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Public Works DEPARTMENT.

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*Proceedings of the Madras Government, Public Works Department,
2nd May 1862.*

No. 41. Read the following letter from Lieutenant-Colonel A. D. TURNBULL, Superintending General of Irrigation North Western Provinces, to the Secretary to Government, Punjab, dated Roorkee, 4th September 1861, No. 1,901 :—

Sir,

1.—I have the honor to forward herewith for submission to His Honor the Lieutenant Governor, my report on the operations of the Western Jumna Canals for the year 1860-61, with appendices as follow :—

- 1.—Statement showing land irrigated and water rent levied in the various Districts of the Western Jumna Canals during 1860-61.
- 2.—Comparative abstract of income and current expenditure for Rubbee 1859-60 and 1860-61.
- 3.—Comparative abstract of income and current expenditure for the years 1859-60 and 1860-61.
- 4.—Statement showing area of cultivation and amount and value of produce on lands irrigated during 1860-61.

2. I regret that I am unable to accompany this Report with the Annual Statement of remunerative works as I am most anxious to adjust the outstanding balance against original works, by bills, which cannot be prepared or submitted till completion Survey reports reach me. The expenditure on *works* as shown in my Progress report differs slightly from that given by Captain Glover in the accompanying Statement, as his calculations for materials expended on works vary in a few instances from those adapted by the Central Office, but the totals in either case are approximately correct, and will answer all purposes, till such time as the *exact* sum is shown in my Statement of remunerative works, which will be submitted at the earliest possible date.

No. 4,471.

Copy of above forwarded to the Secretary to Government, Madras, for information.

(Signed) G. NEWMARCH, Lieut.-Colonel,

Asst. Secy. for Secy. to Govt., Punjab, P.W.D.
Lahore, 5th February 1862.

Report on the operations of the Western Jumna Canals, during the year 1860-61.

1. The Report of operations of this Canal during the last year, may be peculiarly interesting at the present time, when from the failure of the periodical rainy season, the suspension of all cultivation over an immense tract of country in the Punjab and the North Western Provinces has immersed thousands in the horrors of famine, which visitation has been averted by this canal over an area of about 4,500 square miles through which it flows, and which tract, from the produce it has been enabled to rear, has been the means of mitigating the evil in no inconsiderable degree in its own immediate neighbourhood.

2. The amount of rain which fell during the last year was only 16.51 inches according to the Register kept at Dadopoor, at the head of this canal; which amount is less than has been recorded during any year, since 1834, at which date the register commences. The largest recorded fall of rain was in 1856, when 60.75 inches fell, but the average quantity is about 40 inches, so that not more than between one-half and one-third of the usual quantity has fallen this year. There are two other years of failure of rain recorded, viz., in 1837, when 22.25 inches only fell, and 1848, when 20.68 inches fell, but it will be seen that they are neither so small as the last year's fall. Both these years were famine years, or years in which great distress prevailed, and it is a fact worthy of note that the dearth which periodically visits this country appears to be increasing in intensity, or, in other words that the recurring period of such visitation shows a less amount of rain fall than the preceding one showed.

3. It may be found also that the river supply will be similarly affected, and that the periodical deficiency of rain will be accompanied by a decreased volume in the rivers. The supply of water in the Jumna was particularly small during the last year, its surface being much lower than was ever known by any one residing in its vicinity. Captain Glover almost immediately after assuming charge of these canals, finding the supply failing, and having had his attention drawn to the subject, ascertained the discharge of the Jumna on the 1st February 1860, to be 2,854 cubic feet per second from actual measurement. It was determined by Colonel Abbott in February 1849, to be 3,488 cubic feet. In November 1860, Captain Glover again measured the discharge of the river in conjunction with Major Brownlow, Superintendent Eastern Jumna canal, and found it to be only 2,570 cubic feet, at that early period of the season, and it subsequently fell very considerably, but owing to his presence being required on other parts of the canal he was unfortunately unable to make any more measurements at the season of lowest supply, which would have determined the minimum discharge on record. Captain Glover does not think, however, that it could have exceeded 1,900 cubic feet per second in March 1861, which according to his judgment allows 1,250 cubic feet as the discharge of the Western Jumna, and 650 cubic feet for that of the Eastern Jumna canal at that time.

