Public Works (1899) Department.

G.O., No. 911 I

DATED 15 Oct 1899.

[Despatch Abstract.]

Dun Canals Letter from the Govt of the N.W.P. + Oudh, forwarding copies of the completion report on the closing of the Construction Estimate of the — commd to the officers concerned.

Dr

[P. W. 2 / 2,000—29-8-99.]

Indexed. 1/11

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

Public Works (1899) Department.

CURRENT No. 8397

From The Govt of N.W.P & Oudh P.W.D.

Order No. 911 dated 25-10-99.

Communicated to the officers Concerned for information -

No. 3535. I.

Dated 29-9-99

Received } 12-10-99

Registered }

Enclosures 2 Copies -

Spare copies.

16/10 99.

Issue

To

The Chief Engr for Irrign - with 1 Copy of the Report -

" Supg. Engineer I. } With 1 Copy of the Report which is to be passed on by one Supg Engineer, to the other, and finally returned to the P.W.D. Secretariat

.....do..... II

.....do..... III

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.....do..... V

.....do..... VI

SUBJECT.

Completion report on the closing of the Construction Estimate of the Dun Canals — Forwarding 2 Copies of the —

13.10.99

BACK PAPERS.

No.	Date.

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No.	Date.

ALL CORRESPONDENCE SHOULD BE ADDRESSED TO SECRETARY, TO GOVERNMENT, NORTH-WESTERN PROVINCES AND OUDH, PUBLIC WORKS DEPT., IRRIGATION BRANCH.

No. 3535-I OF 1899.

GOVT., N.-W. P. AND OUDH,

IRRIGATION BRANCH.

PUBLIC WORKS DEPARTMENT.

Dated Allahabad the 29th September 1899.

To The Secretary

to the Government of Madras,

P. W. Department.

Sir,

I am directed to forward for information, 2 copies of the Completion Report on the closing of the construction Estimate of the Sirsi Canals.

I have the honor to be,
Sir,
Your most obedient Servant

G. Palmer
Offg: Secretary

Enclosures

2 copies of the Report

Govt. Secrt., P. W. D., No. 29 I.
G.—4,000 of 1899.
P. No. 4913—7-9-99.—P.D.

1810TC

PUBLIC WORKS DEPARTMENT.

Irrigation Branch.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

SUPG. ENGINEER'S OFFICE No. 4780 10 NOV 99 P. W. D. SECOND CIRCLE.

SUPERINTENDING ENGINEER No. 616 Irr 30 NOV. 1899 CIRCLE, P.W.D.

SUPERINTENDING ENGINEER No. 584 Irr 4 NOV. 1899

Read the following

Letter from the Government of N. W. Provinces and Oudh P. W. Department, No. 3535 dated 29th September 1899 forwarding one copy of the Completion Report on the closing of the Construction Estimate of the Dun canals.

SUPERINTENDING ENGINEER Regr. No. 13 NOV. 99 III CIRCLE, BELLARY

SUPG. ENGINEER'S OFFICE No. 13521 20 NOV. 1899 P. W. D. FOURTH CIRCLE

Order thereon No. 911 dated 25-10-99.

Communicated to the officers concerned for information.

(True Extract)

SUPG. ENGINEER'S OFFICE No. 20H 5 DEC. 1899 P. W. D. SIXTH CIRCLE.

Under Secretary to Government.

Encl 1.

To

The Chief Engr for Irrigation — with one Copy of the Report.

5.11. Works No. 1135 G.L.

7

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26.11.99. " do IV "

2/11/99 " do V "

SE's initials

209 T.C 5.2.00 5.2.00 " do VI "

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30.11.99 Rec'd

SUPG. ENGINEER'S OFFICE
No.
10 NOV 9
P. W. D.
SECOND CIR
SUPERINTENDING ENGR.
Regr. No.
13 NOV. 99
4 NOV. 1899

COMPLETION REPORT

OF THE

DUN CANALS.

COMPILED IN THE OFFICE OF THE CHIEF ENGINEER,

IRRIGATION WORKS, NORTH-WESTERN PROVINCES AND OUDH.

ROORKEE:

PRINTED AT THOMASON CIVIL ENGINEERING COLLEGE PRESS.

1899

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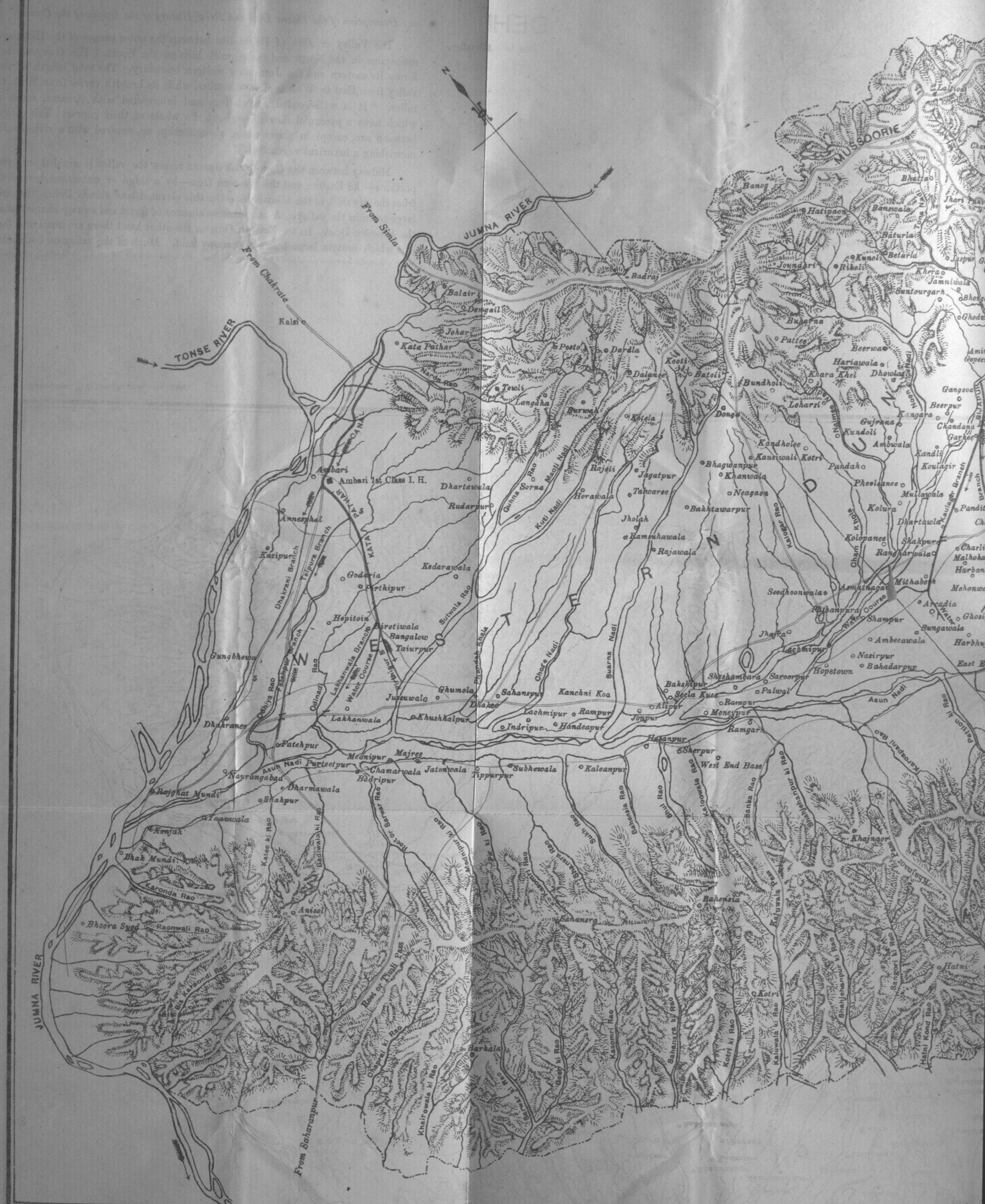


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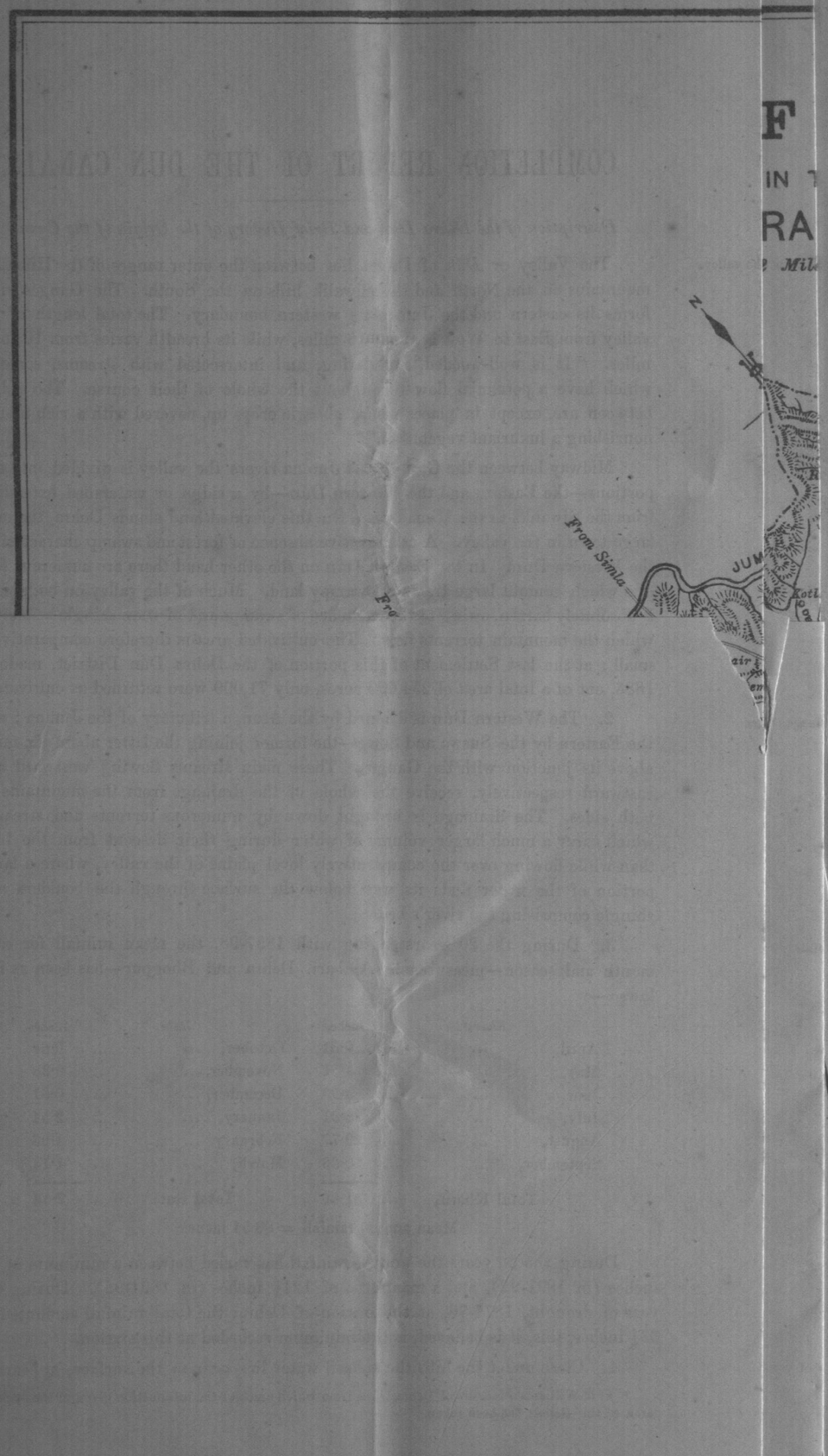
DEHRA DUN.

Scale — 2 Miles = 1 Inch.

REFERENCES.

- *Canals and Branches,*
- *Rivers. Nadis and Raus,*
- *Metalled Road,*
- *Unmetalled do.,*
- *Drainage Cuts,*
- *Inspection Houses,*
- *Railway,*

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COMPLETION REPORT OF THE DUN CANALS.

Description of the Dehra Dún and Brief History of the Origin of the Canals.

Description of the valley.

The Valley or *Dún* of Dehra lies between the outer ranges of the Himalaya mountains on the North and the Siwalik hills on the South. The Ganges river forms its eastern and the Jumna its western boundary. The total length of the valley from East to West is about 48 miles, while its breadth varies from 10 to 15 miles. "It is well-wooded, undulating, and intersected with streams, some of which have a perennial flow throughout the whole of their course. The ridges between are, except in places where shingle crops up, covered with a rich mould, nourishing a luxuriant vegetation."*

Midway between the Ganges and Jumna rivers the valley is divided into two portions—the Eastern and the Western Dún—by a ridge or watershed extending from the Siwaliks to the Himalayas. On this elevated land stands Dehra, the only large town in the valley. A comparative absence of forest and swamp characterizes the Western Dún. In the Eastern Dún on the other hand there are numerous forests which contain large tracts of swampy land. Much of the valley on both sides is absolutely barren, owing to the existence of swamps and of wide shingle beds over which the mountain torrents flow. The cultivated area is therefore comparatively small; at the last Settlement of this portion of the Dehra Dún District, made in 1886, out of a total area of 254,000 acres, only 71,000 were returned as cultivated.

