times 922$	= 46,100	= 1,707 11/27
	Bund $\frac{10 + 80}{2} \times 14 \times 922$	= 580,860	
	Bund − Rectangle	= 534,760	= 19,805 26/27
No V	Bund $\frac{6 + 26}{2} \times 4 \times 760$	= 48,640	= 1,801 13/27
No VI	Rectangle $104 \times 2 \times 590$	= 122,720	= 4 545 5/27
	Bund $\frac{18 + 258}{2} \times 48 \times 590$	= 3,908,160	
	Bund − Rectangle	= 3,785,440	= 140,201 13/27
Rudder	$18 \times 12 \times 590 = 127,440$ $9 \times 10 \times 590 = 53,100$	= 180,540	= 6,686 2/3

Abstract Estimate of Jallamara Reservoir on the Godahallar

(1) Between Contours 224 and 189.

			Rs	a	p
No I	103,828 4/9	Cubic yards of Earthwork	@ 0-2-3 per C.yd. =	14,600	-14-0
No II	648,046 2/9	do. of Rock	@ 0-2-4 do. =	94,506	-11-10
No III	95,933 1/3	do. of Silt	@ 0-2-2 do. =	12,909	-11-6
No IV	19,805 25/27	do. of Rock	@ 0-1-6 do. =	1,856	-12-10
No V	1,801 13/27	do. of Rock	@ 0-1-0 do. =	112	-9-5
No VI	140,201 13/27	do. of Rock	@ 0-4-6 do. =	39,431	-10-8
	6,886 2/3	do. of Puddle	@ 1-0-0 do. =	6,686	-10-8
	39,822 10/27	do. of Roughstone	@ 0-12-0 do. =	29,866	-12-8
		Sluice and waste Weir		199,971	-13-4
		Ancient Channel below		25,000	-0-0
				15,000	-0-0
				239,971	-13-4
		Superintendence Charges @ 10 per cent		23,997	-2-8
				263,968	-15-0
		Land		105,600	-0-0
		Village		20,000	-0-0
			Total Rs	389,570	-0-0 say 4

Estimate of Jallamara Reservoir on the Godahallar

(1) Between Contours 234 and 189.

			C.ft.	C.yards
No I	Cubic yards of Earthwork	95 × 2 × 816 =	155,040	= 5,782 7/9
	Bund 18+243/2 × 45 × 816 =		4,791,960	
	Bund — Revetment =		4,636,920	= 171,737 7/9
No II	Revetment 106 × 2 × 3816 =		808,992	= 29,962 1/3
	Bund 18+268/2 × 50 × 3816 =		27,284,400	
	Bund — Revetment =		26,475,408	= 980,570 2/3

Abstract Estimate of Jallamara Reservoir on the Godahallar

(1) Between Contours 234 and 189

			C.ft.	C.yards
No III	Revetment 82 × 2 × 1000 =		164,000	= 6,074 2/27
	Bund 15+215/2 × 40 × 1000 =		4,600,000	
	Bund — Revetment =		4,436,000	= 164,296 8/27
No IV	Revetment 48 × 2 × 922 =		88,512	= 3,278 2/9
	Bund 12+132/2 × 24 × 922 =		1,593,216	
	Bund — Revetment =		1,504,704	= 55,729 7/9
No V	Revetment 24 × 2 × 760 =		36,480	= 1,351 1/9
	Bund 10+80/2 × 14 × 760 =		478,800	
	Bund — Revetment =		442,320	= 16382 2/9
No VI	Revetment 124 × 2 × 590 =		146,320	= 5419 7/27
	Bund 25+315/2 × 58 × 590 =		5,817,400	
	Bund — Revetment =		5,671,080	= 210,040
Puddle	18 × 10 × 590 = 127,240			
	10 × 9 × 590 = 53,100 =		180,540	= 6,686 2/3

Abstract Estimate of Jallamara Reservoir on the Godahallar

(2) Between Contours 234 and 189

			Rs	a	p
No I	171,737 7/9	Cubic yards of Earthwork	@ 0-2-6 per C.yd. =	26,834	-0-5
No II	980,570 2/3	do. of Rock	@ 0-2-10 do. =	173,612	-11-6
No III	161,296 8/27	do. of Rock	@ 0-2-4 do. =	23,959	-14-0
No IV	55,729 7/9	do. of Rock	@ 0-2-0 do. =	6,966	-3-6
No V	16,382 2/9	do. of Rock	@ 0-1-6 do. =	1,535	-13-4
No VI	210,040	do. of Rock	@ 0-4-8 do. =	61,261	-10-8
	6,686 2/3	do. of Puddle	@ 1-0-0 do. =	6,686	-10-8
	57,867 5/9	do. of Roughstone	@ 0-12-0 do. =	38,900	-10-8
		Carried over		339,787	-10-9

Brought over 339,787-10-9

Sluice and Waste weir ——— 30,000-0-0

Arieul & Channel below ——— 15,000-0-0

384,787-10-9

Superintendence & Sundries @10 per cent — 38,472-5-3

423,260-0-0

Land ——— 125,600-0-0

Village ——— 25,000-0-0

Total Rs 573,860-0-0 Say 5:75 lacs

No II

Estimate of the Soara da Reservoir on the Goromed by Balwara Cultivators 300 and 270

		C:ft	C:yards
No I	Retchment 54 × 2 × 620	= 66,960	= 2,480
	Bund 18+143/2 × 28 × 620	= 1,397,480	
	Bund — Retchment	= 1,330,520	= 49,278 14/27
No II	Retchment 86 × 2 × 1416	= 243,552	= 9,020 4/9
	Bund 18+218/2 × 43 × 1416	= 7,184,784	
	Bund — Retchment	= 6,941,232	= 257,082 2/3
No III	Retchment 100 × 2 × 296	= 59,200	= 2,192 16/27
	Bund 18+248/2 × 50 × 296	= 1,968,400	
	Bund — Retchment	= 1,909,200	= 70,711 1/9
Puddle	18 × 12 × 296	= 63,936	
	9 × 10 × 296	= 26,640	
		= 90,576	= 3354 2/3

(Soara da Reservoir Continued)

		C:ft	C:yards
No IV	Retchment 54 × 2 × 713	= 77,004	= 2852
	Bund 18+143 × 28 × 713	= 1,607,102	
	Bund — Retchment	= 1,530,098	= 56,670

Abstract Estimate of Soara da Reservoir on the Goromed by Balwara Cultivators 300 and 270

			Rs as p
No I	49,278 14/27 Cubic yds of Earthwork	@ 0-2-2 per C:yd	= 6,673-2-1
No II	257,082 2/3 do of do	@ 0-2-6 do	= 40,169-2-8
No III	70,711 1/9 do of do	@ 0-4-0 do	= 17,677-12-5
	3,354 2/3 do of Puddle	@ 1-0-0 do	= 3,354-10-8
No IV	86,670 do of Earthwork	@ 0-2-0 do	= 7,674-1-0
	16,545 1/27 do of Masonry	@ 0-12-0 do	= 12,408-12-5
			87,957-9-3
	Sluices		= 5,000-0-0
	Waste weir		= 10,000-0-0
			102,957-9-3
	Superintendence and Sundries @10 per cent		= 10,292-6-9
			113,250-0-0
	Land 2.05 × 640 × 30		= 12,000-0-0
	Village		= 48,000-0-0
	Total Rs		173,250-0-0
	Say 1.75 lacs.		

No III

Estimate of Boradapilly Reservoir on the Koos Koolia nus

No Balwara Cultivators 226 and 191

		C:ft	C:yards
No I	Retchment 82 × 2 × 1642	= 269,288	= 9936 16/27
	Bund 15+208 × 38 × 1642	= 6,863,360	
	Bund — Retchment	= 6,595,272	= 244269 1/3

(1) Estimate of Boradafilly Reservoir on the Roorkeelia

(2) Between Contours 236 & 191

		C. ft.	C. yards
No I	Embankment 104 × 2 × 1642 =	341,536 =	12,649 13/27
	Bund 18 + 2.58 × 48 × 1642 =	10,876,608	
	Bund — Embankment =	10,535,072 =	390,187 23/27
No II	Embankment 90 × 2 × 940 =	169,200 =	6,266 2/3
	Bund 18 + 233 × 43 × 940 =	5,072,710	
	Bund — Embankment =	4,903,510 =	181,611 13/27
No III	Embankment 128 × 2 × 749 =	191,744 =	7,101, 17/27
	Bund 25 + 325 × 60 × 749 =	7,864,500	
	Bund — Embankment =	7,672,756 =	284,176 4/27
	Puddle { 25 × 12 × 749 = 224,700		
	{ 9 × 10 × 749 = 67,410 =	292,110 =	10,818 8/9
No IV	Embankment 96 × 2 × 538 =	103,296 =	3825 7/9
	Bund 18 1243 × 45 × 538 =	3,159,405	
	Bund — Embankment =	3,056,109 =	113,189 2/9

Abstract Estimate of Boradafilly Reservoir on the Roorkeelia

(2) Between Contours 236 & 191.