4. As the irrigation of this, as also of the Eastern Jumna canal, has extended very considerably of late years, and the amount of water carried by each has been consequently increased, and as the river invariably fails in affording a full supply to each canal according to the present standard, the measurement of the river becomes an important object, and Captain Glover recommends that the discharge be ascertained annually about February and recorded. Such measurements would doubtless be valuable, and, I shall, in future years, endeavour to obtain them, but as the work at the heads is generally over by the month of February, and the Superintendent is visiting other portions of the canal where his presence is urgently required during this month, he may not often be able to make them.

5. The proportion of the river's supply due to each canal has been a source of considerable difficulty for some years, and rules have been laid down from time to time regulating the division, but as the supply in each canal was due, above certain limit, to the exertions of the individual establishments, it followed that a constant straining arose to benefit one canal at the expense of the others, leading to increased and unnecessary expense without any corresponding benefit to Government, as any gain on the one was counterbalanced by a loss on the other. During the last year, therefore, finding the supply likely to fail to an unprecedented extent, Major Brownlow and Captain Glover agreed to a mutual scale of regulation; any fall in the supply of one canal being adjusted by a corresponding decrease of supply in the other. As there were no correct returns of the respective discharges of the two canals at different heights of water surface, these officers were obliged to arrive only at a rough conclusion, but it has been found to work very well, and owing to the low state of the river it may be considered to have had a fair trial. By the present agreement the regulation is left in the hands of the Eastern Jumna canal establishment, who, by opening their escape dam at Fyzabad, are enabled to send down more water to the lower heads of the Western Jumna, and thus increase the supply if requisite; reports of the height of water in each canal are exchanged daily by the officials entrusted with its regulation, and according to these reports the supply in the Eastern Jumna canal is either increased or lowered, every fall of one inch of surface below full supply in these Canals being met by a fall of 2 inches on their gauge.

6. The gauge at Dadoopoor, with full supply in the canal, stands at 4 feet 4 inches, showing a discharge of 2,544 cubic feet per second, but during a great part of January and February last, the gauge only showed 3 feet one inch, and during the latter part of February, and first half of March, it fell even to 2 feet 10 inches, so that Captain Glover calculates that during the very height of the Rubbee crop the discharge of the canal was not more than one-half its full amount. The failure of supply moreover commenced unusually early, about the middle of October, and no increase took place till the middle of April, so that it will be seen that during the most important crop of the year the supply has been most lamentably deficient.

7. During the last year the extension of irrigation has been very great, no doubt caused by the demand for water consequent on the failure of the periodical rainy season. Cultivators had been attracted in very large numbers from all the surrounding districts to the various villages which have been in the habit of using canal water, every available spot in each village had been rented in order to rear a small crop for the support of their families, moreover owing to the great drought many plots which formerly were mere swamps had dried up, and advantage was taken to put them under cultivation so that crops were raised in places where none had been seen for many years.

8. The benefits of the canal have been felt to a very great degree in 695 villages, bordering its course, and situate in the districts of Umballa, Thaneysur, Kurnaul, Delhi, Rohtuc, Hissar, and the independent territory of Jheend. The total amount of land brought under cultivation, and for which irrigation has been afforded from the canal during the past year is the large number of 7,33,267 beegahs, or about 730 square miles, scattered over area of about 10 times that extent, estimating the sphere of irrigation to extend on an average about 5 or 6 miles in width on each side of the canal throughout its whole length.

9. The amount of irrigation during the Rubbee crop was 4,62,377 beegahs, and Captain Glover calculates that the discharge of the canal during a great part of the time did not exceed 1,250 cubic feet per second, so that we are enabled to arrive at a close approximation of the amount of land that can be irrigated by one cubic foot of water per second for one crop, which in this case is about 370 beegahs, a fair conclusion and sufficiently accurate to serve as a basis for future calculations. Captain Glover proposes to ascertain the discharge of this canal for every decrease of one inch in height of surface, in the hope of being able annually to calculate the value of a cubic foot of water, and to ascertain whether it has been employed to the full advantage by comparison with former years.