Its drainage system.

2. The Western Dún is drained by the Asan, a tributary of the Jumna; and the Eastern by the Suswa and Song—the former joining the latter about six miles above its junction with the Ganges. These main streams flowing westward and eastward respectively, receive the whole of the drainage from the mountains on both sides. The drainage is brought down by numerous torrents and streams, which carry a much larger volume of water during their descent from the hills than while flowing over the comparatively level plains of the valley, where a large portion of the water finds its way below the surface through the boulders and shingle comprising the river's bed.

Its rainfall.

3. During the 20 years ending with 1897-98, the mean rainfall for each month and season—measured at Ambari, Dehra and Bhogpur—has been as follows:—

Kharif.	Inches.	*Rabi.*	Inches.
April, ...	0·31	October, ...	0·68
May, ...	1·51	November, ...	0·38
June, ...	9·93	December, ...	0·81
July, ...	28·91	January, ...	2·54
August, ...	29·77	February, ...	1·93
September, ...	10·63	March, ...	1·14
Total Kharif, ...	81·06	Total Rabi, ...	7·48

Mean annual rainfall = 88·54 inches.

During the 20 years the annual rainfall has varied between a minimum of 57 inches (in 1891-92), and a maximum of 124¼ inches (in 1894-95). During the year of drought, 1877-78, at the station of Dehra, the total rainfall amounted to 33¼ inches, this, it is believed, is the minimum recorded at this station.

Scarcity of wells.

4. Close under the hills the subsoil water lies near to the surface, appearing

* *Vide* Williams' Memoirs of Dehra Dún, from which much of the information given in the opening paras. of this Report has been taken.

either in isolated pools or in rivulets which, after flowing a short distance, disappear below the surface ; in all other parts of the valley the subsoil water lies at a great depth rendering irrigation from wells impossible. Even for drinking purposes there are but few wells ; according to the Settlement Report of 1886 there are only 29 in the whole valley. In Dehra itself, with a population of 26,000, there are only five wells. One of these sunk in the kutcherry compound by Mr. Shore cost no less than Rs. 11,000, the water being at a depth of 228 feet.

Origin of the canals.

5. Under these conditions canals and reservoirs afford the only means for irrigation, and almost the only means for supplying the people with drinking water. This fact was recognized long before we occupied the country. At some unknown time—probably early in the 17th century—the Rajpur Canal from the Rispana river was constructed to supply the town of Dehra with drinking water. Again, under the able administration of Najib Khan, Governor of Saharanpur (1757-1770), numerous canals and tanks were made, agriculture flourished, and the Dún at this time was a happy valley containing many flourishing villages. With the death of Najib Khan these palmy days ceased. The people were now harassed by Rajputs, Gujars, Sikhs and Gurkhas in quick succession, and "the once fertile garden was soon converted into a barren waste." When we occupied the country in 1814 the total population of the Dún did not exceed 17,000 ; the greater portion of the land was lying waste for want of hands to till it ; the gross revenue amounted to about Rs. 20,000 per annum ; and the remains of old tanks and water-courses, in the midst of what seemed primeval forest, were the only tangible proofs of the former prosperous state of the valley. The expediency of again constructing such works of utility early arrested the attention of our officers, and the recommendations of Colonel Young, Superintendent of the Dún, finally determined Government to move in the matter. With the deputation in 1837 of Captain (afterwards Sir Proby) Cautley to make an estimate of the cost of a canal from the Tons near the village of Bijapur, a commencement was made on the construction of the Dún Canals. These now consist of the following separate works :—

Name of Canal.	Year of opening.	Total length of channels.		
		Lined with masonry.	Unlined.	Total.
Bijapur Canal, ...	1841	11	$1\frac{1}{4}$	$12\frac{1}{4}$
Rajpur „	1844	$11\frac{1}{4}$	$2\frac{1}{2}$	$13\frac{3}{4}$
Kata Pathar Canal, ...	1853	$8\frac{1}{4}$	18	$26\frac{1}{4}$
Kalanga „ ...	1859	$10\frac{1}{4}$	$2\frac{1}{2}$	$12\frac{3}{4}$
Jakhan „ ...	1863	12	$1\frac{1}{4}$	$13\frac{1}{4}$
Total, ...		$52\frac{3}{4}$	$25\frac{1}{2}$	$78\frac{1}{4}$

A map showing the alignment of the various channels accompanies this Report.

The Bijapur Canal.

Its early history.

6. The plans and estimates for the Bijapur Canal were prepared by Captain Cautley, but the works were constructed under the management of Captain Henry Kirke at that time Adjutant of the Sirmur Battalion. Water was admitted into the canal in January, 1841.

The Head-works.

7. The canal receives its supply from the Tons, a mountain stream fed by the drainage of the Karkauli valley, which lies just south of and under the Mussoorie ridge. In fixing on the immediate site for the head-works, Captain Cautley took advantage of some huge masses of rock which had fallen into the bed of the torrent close to the left bank immediately under the village of Bijapur. Behind these, and protected by them against the rush of the torrent during floods, the masonry head of the canal was constructed. The rocks are still in existence, and appear to be much

as they were when described by Cautley 50 years ago. The head was well placed ; it has suffered but little damage, and up to the present time the only works found necessary for its protection consist of two masonry spurs constructed in 1882-83, to divert the stream which had taken a set towards the canal head. Until 1858 the dam was built entirely of loose boulders. It is now built of horizontal poles laid from one mass of rock to another ; to these are attached vertical stakes, and up-stream of and against these is laid the boulder dam, which has to be renewed after every heavy flood.

Alignment and description of channel.

8. For the first mile of its course the canal runs along the steep slope or scarp of the left bank of the river. Near and under the village of Pirohitwala the precipices are quite perpendicular. For some portions of its length the channel is carried in a masonry flume supported on revetments built against the side of the hill ; in others the channel has been blasted out of the face of the rock itself. The canal in this reach is liable to injury from landslips during heavy rain. A ridge at Pirohitwala is pierced by a tunnel. The channel then crosses a ravine and ridge at Dhakra—the first by an aqueduct and the second by a masonry-lined tunnel. Just beyond the Dhakra tunnel there are flour mills, and originally the masonry channel terminated at this point. Cautley, however, recommended that the channel should be provided with a masonry lining throughout when the value of the water came to be properly appreciated. At mile $1\frac{3}{8}$ the channel bifurcates, the Kaulagir Branch going to the right, and the Kauli Branch to the left. In this, as on the other canals of the Dún, the great slope of the country necessitated the provision of a large number of masonry falls.

The completion of the masonry lining was carried out between 1870 and 1880.

The total length of channel is now $12\frac{1}{4}$ miles made up as follows :—

Name of Channel.	Masonry-lined.	Unlined.	Total.
	M. F.	M. F.	M. F.
Main channel including Kaulagir, ...	5 4	0 3	5 7
Kauli Branch, ...	5 1	0 3	5 4
Gurkha minor, ...	0 3	...	0 3
No. 9 outlet minor, ...	...	0 4	0 4
Total, ...	11 0	1 2	12 2

In the accounts of the works the channels of these canals are now all classed as 'Distributaries' ; but locally the main channels from the head to the first bifurcation are called 'Canals' ; and the distributary channels 'Branches.'

Mills.

9. There are six flour mills on this canal. Those at Dhakra, Bhur, Kaulagir, and Kauli have each two pairs of stones ; those at Ramgharwala and Niranjanpur one pair each.

Cost of works.

10. The original estimate for the canal amounted to Rs. 13,953 ; the amount expended up to date of opening the canal amounted to Rs. 15,926. Since that date, however, there has been a large additional outlay incurred chiefly on lining the channel with masonry, and on constructing the Dhakra reservoir ; and on the 31st March, 1894, when the Construction Estimate was closed, the total expenditure on works amounted to Rs. 98,204.

Dhakra reservoir.

11. The Dhakra reservoir was constructed with a view to storing water which ran to waste in the rains, and at night time in the irrigating seasons. The work was an experimental one, and chiefly owing to the porous nature of the soil in the Dún ravines it proved to be a failure. No further works of the kind have been constructed.

Discharging capacity and available supply.

12. The canal carries a maximum discharge of 80 cusecs, but in a dry year the available supply at the head of the canal falls as low as 15 cusecs.

Areas commanded and irrigated.

13. The canal irrigates in 46 villages; in these it commands a culturable area of 11,377 acres, of which 9,573 are cultivated, 5,318 acres being assessed as canal-irrigated. The land is the very best in the Dún, and most of it is within easy reach of a metalled road leading to the adjacent town of Dehra. During the past ten years the average area irrigated has been 5,009 acres—2,275 acres in *kharif* and 2,734 acres in *rabi*. In 1897-98 the area irrigated reached a maximum of 6,436 acres, 2,579 acres of which are kharif, with an average discharge for the year of 33 cusecs.

Increased economy in the use of water would lead to an increase of the area irrigated by this canal. On both branches there is a large area under dry crops which would be irrigated and cropped with sugar if water were available. A considerable volume of water would be saved if the water-courses were lined with masonry.

Direct receipts.

14. Taking the average for the five years ending 1897-98, the annual direct receipts from the canal amount to Rs. 24,272, distributed as follows :—

	Rs.
Occupier's rate, ...	14,256
Owner's „	1,019
Mill rents, ...	6,937
Miscellaneous, ...	2,060
Total, ...	24,272

In 1896-97 the direct assessments amounted to Rs. 28,423, about 28 per cent. of the cost of works.

The Rajpur Canal.

Its early history.

15. This was the second canal to which Captain Cautley directed his attention. Reference has already been made to the existence of an old water-course for the supply of drinking water to the town of Dehra. In his Notes on the "Dehra Dún water-courses" Captain Cautley, referring to this old work, remarks that "it is probably one of considerable antiquity, and coeval with the establishment of Dehra as the capital of the valley, or of the Sikh temple as the chief residence of the High Priest. The Mahant or High Priest, into whose tank the tail water falls, describes it as having been dug by his forefathers; and it appears that this family did formerly keep it in repair and levy taxes on mills, &c., which were benefited by it. As however the Mahant's power gradually declined, so the water-course went to decay, and on Mr. Shore's assuming charge of the civil duties at Dehra, he found it necessary to take the management of the line into his own hands so as to secure a supply of water to Dehra."

In connection with the work of improving this canal Captain Cautley's attention was directed to the following paragraph from a report, dated 1839, of Mr. H. S. Boulderson, Commissioner of the Meerut Division :—

"The water of the canal is perfectly wholesome and good at its head, but the accumulation of filth, leaves, earth, &c., in its course, even though cleared out twice or thrice in a year, renders it of unwholesome quality. Evaporation and absorption greatly reduce its quantity, so that it is insufficient frequently in the warm months, and as the banks frequently break in the rains it is for several days occasionally stopped. I would recommend that this water-course be made *pucka*."

The main objects then which Captain Cautley had in view were to economize water, and to deliver it to the town of Dehra in a pure and wholesome condition. He submitted his project in November, 1840; work was commenced in 1841, and completed early in the rains of 1844, when water was first admitted into the canal. As in the case of the Bijapur Canal the work was carried out under the superintendence of Captain Kirke.

Head-works.

16. The canal takes its supply from the Rispana, a river which, like the Tons, has its source in the hills near Mussoorie. The head was originally constructed at a point about two miles south of the town of Rajpur, and about a mile below the point at which the stream issues from the hills. In the intervening reach there was considerable loss of water by percolation, and in the early sixties the masonry channel was extended along the river bed to a point 3,750 feet above the head of the canal; again in 1872-73 the masonry channel was carried to a point 842 feet still higher up.

Length and description of channel.

17. The necessity of maintaining the supply of drinking water for the town of Dehra during the construction of the new canal led to some inconvenience, and to the adoption of an alignment generally speaking quite distinct from that of the old water-course. Colonel Cautley in his Notes thus describes the old and new channels :—

"The old line crept along the side of a bank on nearly its whole course to the high land, the bank acting on one side in retaining the water; it was decided that the new work should be carried in straight lines across the valley quite independent of the old *Kúl*. The new channel is raised in many places to a considerable elevation above the country; between Kishanpur and Jakhan a tunnel of 100 feet in length has been carried through a ridge; the canal has been pierced at 18 different points to admit of free under-drainage; at a point near Kishanpur the channel is supported on 37 arches, near Mukandwala by 17, and at other places by arches varying in number from 1 to 11. Boulders from the bed of the Rispana river and from the neighbourhood of the work have been extensively used in its construction, especially in the flooring and solid portions of the foundations; the parapets or retaining walls are built entirely of brick. The main channel, 4 feet in width and 18 inches in depth, continues from the head to a gateway near the head of Captain Kirke's estate at Dehra; hence it is divided into two branches, one of masonry with a channel 2 feet wide and 18 inches deep, which is carried to the Mahant's tank in the town, and the other an excavated channel for the irrigation of lands at Dharampur. At the point where these branches separate a reservoir is established for the purpose of regulating the supply to each branch. The raised reservoir near the lines of the Sirmur Battalion has been enlarged and improved * * * * and other masonry reservoirs have been built in the town for the convenience of the people."