No IV	503,377 2/27 C. ft. of Earthwork Co-2-6 per C.yd.		78,652-10-8
No II	181,611 13/27 Do of Do	Co-2-4- Do =	26,484-15-0
No III	284,176 4/27 Do of Do	Co-4-3- Do =	75,484-4-7
	10,818.8/9 Do of Puddle	Co-1-0-0 Do	10,818-14-2
	25,843 8/9 Do of Roughstone	Co-12-0 Do	22,382,10-8
	Carried over		213,823-7-1

Abstract Estimate of Boradafilly Reservoir on the Roorkeelia

Between Contours 236 & 191 (2)

No IV	312,685 C. yards of Earthwork	Co-2-3 per C.yd.	= 43,771-0-5
No II	107,003 1/3 Do of Do	Co-2-2- Do	= 14,490-0-6
No III	195.120 19/27 Do of Do	Co-4-0- Do	= 48,782-1-5
	8,488 2/3 Do of Puddle	Co-1-0-0- Do	= 8,488-10-8
	24,010 14/27 Do of Roughstone	Co-12-0 Do	= 18,107,14-2
			133,740-0-0
	Sluice and Waste weir		25,000-0-0
	6 Miles of Road and Bridges		17,000-0-0
			175,740-0-0
	Superintendence and Sundries 10 per cent		17,570-0-0
			193,310-0-0
	Villages		20,000-0-0
	Land 2.75 × 640 × 40 =		70,400-0-0
	Total		283,710-0-0 Say 284

Estimate of Boradafilly Reservoir on the Roorkee

(3) Between Contours 216 and 191

No IV	738,050 5/27 C.yards of	Earthwork	@ 0-2-9 per C.yd = 126,852-6-0
No II	282,539 17/27 do of	do	@ 0-2-8 do = 47,089-15-0
No III	377,940 8/9 do of	do	@ 0-4-6 do = 106,858-6-0
	8,488 2/3 do of	Puddle	@ 1-0-0 do = 8,488-10-8
	36,777 17/27 do of	Rough stone	@ 0-12-0 do = 27,583-3-6
			316,872-9-2
	Sluice and waste weir		35,000-0-0
	10 Miles of road & Bridges		25,000-0-0
			376,872-9-2
	Superintendence @ 10 per Cent		37,687-6-10
			414,560-0-0
	Villages		25,000-0-0
	Land 4×640×40		102,400-0-0
			Total Rs 541,960-0-0
			Say 5:5 Lacs.

No IV

Estimate of Belliguleh Reservoir on the Roorkee

(1) Between Contours 271 & 231

		Cft.	C.yards
No I	Benchmark 110×2×820	= 65,600	= 2,429 17/27
	Bund 10+110/2 × 20 × 820	= 984,000	
	Bund — Benchmark	= 918,400	= 34,014 22/27
		Cft	C.yards
No II	Benchmark 80×2×2889	= 462,240	= 17,120
	Bund 151+715/2 × 40 × 2889	= 13,289,400	
	Bund — Benchmark	= 12,827,160	= 475,080

Estimate of Boradafilly Reservoir on the Roorkee

(3) Between Contours 216 & 191

		Cft	C.yards
No I	Benchmark 128×2×1642	= 1120,352	= 15,568 16/27
	Bund 25+325/2 × 58 × 1642	= 16,666,300	
	Bund — Benchmark	= 16,248,948	= 601,701 7/9
		Cft	C.yards
No II	Benchmark 116×2×940	= 218,080	= 8,077 1/27
	Bund 25+290/2 × 53 × 940	= 7,848,650	
	Bund — Benchmark	= 7,628,570	= 282,539 11/27
		Cft	C.yards
No III	Benchmark 152×2×749	= 227,896	= 8,429 13/27
	Bund 25+375/2 × 70 × 749	= 10,486,000	
	Bund — Benchmark	= 10,258,404	= 379,940 8/9
	Puddle { 18×12×749 = 161,784		
	10×9×749 = 67,410	= 229,194	= 8,488 2/3
		Cft	C.yards
No IV	Benchmark 118×2×538	= 126,968	= 4,702 14/27
	Bund 25+300/2 × 55 × 538	= 4,808,375	
	Bund — Benchmark	= 4,681,407	= 136,314 11/27

Earthwork	213,823-7-1
Sluice and waste weir	30,000-0-0
8 Miles of road & Bridges	23,000-0-0
	266,823-7-1
Superintendence @ 10 per Cent	26,686-8-11
	293,510-0-0
	22,500-0-0
Villages	89,600-0-0
Land 3.5×640×40 =	

Total Rs 405,610-0-0 Say 4.25 Lacs

		C ft	C yds
No III	Revetment 94 × 2 × 658	= 123,704	= 4,581 17/27
	Bund $\frac{18+24\frac{3}{4}}{2}$ × 45 × 658	= 3,197,880	
	Bund — Revetment	= 3,074,176	= 113,858 10/27

		C ft	C yds
No IV	Revetment 112 × 2 × 339	= 75,936	= 2,812, 4/9
	Bund $\frac{18+28\frac{1}{2}}{2}$ × 53 × 339	= 2,704,033½	
	Bund — Revetment	= 2,628,097½	= 97,336 13/18
	18 × 12 × 339	= 73,224	
	9 × 10 × 339	= 30,510	= 103,734 = 3,842

Abstract Estimate of Bulligutch Reservoir on the Roorkee
(1) Between Contours 271 & 231.

No I	21,041 21/27	C yds of Earthwork	@ 2-0-6 per C yd = 4,231-13-7
No II	475,080	do of do	@ 2-2-6 do = 74,231-4-0
No III	113,858 10/27	do of do	@ 2-2-8 do = 18,970-6-3
No IV	97,336 13/18	do of do	@ 2-4-0 do = 24,334-2-6
	3,842	do of Puddle	@ 1-0-0 do = 3,842-0-0
	26,943 12/27	do of Roughstone	@ 2-12-0 do = 17,707-12-5
			143,343-6-9
Sluice and waste Weir			25,000-0-0
3 Miles of road & Bridges			6,000-0-0
			174,343-6-9
Superintendence & Sundries @ 10 per cent			17,656-9-3
			192,000-0-0
Village			10,000-0-0
Land 1.5 × 640 × 40			38,400-0-0
Total Rs			240,400-0-0
Say 2.5 lacs.			

Estimate of Bulligutch Reservoir on the Roorkee Rodia
(2) Between Contours 281 & 231.

		C ft	C yds
No I	Revetment 61 × 2 × 820	= 100,040	= 3,705 5/27
	Bund $\frac{15+16\frac{5}{2}}{2}$ × 30 × 820	= 2,214,000	
	Bund — Revetment	= 2,113,960	= 78,294 22/27

		C ft	C yds
No II	Revetment 107 × 2 × 2889	= 618,246	= 22,896
	Bund $\frac{18+26\frac{8}{2}}{2}$ × 50 × 2889	= 20,666,350	
	Bund — Revetment	= 20,038,104	= 742,152.

		C ft	C yds
No III	Revetment 117 × 2 × 658	= 153,972	= 5,702 2/3
	Bund $\frac{18+29\frac{3}{2}}{2}$ × 55 × 658	= 5,627,545	
	Bund — Revetment	= 5,473,573	= 202,724 25/27

		C ft	C yds
No IV	Revetment 138 × 2 × 339	= 93,564	= 3,465 1/3
	Bund $\frac{20+33\frac{5}{2}}{2}$ × 63 × 339	= 3,790,867	
	Bund — Revetment	= 3,697,303	= 136,937 4/27
Puddle	18 × 12 × 339 = 73,224		
	10 × 9 × 339 = 30,510	= 103,734	= 3,842.

Abstract Estimate of Bulligutch Reservoir on the Roorkee
(2) Between Contours 281 & 231.

No I	78,294 22/27	C yds of Earthwork	@ 2-2 per C yd = 10,602-6-9
No II	742,152	do of do	@ 2-2-6 do = 115,961-4-0
No III	202,724 25/27	do of do	@ 2-2-9 do = 34,843-5-6
No IV	136,937 4/27	do of do	@ 2-4-0 do = 34,234-4-7
	3,842	do of Puddle	@ 1-0-0 do = 3,842-0-0
	35,771 5/27	do of Roughstone	@ 2-12-0 do = 26,828-6-2
Carried over			226,311-11-0

Brought over ——— 226,311-11-0

Sluice and waste weir ——— 30,000-0-0

4 Miles of Road & Bridges ——— 8,000-0-0

264,311-11-0

Superintendence & Sundries 10 per cent — 26,188-5-6

290,800-0-0

Villages ——— 12,000-0-0

Land 2×640×40 ——— 31,200-0-0

Total Rs 354,000-11-0 Say 3.