10. In addition to the water-rent there are other sources of revenue on the canal, consisting of mill rent, fees on navigation, and rafting of timber, and sale of canal produce, each of which Captain Glover notices as follows:—

“The mill rent is levied by letting out the corn mills constructed in the city of Delhie and town of Hansie, the revenue from this source has, however, fallen off this year on account of the great demand for water for the more important object of irrigation not admitting of a constant supply being sent into the city of Delhie where it is employed as a motive power for these mills, and afterwards allowed to run to waste into the Jumna. At Hansie the demand for the use of the mills has declined considerably of late years since the breaking up of the Military Cantonments there.”

“Fees are levied agreeably to the scale laid down in the *Government Gazette* of 1st July 1845, on all timber which is rafted down the canal from the forests, where it is cut in the hills near the banks of the Jumna; the amount realized on this account has, however, fallen off very considerably of late years owing to the exhaustion of these forests, the extent of which may be inferred from the fact that sal timber of larger scantling than 6 inches square, and that only in small quantity, is not now procurable at Dadoopoor near the head of the canal whereas formerly the largest timbers were obtainable there. On a late occasion I was obliged to send to the Ganges, a distance of 40 or 50 miles, for timber which was required for the use of the canal.”

“The revenue realized by the sale of canal produce is very precarious, and varies considerably in amount, it is derived from the sale of timber and grass grown on the canal banks.”

“Fines are inflicted for the infringement of Canal regulations, and credited to Government. I have, however, endeavored to decrease their amount as much as possible, but in a year like the last when water was worth its weight in silver, the crime of water stealing became more

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"than usually frequent, so that I was not able to reduce the amount of the fine account so much
"as I could have wished, but I think that the total sum levied under this head is very moderate.
"The total of the fines levied last year amounted only to rupees 5,424-4-8, of which rupees
"249-1-0 were inflicted on the canal establishment, so that rupees 5,175-3-8 only are due to the
"breach of Canal regulations, and are spread over 695 villages, giving an average of rupees
"7-7-1 only to each."

"Water rent is levied on the actual area irrigated, and is assessed at different rates accord-
"ing to whether the water is capable of flowing naturally over the ground irrigated, or whether
"it is raised artificially. The crops usually grown are divided into two classes and are charged
"at different rates according to their classification, the amount of water rent per beegah, under
"different circumstances, being laid down in the *Government Gazette* North Western Provinces,
"1st July 1845."

11. The total amount of water-rent is determined twice annually at the expiry of each
half-yearly crop, and is ascertained by the actual measurement of each field irrigated. These
measurements are made under the superintendence of 3 darogahs, or superior officers, assisted
by a staff of moonshees and chainmen. Formerly a great number of villages took water by
paying a certain fixed sum, according to the number and sizes of their water courses, but these
contracts which were made in 1840, for a period of 20 years, expired at the commencement of the
past year, and as Captain Glover did not wish to renew them without thorough investigation, he
has been obliged to measure all lands irrigated during this year, which has greatly increased the
amount of work. In 1859-60, when contracts were in operation, the area of land to be
measured amounted to 296,252 beegahs only, and this was much in excess of ordinary years,
whereas in 1860-61 it amounted to 733,267 beegahs; in consequence of this great increased
area, Captain Glover was obliged to entertain some extra ameens and chainmen for a few
months. The total cost of the measuring establishment for the year 1860-61 amounted to
rupees 6,078-2-8, giving a cost for measurement of rupees 0082, or about 1½ pies per beegah, or
1-37 rupees per cent. on actual total amount of water-rent collected.