In the early eighties the Dharampur Branch was provided with a masonry lining.

The total length of channel is 13 miles 6 furlongs made up as follows :—

Name of Channel.	Masonry-lined.	Unlined.	Total.
	M. F.	M. F.	M. F.
Main Canal, ...	5 3	0 4	5 7
Dehra Branch, ...	2 0	...	2 0
Dharampur Branch, ...	3 7	2 0	5 7
Total, ...	11 2	2 4	13 6

Mills.

18. Mills containing in all 17 pairs of stones were constructed at the following sites :—Amwala (3), Bajriwala (4), Simalwala (1), Nagal (2), Jhakan (2), Mukandwala (2), Bhandariwala (2), and Dharampur (1).

The Simalwala mill was damaged in 1890, and another mill, called the Aqueductwala, was built in the following year, a few furlongs higher up the canal.

Cost of works.

19. The original estimate for the work amounted to Rs. 41,208. The amount expended on construction up to date of opening the canal was Rs. 42,984. Details of the further expenditure incurred up to 1862-63 are not known; at the end of that year the Capital expenditure on 'Works' amounted to Rs. 65,475. Up to date

of closing the Construction Estimate a further expenditure of Rs. 6,655 was incurred chiefly on lining the channel with masonry, bringing the total expenditure on Works to Rs. 72,130.

Discharge.

20. The maximum discharge of the canal is 40 cusecs, but in a dry year during the hot season the available supply in the river dwindles down to a very small amount. In 1892 a discharge of less than 3 cusecs was measured. In 1897 at the end of the rabi, and during the early kharif season, the supply in the canal was only 6 cusecs. Under these circumstances it is obvious that any diversion of the supply for domestic and other purposes to buildings in the vicinity of Mussoorie, Landour and Dehra, must seriously affect the earnings of the Rajpur Canal and the interests of the town of Dehra. Of recent years in more than one instance the supply has been encroached upon in this way. The particular cases were brought to notice at too late a date to admit of any action being taken, but in the interests of the town itself it will be necessary to guard against any further encroachments on the supply of this canal, and where encroachments have already been made it will be necessary to see that the water is not wasted.

Area commanded and irrigated.

21. The canal irrigates in 19 villages and commands in these villages a culturable area of 5,188 acres, of which 4,117 acres are cultivated; 2,959 acres were shown as canal-irrigated in the Settlement of 1886. The soil is good, and the value of the crops grown is enhanced by the vicinity of the tract to the town and station of Dehra. During the past ten years the average area irrigated was 2,365 acres. In 1891-92, 2,641 acres were irrigated—865 in *kharif*, with an average discharge utilized of 8·2 cusecs, and 1,776 acres in *rabi*, with an average discharge utilized of 8·7 cusecs—giving 'duties' respectively of 106 and 204 acres. The duties shown for this and other canals of the Dún must, however, be accepted with some caution; when there is no demand for water for irrigation purposes the canals are still kept running for public convenience and for working numerous mills; it is difficult, therefore, to arrive at accurate figures of the volumes used for irrigation only. It should be possible to economize water by lining with masonry the two miles of earthen channel on the Dharampur Branch, where there is a tract of 500 acres which could be sown with rabi crops and late rice if water were available.

Average direct receipts.

22. Taking the average for the five years ending 1897-98, the annual direct receipts from the canal now amount to Rs. 21,868 distributed as follows:—

	Rs.
Occupier's rate, ...	8,064
Owner's rate, ...	593
Mill rents, ...	11,121
Miscellaneous, ...	2,090
Total, ...	21,868

In 1897-98 the direct assessments amounted to Rs. 23,920—more than 33 per cent. of the Capital cost of the canal works.

Financially this is the most successful of the Dún Canals chiefly owing to the large annual income derived from the mills. In water-rates and mill rents alone each cusec of discharge brings in an annual direct income of about Rs. 1,300—a figure which is reached by no other canal in these provinces, and, so far as is known, by no other canal in India.

Dehra water-supply.

23. This result is reached in spite of the fact that no charge is made for the drinking water supplied to the town of Dehra. The question of levying some annual charge has been more than once raised. In 1869, under the orders of the Government of India, the Municipality was called upon to pay Rs. 200 per mensem for the use of the canal water. The Municipality appealed against this decision, and finally, with the concurrence of the Government of India, it was decided that although the claim for payment was unquestionable, the matter should remain in

abeyance. The only return which Government now receives for water supplied to the town of Dehra is a sum of Rs. 50 paid annually, under an arrangement which came into force in 1887, as the price of the water used in flushing the drains of the town. The extent to which the town has benefited by the canal may be judged from the following extract from the Revenue Report of 1859-60:—

"The substitution of a masonry channel for the old earthen one with its few inches of water has taken away from Dehra its character of unhealthiness, and the native city is now rising into importance from the constant accession to its inhabitants. There is one striking instance of a disease being totally eradicated: formerly every second man in the place had attached to his leg or arm a little piece of stick round which he was laboriously coiling the thread-like body of the guinea worm, to draw it forth from under his skin. The disease ceased as soon as the masonry channel was made."

The Kata Pathar Canal.

History of the project.

24. During the cold weather of 1840-41, Captain Cautley prepared a project for irrigating the extreme western portion of the Dún by means of a canal fed from the river Jumna. The construction of the work was warmly recommended by the Civil authorities as the only means of developing a thinly populated but rich tract of country in which there was then no water available, not only for irrigation, but even for drinking and domestic purposes, beyond that supplied by a single well in the village of Pirthipur, but the project met with some opposition from the Canal Department, on the grounds that the diversion of a volume of about 80 cusecs from the river would cause a serious diminution in the supply available for the Eastern and Western Jumna Canals. The project remained in abeyance for some 8 or 10 years, after which the construction of the work was decided upon, and the canal was opened in May, 1854.

Head-works.

25. Captain Cautley fixed the position of the head of the canal immediately below the village of Kata Pathar, which he described as the highest point to which the mountains would allow him to go. This decision has since been criticized. The head-works it has been said might have been carried still further up the gorge; the extra head so gained would have enabled the required supply to be carried by a smaller channel, and would have given water to large tracts of land which are not commanded by the present canal; in this way also the channel could have been carried round the heads of deep ravines which are now crossed by means of heavy embankments and high aqueducts. During the rains of 1894 the river set towards its left bank and washed away 300 feet of the masonry channel of the canal. Pending the construction of a temporary trough of corrugated iron sheets the canal supply was obtained from the Naru nadi; but this supply, which fell to 15 cusecs at the beginning of October, was insufficient. The trough, however, was ready for the rabi season, and by means of it the supply to the canal was maintained while other and more permanent arrangements were being considered, and the necessary works constructed. Owing to the scouring out during recent years of the bed of the river opposite the canal head, it was found necessary to extend the canal upwards so as to secure command of the supply. The channel of the extension, to the site of a large rock at a point 500 above the existing head, was lined with masonry; for a distance of 900 feet above the large rock the canal is carried in an earthen channel. The extension channel is protected from the river by a boulder bank 10 feet wide at top. The supply to the canal is taken in through a culvert built near the upper end of the protecting bank.

The new masonry channel is liable to be covered entirely in a high flood; and to prevent any excessive supply passing down the old canal, a regulating escape and scouring sluice have been provided in the revetment wall just above the old head. Owing to the possibility of a breach in the protecting bank, and to the fact that the earthen channel carries a much larger discharge than is required for the canal, an escape has been provided above the head of the new masonry channel;

also a regulator for controlling the supply to the canal. These works which were designed by Mr. Dupuis, Assistant Engineer, were completed in 1897-98.

Alignment, &c., of channel.

26. For the first six furlongs of its course below the old head the canal proceeds over fairly even and in parts somewhat low ground. In this reach it crosses two mountain torrents being carried under the larger—the Naru Rao—by means of four siphons. The channel then creeps along the slopes and scarps of the left bank of the Jumna until it reaches the high land at Ambari, where it strikes out on to the surface of the country. It then bifurcates—the Dhakrani Branch on which there are no important works diverging to the right, and the main channel running south towards the village of Pirthipur; the latter crosses streams at eight different points by aqueducts of various dimensions, and finally discharges its tail water into the Satwala Rao. The total length of channel is now 26¼ miles made up as follows :—

Name of Channel.	Masonry-lined.		Unlined.		Total.	
	M.	F.	M.	F.	M.	F.
Kata Pathar main canal, including Pirthipur Branch, ...	3	2	5	6	9	0
Lakhanwala Branch, ...	...		1	6	1	6
Fatehpur ,, ...	0	1	3	0	3	1
Telpura ,, ...	2	2	1	2	3	4
Dhakrani ,, ...	2	5	4	0	6	5
Colonel Ouseley's minor, ...	...		0	5	0	5
Udya Khala feeder, ...	...		1	5	1	5
Total, ...	8	2	18	0	26	2

The whole length of the main channel from the head to mile 3⅜ was lined with masonry under the original estimate. In 1884 the first 2½ miles of the Dhakrani Branch were provided with a masonry lining, and in 1893 an estimate was sanctioned for lining 2½ miles of the Telpura Distributary, and for remodelling the Bulakiwala or Fatehpur Distributary.

Its liability to damage from floods.

27. No amount of care or forethought can entirely prevent damage from the heavy floods—notably those of the Jumna river and Naru Rao—to which the channel is subject at certain points. The Jumna river especially has of recent years given considerable trouble, and after the floods of 1894, in addition to the cost of the works necessary to ensure a supply to the canal, a considerable expenditure had to be incurred on protecting the canal against the encroachments of the river. In 1889 one of the four siphons under the Naru Rao suffered so severely that it had to be replaced by an entirely new work.

Mills.

28. The only mills on this canal are those at Ambari with two pairs of stones; at Pirthipur with one pair, and at Chuharpur with one pair.

Cost of works.

29. Captain Cautley's original estimate for the work amounted to Rs. 90,307, but it allowed for the construction of only eight miles of channel. At the end of 1862-63, when about 16 miles of channel had been constructed, the Capital cost of 'Works' had reached Rs. 2,15,128. The construction of the Fatehpur and Lakhanwala Distributaries, and the cost of other improvements, increased the amount to Rs. 2,33,778, the expenditure on date of closing the Construction Estimate.

Discharging capacity.

30. The canal was designed and constructed to carry a maximum supply of 80 cusecs. Taking its supply from the Jumna river it has one great advantage over the other canals of the Dún, it never suffers from failure of supply at the head, but owing to the cracking and subsidence of many of the masonry works—which appear to have been carelessly constructed in the first instance—the channel for many years was unable to carry more than half of its full supply. As a result of this, and of the fact that breaches—caused either by floods entering the canal or

by the opening of cracks in the aqueduct walls or masonry flooring—were of frequent occurrence, the cultivators for some time lost confidence in the canal. In the early seventies matters were put right by the expenditure of nearly Rs. 15,000, charged to revenue, and the canal is now capable of carrying about 66 cusecs.

Areas commanded and irrigated.

31. The canal irrigates in 43 villages and in these villages commands 8,374 culturable acres, of which 5,597 were shown as cultivated, and 3,816 as canal-irrigated, at the last Settlement (1886). The average area irrigated annually is 4,635 acres. In 1897-98 the canal irrigated 2,951 acres in *kharif*, with an average discharge of 48 cusecs, and 4,566 acres in *rabi*, with an average discharge of 51 cusecs.

Average direct receipts.

32. Taking the average for the five years ending 1897-98 the annual direct receipts from the canal now amount to Rs. 13,810, distributed as follows :—

	Rs.
Occupier's rate, ...	11,115
Owner's ,, ...	882
Mill rents, ...	1,414
Miscellaneous, ...	399
Total, ...	13,810

In 1897-98 the gross direct receipts amounted to Rs. 19,710—only 9 per cent. of the cost of works. Considering the direct returns only it will be seen that the canal compares very unfavourably with the Rajpur and Bijapur Canals. Indirectly, however, the canal has been of great benefit in leading to a considerable extension of cultivation in the Western Dún.

The Kalanga Canal.

History of its construction.

33. There is very little on record relating to the first construction of this canal. In his Notes written in 1845, Captain Cautley suggested that the head of the Song river should be carefully examined with a view to taking out a canal for the improvement of a portion of the Eastern Dún; he states that a cut had been made by Mr. Vansittart (at that time Superintendent of the Dún) from a point on the Song eastward of the Kalanga ridge from which water was supplied to the villages of Raipur, Mianwala and Harawala, &c. It was to take up the irrigation performed by this channel, and to open up to cultivation a tract of country which was then chiefly sál forest, that the Kalanga Canal was constructed. Work was commenced in 1855, and the canal was opened in the *rabi* of 1859-60. The opening of the canal was much delayed by the settlement of the heavy embankments, in parts 30 feet high.

Head-works.