No V

Estimate of Bavancona Reservoir on a tributary of the Kohanahin

(1) Between Contours 150 and 105

		C.ft	C.yds
No I	Revetment 84×2×30.8	= 60,144	= 2,227 9/27
	Bund 18+215/2 ×40×30.8	= 1,646,800	
	Bund — Revetment	= 1,586,656	= 58,765 1/27
No II	Revetment 106×2×826	= 175,112	= 6485-17/27
	Bund 18+268/2 ×50×826	= 5,905,900	
	Bund — Revetment	= 5,730,788	= 212,251 11/27
No III	Revetment 134×2×100	= 26800	= 992 16/27
	Bund 18+331/2 ×63×100	= 1,105,650	
	Bund — Revetment	= 1,078,850	= 39,957 11/27
Puddle	18×12×100 = 21,600 10×9×100 = 9000	= 30,600	= 1,133 1/3

(Bavancona Reservoir-Continued)

		C.ft	C.yds
No IV	Revetment 128×2×1094	= 280,064	= 10,372 20/27
	Bund 184 318/2 ×60×1094	= 11,028,420	
	Bund — Revetment	= 10,748,456	= 398,090 26/27
No V	Revetment 52×2×1230	= 127,920	= 4737. 9/9
	Bund 184 143/2 ×25×1230	= 2,475,375	
	Bund — Revetment	= 2,347,450	= 86,942 16/27

Abstract Estimate of Bavancona Reservoir on a tributary of the Kohanahin

(1) Between Contours 150 & 105

Abstract	58,765 1/27	C.yds	Earthwork C 0-2-2 per C.yd	= 7,957-12-3
No I	212,251 11/27	do	do C 0-2-8 do	= 35,375-3-9
No II	39,957 11/27	do	do C 0-3-6 do	= 8,740-10-11
No III	1,133 1/3	do	Puddle C 1-0-0 do	= 1,133-5-4
No IV	398,090 26/27	do	Earthwork C 0-3-0 do	= 74,642-0-10
No V	86,942 16/27	do	do C 0-2-0 do	= 10,867-13-2
	24,816 3/27	do	Rough stone C 0-12-0 do	= 18,612-3-6
				157,329-1-9
			Sluice and waste weir	15,000-0-0
				172,329-1-9
			Superintendence & Sundries 10 per cent	17 230-14-3
				189,560-0-0
			Villages	15,000-0-0
			Land 2×640×40	51,200-0-0
			Total	255,760-0-0
			Say 2.55 lacs.	

Estimate of the Batavanoa Reservoir on a tributary of Kohanakandy

(2) Belumma Contour 1140 and 1105 - 10ft Lower

		Cft	C.yds
No I	Revetment 38×2×288 =	21,888	= 820 $\frac{2}{3}$
	Bund $\frac{15+115}{2}$ × 20×288 =	374,400	
	Bund — Revetment =	352,512	= 13,056
No II	Revetment 70×2×250 =	35,000	= 1296 $\frac{5}{27}$
	Bund $\frac{15+190}{2}$ × 35×250 =	896,875	
	Bund — Revetment =	861,875	= 31,921 $\frac{8}{27}$
No III	Revetment 109×2×100 =	21,800	= 807 $\frac{2}{27}$
	Bund $\frac{18+283}{2}$ × 53×100 =	797,650	
	Bund — Revetment =	775,850	= 28,735 $\frac{5}{27}$
	Puddle 18×12×100 =	21,600	
	" 10×8×100 =	9,000	= 30,600 = 1,133 $\frac{1}{3}$
No IV	Revetment 104×2×1094 =	227,552	= 8,427 $\frac{23}{27}$
	Bund $\frac{15+265}{2}$ × 50×1094 =	7,658,000	
	Bund — Revetment =	7,430,448	= 275,201 $\frac{7}{9}$
No V	Revetment 71×2×876 =	124,392	= 4607 $\frac{1}{9}$
	Bund $\frac{15+190}{2}$ × 35×876 =	3,142,650	
	Bund — Revetment =	3,018,258	= 111,787 $\frac{1}{3}$
No VI	Revetment 26×2×500 =	26,000	= 962 $\frac{26}{27}$
	Bund $\frac{12+87}{2}$ × 15×500 =	373,250	
	Bund — Revetment =	347,250	= 12,861 $\frac{1}{9}$

Abstract Estimate of Batavanoa Reservoir on a Tributary of the Kohanakandy (2) Belumma Contour 1140 & 1105 — 10ft Lower

No I	13,056 C. yards of Earthwork C.o-1-9 per C.y =		1,428-0-0
No II	31,921 $\frac{8}{27}$ do of do do C.o-2-2 do =		4,322-10-9
No III	28,735 $\frac{5}{27}$ do of do do C.o-3-6 do =		5,387-13-6
	1,133 $\frac{1}{3}$ do of Puddle C.1-0-0 do =		1,133-5-4
No IV	275,201 $\frac{7}{9}$ do of Earthwork C.o-2-6 do =		43,000-4-5
No V	111,787 $\frac{1}{3}$ do of do do C.o-2-2 do =		15,137-13-10
No VI	12,861 $\frac{1}{9}$ do of do do C.o-1-6 do =		1,205-11-8
	16,922 $\frac{8}{27}$ do of Rough stone C.o-12-0 do =		12,691-11-6
	Sand measure and Share		84,307-7-0
	Superintendence and Sundries C10 per cent		10,000-0-0
			94,307-7-0
			9,432-9-0
			103,740-0-0
	Village		12,000-0-0
	Land 2×640×40		51,200-0-0
			Total Rs 166,940-0-0
			Say 1.66 lacs

No VII

Estimate of Kallada Reservoir on the Mahanaddy -

(1) Belumma Contour 91 and 54

	Cft	C.yds
Revetment 46×2×570 =	5,244	= 194 $\frac{2}{9}$
Bund $\frac{10+135}{2}$ × 25×570 =	1,033,125	
Bund — Revetment =	1,027,881	= 38,069 $\frac{2}{3}$

		C ft	C yards
No II	Revetment 78×2×758 =	118,248	= 4,379 5/9
	Bund $\frac{15+215}{2}$ ×40×758 =	3,486,800	
	Bund — Revetment =	3,368,552	= 124,761 5/27
No III	Revetment 110×2×4830 =	1,062,600	= 39,355 5/9
	Bund $\frac{20+295}{2}$ ×55×4830 =	41,839,875	
	Bund — Revetment =	40,777,275	= 1,510,269 4/9
No IV	Revetment 184×2×300 =	110,400	= 4,088 8/9
	Bund $\frac{20+320}{2}$ ×60×300 =	3,060,000	
	Bund — Revetment =	2,949,600	= 109,244 4/9
No V	Revetment 78×2×332 =	65,072	= 2410 2/27
	Bund $\frac{15+265}{2}$ ×50×332 =	2,324,000	
	Bund — Revetment =	2,258,928	= 83,664
No VI	Revetment 53×2×1084 =	114,904	= 4,255 1/3
	Bund $\frac{101-160}{2}$ ×30×1084 =	2,764,200	
	Bund — Revetment =	2,649,296	= 98,122 2/27

Abstract Estimate of Kollada Reservoir on the Mahanadi

(1) Between Contours 94 and 54

No I	38,069 2/3 C. yds of Earthwork	C 0-1-8 per C yd =	3,965-9-5
No II	124,761 5/27 do of — do —	C 0-2-0 do =	15,595-2-4
No III	1,510,269 4/9 do of — do —	C 0-2-8 do =	251,711-9-2
No IV	109,244 4/9 do of — do —	C 0-3-0 do =	20,483-5-4
No V	83,664 do of — do —	C 0-2-8 do =	13,944-0-0
No VI	98,122 2/27 do of — do —	C 0-1-9 do =	10,732-1-6
	Carried over —		316,431-11-9

Brought over —	316,431-11-9
54,684 C yds of Ring bund @ 0-12-0 per C yd =	41,013-0-0
	357,444-11-9
Sluice	5,000-0-0
Waste weir	20,000-0-0
Puddling	5,000-0-0
	387,444-11-9
Superintendence & Sundries @ 10 per cent	38,755-4-3
	426,200-0-0
Villages	20,000-0-0
Land 6×640×30 =	115,200-0-0
Total	561,400-0-0
	say 5.6 lacs.