12. Owing to the great increase of area to be measured, great delay has occurred in com-
pleting the measurements of irrigated areas. The establishment commenced their field operations
in September, which was very early in the season, and when they suffered much from fever;
the last measurement not being completed till the end of June, during the whole of which
period they have been solely employed in measuring the irrigation. Captain Glover had the
subject of expediting the measurements constantly under his consideration; and early in the
year recommended that the village field Maps or Shurjrahs should be made use of, and authority
was obtained for copies to be made of them for the use of this department. In these maps each
field is marked and numbered, and the area is ascertained from other documents kept by the
village accountant or putwarrie; it appears, however, that the maps now in use in the greater
part of the districts through which the canal flows are very old, and were made at the time of the
settlement some 20 years ago, since when considerable changes have taken place in the distribu-
tion of land, and the boundaries of the fields, so that in most cases these maps are useless for the
purpose to which he proposed to put them. In the Hisser district however a new settlement
is now being made, and new maps are being prepared in the Rohtuc and Delhi districts also.
I believe many of the maps were destroyed in 1857, so that new ones are required and are now
being made. Captain Glover proposes therefore as soon as they are completed to obtain copies
from the district officers, and trusts no difficulty may then be experienced in introducing the
new system. By the old plan each moonshee was accompanied by a chaining party, and he was
only able to measure and calculate the contents of about 200 beeghas daily in the Khureef and
300 beeghas in the Rubbee, but by the new system nearly all chaining and calculation will be
avoided, and he will merely have to walk over the ground with his map in his hand, taking
down the numbers of the fields irrigated and the nature of the crops, and on his return to his
tent in the evening, he will, by looking at the Khusras or Index, be able to ascertain the area
of each field. Captain Glover calculates therefore, that he will be able to do from 800 to 1,000
beeghas daily, which will reduce the time or measurement to between 2 and 3 months only
annually. During the last year Captain Glover attempted to introduce this system by using

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the Collectory maps, but owing to the changes that had taken place which have been before
referred to, in the boundaries of fields, and the want of acquaintance on the part of the establish-
ment with maps, he did not succeed as he had wished, but he intends to keep the Darogahs and
Moonshees hard at work during the recess between their working seasons in learning the
construction of maps of this description and also the use of the plane table, and he trusts that
with a little practice they may be able to introduce the system as soon as the new maps may be
ready in the different districts, should it be found practicable to use these village field maps, and
that the annual measurement of irrigation is expedited to the extent anticipated. Captain
Glover is of opinion that the system of measurements of actual area of irrigation is the fairest
mode of levying a water tax that can be introduced and in this opinion I entirely concur.

13. The total income of the canal from all sources for the past year amounts to Rupees
463,344-9-2 being an increase of Rupees 97,010-3-4 above the greatest revenue yet realized
since the opening of the canal. The expenditure for maintenance, repairs, and establishment
for the year amounts to Rupees 205,752-2-11 or 44-4 per cent. on the revenue; so that net
revenue after deduction of all charges amounts to Rupees 257,592-6-3, which is not far short of
the gross income of ordinary years, a most gratifying result when it is considered that during a
great portion of the most important crop, the volume of water was but little more than half of
the full supply of the canal, and proving I think most clearly that the water has been turned to
the utmost account during this year of drought and famine.

14. Since the opening of the Canal in 1821, the total expenditure incurred in construc-
tion and improvement has amounted to Rupees 16,84,624-13-2 and the net profit derived by the
Government after repaying its original cost, and deducting the amount of the annual expenses
of maintenance and establishment, has amounted to Rupees 37,75,595-15-9, so that this Canal
has actually repaid 325 per cent. on the original outlay, and the profit returned to Government
for the last year in direct taxation amounted to 18 per cent. on the capital invested. This does
not, however, represent one tithe of the indirect benefit accruing to Government from the
increased land tax, and the general improvement in the prosperity and wealth of the country.

15. The total value of staple products of the Canal irrigation will be seen from the return
annexed, vide Appendix, and Captain Glover estimates it at no less a sum than 312½ lacs of
Rupees or upwards of 3 millions of £ sterling, the whole of which we may fairly assume
would have been lost to the country in a year like the last, had it not been for the influence
of these Canals. I think Captain Glover's estimate is somewhat high when we consider the
vast space over which, and the inferiority of much of the land upon which, these crops are raised,
and I would reduce their value to about 2½ or 2¾ millions of £ sterling, a sum sufficiently large
to show the enormous advantages derived by the community from these Canals in a famine year.
The amount of grain affording food for man thrown into the market amounts to 72,51,685
maunds; and allowing a man to consume 1 seer daily, the Canal will have raised sufficient food
to support about 8,00,000 of people for one year; or, allowing 2lb. to a man and child, will have
kept at least 12,00,000 of people alive for the same period, to say nothing of the fodder thus
obtained for the cattle. These facts speak for themselves, and serve to show the importance to the
country of even so primitive a canal as this. But when it is shown that the Government can
combine a benefit to the country with actual gain to themselves by establishing works of irrigation
it is to be hoped that the subject may receive the great attention which it undoubtedly deserves.