34. As originally constructed the head of the canal was at a point on the Song river near the village of Raipur down-stream of the Kalanga hill. The head was not taken higher up as the eastern face of the Kalanga hill was considered unsafe for a masonry channel, both in itself and as being exposed to the full sweep of the Song river. The site chosen was not a good one: by commencing so low down the canal lost command of a large tract of country, and its right branch had to be carried over a series of ravines by long embankments and lofty aqueducts; but above all a large portion of the supply was lost in the boulder bed of the river above the site of the canal head. To remedy this latter evil, in 1861 a small masonry channel, about 1 mile and 5 furlongs in length, was carried from the head to a point on the Song river, a short distance below the confluence of the Sansadhara. The head of this channel is now known as the Chanduwala or 'Rains' head. The channel was designed to carry only about 20 cusecs—the minimum hot weather supply—which would otherwise have lost itself in the bed of the river. It served its purpose for some years, but it was soon noticed that the bed of the river became dry at a higher point each successive year, and further measures for assuring a supply to the canal became necessary. In 1869-70 the masonry channel

was carried up to Maldeota ; and in 1872-73 to Serki on the Bandal river, the water being carried in an open channel across the Sansadhara. In the following year the waters of the Sansadhara were tapped at a point about two miles above their confluence with the Song, and carried down to the canal by means of a small earthen channel known as the Sansadhara feeder. The attached sketch map shows the position of the various channels and head-works.

Present arrangement for obtaining supply.

35. The supply to the canal is now obtained in the following way :—

During the dry season of the year the greater portion of the supply is taken in at the Serki head on the Bandal river ; this is supplemented by a small volume taken from the Song at Maldeota ; and by a further small volume brought down by the Sansadhara feeder. Between Chanduwala and Raipur the supply runs in the small masonry channel constructed in 1861.

During the rains, and for some time after their cessation, the whole of the supply is taken in at the Chanduwala head and carried to the original head at Raipur, partly in the small masonry channel, but chiefly in an excavated channel running along side it.

Further alteration proposed in the head-works.

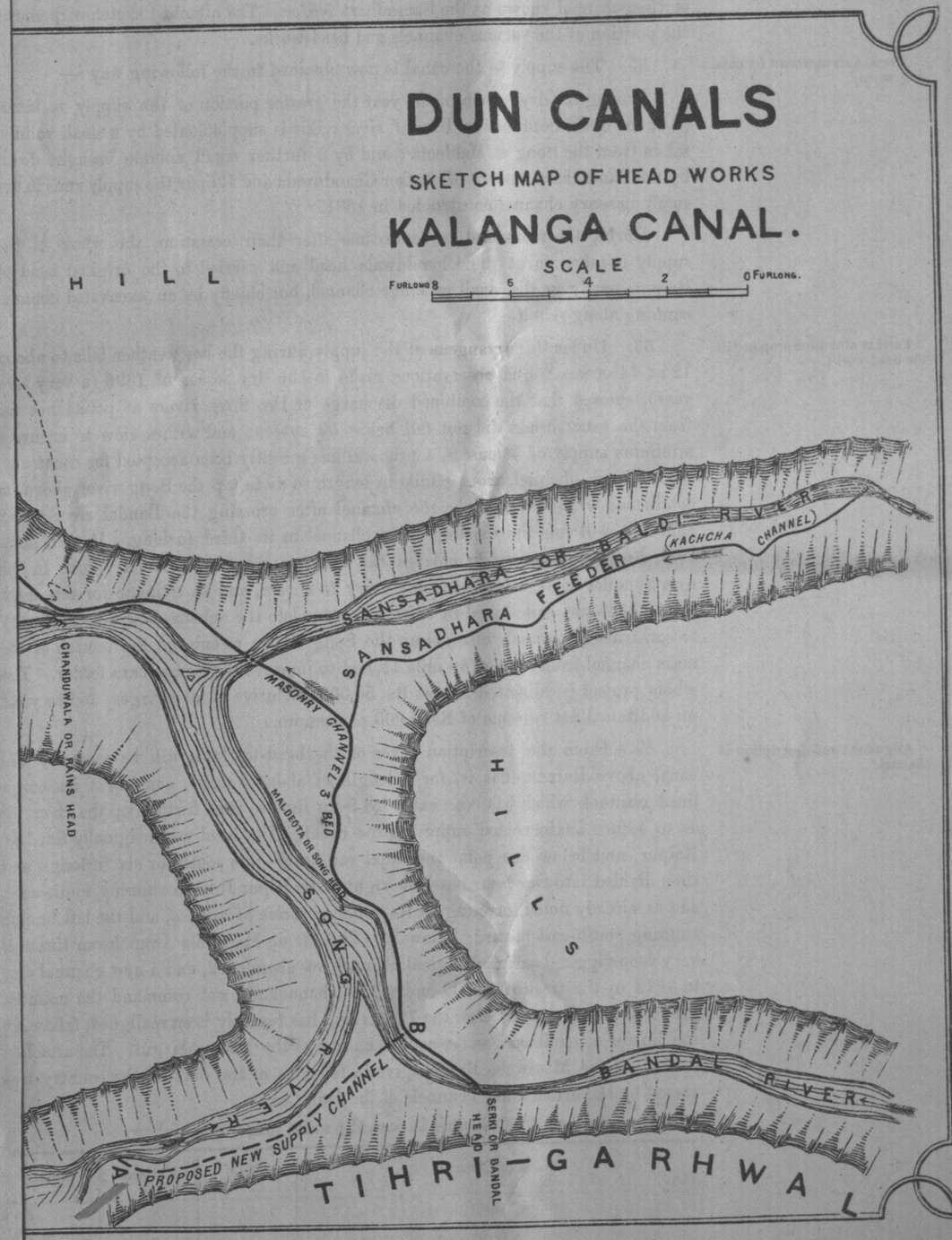
36. Under this arrangement the supply during the hot weather falls to about 12 or 14 cusecs. But observations made in the dry season of 1896 (a very dry year), showed that the combined discharge of the three rivers at points not far from the canal heads did not fall below 50 cusecs ; and with a view to ensure a minimum supply of 40 cusecs, a proposal has recently been accepted for constructing a branch channel about 1 mile in length so as to tap the Song river above its confluence with the Bandal ; the channel after crossing the Bandal river by an aqueduct will join the existing main channel in its third furlong. It will, however, first be necessary to enlarge the existing masonry channel, which in the first $2\frac{5}{8}$ miles of its length can only carry 25 cusecs, and an estimate for this work (Rs. 6,334) was sanctioned in 1896. To complete the scheme it will be necessary to construct the branch channel up the Song river ; to enlarge the section of the main channel from mile $2\frac{5}{8}$ to mile $4\frac{5}{8}$, and to improve the Sansadhara feeder. The whole project is estimated to cost Rs. 50,000, inclusive of all charges, and to yield an additional net revenue of Rs. 4,000 per annum.

Alignment and description of channel.

37. From the description given of the head-works it will be seen that the canal above Raipur, that is, for a length of about 5 miles, consists of masonry-lined channel, which has been extended from time to time further up the river, so as to secure an increased supply to the canal. The head was originally fixed at Raipur, and below this point the canal ran nearly due south for six furlongs, and then divided into two branches—the right or Badripur Branch running south-west, and as already noted, meeting in its course a series of ravines, and the left branch running south-east towards Balawala. The left or Mianwala Branch ran through very deep digging, and the original channel was abandoned, and a new channel dug in 1872 to the west of the old one. This channel did not command the country properly, and the canal below the 7th furlong has recently been realigned, following the line of a zemindari water-course known as the Harawala gúl. The attached section of the Mianwala Branch gives a fair idea of the slope of the country traversed by the distributary channels of the Dún Canals.

The total length of channel is now $12\frac{3}{4}$ miles made up as follows :—

Name of Channel.	Lined.	Unlined.	Total.
	M. F.	M. F.	M. F.
Main channel, ...	4 7	...	4 7
Badripur Branch, ...	2 3	0 7	3 2
Mianwala „	3 0	1 5	4 5
Total, ...	10 2	2 4	12 6



DUN CANALS

SKETCH MAP OF HEAD WORKS

KALANGA CANAL.

SCALE

FURLONG 8 6 4 2 0 FURLONG.

From Dehra

From Dehra

BADRIPUR BRANCH

Raipur Bangalow

Raipur

KALANGA HILLS

MIANWALA BRANCH

MASONRY CHANNEL 7' BED

MASONRY CHANNEL OF SMALL SECTION 2 & 3' BED (MOSTLY IN TUNNEL)

KACHCHA CHANNEL FOR RAINS SUPPLY

ESCAPE

RAIPUR HEAD

TERRACE BANK ABOUT 100' HIGH

CULTIVATION

SONG VALLEY

(Scrub jungle and old channels)

SONG RIVER

CHANDUWALA OR RAINS HEAD

SANSADHARA OR BALDI RIVER

SANSADHARA FEEDER (KACHCHA CHANNEL)

MASONRY CHANNEL 3' BED

MALDEOTA OR SONG HEAD

SONG RIVER

PROPOSED NEW SUPPLY CHANNEL

SERMI OR BANDAL HEAD

BANDAL RIVER

HILLS

TIHRI—GARHWAL

Photo-Zinco., T. C. Press, Roorkee.—No. 5002

U. D. E. J. C.

DUN SUB-DIVISION

KALANGA CANAL

REMODELLING MIANWALA BRANCH

LONGITUDINAL SECTION

HORIZONTAL SCALE.

FURLONG 8 7 6 5 4 3 2 1 0 FURLONG.

FEET 10 5 0 10 20 30 40 50 FEET.

VERTICAL SCALE.

REFERENCES.

BED LEVEL, MASONRY FALLS AND CISTERN SHOWN THUS.

BRIDGES SHOWN THUS.

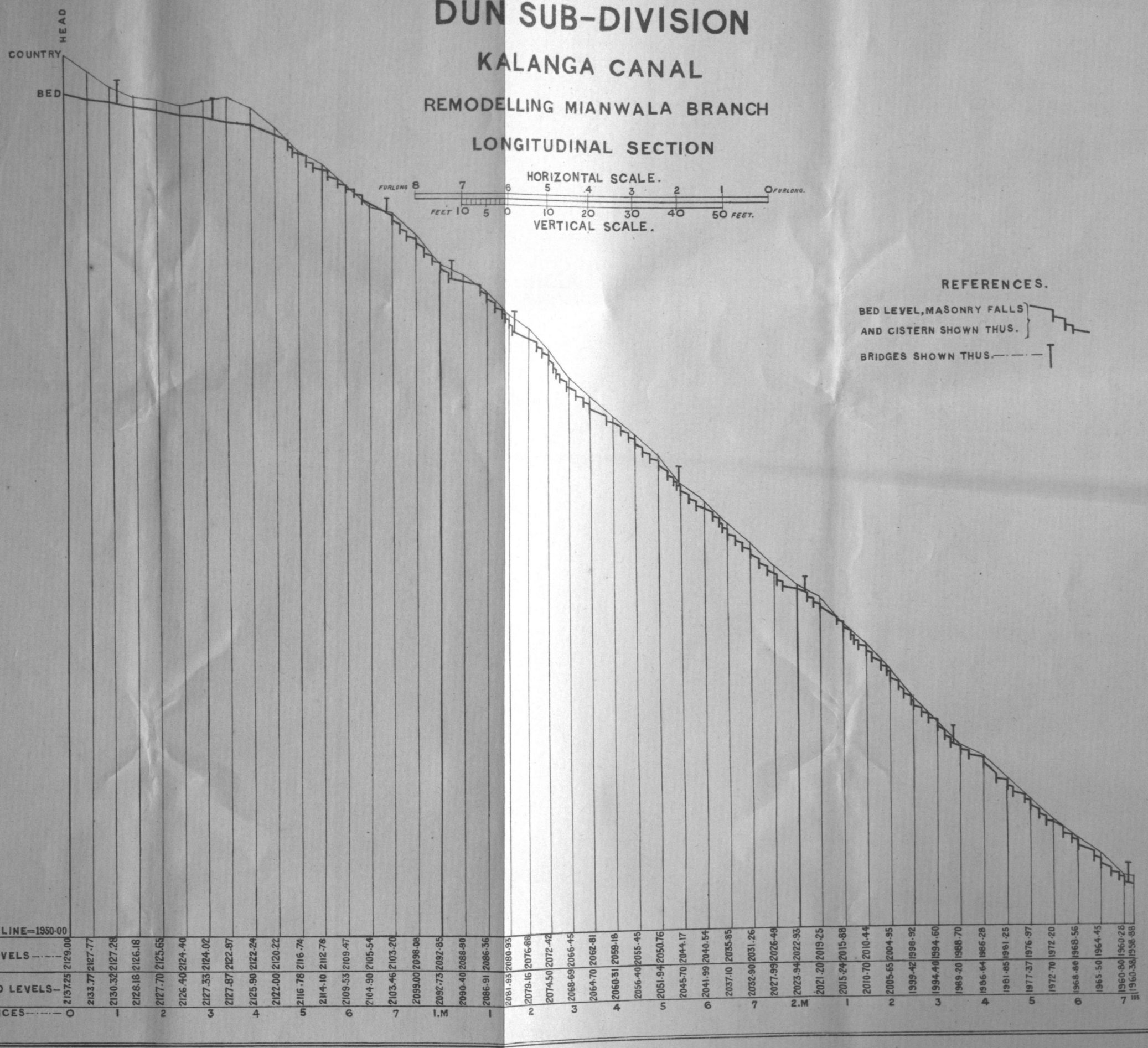


Photo.-Zinco., T. C. Press, Roorkee.—No. 5002

On the date of closing the Construction Estimate, the greater portion of the main channel and a small portion of the Badripur Branch had been lined with masonry ; an estimate for lining the Mianwala Branch was current, and another estimate for completing the lining of the main channel and extending that of the Badripur Branch has since been sanctioned.