Estimate of Kollada Reservoir on the Mahanadi

(2) Between Contours 101 & 54

		C ft	C yards
I	Revetment 73×2×760 =	110,960	= 4,109 17/27
	Bund $\frac{15+190}{2}$ ×35×760 =	2,726,500	
	Bund — Revetment =	2,615,540	= 96,871 23/27
II	Revetment 107×2×758 =	162,212	= 6007 23/27
	Bund $\frac{18+268}{2}$ ×50×758 =	5,419,700	
	Bund — Revetment =	5,257,488	= 194,721 2/9
III	Revetment 138×2×4830 =	1,333,080	= 49,373 1/3
	Bund $\frac{20+345}{2}$ ×65×4830 =	77,295,875	
	Bund — Revetment =	75,962,795	= 2,813,436 23/27
IV	Revetment 152×2×300 =	91,200	= 3377 7/9
	Bund $\frac{20+370}{2}$ ×70×300 =	4,095,000	
	Bund — Revetment =	4,003,800	= 148,288 8/9

		Cft	C.yds
No V	Revetment 128×2×332	= 84,992	= 3147 23/27
	Bund $\frac{18+318}{2}$ ×60×332	= 3,346,560	
	Bund — Revetment	= 3,261,568	= 120,798 21/27

		Cft	C.yds
No VI	Revetment 84×2×1084	= 182,112	= 6,744 8/9
	Bund $\frac{15×215}{2}$ ×40×1084	= 4,986,400	
	Bund — Revetment	= 4,804,288	= 177,936 16/27

Abstract Estimate of Kolla da Reservoir on the Mahanuddy

(3) Between Contours 101 & 54.

No I	96,871 23/27	C.yds of	Earthwork @ 0-2-2 per C.yd	= 13,118-1-0
No II	194,721 7/9	do of	do @ 0-2-9	do = 33,467-12-10
No III	2,813,436 23/27	do of	do @ 0-3-2	do = 556,826-0-8
No IV	148,288 8/9	do of	do @ 0-4-6	do = 41,706-4-0
No V	120,798 22/27	do of	do @ 0-3-0	do = 22,649-12-5
No VI	177,936 16/27	do of	do @ 0-2-6	do = 27,802-9-6
	72,761 1/3	do of	Rough stone @ 0-12-0	do = 54,571-0-0
				750,141-8-5
	Sluices and Wasteweir			30,000-0-0
	Puddling			5,000-0-0
				785,141-8-5
	Superintendence & Sundries @ 10 per cent			78,518-7-7
				863,660-0-0
	Villages			25,000-0-0
	Land			125,000-0-0
				Total Rs 1,013,660-0-0
				Say 10 lacs

Special Engr Office Chatterpore 21st May 1870

J. Buckley, Captain R.E. Executive Engr Gangaur

From
The Executive Engineer
Aurungabad Duty
Gangaur
To
The Superintending Engr
1st Division
Dated Aurungabad 21st May 1870
Rec'd
No. P.N. 38 11/70
Forwarding abstract Estimate of the Proposed Lose Reservoirs in connection with the Irrigation Project North Gangaur.

9

Cft Copy

Rov Revetment 128 x 2 x 232 01 00 2 11 24

68

Superintending Engr's Office
1st Division
No 833 New Caiwar 9th June 1870

From, Alex Jelinge, Superintending Engineer
1st Division

To, Alex Jelinge Chief Engineer
for Irrigation
Madras

Sir,

I have the honor to forward for
your information, the accompanying original
report and statement together with the charges
of the Revetment Works referred to, executed
from Capt Cubbon R.E. the Executive
Engineer in Special charge Gingee, for protecting
the irrigation in Tank Channels from the
Vellar River.

2 Mr Cubbon states in his letter, that
several repairs had to be effected to the Revetment
walls, which have not been maintained for
many years but which are sufficient from
what has been done, with Reservoirs, a form
sent shortly to be maintained in the
Channels during the ensuing season to secure
the Masonry in its Situation for the Tank
will work properly. Recommend
ed.

are required to determine how much more the water can be utilized.

3 I am decidedly of opinion that it would be the greatest mistake possible to omit the Navigation part of the projects, the entire economical results looked to are obtained by the works alone by Agreement. Upon this it is not absolutely necessary to have any particular Classification of Locks for the whole Presidency, this is merely creating a restriction of a very arbitrary Character, and for no purpose. The Locks should be made suitable to the kind of boat it is intended to employ on the particular line of Canals to be provided for any District, and not in my opinion, taken from one System of Navigation to be the design for all parts of the Country. In the case of Captain Beckley's Canals, although 14 Locks 70 × 11 with single gates would be the best arrangement to adopt, a boat drawing 3 feet of water would be able to convey from 20 to 25 tons of produce, and with the available water-supply, regulated and distributed by Reservoirs, it would be easy to keep from

from 4 to 4½ feet on the Rockhills, which is quite sufficient for good Navigation in so small an area of Country, as has here to be provided for.

4 I agree with Captain Beckley generally, as to the manner in which he proposes to carry out and construct the several works proposed by him - it will be seen, that Officers shews, it would not be expedient to increase the Slope of the Canal bed, and as this would moreover interfere with the Navigation, it would be highly objectionable. I have not been able to go further into the matter as the Designs for the Canals are not in this Office.

5 As regards the rates in the Estimates, I think it would be very inadvisable to put these down much in excess of those now prevailing, and that it is far better to have an understanding in a matter of this kind, what rates are allowed in the Estimate are certain to be asked for by Contractors and Executive Officers would be put to great inconvenience, if any further rise were

were to take place from unforeseen circumstances.

I have the honor to be
Sir,
Your most Obed.t Servant

Geo. B. Buckle Major R.E.
A.S. Supg Engineer 1st Division

From Lieut. Col. Gordon R.E.
To A.S. Supg Engineer
1st Division

Forwarded to Chief Engineer
for Irrigation
Madras

Dated 9th June 1870
Read 11th June 1870

Forwards the Original Report per Revenue from Captain Buckle, R.E. Engineer on Special duty Irrigation for Inspection the Irrigation in the District from the Krishna to Cuddapah.

Sent

Copy

Forwarded to Chief Engineer for Irrigation

Dated 9th June 1870

Rec.d 13th Oct.r 1870

No 377

Forwarded to Chief Engineer for Irrigation

Dated 9th June 1870

Note by the Acting Chief Engineer for Irrigation

Since the order of Government of the 8th February last N° 441, was passed on the Koshkoolia Project, the Superintending Engineer has submitted a further report by Captain Beckley containing some additional information, as also the results of his examination of the country in search of reservoir sites.

2. The project is not yet sufficiently matured to admit of its submission to Government, but it will be convenient to review the information which has been collected by Captain Beckley and to show, as far as may be, the probable value of the project, and what is still necessary to enable Government to decide whether it should be submitted to the Government of India for sanction.

3. I propose therefore to consider here the features presented by the Project as regards 1st the water supply and the arrangements proper in connection therewith.

2nd such details of the project as appear to require

require notice.

3 The probable cost of the works and the returns to be expected from the scheme

4 The data for estimating the water supply available are still very imperfect, and as yet the information given regarding the position and circumstances of the area to be irrigated is insufficient to enable a clear idea of the best way of dealing with the supply to be formed. A part of the supply is to be drawn from the Mahanuddy, and of the discharge of the Mahanuddy Canal a portion will no doubt be utilized in the irrigation of the Doab, and the rest will be carried on to the Rooshikoolia and there taken into the canal from this latter river.

Water supply

Captain Beckley's return of 11 Sept 1869 gives 37,5000 acres as the area in the Doab, but it is not clear upon what data this conclusion is based.

5 On para 3 of the Memorandum printed in the order of Government quoted at the beginning of this note, it was mentioned that the highest duty which should be assigned to a cubic foot of water per second should be the irrigation of 100 acres. This duty is 50 per cent higher than that allowed in Districts to the South of Ganjam. Captain Beckley

Letter No 38 paras 3 and 4.

Beckley appears to think that the quantity of water named is capable in Ganjam of irrigating a larger area. He alludes to the great difference between the climate of Ganjam and that of the Southern Districts, and mentions that, whereas in the latter rice cultivation without artificial irrigation is impracticable, in the former it has been so cultivated from time immemorial. It must be remembered that the chief value of the scheme will be in securing fair average crops in adverse seasons, when consequently the ordinary existing sources of water supply would either fail altogether or be greatly diminished, and when therefore nearly the whole area under the canals would be entirely dependent upon the additional or new supply, which it is proposed to provide. The rainfall register submitted with Captain Beckley's letter gives an average of 48.92 inches for 1869 at the six stations at which the rainfall has been recorded, and the average would not be materially altered by taking those stations only which this officer considers to fairly represent the tract of country to be irrigated. June to October are

× Chitterpore - 43.78
Berhampore - 49.70
Asha - 48.15
141.63
47.21

are the monsoon months, and they correspond with the season for cultivation. The rainfall differs but little in quantity from that of Madras, and in the absence of any direct evidence as to the supply of water required to bring rice crops to maturity in Ganjam, it would not, I think, be prudent to calculate upon a higher duty than 50 per cent in excess of the irrigating power of a cubic foot a second in other Districts. Taking then 100 acres to the cubic foot per second, the area intended to be watered being 110,000 acres the average supply must be 1,100 cubic feet a second. Elsewhere it has been considered necessary that variations in the supply should be compensated for within periods of 10 days each, but here it will probably suffice if the whole total supply required be made available within 15 day periods, or in other words if the short supply of some of the 15 days be made up by a corresponding excess during the remainder of the period.