16. Among the more valuable products may be observed, sugar, which has been grown to
the value of nearly 30½ lacs of Rupees, Indigo 55,901 Rupees, and cotton upwards of 20 lacs of
Rupees. With reference to that last named, I may mention that some improved description of
seed have been kindly furnished to me by Mr. L. Berkeley, Extra Assistant of the Delhie
division, forwarded on to Captain Glover who will distribute them amongst the Zamindars for
sowing during the present season, and will forward specimens of their produce when the crops
shall have arrived at maturity. Captain Glover thinks it may be worthy of consideration,
"whether with the increased facilities of transport afforded by the Railroad now rapidly
"approaching Delhie, advantage might not be taken of a means of irrigation such as the canal
"guarantees to establish a large cotton growing country in this neighbourhood; the subject
"might be worthy, the attention of those interested in it."

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17. To show the benefits conferred by the canal on individual communities, Captain Glover instances the village of Bhutgaun in the Soneput district where the area of land under rice cultivation, amounted last year to 3,094 beegahs, yielding an estimated outturn of 46,410 maunds which, supposing it sold at the rate of 12 seers to the Rupee, bears a money value of upwards of 1½ lacs of Rupees for this one village alone; and for which the amount of water rent taken by the canals amounts to the inconsiderable sum of 2,469 Rupees or 16 per cent. only on the value of crop.

18. It is a most remarkable fact which should be well remembered, that this village of Bhutgaun was the first, and foremost among the three villages which petitioned the Commissioner in the previous year to have the Canal stopped, in consequence of the supposed loss which they had sustained by it from over saturation in ordinary seasons. There is no doubt that this village suffers from supersaturation for five out of six, or, perhaps six out of eight years, but a remission of the land revenue has been made to it on this account, and in ordinary years therefore its gains are not nearly such as have been shown above. But when the moist land is rendered fit for cultivation by drought, and the rates at which grain sells are high, as they are always in a season like the last, the village profits accordingly, and I believe last year was enabled to pay off debts which had been hanging over it for many years past. The case of Bhutgaun is not solitary, but many villages on the Canals have similarly profited by last year's increased produce and enhanced prices.

19. Of late years a white efflorescence commonly called by the Natives "Rêh" but whose chemical name is Sulphate of Soda has been observed to make its appearance in the neighbourhood of the Canal, rendering the land on which it is observed, quite unfit for cultivation. The subject has received considerable attention from time to time, but no remedy of practical value has apparently been adopted. Captain Glover considers "that this salt exists in the ground itself but having a great antipathy to damp, it has in order to escape, forced itself to the surface, as the height of the water level of springs has been raised by the influence of the Canal; and that the only real remedy is to provide complete surface drainage, so as to allow the water during the rainy season to flow off readily, washing the soil and carrying away with itself this efflorescence, by which means the supply would in course of time become exhausted. This however is a very difficult and expensive operation and must be the work of time."

20. Mr. Edward Brandreth the Commissioner of the Delhie Division writes as follows on the subject: "In Mr. Sherer's report; the injury to the land is principally ascribed to the salt being brought near the surface from below, where it has always existed, by the raising of the springs. This theory no doubt accounts for a good deal of the damage which has been, sustained, but there are other parts that have been injured by "Shor" where the springs are so deep especially in the neighbourhood of Delhie where the canal is very shallow, that the origin of the saline efflorescence cannot be accounted for in this way. In these cases it is to be attributed, it appears to me, to excessive irrigation, the soil is damp for several feet below the surface, and its mere dampness is sufficient to cause the salt to rise to the surface. Saltpetre, in the same way, may often be observed to get into the lower parts of the walls of houses, especially in damp situations."