Mills.

38. There are only two mills on this canal—one at Raipur with two pairs of stones, made when the canal was constructed, and another at Sansadhara, with one pair of stones, built in 1888-89.

Cost of works.

39. The amount of the original estimate of the cost of the canal cannot be ascertained from the records. On the date of closing the Construction Estimate the expenditure on works amounted to Rs. 72,145.

Discharging capacity and supply available.

40. The canal carries a maximum supply of 70 cusecs. This volume is available during the rains and early cold weather ; the supply then rapidly falls off until at the end of March only about 20 or 25 cusecs are available. During the hot weather the supply may dwindle down to 10 cusecs. As already explained a scheme for securing a minimum supply of 40 cusecs has recently been sanctioned.

Areas commanded and irrigated.

41. The canal irrigates in 29 villages, and in these villages commands 5,522 culturable acres, of which 4,766 acres are shown as cultivated, and 2,539 acres as canal-irrigated, in the last Settlement Report (1886). The area irrigated averages 3,177 acres divided fairly equally between the two fasls. In the dry year of 1896-97 the canal irrigated 3,363 acres ; the discharge varied from 14 to 60 cusecs with an average of 37 cusecs.

Average direct receipts.

42. Taking the average for the five years ending 1897-98, the annual direct receipts from the canal amount to Rs. 10,201, distributed as follows :—

	Rs.
Occupier's rate, ...	8,283
Owner's rate, ...	320
Mill rents,...	1,365
Miscellaneous, ...	233
Total, ...	10,201

In 1897-98 the gross assessments amounted to Rs. 12,857—about 18 per cent. of the cost of the works.

The Jakhan Canal.

Early history of the project.

43. In his "Notes on the Dehra Dún water-courses (1845)," Captain Cautley stated that there appeared "to be a field for extending irrigation in the North-East angle of the Eastern Dún by taking possession of the water which exists in the early part of the course of the Jakhan river." Mr. Vansittart, then Superintendent of the Dún, in a letter written in 1843 had called his attention to the matter, stating that "the forest below Bhogpur and Basantpur bearing the name of Rani Pokhri is situated in a healthy part of the Dún, but uncultivable for want of water for drinking and domestic purposes. The Jakhan Rao, at a spot a little above Bhogpur and distant from it three miles, contains a supply of water during the whole year." It appeared to Mr. Vansittart that a canal taken out from this site had once existed. Captain Cautley had no time to visit this portion of the district, but subsequently a project for a canal was prepared by Mr. R. E. Forrest, Superintendent of the Dún Canals, and the works were constructed by that officer in 1855 to 1861. The canal was opened in the kharif fasl of 1863 ; it had irrigated a small area in 1861-62, but as the supply was not steady the revenue was remitted.

Head-works.

44. The canal takes off from the left bank of the Jakhan Rao. The site for the head-works was fixed at a point about three miles above Bhogpur, high up in the river's course, so as to ensure a continuous supply of water. The water is turned into the canal by means of a temporary dam. During the rainy season the

supply is obtained by feeders from the Amgarh, Kua Khala, Mahadeo Khala and Sansra Khala torrents; from the first-named of these a small supply is also obtained during the dry season.

Alignment and description of channel.

45. In its upper portion the main channel—a masonry flume 4 feet wide by 3 feet deep—is carried along the slope of the hill for about 4 miles, and is exposed to the attacks of numerous mountain torrents, notably the Amgarh, Manigarh, Kua Khala, and Mahadeo Khala, over which it is carried by means of masonry aqueducts. The hill sides are covered with loose shale, and in the rains slips are of frequent occurrence. These, if coming from above, choke up the channel; the water flows over the sides of the masonry flume and cuts away the shale below. In this way a slip often leads to the subsidence of a considerable length of the flume itself. To guard against this danger those portions of the flume which are most exposed to the danger of slips in the shale above have been covered by a semicircular arch of fine concrete. To prevent damage from slips of the shale on which the flume is supported it has been necessary to strengthen portions of the hill side by buttresses of masonry or revetment of boulder pitching.

The canal reaches open country at 5 miles 2 furlongs, and bifurcates just below the 5th mile into the Rani Pokhri Branch on the right and the Jhilwala Branch on the left; the former for a considerable portion of its length runs through forest.

The total length of channel is 13¼ miles made up as follows :—

Name of Channel.	Lined.	Unlined.	Total.
	M. F.	M. F.	M. F.
Jakhan Canal, main canal, ...	5 2	...	5 2
Rani Pokhri Branch, ...	2 0	...	2 0
Ghamandpur „	0 6	0 7	1 5
Listerabad „	0 1	...	0 1
Thilwala „	2 2	...	2 2
Barkat „	1 1	0 1	1 2
Feeders, ...	0 4	0 2	0 6
Total, ...	12 0	1 2	13 2

Owing to breaches occurring from the fall of dèbris, the canal for many years had to remain closed at night during the rainy season. In 1880 it was decided to close the canal during the rains for the first four miles of its length, that is, above the Kua Khala confluence, and to obtain the whole of the supply from the Kua, Mahadeo, and Sansra Khalas.

Mills.

46. The only mill on this canal is situated at Bhogpur.

Cost of works.

47. Up to the end of 1863-64, the year on which the canal was opened, the expenditure on 'Works' amounted to Rs. 1,00,826. Since that date no further expenditure has been incurred against Capital.

Discharging capacity and available supply.

48. The canal can carry a maximum supply of 70 cusecs; in a dry year the available supply falls to 11 or 12 cusecs at the end of the rabi, and 8 cusecs in the early kharif season.

Areas commanded and irrigated.

49. The canal irrigates in 20 villages in which it commands 2,562 culturable acres, all but 19 acres of which are shown as cultivated in the last Settlement Report (1886); 1,884 acres were then shown as canal-irrigated. On an average it irrigates annually 1,225 acres—475 in kharif and 750 in rabi. In 1897-98 an area of 1,927 acres was irrigated with an average supply of 14 cusecs.

The upper portion of the tract commanded has a very poor soil, while the lower portion, though rich in soil, is very malarious.

Average direct receipts.

50. Taking the average for the five years ending 1897-98, the annual direct receipts earned by the canal now amount to Rs. 4,386, distributed as follows :—

	Rs.
Occupier's rate, ...	3,105
Owner's „	426
Mill rents,...	670
Miscellaneous, ...	185
Total, ...	4,386

Areas irrigated, principal crops, water-rates.

Total area irrigated by canals.

51. The total area irrigated by all canals is now about 16,000 acres in an ordinary year, and 22,000 acres in a year favourable for irrigation. Roughly about 60 per cent. of the area consists of *rabi* crops. The areas irrigated by each canal, and the total areas irrigated in each fasl and year since 1863-64, are shown in Statement D.

Principal crops.

52. The principal crops which take canal water are wheat, rice and sugar-cane. Tea is one of the most important products of the district; without the aid of canal water it could not have been grown at all, but as is explained below only a small area of this crop is now annually irrigated.

Wheat.

53. About one-third of the total irrigated area consists of wheat. The outturn per acre of this and other rabi crops is less than in the adjoining district of Saharanpur—Mr. Daniell, Settlement Officer, says one-fifth less; he gives the outturn of irrigated wheat as 7 to 10 maunds per acre. The stiffness of the soil and the consequent difficulty of working it, is said to be the cause of the smaller outturn. In an ordinary year wheat takes three waterings. The occupier's rate for it and other rabi crops is Rs. 2-4 per acre. The rate generally in force in the Doáb is Rs. 3 per acre. A lower rate was fixed for the Dún in consideration of the fact that though the cultivator in the Dún gets a higher price for his *rabi* crops than his brother south of the Siwaliks, his gain on the whole is smaller owing to the higher price of seed grain; greater labour in working a stony or stiff clay soil; higher rate of wages; and a smaller outturn.

The present occupier's rate was first introduced in 1892.

Rice.

54. The area under rice varies from 5,000 to 7,000 acres. The varieties of rice grown are numerous; they may be grouped according to their method of cultivation into (1) those transplanted from seed-beds, and (2) those sown broadcast. As a rule, the finer varieties are transplanted and the coarser sown broadcast; but there are some exceptions—*Nakka*, a coarse variety, appears to be always transplanted, while of the finer varieties *Mamraj* and *Anjni* are sown on both systems. The coarse varieties as a rule are sown in May after the ground has had one or at most two '*paleo*' or preliminary waterings; the crop itself is not watered. The finer varieties are transplanted in the first fall of rain (about 10th June), and take water all through the rains; the crop ripens at the end of August. Transplanted rice, when canal-irrigated, yields on an average 17¾ maunds, and broadcasted rice about 16¼ maunds per acre, the weight being that of the rice before it is hulled. In consideration of the relative values of the crop and of the quantity of water required to bring each variety to maturity, the finer varieties have always been supposed to be charged a higher water-rate. But the attempts at classification have not been satisfactory. The two classes of rice merge into one another, and it is sometimes impossible to distinguish between them. Again, at the time of measurement, when the crop is two-thirds grown, it is often difficult to say under what system a field has been sown. Usually it has been the custom to assess at the lower rate rice which takes a 'paleo' watering only; if the crop itself is irrigated it is charged at the higher rate. According to Notification No. 698 I., dated 17th February, 1896, this is now the authorized classification. Rice which takes a paleo

watering only is charged Re. 1-4 per acre ; when the crop itself is irrigated the charge is Rs. 4 per acre. The higher rate was raised to Rs. 4 in 1893 ; the lower rate has been in force since 1865. The present large difference in the rates naturally tends to encourage the cultivation of the coarser qualities of rice, and to diminish the area under the finer qualities. Previous to the introduction of the higher rate the area of 'transplanted' was nearly three times that of the 'broadcasted' rice ; with the same total area the proportion is now about four to three. And there is still a difficulty in classification at time of measurement—it is often impossible to say if a field took a 'paleo' watering only or if the crop itself was irrigated. Of recent years the local Canal officers have strongly advocated the adoption of one uniform rate for rice of all kinds. They contend (1) that though the broadcasted or paleo rices give a somewhat smaller outturn per acre and sell on the whole at a lower rate, the cost of cultivation is less than that of transplanted rice ; (2) that the 'paleo' rice takes water when the supplies in the canals are at their lowest ; and (3) that having a difference in the rates leads to irregularities and fraudulent complaints.

The Board of Revenue objected to the proposal for a uniform rate on the ground that the 'broadcasted' is much less remunerative than the transplanted crop. They considered that laying aside natural causes, there had been no increase n the extent of 'paleo' cultivation ; and that if at any future time 'paleo' rice should be too extensively cultivated it would be a sufficient check to raise the lower rate to Rs. 2 or Rs. 2-4 per acre. Government, while of opinion that an enhancement of the lower rate would eventually be found desirable, accepted the Board's view and allowed the present rate to stand. (*Vide* I. B. Works Proceedings, April, 1896, Nos. 1—16).

Sugarcane.

55. The area under cane averages about 1,100 acres, nearly all on the Bijapur and Rajpur Canals. It is grown only on irrigated land. A small area is grown on the village lands by the villagers themselves, but the greater portion is grown on the Dehra plateau by outsiders who, when the price of *gúr* runs high, come in large numbers and lease the land from the proprietor or from the occupancy tenant for a couple of years. In 1893 the occupier's rate for this crop was raised from Rs. 5 to Rs. 6 per acre.

Tea.

56. The total area under tea is about 5,000 acres, but as canal water is indispensable only for a short period in the life of the tea plant the irrigated area is comparatively small—five to six hundred acres.

Freshly-planted tea requires a watering every 7th or 8th day during the hot weather ; in the third year when the roots have struck deep two or three waterings are sufficient. After the third year water is seldom given. The present occupier's rate of 12 annas per watering was fixed in 1872. In 1880 the Local Government proposed to raise the rate to Rs. 1-8 per watering, on the grounds that the present rate is unreasonably low compared with the value of the crop, and that tea, which only requires water for a few years, displaces other crops which would take canal water every season. Considering the small area that had been brought under tea cultivation in the Dún, and the serious depression which the tea industry was then suffering, the Government of India did not deem it "desirable to raise the water-rate for tea at present."

Minor crops.

57. Among the minor crops irrigated by the canals are barley, oats, gram, maize, peas and masúr in the rabi ; and tobacco, *mandua til* in the kharif ; also orchards and vegetables in both seasons of the year.

Indigo, cotton, opium and water-nuts are specified in the schedule of rates, but they are seldom if ever grown in the Dún.

Water-rates.