6 In order that it may clearly be understood what the rivers can do, and how far they must be supplemented by storage reservoirs, it will be advisable to prepare statements showing for the Mahanuddy canal in

Column 1- The dates of the several 15 day periods

" 2- The supply required for cultivation in each period

" 3- The quantity available in the river within the maximum capacity of the canal

" 4- The quantity deficient in canal & to be provided for by storage

" 5- The quantity surplus in the canal & available for the Koothkoolia canal.

" 6- The quantity surplus in the river and available for storage.

Similarly for the Koothkoolia canal should be shown in

Column 1,
" 2 } as for Mahanuddy canal
" 3 }
" 4 Quantity available from Mahanuddy canal
" 5 Total available within maximum capacity of the canal.

" Column

Column 6. Quantity deficient in canal to be provided for by storage.

" 7 Quantity surplus in river and available for storage.

" 8 Quantity (if any) which must be stored in rivers not falling into the Koosh-Kooliah above the anicut.

A maximum discharge has been spoken of for these canals, and this maximum may be taken at 50 per cent in excess of the ordinary full supply, for, for the,

Mahanuddy canal 450 + 225 = 675 lb. ft a second

Koshkoolia canal 950 + 475 = 1425 " "

the proportions may require modifications with reference to the areas under the two canals respectively, and the above supposes that $\frac{9}{28}^{ths}$ of the whole area will be irrigated from the smaller canal or in the Doab, and $\frac{19}{28}^{th}$ from the larger canal. If nearly the whole of the cultivation be under the Koshkoolia canal its ordinary capacity should be $\frac{\text{acreage}}{100}$ = cubic feet per second and its maximum capacity

50 per cent additional. 74 Lf.

The tables of computed discharges of the rivers will enable a rough approximation to be made of the irrigating power of the rivers, and of the extent to which their supply must be economized or supplemented by reservoirs, they commenced with August 1868. The season will here be taken as extending from the 16th June to the end of November, and it may be supposed that for the first 15 days, and for the last 30 days, of the season, half a full supply will suffice, for the seed beds in the former period, and for the smaller area requiring water in the latter. Shew the total supply to be provided per acre will be

16th to 30th June	$15 \times 24 \times \frac{2}{3}$ =	240
July	$31 \times 24 \times 1\frac{1}{3}$ =	992
August	$31 \times 24 \times 1\frac{1}{3}$ =	992
September	$30 \times 24 \times 1\frac{1}{3}$ =	960
October	$31 \times 24 \times 1\frac{1}{3}$ =	992
November	$30 \times 24 \times \frac{2}{3}$ =	480
	Total cubic yards	4656

against

against 6.000 cubic yards the ordinary allowance for the 1st crop in other Districts. The total supply required in each month for the whole area, and the quantity available, are shown below, as also the surplus in the rivers in excess of the maximum of 2100 cubic feet or seconds or 280,000 cubic yards an hour, which the canals have been supposed to be capable of carrying, viz. 90,000 for the Mahanuddy and 190,000 for the Rookhkoodia canal; **the figures denote millions of Cubic yards and decimal parts of a million.**

Periods	Quantity required for irrigation	Available within capacity of Canals		Total available	Deficiency to be provided for by storage	Surplus available for storage		Total surplus
		Mahanuddy	Rookhkoodia			Mahanuddy	Rookhkoodia	
Latter half of June	33.60	20.325	8.340	28.665	4.93	4.405	0.105	14.51
July	138.88	43.015	42.571	85.586	53.30	61.589	6.799	68.38
August	138.88	44.640	94.240	138.880	–	678.530	446.450	1125.98
September	134.40	43.200	91.200	134.400	–	808.930	366.710	1175.64
October	138.88	44.640	94.240	138.880	–	674.083	501.330	1178.41
November	67.20	21.600	45.600	67.200	–	29.949	69.920	94.87
Totals	651.84	217.420	376.191	593.611	58.23	2260.486	1392.314	3652.79

The above is for the year 1869 and, from August to the end of the season, the rivers, with the exception of one day in September, were discharging more water than the canals would.

× 10.7 ft. per second per 100 acres

would require and therefore the ordinary full supply only has been taken, and the balance entered as available for storage. Similar particulars for the part of the season of 1868, for which records were kept, are given below.

Periods	Quantity required for irrigation	Available within capacity of canals		Total available	Deficiency to be provided for by storage	Surplus available for storage		Total surplus
		Mahanuddy	Rookhkoodia			Mahanuddy	Rookhkoodia	
17 days in August	76.16	18.278	26.578	44.856	31.31	4.277	39.908	43.418
September	134.40	43.200	91.200	134.400	–	35.459	55.928	91.38
October	138.88	30.122 38.100	40.537	109.959	29.82	15.926	3.235	19.16
November	67.20	4.320		4.320	62.88			
Totals	416.64			292.635	124.01	55.662	98.371	154.02

Captain Buckley, in para 30 of his letter, states the drainage basin of the Rookhkoodia a little above the ancient site, to be 825 square miles, and that of the Mahanuddy may be estimated from paras 34 & 35 to be about 450 square miles. Rivers of this class are dependent upon what may be termed local rainfall; considerable freshes are of short duration, and the quantities discharged vary greatly from day to day. On the whole however the above particulars give a fairly favourable view of the rivers

and

and probably in the hill country, in which they take their rise; the rains are less liable to total or nearly entire failure than in the plains in which it is proposed to throw their waters to some account. It is not practicable on the data available to form a reliable opinion as to the amount of storage which would be likely to suffice to render the cultivation secure, but it is probable that, when returns for a series of years are forthcoming, it will be found that if reservoirs capable of holding one-third of the total quantity required, or say 250 millions of cubic yards, be provided, the supply in the canals will be capable of being maintained throughout the season, even in years which are much less favourable than the average, while in good years one-third of this quantity would perhaps be sufficient.

8. Under these circumstances it appears to me that a tentative arrangement will

will be the best. The development of irrigation will be the work of some years, and it would not therefore be economical to provide storage for the whole ultimate area at once. I would therefore propose that in the first instance one or two reservoirs of moderate dimensions be constructed, and it will be preferable to select sites for these rather on considerable tributaries of, than on, the principal rivers. It must be remembered that 100 millions of stored water must be taken as the equivalent of 75 millions drawn direct from the river, in order to allow for evaporation and wastage en route to the canals. On the other hand, if the drainage basin be large in proportion to the quantity to be stored, it may be assumed that the tank will be refilled after a portion of its contents has been drawn off, and perhaps therefore the practical capacity of such a reservoir may be without risk assumed at 1½ times its nominal contents. The Dorada site on the

Doranaddy

Jorruddy, a tributary of the Kooshkoolia and falling into the latter river about 12½ miles above the proposed anicut, appears to me very suitable, as far as the information at present available will enable a judgment to be arrived at, for affording a moderate supplemental supply to the scheme of irrigation The site is described in para 29 of Captain Beckley's report and the particulars may be thus summarized

Area of catchment basin	× 232 square miles	× Surface The area a little over 250 square miles.
Depth of water proposed	30 feet	
Area of water spread	5.14 square miles.	
Maximum area liable to submergence with 3 feet on waste weir	5.50 do	
Capacity	70 millions C. yds	
Estimated cost	Rupees 1,75,000	

The storage here then would be at the rate of 400 cubic yards for the Rupee if once filled each season, and 600 cubic yards if an additional half supply were received, and utilized

utilized. The Jorruddy rises in the hills S.S.W. of Sorada and according to the atlas sheet, its head waters are at a distance of 22 miles from its junction with the Kooshkoolia, the reservoir site being but little above that junction In moderately good seasons the supply of the Santo might be expected to amount to 8" draining off the whole area, or about ⅛ of the rainfall and this would amount to 172 millions of cubic yards of which it has been assumed that 70 + 35 = 105 millions, would be stored & used In bad seasons probably the Santo would be just filled. The maximum discharge to be provided for at the waster weir of the reservoir would perhaps be six inches of drainage from the whole catchment basin, less half the capacity of the reservoir, in the 24 hours, and if so the length of the waste weir with 3 feet going over would require to be 1600 feet The actual maximum discharge should be ascertained from flood marks, or information obtained from villagers, compiled into longitudinal and transverse sections of the river. Captain Beckley allows 10,000 Rupees for the waste weir