21. I believe myself that the causes of the appearance of this destructive salt, are the great height of canal supply above the level of the country, and defective drainage due to obstructions formed by the ill-constructed water courses which cover this tract, and, therefore, that lowering the bed of the canal, placing the water's surface under soil, where now it runs far above soil, a re-distribution and a re-alignment of the numerous water courses which are led off from this line, added to careful and proper arrangements for passing off surface drainage under them, will either entirely remedy or at all events arrest the progress of the evil; and in reference to Mr. Brandreth's remark "that there are other parts that have been injured by "Shor" especially in the neighbourhood of Delhie," I would observe that however much these parts may be affected now, and may be suffering from the injurious effects of "Shor," many of the lands in the lower part of the Delhie canal from below Gungatowlee, on both sides of it, and especially in the neighbourhood of the Hujusgurh jheel have much improved of late years; lands which in my recollection bore only the most scanty crop, have of late years yielded crops far above the average.

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22. The keekur or *Mimosa Arabica* being well known as a most hardy tree, common in that part of the country, and capable of growing in land infected to a certain extent with "Rêh," Captain Glover recommended that plots of waste land should be taken up enclosed and sown with the seeds of this tree, and the Government has accorded sanction to the experiment being made on a small scale.

23. One of the great difficulties in establishing the Railroad between Delhie and Lahore is the great want of fuel existing along the whole line, and if therefore we can succeed in sowing this tree in large quantities at a trifling expense, we should be rearing a large supply of this commodity which would have arrived at maturity, simultaneously with the completion of the Railroad, moreover Captain Glover considers "that the large increased amount of vegetation would have a salutary effect on the country in decreasing the excessive heat by the protection and shade afforded, and also in preserving the natural humidity by preventing evaporation." If convenient seasons, such as the periodical rains, are seized, the experiment might be carried on in any part of the country, while on the canal it might be commenced at any time. Captain Glover's object in bringing this subject to notice was "to show that these lands partially infected with "Rêh" are still capable of being turned to practical use and are not entirely useless as is supposed."

24. The total cost of all establishment employed on these canals during the last year including the pay of officers and office establishment, amounts to Rupees, 96,894-8-4 of which Rupees 61,787-11-1 are chargeable to the Executive Department, leaving Rupees 35,106-13-3, or about 7.5 per cent. only on the income for the expense of measurement, collection of Revenue, and Police, which is a most satisfactory result; and which I can conceive no method of reducing, as the different duties are so intimately connected that the removal of any one description would not admit of a reduction of Establishment.

25. The total expenditure on works of all kinds on these canals for the last year amounts to Rupees 165,950-4-0, and the establishment employed to 61,787-11-1, or 37 per cent. on the expenditure; which appears a large proportion, but when it is considered that this included the pay of all the Officers, Overseers, and office establishment, usually chargeable to the

Original Work.....	34,964	13	4
Ordinary Repairs.....	64,560	8	6
Plantations.....	3,862	11	0
Contingencies.....	40,428	7	1
Tuckavee Works.....	22,127	12	1
Total..	165,950	4	0

Public Works Department, it will, I hope, be seen that the charge is not large. It must be considered that constant supervision has to be maintained over a length of canal of 434 miles, of which both the banks have to be patrolled and kept in repairs, besides a considerable length of which both the banks have to be patrolled and kept in repairs, besides a considerable length of Rajbhas and drainage lines, which probably double this extent. And as an accident to any portion of the line would entail heavy losses to Government in reimbursing the country for damages committed by the water, and entail a direct loss in canal revenue, it will be seen that heavy interests are at stake, and that it would be false economy to reduce the present scale of establishment; last year the Government sanctioned the division of the whole line into four executive charges and I have little doubt that the extra supervision thus obtained, and the more ready means of access to European officers thus afforded to the cultivators has greatly tended to bring about the splendid results of the past season.

26. The expenditure on original works for the past year amounts to Rupees 34,964-13-4. The principal works are a large cut in the Jumna at Dadoopoor for carrying off the floods of the Sombe and Patralla rivers into the branch of the Jumna, commonly called Blane's cut: a new cut Kanjnoon Escape channel, nearly a mile in length, giving improved means of regulating the canal supply: a large drainage line excavated nearly 2 miles in length for removing the swamps existing on the left bank of the canal between Indree and Kurnaul: and the regulating bridge at Rer has been considerably improved. On the Delhie line upwards of a mile of new canal in different places has been excavated: a new 2nd class chowkee has been erected at Durriapoor: and the Poolchudder Aqueduct near Delhie, as well as several bridges destroyed by the British Forces in 1857, have been repaired.