58. Statement F. of the Appendices shows the schedule of water-rates which have been successively in force in the Dún since 1865. It will be noticed that the schedule introduced in 1871-72 laid down a reduced scale of rates for

certain canals, more especially the Jakhan Canal. It was hoped that a reduction of the rates would lead to a development of cultivation in backward tracts, and to an increase in the total area irrigated. These hopes were not realized, and in 1892 the rates were again equalized on all canals.

Financial Results.

Capital outlay.

59. The Construction Estimate of the canals was closed on the 31st March, 1894. On that date the total outlay on Works amounted to Rs. 5,97,550, and the total Capital outlay, direct and indirect, to Rs. 6,67,808, as shown in Appendix Statement A. In preparing the Statement no attempt has been made to classify the expenditure by sub-heads ; most of it was incurred before 1863, and details of the expenditure, previous to that year, are not given in the accounts. The outlay has been incurred under estimates sanctioned from time to time by the Local Government. In such cases the actual expenditure on the date of closing the Construction Estimate is treated as the amount of that estimate ; it seems unnecessary, therefore, to prepare a statement comparing the actual with the sanctioned expenditure (*vide* Public Works Code, Vol. II., Chap. IX., paras. II—III).

General statement showing financial results attained.

60. The financial results attained are conveniently exhibited in the following Table :—

Particulars.	54 years. 1840-41 to 1893-94.	10 years. 1884-85 to 1893-94.	4 years. 1894-95 to 1897-98.
GROSS REVENUE.	Rs.	Rs.	Rs.
Direct { Occupier's rate, ...	8,30,946	3,03,537	1,69,502
Direct { Owner's rate, ...	50,916	31,241	11,325
Mill rents, ...	7,61,929	2,28,227	84,908
Miscellaneous, ...	73,390	24,998	20,530
Gross Direct Revenue, ...	17,17,181	5,88,003	2,86,265
Indirect enhanced land revenue, ...	5,65,208	2,30,237	99,920
Total Gross Revenue, ...	22,82,389	8,18,240	3,86,185
WORKING EXPENSES.			
Extensions and improvements, ...	96,428	47,638	10,356
Maintenance and repairs, ...	4,60,651	1,61,864	77,222
Establishment, ...	6,04,764	1,89,405	86,016
Tools and plant, ...	14,386	2,144	3,906
Refunds of revenue, and profit and loss, ...	5,917	129	809
Leave and Pension allowances, ...	96,881	26,266	11,906
Gross Working Expenses, ...	12,79,027	4,27,446	1,90,215
Gross Net Revenue, ...	10,03,362	3,90,797	1,95,970
Average Gross Revenue.	...	81,824	96,546
„ **Working Expenses,**	...	42,744	47,554
„ **Net Revenue,**	...	39,079	48,992
Proportion of Working Expenses to Gross Revenue, ...	Per cent. 56·04	Per cent. 52·24	Per cent. 49·28
Working Expenses per acre irrigated, ...	...	2·89	2·80

Gross revenue.

The details for each year are given in Appendix Statement C.

61. The revenue credited to the canal is derived from (1) direct receipts on account of occupier's and owner's rates, mill rents and miscellaneous revenue ; and (2) indirect receipts or share of enhanced land revenue due to the canals. The average annual direct receipts during the ten years previous to the closure of the Construction Estimate amounted to Rs. 56,844 ; and during the four subsequent years ending 1897-98 to Rs. 71,566, the increase being due partly to improvements

carried out during recent years, and partly to the enhancement of the water-rates in 1892-93. The receipts from mill rents included in these figures amount on the average to about Rs. 22,000 per annum.

The last revision of Settlement of the land revenue of the Dún took effect from 1st June, 1886. The total revised demands amounted to Rs. 51,488, or in canal-irrigated villages only to Rs. 32,452 ; the canal share was fixed at Rs. 24,980, the area under canal irrigation being shown as 13,462 acres.

The average gross revenues, direct and indirect, for the two periods ending 1893-94 and 1897-98, are respectively Rs. 81,824 and Rs. 96,546.

Working expenses.

62. About 50 per cent. of the gross revenue of the canals is expended on their maintenance. In this respect, owing chiefly to the comparatively large receipts from mills, the canals do not compare unfavourably with the other Minor Works in these provinces ; but the maintenance charges per acre are exceptionally high for these canals, the average figure for the past 14 years being Rs. 2·85 per acre. In 1896-97 the charge per acre amounted to Rs. 2·62, while those for the Rohilkhand and Bijnor Canals were under one rupee. The excess expenditure on the Dún Canals is incurred almost entirely on the maintenance of the numerous head and torrent works. The main channels run, not like those of the Bijnor and Rohilkhand Canals along a flat alluvial plain, but for many miles along the face of almost perpendicular cliffs, exposed in many parts to attacks from the river below ; they cross deep ravines and have to be carried over numerous mountain torrents. The canals are little streamlets that you can step across, but as Colonel Brownlow pointed out in 1865, the expenditure on a torrent work may depend much more on the magnitude and nature of the stream crossed than on the capacity of the channel crossing it. Thus though the mileage of the Dún Canals is only about one-fifth of those of Rohilkhand, yet the annual charges for maintenance and repairs of works are much the same in both cases.

Annual net earnings.

63. During the ten years ending 31st March, 1894, the canals yielded an average net revenue of Rs. 39,000, or 5·84 per cent. on their Capital cost. Owing partly to recent improvements, but chiefly to the enhancements made in the water-rates in 1892-93, the average net receipts have now risen to Rs. 49,000 per annum. This represents a return of 6·85 per cent. on the Capital cost of the canals at the end of the year 1897-98.

Total receipts and charges from opening of canals to date of closing Construction Estimate.

64. From the statement given in para. 59 it will be seen that the total Direct receipts to 31st March, 1894, amounted to Rs. 17,17,181, and the Indirect receipts or share of enhanced land revenue to Rs. 5,65,208 ; giving a total revenue of Rs. 22,82,389. During the same period the total of the annual charges amounted to Rs. 12,79,027. On the date of closing the Construction Estimate there was thus a balance of over ten lakhs in favour of the canals—a sum far in excess of their Capital cost.

Indirect results of the canals.

65. The figures given in the preceding paras. show that financially the works have been successful. But the main object of their construction was not to obtain a direct return on outlay, but to open up waste lands to cultivation and attract cultivators to the Dùn. Of the useful results of the works in these respects we have ample evidence. Mr. Baker in his Settlement Report of 1886 says that "the canals are without doubt the making of the Dún. By their aid people are able to live on and cultivate land which would otherwise be left barren as being too far off from drinking water. Again a tenant obtaining three or four acres of canal-irrigated land will cultivate ten or twelve acres of dry land. But for the canal the whole would be left uncultivated." "Canals again," remarks Mr. Williams in his interesting 'Memoirs of the Dún,' "have had a valuable moral effect. The powerful stimulus they have given to agricultural enterprise has gone far towards rousing the natives from their incorrigible apathy." Between 1847 and 1886, that is, in about 40 years, the population of the Dún more than trebled, the irrigated area increased from 7,500 to 26,000 acres, and the total cultivated area from 34,000

to 71,000 acres. It has generally been conceded that these increases are almost entirely due to the influence of the canals in attracting cultivators.

Probable further outlay on the canals.

66. Any further extension of the irrigated area from existing canals can only be obtained by economizing water and by increasing the minimum supply during the winter and during the dry months of the kharif season. An increase in the minimum supply can be assured to at least one canal—the Kalanga ; a large saving of water should be possible on all canals. So far then as can at present be foreseen, the further expenditure on the Dún Canals will be incurred chiefly on remodelling the Kalanga Canal ; on completing the masonry lining of all channels ; and on constructing new channels to utilize the water obtained or saved by these means. Details of the probable further expenditure are given in Appendix B, the total estimated amount being Rs. 2,92,192. The proposed improvements of the Kalanga Canal have already been described in para. 36. The proposal to expend 2½ lakhs on completing the masonry lining of all channels and on constructing new distributaries was approved by Government in 1893. The canals then consisted of 34¼ miles of earthen and 46 miles of masonry channel. It was considered that by improving the existing masonry channels and lining the earthen channels with masonry a volume of 45 cusecs—equal to one-fourth of the average supply of the canals—now lost by percolation would be rendered available for irrigation. This would allow of an extension of cultivation at the tails of all canals except the Jakhan, of which the channels had already been lined, almost throughout, with masonry. Under estimates sanctioned since 1892, the length of masonry channel has been increased to 57¾ miles ; in the realignment of channels of the Kata Pathar Canal, two miles have been abandoned, leaving a total of 25½ miles still to be lined.

Financial prospects of the canals.

67. If funds are available the works should be completed in five or six years, and on their completion the Direct Capital outlay will amount to Rs. 9,41,751, and the Indirect to approximately Rs. 18,249, giving a total Capital outlay of Rs. 9,60,000. The additional water—15 cusecs—secured by the remodelling of the head-works of the Kalanga Canal ; and the water saved—45 cusecs—by lining the earthen channels with masonry should raise the irrigated area to an average of at least 21,000 acres. We may allow also for an increase of Re. 1 per acre in the occupier's rate for 'broadcasted' rice. During the past 14 years the average annual charges—direct and indirect—against revenue amount to Rs. 44,000 ; owing chiefly to heavy floods and numerous accidents to head and torrent-works, the average for the past four years has increased to Rs. 47,000. The new works will lead to no increase in annual charges other than that due to cost of collecting increased revenue, and of maintaining some few miles of additional channel in the comparatively level part of the country ; and when the works are completed, the annual charges should not, it is considered, exceed on an average Rs. 50,000. The annual net revenue should then be as follows :—

	Rs.
Direct Receipts—	
Occupier's rate, 21,000 acres, at Rs. 2·89*, ...	60,690
Increase of rate on broadcasted rice, ...	2,500
Owner's rate, say, ...	5,810
Mill rents,...	22,000
Miscellaneous, ...	3,000
Total direct receipts, ...	94,000
Total indirect receipts, ...	25,000
Total receipts, ...	1,19,000
Total charges, ...	50,000
Net revenue, ...	69,000

* Present average occupier's rate in a normal year.

This represents a return of 7·2 per cent. on the probable total Capital expenditure of Rs. 9,60,000.

Value of crops irrigated and incidence of water-rate per acre.

68. The average value of the crops annually raised in the Dún by the aid of canal water for the past five years is Rs. 6,26,753, giving an average of Rs. 37 per acre; the average occupier's rate, Rs. 2·82 per acre, and the average total charge made for the use of the water in the shape of occupier's rate, and of either owner's rate or enhanced land revenue, Rs. 4·50 per acre, or 12 per cent. of the value of the crop.

Abstract of financial results attained and anticipated.

69. Briefly stated then the financial results attained and those now anticipated are as follows:—

(i). On the closure of the Construction Estimate the Capital outlay amounted to Rs. 6,67,808.

(ii). For the ten years previous to the closure of the estimate, the canals irrigated yearly an average of 14,700 acres, and yielded an average net revenue of Rs. 39,000, being a return of 5·84 on the total Capital outlay. During the four succeeding years the canals irrigated an average of 16,952 acres, and the net revenue amounted to Rs. 49,000, or 6·85 per cent. on the Capital outlay to 31st March, 1898.

(iii). When the Construction Estimate was closed, the accumulated excesses of revenue over working expenses amounted to over ten lakhs, and to over three lakhs in excess of the Capital outlay.

(iv). The canals have led to a considerable extension of cultivation in the Dún and to an increase in the population; thus the main object of their construction has been attained.

(v). For the improvement of the canals and the further extension of irrigation and cultivation, an additional expenditure of somewhat under three lakhs is required. As a consequence of these improvements the annual net revenue derived from the canals will, it is considered, rise to an average of over 7 per cent. on their Capital cost.

These results must be considered very satisfactory, and there can be little doubt that the comparatively large sum which it has been decided to spend on the improvement of the Dún Canals will be money well laid out. It will yield an adequate direct return, and at the same time assist in extending cultivation, and in advancing the prosperity of the Dún. It is to be hoped, therefore, that there will be no difficulty in allotting funds for the works.

DUN CANALS.

APPENDIX A.—*Capital Outlay to end of* 1893-94.