D = 29,395 C ft per second = 3.92 millions of C yds an hour

The formula $D = 75.000 M^{\frac{2}{3}}$ gives 2.976 millions of cubic yds an hour

weir? which does not seem likely to be enough, unless a very favourable site to be discoverable, and the sluice will perhaps cost 10,000 instead of 5,000 Rupees; as it must be capable of passing a large body of water, and will require to be provided with small openings for use when the tank is full, and not too large pents for passing the required discharge with a small head. The detailed plans show that the length of the bund at top would be 3,675 feet, the level of the top 313 against 300 for full tank and 303 for maximum water level. I think that the maximum level might be taken at 305; and that 5 feet of water might be allowed to pass over the waste weir during the few hours that extreme floods would last, and the length of the weir would then be reduced to less than one half that required with a depth of 3 feet. Captain Beckley should however use his discretion, with reference to the circumstances of the site and of the materials available, in determining the maximum depth to be allowed on the crest of the

say 750 Cft a second

The datum used is mean sea level

the weir. On cross section N° 3 of the bund, Captain Beckley has shown the arrangement of puddle core estimated for by him. On any case the puddle wall should be carried up a few feet above maximum water level and I have shown in red pencil 2 arrangements either of which may be adopted. On the one case the wall occupies the centre of the bund; its top is 3 feet broad and 3 feet above maximum water level and each face has a batter of 1 in 6. On the other case the bottom and top thicknesses are similar, and the upper surface is placed parallel to and 6 feet below the interior slope of the bund so as to have that thickness of soil between the retainment and the puddle. The retainment should be bedded against a layer about 1 foot thick of clayey gravel; ordinary laterite gravel is a good material.

On the case of this reservoir the capacity is 1 million of cubic yards for about every $3\frac{4}{7}$ square miles, or every 11 millions of square yards of catchment basin, so that a drainage of $3\frac{3}{11}$ inches will be needed to fill it. It may be assumed, I think, that this reservoir may be constructed

structed in a thoroughly efficient manner within 2 lacs of Rupees, and the moderate cost is an advantage inasmuch as it lessens the risk of failure.

9. I do not contemplate the early construction of another reservoir, but it may be necessary hereafter to provide one for the cultivation under the Cauvery Canal, and it may be useful therefore to make a few remarks on the two sites, Nos 5 and 6, which have been surveyed, and which, of the 6, would alone serve for this cultivation. No 5 or the Bavaneona site is, whether the higher or lower contour be taken, expensive in proportion to the capacity; in the one case the storage would be at the rate of 23.5 cubic yards and in the other 181 cubic yards per Rupee. The catchment basin 20 square miles also is very small, and only in extremely favourable seasons would the tanks fill if made of the larger capacity, seeing that 1 million of cubic yards would have to be obtained from every ⅓ of a square mile, or every 1.03 millions square yards, of catchment basin: or in other words; 36 inches of drainage would be required; while on the other hand the smaller tanks could not be expected to fill every year. This site may therefore I think be rejected as unsuitable.

10. Site No 6 at Korlada on the Arkavathy has been examined for 3 different capacities viz:

for a depth of 27 feet with a capacity of 110 millions cubic yards
" 30 " " " 135 " " "
" 37 " " " 210 " " "

In the first the storage would be at the rate of 196 cubic yards per Rupee; in the second cubic yards 208; and in the third, or largest, cubic yards 210 per Rupee. The catchment basin is reported to be 305 square miles, so that for the smallest reservoir 1 million cubic yards would have to be obtained from every 2.77 square miles, or 8.58 millions square yards, of catchment basin, equivalent to a drainage of about 4¼ inches; for the intermediate size 1 million cubic yards would be derivable from every 2.26 square miles, or 7 millions of square yards, of catchment basin, equivalent

to

to a drainage of 5½ inches; while for the largest capacity 1.45 square miles, or 4½ millions square yards; would have to yield a million cubic yards, and the equivalent drainage would be 8 inches. The high cost of storage at this site is due to the length of the bund, which is at top 3050 feet for the lowest capacity, and to the low level of the ground between the hills. On the estimate Rupees 20,000 are allowed for a waste weir, but nothing is said in the report (paras 35 & 36) regarding a suitable site being available. On the whole I do not think that it will be economically practicable to construct a reservoir in this locality, because the storage would not be cheap, the smallest capacity estimated for is probably larger than will be required for the Mahanuddy canal cultivation, while a smaller capacity would be likely to be proportionately more expensive, and would absorb too small a portion of the average drainage. Captain Beckley does not speak favourably of the country through which the Mahanuddy and its tributaries flow, but it may yet be possible to discover a site for a reservoir capable of

containing 40 or 50 millions of cubic yards, with a catchment basin above of from 120 to 160 square miles, and giving a storage rate of from 250 to 300 cubic yards the Rupee.

11. Though not immediately required, it may be well to consider whether Reservoir site No 1 on the Goda Nullah is likely to prove a good position for future storage requirements. Any supply stored here would be additional to that derived from the rivers whence the canals are intended to take off, and this would be some advantage. I have not been able to lay down the position very accurately on the atlas sheet, for Captain Beckley (para 27) speaks of Jellamurra being about 2½ miles below Kolady, whereas on the printed map the former village is about 2 miles above the latter. However the bund site would appear to be near the village called Ambagow on the atlas sheet. Captain Beckley estimates the area of the catchment basin at 450 square miles, but I think this is a mistake, and that 240 miles approximate

to

to the actual area. The drainage basin is fairly well situated, among the hills, though it is perhaps hardly as well circumstanced as that of the Ironmaby for the Sorada site. Perhaps a capacity of 90 millions would be the largest which it would be advisable to give with reference to the area of the catchment basin. The site has been surveyed for 2 capacities

1st with a depth of 35 feet & capacity of 70 millions C yds

2nd " " 45 " " " 140 " "

In the first case the storage would, according to the approximate estimate, be at the rate of 175 cubic yards the Rupee, and in the second at 243 cubic yards a Rupee. Neither of these is particularly favourable, but the latter would do very well were the drainage basin as large as Captain Bickley has supposed it to be. Perhaps with a capacity of 90 millions the storage rate would be 200 cubic yards a Rupee, and (supposing) the quantity of water utilized to be only 90 millions annually, instead of probably 135 millions, the net quantity distributed would be

*100 millions stored = 75 millions direct irrigation.

be *67½ millions, and at 4656 cubic yards per acre this would suffice for 14.500 acres. The cost of the reservoir would be about 4½ lacs, so that the storage per acre would cost 31⅓ Rupees, which is not unreasonable. I would recommend therefore that this site be worked out in detail for a water level at about 229, if efficient arrangements for a waste weir at that level can be made. It may be remarked that in this, and all cases, the possibility of making due provision at a reasonable cost for the discharge of surplus water must govern to a great extent the selection of sites, and determine the exact level of the water surface.

Details of the Project

12. The plans & estimates of the canal work have not been submitted in a revised form with reference to my mem. of the 20th December last № 320, but most of the points noticed are referred to in Captain Bickley's letter. It was pointed out that apparently it would be necessary in order to keep the cost of the project within moderate limits to give up the idea of making the canal one of navigation as well as irrigation. Captain Bickley (para 6), strongly recommends

recommends that, even if locks be not given in the first instance, the canal may be so designed as to admit of its being hereafter adapted to navigation. At the end of para 7 he mentions that at least down to Chargada, a distance apparently of 12 miles, it would not be economical to increase the fall from 6 to 8 inches a mile. Not having the longitudinal & cross sections of the canal I cannot examine into this in detail, but it is a matter which could easily be worked out, and of course the result of allowing the maximum fall which the soil is adapted to admit of must be considered for the whole length of the canals, and not only for that part above the cutting. On sideling ground a higher velocity would reduce the cost of carrying any given quantity of water. There can be no doubt however of the benefit to the community which facilities for navigation would confer, and if the additional cost of making the canals navigable will not reduce the gross returns per cent. below 10, it would be advisable

to provide for navigation and probably if this be done, the ryots would be able to pay an additional water rate of 4 annas an acre, which would be a light tax for enabling produce to be carried to market at a cost which, compared with land carriage, would be almost nominal. 2nd class locks would, with the weirs connected with them, cost about 2500 Rupees a foot of lift. The canal at its head will be about 169 feet above mean sea level, and its length will be between 67 & 68 miles, so the fall, to 4½ feet below M.S.L., to be disposed of by locks would be 140 feet, & the cost 3½ lacs. Four annas an acre on 140,000 acres would yield 10 per cent on that sum, so that there would be little doubt of eight annas an acre covering all expenses connected with navigation.