Heads of Account.	Actual Outlay to end of 1893-94.	Remarks.
I. WORKS.	Rs.	
BIJAPUR CANAL—		
Outlay to end of 1861-62, ...	40,242	
Lining Kauli Branch with masonry, ..	3,469	1862-64.
Raising side walls of masonry channel,	2,303	1863-64.
Dhakra reservoir, ...	14,856	1864-70.
Lining channel with masonry, ...	37,334	1873-79.
Total Bijapur Canal, ..	98,204	
RAJPUR CANAL—		
Outlay to end of 1861-62, ...	65,475	
Lining channel with masonry	3,304	1864-67.
,, ,, ,, ,, ...	3,351	1872-74.
Total Rajpur Canal, ..	72,130	
KATA PATHAR CANAL—		
Outlay to end 1861-62, ...	2,15,128	
,, during 1863-64, ..	3,356	
Out-houses, Ambari Inspection house, ..	555	
New Distributaries, ...	2,763	1873-74.
Remodelling Bulakiwala and Telpura Branches, ...	11,976	Work in progress on 31st March, 1894.
Total Kata Pathar Canal, ..	2,33,778	
KALANGA CANAL—		
Outlay to end of 1861-62, ...	52,398	
,, during 1863-64, ...	7,068	
Extending masonry channel, ...	12,679	1871-74.
Masonry lining Mianwala Branch, ..	12,609	Work in progress on 31st March, 1894.
Total Kalanga Canal, ..	84,754	
JAKHAN CANAL—		
Total outlay—details not known, ..	1,00,826	
Additions made by Examiner in adjustment of account, ...	7,858	1873-75.
Total, I. Works.	5,97,550	
Total, II. Establishment, ..	51,446	
Total, III. Tools and Plant, ..	4,146	
Total, IV. Suspense balance, ..	..	
Total, V. Receipts on Capital Account, ...	−1,050	
Total Direct Charges, ..	6,52,092	
Capitalized abatement of land revenue, ..	6,886	
Leave and Pension allowance, ...	8,830	
Total Indirect Charges, ..	15,716	
Total Capital Outlay, direct and indirect, to end of 1893-94, ...	6,67,808	

DUN CANALS.

APPENDIX B.—*Estimate of the probable further Outlay to be incurred, and of the ultimate gross outlay against the Capital Account of the Canals.*

Item No.	Description of Works.	Probable further outlay.				Remarks.
		Works.	Establishment.	Tools and Plant.	Total.	
		Rs.	Rs.	Rs.	Rs.	
1	Completing the remodelling of the Bulakiwala and Telpura Branches of the Kata Pathar Canal, ...	3,912	900	59	4,871	Actual expenditure after 31st March, 1894.
2	Completing work of lining with masonry the Mianwala Branch of the Kalanga Canal, ..	4,018	859	56	4,933	Do. do.
3	Masonry lining 1,218 feet of main channel and embankments of the Badripur Branch of the Kalanga Canal, ...	7,846	1,805	118	9,769	G.O. No. 3223 I., dated 22nd December, 1894.
4	Constructing the Badripur Branch Escape of the Kalanga Canal, ...	1,500	299	19	1,818	G.O. No. 1805 I., dated 23rd May, 1895.
5	Improvement of Head-works of the Kalanga Canal, ...	5,336	1,219	79	6,634	G.O. No. 3628 I., dated 25th September, 1897.
6	New Head for Kata Pathar Canal, ..	11,548	2,656	173	14,377	G.O. No. 2155 I., dated 4th June, 1897.
7	Constructing the Udia Khala Feeder, ..	2,842	549	36	3,427	G.O. No. 2376I., dated 24th June, 1896.
8	Completing improvements of Head-works of Kalanga Canal, Rs. 50,000—Rs. 6,634 (item 5),	34,800	8,000	566	43,366	Expenditure sanctioned administratively in the Financial Department on 11th September, 1897.
9	Completing the masonry lining of all channels, Rs. 2,50,000 — Rs. 49,536 (total of sanctioned estimates for items 1, 2, and 3) and constructing new distributaries, ...	1,61,000	37,000	2,464	2,00,464	Do. do., on 2nd December, 1892.
	Total probable Direct outlay, ..	2,32,802	53,287	3,570	2,89,659	
	Indirect charges, say, ..	..	..	..	2,533	
	Total further outlay, ..	..	..	..	2,92,192	

DUN CANALS.

APPENDIX C.—*Statement of general Financial results.*

Year.	CAPITAL OUTLAY.				REVENUE RECEIPTS AND CHARGES.						Percentage of net revenue on Capital outlay.		Remarks.
	Direct Capital outlay.		Indirect Capital outlay.	Total Capital outlay to end of year.	Gross revenue due to works.			Enhanced land revenue or indirect receipts.	Total of charges both direct and indirect against Revenue Account.	Net revenue due to works.			
	During year.	To end of year.	During year.	To end of year.	Direct receipts.		Total.				Of excess revenue.	Of excess expenditure.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	
To end of 1841,	..	15,927	..	..	15,927	29	29	..	3,059	— 3,030	..	19·02	Bijapur Canal opened.
1841-42,	11,240	27,167	..	..	27,167	2,105	2,105	..	2,163	— 58	..	·21	
1842-43,	..	27,167	..	..	27,167	3,452	3,452	..	2,334	1,118	4·12	..	
1843-44,	198	27,365	..	..	27,365	5,496	5,496	..	4,830	666	2·43	..	Rajpur Canal opened.
1844-45,	50,145	77,510	..	..	77,510	5,447	5,447	..	4,771	676	·87	..	
1845-46,	12,564	90,074	..	..	90,074	10,796	10,796	..	4,416	6,380	7·08	..	
1846-47,	471	90,545	..	..	90,545	6,984	6,984	..	7,858	— 874	..	·96	
1847-48,	495	91,040	..	..	91,040	10,061	10,061	..	5,887	4,174	4·59	..	
1848-49,	469	91,509	..	..	91,509	8,272	8,272	..	5,559	2,713	2·96	..	
1849-50,	463	91,972	..	..	91,972	9,226	9,226	..	5,616	3,610	3·93	..	
1850-51,	620	92,592	..	..	92,592	11,094	11,094	..	6,213	4,881	5·27	..	
1851-52,	635	93,227	..	..	93,227	11,265	11,265	..	8,390	2,875	3·08	..	
1852-53,	2,631	95,858	..	..	95,858	11,497	11,497	..	7,517	3,980	4·15	..	
1853-54,	2,12,934	3,08,792	..	..	3,08,792	8,393	8,393	..	7,086	1,307	·42	..	
1854-55,	2,996	3,11,788	..	..	3,11,788	9,045	9,045	..	13,492	— 4,447	..	1·43	Kata Pathar Canal opened.
1855-56,	14,516	3,26,304	..	..	3,26,304	8,851	8,851	..	14,318	— 5,467	..	1·67	
1856-57,	15,676	3,41,980	..	..	3,41,980	10,837	10,837	..	9,768	1,069	·31	..	
1857-58,	38,485	3,80,465	..	..	3,80,465	10,479	10,479	..	12,356	— 1,877	..	·49	
1858-59,	31,588	4,12,053	..	..	4,12,053	11,917	11,917	..	12,814	— 897	..	·22	
1859-60,	19,109	4,31,162	..	..	4,31,162	11,903	11,903	..	13,271	— 1,368	..	·32	
1860-61,	27,330	4,58,492	..	..	4,58,492	12,865	12,865	..	14,387	— 1,522	..	·33	Kalanga Canal opened.
1861-62,	38,853	4,97,345	..	..	4,97,345	15,568	15,568	..	22,385	— 6,817	..	1·37	
1862-63,	23,324	5,20,669	..	..	5,20,669	15,984	15,984	..	22,020	— 6,036	..	1·15	
1863-64,	12,201	5,32,870	..	..	5,32,870	20,066	20,066	4,747	16,126	8,687	1·63	..	Jakhan Canal opened.
1864-65,	10,693	5,43,563	..	..	5,43,563	25,071	25,071	4,747	24,813	2,229	·41	..	
1865-66,	3,820	5,47,383	..	..	5,47,383	24,551	24,551	4,747	29,818	8,868	1·62	..	
1866-67,	— 2,514	5,44,869	..	..	5,44,869	35,656	35,656	4,747	29,298	20,899	3·83	..	
1867-68,	— 1,222	5,43,647	..	..	5,43,647	35,182	35,182	4,747	40,403	14,792	2·74	..	
1868-69,	300	5,43,947	..	..	5,43,947	37,951	37,951	4,747	42,698	17,637	3·24	..	
1869-70,	8,131	5,52,078	..	..	5,52,078	43,922	43,922	4,747	48,669	24,483	4·43	..	

APPENDIX C.—(*concluded*).

Year.	Capital Outlay.					Revenue Receipts and Charges.					Percentage of net revenue on Capital outlay.		Remarks.
	Direct Capital outlay.		Indirect Capital outlay.		Total Capital outlay to end of year.	Gross revenue due to works.			Total of charges both direct and indirect against Revenue Account.	Net revenue due to works.			
	During year.	To end of year.	During year.	To end of year.		Direct receipts.	Enhanced land revenue or indirect receipts.	Total.			Of excess revenue.	Of excess expenditure.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	
1870-71, ..	778	5,52,856	..	..	5,52,856	38,700	4,747	43,447	24,658	18,789	3·39	..	
1871-72, ..	8,154	5,61,010	..	..	5,61,010	47,143	4,747	51,890	26,283	25,607	4·56	..	
1872-73, ..	11,523	5,72,533	..	..	5,72,533	47,905	4,747	52,652	25,044	27,608	4·82	..	
1873-74, ..	6,539	5,79,072	..	..	5,79,072	52,415	4,747	57,162	27,482	29,680	5·13	..	
1874-75, ..	11,001	5,90,073	6,533	6,533	5,96,606	48,083	4,747	52,830	26,787	26,043	4·36	..	
1875-76, ..	9,423	5,99,496	..	6,533	6,06,029	36,016	1,50,399	1,86,415	25,389	1,61,026	26·57	..	Accounts of Indirect receipts adjusted and arrears of Rs. 1,34,448 credited to the canals.
1876-77, ..	6,980	6,06,476	..	6,533	6,13,009	50,554	15,951	66,505	27,552	38,953	6·35	..	
1877-78, ..	11,192	6,17,668	327	6,860	6,24,528	45,119	18,133	63,252	18,984	44,268	7·08	..	
1878-79, ..	7,236	6,24,904	..	6,860	6,31,764	47,969	15,951	63,920	24,417	39,503	6·25	..	
1879-80, ..	− 2,219	6,22,685	8,049	14,909	6,37,594	58,442	15,951	74,393	36,461	37,932	5·95	..	
1880-81, ..	− 163	6,22,522	..	14,909	6,37,431	58,512	15,951	74,463	38,524	35,939	5·64	..	
1881-82, ..	− 290	6,22,232	..	14,909	6,37,141	48,188	15,951	64,139	38,748	25,391	3·99	..	
1882-83, ..	246	6,22,478	..	14,909	6,37,387	55,707	15,951	71,658	47,445	24,213	3·79	..	
1883-84, ..	84	6,22,562	..	14,909	6,37,471	58,278	15,951	74,229	39,957	34,272	5·37	..	
1884-85, ..	− 490	6,22,072	..	14,909	6,36,981	53,720	15,951	69,671	37,043	32,628	5·12	..	
1885-86, ..	431	6,22,503	..	14,909	6,37,412	48,879	15,951	64,830	32,944	31,886	5·00	..	
1886-87, ..	− 419	6,22,084	..	14,909	6,36,993	64,818	23,475	88,293	34,946	53,347	8·37	..	
1887-88, ..	737	6,22,821	..	14,909	6,37,730	56,436	24,980	81,416	36,843	44,573	6·99	..	
1888-89, ..	173	6,22,994	..	14,909	6,37,903	57,547	24,980	82,527	37,104	45,423	7·12	..	
1889-90, ..	− 1,070	6,21,924	..	14,909	6,36,833	57,600	24,980	82,580	46,209	36,371	5·71	..	
1890-91, ..	..	6,21,924	..	14,909	6,36,833	59,906	24,980	84,886	52,449	32,437	5·09	..	
1891-92, ..	..	6,21,924	..	14,909	6,36,833	60,725	24,980	85,705	56,762	28,943	4·54	..	
1892-93, ..	..	6,21,924	..	14,909	6,36,833	59,243	24,980	84,223	50,452	33,771	5·30	..	
1893-94, ..	30,167	6,52,091	807	15,716	6,67,807	69,129	24,980	94,109	42,694	51,415	7·70	..	
Adjustment of accounts, ..	1	6,52,092	..	..	6,67,808	2,182	− 2,182	..	55,307	− 55,307	..	..	Rs. 2,182, Owner's rate, transferred from indirect to direct receipts, and Rs. 55,307 added to Indirect charges on account of Leave and Pension allowances previous to 1879-80.
Total to end of 1893-94, ..	6,52,092	6,52,092	15,716	15,716	6,67,808	17,17,181	5,65,208	22,82,389	12,79,027	10,03,362	..	..	
1894-95, ..	9,866	6,61,958	258	15,974	6,77,932	60,937	24,980	85,917	52,179	33,738	4·98	..	
1895-96, ..	8,692	6,70,650	227	16,201	6,86,851	60,576	24,980	85,556	44,641	40,915	5·96	..	
1896-97, ..	9,715	6,80,365	327	16,528	6,96,893	79,562	24,980	1,04,542	51,376	53,166	7·63	..	
1897-98, ..	17,909	6,98,274	509	17,037	7,15,311	85,190	24,980	1,10,170	42,019	68,151	9·53	..	
Total to end of 1897-98, ..	6,98,274	6,98,274	17,037	17,037	7,15,311	20,03,446	6,65,128	26,68,574	14,69,242	11,99,332	..	..	

DUN CANALS.