13. Captain Beckley's explanations regarding the site selected for the Koositcoolie anicut show it to be unobjectionable, and apparently superior to either of the sites lower down

para 8

which

which were suggested by me. The roadway of the head sluices should not be less than 4 feet above the maximum ascertained flood level. The sills of the weirs should be placed at such a level as will, when the water in the river is flush with the crest of the anicut, give, with the canal running full, the head required to generate the velocity needed to discharge a full supply. Velocity of approach in the river should be disregarded; it is a variable quantity and, with the undersluices open, it often is, in the direction of the head sluices, inappreciable, while with the supply in the river just equal to the draught of the canal it may be inconsiderable. The remarks in para 9 of this office memo dt 320 are sound. Of the details of the anicut should be attended to in framing the estimates. The exact arrangement of groynes will have to be determined as the works progress, but groynes will be necessary, particularly close to the undersluices, and provision should be made for them, as also for a bank of quarry rubbish between the groynes and for similar material under the anicut.

14. With regard to the dimensions to be given to the piers of undersluices, bridges, aqueducts and similar works, Captain Beckley is quite right in considering that sand stone piers, where the material is much harder & heavier than the sand stone of the Godavery Delta works, need not be of the thickness usually allowed for less dense stone. This office has not however stated what the stone to be used is said, unless he has experimented upon it, it will not be prudent to run the risk of failure by reducing the dimensions too much. Under any circumstances 2¼ feet piers for 30 feet arches, as in the design for the Godachalloo aqueduct, would seem to be out of proportion, and could not be approved without a full demonstration of their sufficiency. It is very essential that piers should (para 11) afford a full bearing to the arches they support, but this is not all that is required of them; and they should be amply strong enough to sustain the weight they are to carry, to resist the pressure of water increased

ve increased by accumulation of drift, and the blows
ke of trees coming down the rivers &c. I think it
the that it will not be advisable to provide entstone
of in works for which rubble masonry is a suitable
as material, and particularly so where the stone
ma is hard & therefore, it may be supposed, not
the easily worked. It is not easy to estimate the
Velo cost of entstone works or the time required for
rega its execution, unless considerable experience in
the large works with the stone to be used is avail-
of able. Captain Beckley should consider therefore
the this point, and take care to keep works of
ma this description within perfectly safe limits.
ow 15. With regard to the contraction of
wa waterway at aqueducts, with a view to di-
be minish cost (para 10), the instructions contain-
exact ed in this Office Circular № 14 of the 28th May
deter 1869 are as applicable to aqueducts carrying
will navigable canals, as to bridges over such
unde works.
for th 16. The scale of maximum discharges Captain Beckley № 320 para 34
brid for minor channels given in para 27 of my para 18
memorandum № 320 is applicable to the

where 2 cubic yards per acre per hour is the average
consumption. In Gujarat $\frac{2}{3}$rds of those quantities
may suffice. The object of the arrangement
has been explained in Circular Memorandum
of 7th May 1870. Of course if all the minor
channels were carrying on the average a
much larger quantity per acre than the
main canal, the lower cultivation would get
more; the average is intended to be equal, but
the actual supply of small areas at different
times does not approximate to the average,
but varies between wide limits one of which
is, no water at all, and the other many times
the average consumption.

17. Captain Beckley at the end of para
16 supposes that were the depth of the water cus-
tion of the Mahanuddy anicuts doubled the cushion
wall would be only 1 foot lower than the guard
wall of the dam. He has forgotten that the
floor of the cushion might be lowered instead
of raising the cushion wall. As before pointed
out the cushion may be omitted altogether

of

which if a suitable apron be provided.

Sec 18:- Regarding the maximum depth of water to be allowed in reservoirs, with earthen dams, and other details of works of this class, as I may mention that, so far as it does not seem probable that sites for very deep reservoirs will be available; if sites for reservoirs of moderate depth i.e. under 50 feet deep, and allowing of water being stored at a cost not exceeding one Rupee for 200 cubic yards, it will be better to make use of such sites rather than to construct deeper ones even at a somewhat less cost. On the other hand facilities for disposing of surplus water, the occupation of waste instead of cultivated lands, and possibly the opportunity of using water power for the excavation and deposition of soil, might make it advisable to prefer deep to comparatively shallow reservoirs. 60 feet depth of water should be considered a maximum where the earthen dam would have to be constructed by manual labour, and it is perhaps not probable that the dam requisite for this depth could be carried out unless facilities existed for obtaining fresh soil under the embankments, or under the hills on the flanks, during the time of construction. If the whole or a considerable part of the dam were capable of formation by the jetting process, the case would be different, and a depth of 100 feet of water might be retained without any serious risk of failure. Captain Beckley will be furnished with such information as is available regarding the construction of bunds by water, in order that he may, when examining the parts of the rivers among the hills, ascertain whether small streams of water could be led to any bund sites at a level sufficiently high to admit of their being used to excavate and deposit soil of height by water gravity. I can hardly gather from the papers connected with the reservoir sites which Captain Beckley has examined whether that officer has sufficiently considered the means available for disposing of surplus water. Localities in all other respects favourable

Para 23, 24 & 25 of Captain Beckley's report

Ph G/ 2003 dated 28th June 1869 & 3900 dated 10th December 1869 — No date

15

85

favourable may be altogether unsuitable from the absence of facilities for this purpose, and it will frequently be inadvisable to expend time and labour on running contour or other levels over the basin, unless it has first been ascertained that a good position for a waste weir is available. On shallow reservoirs the difficulty of discharging surplus, though it may be considerable, need not be insuperable, but where any great fall has to be overcome, it is generally economically essential that the escape weir should be built on rock. Usually also it is difficult to construct an efficient escape at either flanks of the bund, unless the hill side at full tank level lies in slope sufficiently gentle to afford the required space, and unless the subsoil is rock or so rocky as to allow of the water running down it without erosion, and with at most a training wall to guide the outfall to the point where the water may be allowed to re-enter the river channel. A detached saddle is the preferable situation for the discharge of surplus water and, where such a saddle with a subsoil of hard material can be found at, or about, the required level, it should be selected for the escape weir. These remarks touch after all upon but a few of the many considerations which must be taken into account in determining, from a preliminary examination of the valleys of rivers, which parts afford the best chance of working out a reservoir project possessing all that is necessary to efficiency. If one place there may be a short length of bund but no facilities for the temporary or permanent discharge of water; at another all that is required in this respect, but no, or an insufficient quantity of good soil; at a third the climate may be too unhealthy to make it prudent to undertake works, the success of which is often greatly dependent upon the possibility of carrying out punctually predetermined arrangements. I think therefore the best plan would be for the Executive Engineer to ask for advice, officially or demi-officially

cially, whenever any matters of difficulty may be met with, for it is far from easy to give before hand such detailed instructions as would dispose of any considerable portion even of the principal points which need to be attended to. Ith is comparatively simple to determine the best arrangements at any given spot where it may be considered necessary to construct a Tank, but here in Ganjam what is required is the solution of a far more complex problem viz the selection of the best sites available over a great extent of country with reference to

1st a sufficient but not too superabundant supply
2nd economy of storage
3rd facilities of construction & of disposal of surplus water
4th security & economy of maintenance
5th situation with respect to the canals to be supplied, so that the regulation of the discharge from time to time may be managed without difficulty.

19. The last subject to be considered — Outlay and returns

in this note is the aspect of the project as regards the probable returns to be expected from the outlay required. The Revenue information is as yet very imperfect: it will be seen from the letter, as per margin, from the Collector of Ganjam to the Executive Engineer that the former officer wished to limit the Revenue statistics to the past three years, and that he considered that there would be many difficulties in the way of furnishing in a complete form the details asked for in para 30 of my memo dt 320 of the 20th December last

dt 15/- 1/ Feb 1870

dt 185 - 22nd August last

A further memorandum on this subject to the Superintending Engineer 1st Division is submitted with this note, and it seems requisite that no time should be lost in making such investigations into the probable revenue returns which may be expected from the irrigation of the tract of country commanded by the proposed canals, as will afford the fullest obtainable data for estimating the financial results of the outlay which the execution of the project would involve.

The

20. The information at present available is very limited. In para 37 of Captain Beckley's report of the 11th September 1869 it is shown from "the Collector's accounts" that, of the 140,000 acres proposed to be irrigated, and of this a large portion appears to be irrigated at present imperfectly.

		Present Revenue
20,000 acres are assessed at Rs 3		60,000
50,000 " " "	" 2	100,000
50,000 " " "	" 1½	75,000
20,000 " yield no revenue		
		2,35,000

Captain Beckley supposed the average assessment with improved irrigation would be 4 Rupees an acre, which is equivalent to the bare water rate in the Godavery and Kistna Deltas, and probably with navigation added Rupees 4½ an acre would not be too high. In that case the returns would be.