APPENDIX D.—*Statement showing areas annually irrigated by the Dún Canals.*

Year.	Bijapur Canal.			Rajpur Canal.			Kata Pathar Canal.			Kalanga Canal.			Jakhan Canal.			Total.		
	Area irrigated in acres.			Area irrigated in acres.			Area irrigated in acres.			Area irrigated in acres.			Area irrigated in acres.			Area irrigated in acres.		
	Kharif.	Rabi.	Total.	Kharif.	Rabi.	Total.	Kharif.	Rabi.	Total.	Kharif.	Rabi.	Total.	Kharif.	Rabi.	Total.	Kharif.	Rabi.	Total.
1863-64, ...	1,647	1,825	3,472	1,006	954	1,960	1,212	731	1,943	617	499	1,116	251	384	635	4,733	4,393	9,126
1864-65, ...	1,574	2,038	3,612	874	1,610	2,484	1,452	1,681	3,133	599	1,195	1,794	379	864	1,243	4,878	7,388	12,266
1865-66, ...	1,209	906	2,116	643	590	1,233	909	628	1,537	623	458	1,081	417	606	1,023	3,802	3,188	16,990
1866-67, ...	986	1,856	2,842	530	1,090	1,620	714	1,049	1,763	495	1,194	1,689	430	507	937	3,156	5,696	8,852
1867-68, ...	1,635	2,823	4,458	590	1,567	2,157	1,038	1,247	2,285	542	1,061	1,603	527	956	1,483	4,334	7,654	11,988
1868-69, ...	1,515	3,949	5,464	532	1,507	2,039	851	2,306	3,157	793	1,285	2,078	453	827	1,380	4,144	9,874	14,018
1869-70, ...	1,502	2,565	4,067	528	829	1,357	1,233	1,194	2,427	394	772	1,023	448	740	1,188	4,105	6,100	10,205
1870-71, ...	1,608	2,813	4,421	677	1,150	1,827	1,348	1,622	2,971	509	1,079	1,589	381	904	1,285	4,524	7,569	12,093
1871-72, ...	2,306	2,134	4,440	940	875	1,815	894	730	1,624	840	880	1,720	358	778	1,137	5,338	5,397	10,736
1872-73, ...	1,960	3,289	5,249	943	1,678	2,621	1,013	1,735	2,748	800	1,249	2,049	398	698	1,096	5,114	8,649	13,763
1873-74, ...	2,288	2,781	5,169	955	1,229	2,184	1,406	1,216	2,622	823	998	1,821	494	553	1,047	6,066	6,777	12,843
1874-75, ...	1,915	3,881	5,796	931	1,445	2,376	1,257	2,145	3,402	1,003	1,745	2,748	379	720	1,099	5,485	9,936	15,421
1875-76, ...	2,349	2,108	4,458	914	995	1,909	1,488	1,451	2,939	995	1,140	2,135	412	292	704	6,158	5,986	12,144
1876-77, ...	2,031	2,521	4,552	782	1,059	1,841	1,428	1,987	3,415	1,045	933	1,978	345	464	809	5,726	6,869	12,595
1877-78, ...	1,665	2,097	3,762	601	714	1,315	1,583	2,567	4,150	848	1,515	2,363	282	488	770	4,979	7,381	12,360
1878-79, ...	1,201	3,439	4,640	640	1,580	2,220	706	2,044	2,750	754	1,663	2,417	296	881	1,177	3,597	9,607	13,204
1879-80, ...	1,966	3,043	5,009	864	1,504	2,368	2,002	2,250	4,252	924	1,337	2,461	343	439	782	6,099	8,773	14,872
1880-81, ...	2,390	2,354	4,744	1,051	1,133	2,184	1,455	1,461	2,916	1,142	1,241	2,383	402	679	1,081	6,440	6,868	13,308
1881-82, ...	1,993	2,797	4,790	803	1,454	2,257	1,079	1,575	2,654	1,028	1,372	2,400	412	940	1,352	5,315	8,138	13,453
1882-83, ...	1,988	3,138	5,126	937	1,578	2,515	1,179	2,048	3,227	989	1,573	2,562	430	1,108	1,538	5,523	9,445	14,968
1883-84, ...	1,899	2,668	4,567	811	1,539	2,350	1,089	2,201	3,290	1,062	1,546	2,608	369	1,092	1,461	5,293	8,983	14,276
1884-85, ...	1,926	1,808	3,734	713	1,298	2,011	1,297	1,618	2,915	1,081	1,639	2,720	373	800	1,173	5,391	7,162	12,553
1885-86, ...	1,757	2,191	3,948	830	1,004	1,834	1,286	1,662	2,948	1,036	1,373	2,409	479	689	1,168	5,424	6,882	12,306
1886-87, ...	1,975	1,713	3,688	897	1,058	1,955	1,409	2,060	3,469	1,168	1,186	2,354	435	571	1,006	5,884	6,588	12,472
1887-88, ...	1,968	2,822	4,790	922	1,731	2,653	1,569	1,761	3,330	1,359	1,574	2,933	482	1,210	1,692	6,300	9,098	15,398
1888-89, ...	2,198	2,626	4,824	1,022	1,434	2,456	1,604	1,968	3,572	1,508	1,464	2,972	450	864	1,314	6,782	8,356	15,138
1889-90, ...	2,179	3,427	5,606	1,096	2,243	3,339	1,835	3,060	4,895	1,545	1,862	3,407	510	1,463	1,973	7,165	12,055	19,220
1890-91, ...	2,513	2,721	5,234	1,069	1,375	2,444	2,367	2,601	4,968	1,534	1,496	3,030	572	712	1,284	8,055	8,905	16,960
1891-92, ...	2,470	3,295	5,765	865	1,776	2,641	2,350	3,776	6,125	1,468	1,847	3,315	501	1,365	1,866	7,654	12,058	19,712
1892-93, ...	2,041	2,340	4,381	810	1,277	2,087	2,369	1,768	4,137	1,241	1,327	2,568	350	858	1,208	6,811	7,570	14,381
1893-94, ...	2,185	1,237	3,422	1,070	625	1,695	1,285	966	2,251	1,107	578	1,685	328	278	606	5,975	3,684	9,659
1894-95, ...	2,031	1,050	3,081	870	571	1,441	1,641	892	2,533	1,328	658	1,986	313	116	429	6,183	3,287	9,470
1895-96, ...	2,168	3,007	5,175	948	1,516	2,464	1,383	2,818	4,201	1,292	1,605	2,897	383	907	1,290	6,174	9,853	16,027
1896-97, ...	2,579	3,591	6,170	834	1,519	2,353	2,409	3,743	6,152	1,475	1,888	3,363	431	1,129	1,560	7,728	11,870	19,598
1897-98, ...	2,388	4,048	6,436	816	1,914	2,730	2,951	4,566	7,517	1,689	2,416	4,105	535	1,392	1,927	8,379	14,336	22,715

DUN CANALS.

APPENDIX E.—*Statement showing annual receipts on account of Mill Rents.*

Year.	Bijapur Canal.	Rajpur Canal.	Kata Pathar Canal.	Kalanga Canal.	Jakhan Canal.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1857-58, ...	..	..	..	..	..	..
1858-59, ...	..	..	..	..	..	..
1859-60, ...	2,391	4,983	241	116	..	7,731
1860-61, ...	2,405	4,691	301	226	..	7,623
1861-62, ...	..	..	..	..	..	8,582
1862-63, ...	1,852	4,740	233	292	..	7,117
1863-64, ...	3,268	5,214	340	452	84	9,358
1864-65, ...	3,823	6,845	633	422	127	11,852
1865-66, ...	4,112	7,234	629	540	238	12,788
1866-67, ...	3,260	6,963	457	516	289	11,485
1867-68, ...	3,611	8,551	620	452	389	13,623
1868-69, ...	3,177	6,942	666	486	342	11,613
1869-70, ...	3,746	8,278	817	570	372	13,783
1870-71, ...	4,522	8,150	944	568	420	14,604
1871-72, ...	6,332	11,267	589	768	382	19,338
1872-73, ...	6,560	12,637	1,012	886	348	21,443
1873-74, ...	6,864	14,234	1,073	655	323	23,149
1874-75, ...	6,598	14,103	916	678	340	22,635
1875-76, ...	8,177	12,953	912	1,497	350	23,890
1876-77, ...	8,531	13,692	739	1,600	372	24,934
1877-78, ...	6,044	12,491	736	1,935	336	21,542
1878-79, ...	7,691	14,771	950	2,427	344	26,183
1879-80, ...	6,669	16,625	1,144	1,556	204	26,198
1880-81, ...	7,446	14,900	975	1,124	257	24,702
1881-82, ...	5,863	14,047	631	1,382	343	22,266
1882-83, ...	6,760	13,824	990	1,593	402	23,570
1883-84, ...	7,682	14,592	1,082	1,843	495	25,694
1884-85, ...	..	..	..	..	..	26,933
1885-86, ...	9,299	15,244	1,587	3,807	611	30,548
1886-87, ...	7,183	11,666	959	1,814	680	22,302
1887-88, ...	7,520	13,468	859	2,476	605	24,928
1888-89, ...	5,253	11,480	966	1,469	496	19,664
1889-90, ...	6,035	11,941	1,060	2,672	690	22,398
1890-91, ...	5,481	8,913	1,026	1,702	607	17,729
1891-92, ...	8,095	12,283	1,466	1,571	676	24,091
1892-93, ...	6,578	12,116	996	1,336	703	21,729
1893-94, ...	7,964	11,393	1,264	1,296	710	22,627
1894-95, ...	7,263	10,784	1,419	1,181	715	21,362
1895-96, ...	6,712	11,014	1,498	1,279	732	21,235
1896-97, ...	7,131	11,182	1,549	1,571	684	22,117
1897-98, ...	5,618	11,232	1,340	1,494	510	20,194

DUN CANALS.

APPENDIX F.—*Statement showing Water-rates in force from* 1865 *to the present time.*

Rates in force from 1865 *to fasl Kharif* 1873.

Class.	Nature of Crops.	Rate per acre. Tor. Rs. A. P.	Rate per acre. Dâl. Rs. A. P.	Period.
I.	Tea, sugarcane, gardens, and all land requiring water throughout the year,	5 0 0	3 5 4	Annum.
II.	First class rice, tobacco, opium and singhara, ...	3 0 0	2 0 0	Fasl.
III.	Indigo and cotton, ...	2 4 0	1 8 0	,,
IV.	2nd class rice, wheat, and all other crops, ...	1 4 0	0 13 4	,,
	Vide Board of Revenue Notification No. 13, dated 2nd August, 1865.			

Rates in force from fasl Kharif 1873 *to fasl Rabi* 1892-93.

Class.	Nature of Crops.	Rate. Rs. A. P.
		Per year.
	Bijapur Canal.	5 0 0
I.	Sugarcane, ...	Per fasl.
II.	Garden produce, 1st class rice, tobacco, opium, and water-nuts (singhara), ...	3 0 0
III.	Indigo and cotton, ...	2 4 0
IV.	2nd class rice, wheat, oats, and all other inferior crops, ...	1 4 0
		Per year.
	Rajpur, Kata Pathar and Kalanga Canals.	5 0 0
I.	Sugarcane, ...	Per fasl.
II.	Garden produce, 1st class rice, tobacco, opium, and water-nuts (singhara), ...	3 0 0
III.	Indigo and cotton, ...	2 4 0
IV.	2nd class rice, wheat, oats, and all other inferior crops, ...	0 12 0
		Per year.
	Jakhan Canal.	5 0 0
I.	Sugarcane, ...	Per fasl.
II. & III.	Garden produce, 1st class rice, tobacco, opium, water-nuts (singhara), indigo and cotton, ..	2 4 0
IV.	2nd class rice, wheat, oats, and all other inferior crops, ...	0 12 0
	Rate for tea on all canals for each watering, ...	0 12 0
	Vide Notification No. 948 I.C., dated 10th April, 1873.	

APPENDIX F.—*Statement showing Water-rates in force from* 1865 *to the present time*—(concluded).

Rates in force from fasl Rabi 1892-93 *to fasl Kharif* 1896.

Class.	Nature of Crops.	Rate per acre.	Per
		Rs. A. P.	
I.	Sugarcane, ...	6 0 0	year.
I.	Garden produce, ...	6 0 0	fasl.
II.	1st class rice, tobacco, opium and water-nuts, ...	4 0 0	,,
III.	Wheat, indigo and cotton, ...	2 4 0	,,
IV.	2nd class rice, oats, and all other inferior crops, ...	1 4 0	,,
IV.	Tea, ...	0 12 0	each watering.
	Vide Notification No. 527 I., dated 10th February, 1892.		

Rates in force from fasl Kharif 1896 *to present time.*

Class.	Nature of Crops.	Rate per acre.	Per
		Rs. A. P.	
I.	Sugarcane, ...	6 0 0	year.
I.	Garden produce, ...	6 0 0	fasl.
II.	Rice, tobacco, opium and water-nuts, ...	4 0 0	crop.
III.	Wheat, indigo and cotton, ...	2 4 0	,,
IV.	"Paleo" for rice not again irrigated, oats, and all other inferior crops, ..	1 4 0	,,
IV.	Tea, ...	0 12 0	each watering.
	Vide Notification No. 698 I., dated 17th February, 1896.		