140,000 acres at Rupees 4½ =		630,000
deduct maintenance at 8 annas an acre (11 per cent on Revenue)	70000	
the present Revenue	235000	325000
Net returns		305,000

with regard to the cost of the works, Captain Beckley's original estimates amounted including establishments to 80 — 13.2 lacs

and probably when revised they will amount to — 15 lacs

cost of Sloorada Reservoir for 70 millions of cubic yards pay 2 lacs establishment ½ — 2.5 "

the storage they would be at the rate of 280 cubic yards per Rupee

cost of 180 millions of additional storage, which may ultimately be required, at 250 Cyds per Rupee — 7.2

contingencies — 0.3

Grand Total Lacs — 25.0

On this gives the anticipated net returns amount to 12.2 per cent.

21. After giving the project as a whole careful consideration, I am of opinion that there is very strong primâ facie evidence for believing that a system of irrigation, capable of conferring great benefits upon a considerable tract of country, and of yielding as large a returns

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21. After giving the project as a whole careful consideration, I am of opinion that there is very strong primâ facie evidence for believing that a system of irrigation, capable of conferring great benefits upon a considerable tract of country, and of yielding as large a returns

return upon the outlay required as will suffice to pay interest on the capital expenditure, and at the same time increase the resources of the State, can be worked out in connection with the Mahanuddy and Boshkoolia, and the result of the investigations, so far as they have at present been carried, is such as, I think, to make it desirable to ask the Government of India to sanction the charge to Loan Funds of the cost of the establishments therein employed from the commencement of the current official year.

Cuttack
9th September 1870

Yours &c
Chamberlain
Major R.E.
(Acting) Chief Engr for Irrigation

To
The Secretary to Govt N.W.D

57

P. W. 1870 Departt
Proceedings for Oct.
No. 3811.

From

The Actg Chief Engineer
for Irrigation

Dated 9th Sept.
Recd 26 " } 1870

J. E. Ed. O.

Enclosures ✱ A Plans 26

✱ Note on papers connected with the proposed scheme of irrigation from the Mahanuddy and Roosh Koolia Rivers in Ganjam.

No 398

Nos 2553 & 2554, 27th Oct. 70.

No. 2553 Read 90

Proceedings of the Madras Govt

Read the following:-

From the Chief Engr for Irrign. } to G.O. No 89 of Sept 70.

The Government are glad to learn from the papers submitted by the Acting Chief Engineer for Irrigation, that the investigations in Ganjam, in connection with a system of irrigation to be supplied from the Mahanuddy

Mahanuddy and Rooshkoolia, afford good reason for believing that it will be practicable to carry out a scheme, which will be of material benefit to the part of the Ganjam District within its influence; and which will at the same time be sufficiently remunerative.

2. A reference to the papers marginally noted (subsequently to the famine of 1866) show that the Secretary of State has repeatedly urged the importance of the improvement of the system of Agriculture in Ganjam by works which will tend to secure fair crops over the areas which they are designed to irrigate.

The outlines and considerably more of a moderate, but in itself sufficiently extensive scheme, to be really worth carrying into execution, have now been marked

insert subsequently to the famine of 1866. N.

I would suggest

The outlines and principal features of a comprehensive but practicable scheme has now been sketched. No time should be lost in completing the plans and estimates and in pursuing such further inquiries, as may be found requisite to render the project complete and

~~art, and no time~~
~~should be lost in~~
~~completing the designs~~
~~and estimates, and~~
~~in prosecuting such~~
~~further enquiries as~~
~~may be necessary~~
~~to render the project~~
~~in all respects complete~~
~~and likely to be~~
~~efficient~~

capable of being submitted to the Govt. of India as the ~~in the first~~ remunerative work

3 The Government approve of the Acting Chief Engineer's proposal to construct, in the first instance, one moderately

moderately large reservoir to supplement the direct irrigation from the river, and His Excellency in Council thinks that only by such tentative measures as those suggested, can the real wants of the country in the absence of records of river discharges for a long series of years, be provided for without running the risk of incurring unnecessary expenditure by the

formation of reservoirs
in excess of the im-
mediate or perhaps
ultimate wants of the
area to be irrigated.
Though estimates for
more than one reservoir
will not at present
be required, Captain
Beckler should be
instructed, when he
has completed the
work needed for the
submission of his
scheme for sanction,
to investigate such ad-
ditional sites as ma

be advisable with a
view to the ultimate
formation of reser-
voirs capable of storing
together about 250
millions of cubic yards,
and in doing so
he should give con-
sideration to the re-
marks of the Acting
Chief Engineer on
the subject of the prin-
cipal points to be
attended to, and he
should obtain from
time to time from
that Officer such
further instructions as

be required.

A Plan & Papers will be communicated to the Revenue Department in order that the Collector of Jessore may be requested to prepare the Revenue information required in support of the project, and in elucidation of its probable effect upon the Revenue. In order that all doubtful points also may be definitively settled with the Collector relative to the Plan & Papers in question, I am directed by the Lieutenant Governor in Council to request that a report may be furnished to the Board of Revenue as early as may be practicable, leaving details of area and cultivation &c. for a subsequent report, after the general question of land, shall have been submitted for the consideration of the Board of Revenue as early as may be practicable, leaving details of area and cultivation &c. for a

series of years to follow in this case.

The importance which the Secretary of State, and this Government also, attach to measures for the amelioration of the circumstances which render the naturally fertile Districts of Gurgaon liable to severe and periodical visitations of famine ~~makes~~ makes it desirable that every effort should be made

in the Irrigation Public Works Department to get this project completed as early as practicable. The primâ facie evidence in favor of this scheme of Irrigation is, the Government considers sufficiently strong to make it highly probable that it will be carried out from Loan Funds, and the Government of India will therefore be requested to sanction

the charge to cover
floods of the east-
of the Public Works
establishment em-
ployed upon the pre-
paration of the pro-
ject, with effect from
the Commencement
of the Current Official
year.

Ordered that
the following letter
be sent.

To

The Secretary
to the Government
of India P.W.D.
No 2554.

I am directed to
transmit for the
consideration of the
Government of India
a copy of the Proceed-
ings of this Govt
under date the 27th Octo-
ber 1870 No 2553, on the
subject of a proposed
scheme of irrigation
from the Mahanuddy
and Koosh Koolia
rivers in Sangam

74 96

71

80
6

The Chief Engineer 1st Dist
" Ch Engineer for Irrigation
" Revenue Secretary
" Controller

Decr 1/11/70

which has for its
object, so far as the
scope of the project
extends, the prevention
of those periodical
famines which have
been attended not only
with great suffering
and loss of life
among the people,
but also with a heavy
cost to the State.

2. The Secretary
of State has, I am
to point out, repeatedly
urged upon the Govt

the adoption of
measures such as
are contemplated in
this scheme, and His
Excellency the Gover-
nor in Council
hopes at no distant
date to be able to lay
before the Govern-
ment of India a
complete project sup-
ported by full in-
formation on all
details. In the
meantime I am
in drawing attention
to the evidence in

favor of the feasibility and remunerative character of the scheme, to solicit the sanction of His Excellency the Governor General in Council to the change to Loan Funds from the commencement of the current Fiscal year, of the cost of the Establishment employed upon the preparation of the project. That Establishment

Establishment at present consists of -

		Cost per month:
1	Executive Engineer 1st Grade	993-10-
1	Surveyor	150
1	Draughtsman	50
1	Draughtsman	20
1	Do	15
1	Surveyor	75
1	Do	50
5	Lascars @ 7	21
9	Do @ 6	54
	Total	1328-10

It may however be advisable, with a view to hasten the completion of the plans and estimates, to increase the strength of the Executive Engrs' Office for a short time, and I am therefore

to request permis-
sion to add to the
monthly charge, for
a period not exceed-
ing six months,
such extra establish-
ment, within a total
cost of 250 Rupees
a month, or 1500
Rupees altogether,
as the Executive En-
gineer may think
to be required.

16/9/70

No 3811

of {1870} Madras.

BLIC WORKS.

Superintending Engr
1st Circle
and
Secretary to the Govt
of India

17/8/70 ✓

Further Rs 1,59,000
for 3 years
for 1870-71 to 1872-73

Plans 61

27 Oct 1870, No 2553 & 2554

Nos. 377 & 379 & 380

with remarks
forwarding a Copy
of the Madras Govt Minute on
the proposed Scheme of Irriga-
tion from the Mahanuddy &
Kaud Rivers in Cuttack &
requesting sanction to the Irriga-
tion Funds, from the com-
mencement of the current Official
Year, of the Cost of the Establish-
ment employed upon the prepara-
tion of the project.

Irrigation - Plans, orders on
for celebrating the
Scheme of Irriga-
tion from the Mahanuddy
Kaud Rivers in
the Province of Cuttack