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27. On the Hansie branch a new cut of nearly a mile in length has been excavated, and a bathing ghat constructed for the village of Shera. The new cut above referred to, is in substitution of an old tortuous channel at the head of the Rohtuc canal, which used to collect silt in such vast quantities, that silt clearances were constantly required to keep the head of the Rohtuc branch open. These silt clearances which had to be excavated in running water were very expensive, and even in spite of them it was a matter of extreme difficulty to maintain the supply of water in that Canal. The new cut will, I trust, entirely remedy this serious evil, and enable the supply of the Rohtuc canal to be maintained with regularity. The cost of all these works is chargeable to the original construction of the canal, thereby increasing the amount of the capital.

28. The total cost on annual repairs, including plantations and contingencies, amounts to rupees 108,857-10-7, giving a cost of about rupees 250 per mile for the cost of maintenance and repair, a charge susceptible of considerable reduction, as the state of the canal generally becomes improved. This charge includes repairs to banks, masonry works, and canal bed itself.

29. There are several new projects under consideration, some of which have been submitted to Government, and some are still awaiting details, to admit of their being forwarded. Among the principal may be noticed a new line of about 40 miles in length on the Delhi branch, the details of which are being elaborated, and by which it is hoped to reduce the surface level of the water, and get rid of many of the evils to which the present high level gives rise.

30. The next project is for a new line about 12 miles in length between Indree and Booda Khera, by which it is hoped to effect a saving of about 8 miles in the length of the canal, and to bring into utility about 300 cubic feet per second of water which now runs to waste in feeding jheels, bordering the present line of canal. The cost of this project is estimated at Rupees 1,75,000, and it is anticipated that it will return a direct income of Rupees 50,000 annually. This has received conditional sanction from Government, and is now under construction.

31. In conjunction with the above Captain Glover suggests a new line of Rajbaha of 20 or 25 feet of width of bottom to leave the canal at Indree, the head of the cut referred to in the last paragraph, and run along the high land, skirting Kurnaul and re-entering the canal in the Bullah branch near Moonuk, this would afford irrigation to a considerable tract of country where it would be much appreciated. I believe this line to be perfectly practicable, though the excavation at the head where it enters the Bangur or high land may be deep, and its cost may therefore be somewhat high, but the value of 300 cubic feet per second of water is too great to be thrown away, and would very soon cover the cost of the Rajbaha required for distributing it over the country. The Superintendent of the Western Jumna canals has therefore been requested to pay his attention to this line of Rajbaha or branch canal, at an early period of the next working season, when the project will be submitted to the Government.

32. Captain Glover has also submitted a project for a new supplementary head leaving the Jumna near the village of Kulsowra and entering the canal near Booda Khera above Kurnaul. The cost of this is estimated at about Rupees 40,000, and it is calculated that in the lowest seasons of the river supply it would throw about 300 cubic feet of water per second into the canal, and be a most valuable aid to irrigation just at the time it was most required. Had this head been in existence during the last year, its assistance would have been incalculable.

33. The upper portion of the Rohtuk branch for about 20 miles in length requires remodelling, and instructions have been issued to have the line examined early next cold weather.

34. In the Northern division, Captain Glover proposes to alter the whole line and to divide the alteration into 3 or 4 portions, starting from the various bridges as obligatory points and remodelling the portions of canal between them. Great wastage of water occurs in this portion of the canal and great good effect would result from its improvement.

35. In the Hansi branch also, much has to be done to bring it to perfection, and the improvements of this line will receive the attention of the officer in charge of it.

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36. I feel assured that the result of Captain Glover's operations during the past year will be considered highly satisfactory by the Punjab Government. Captain Glover from the time he took charge of the Western Jumna canals has labored most zealously and efficiently both for the welfare of agricultural community, with whom in this important charge he is thrown into such constant communication, and also for the interests of Government. We were visited last year both by His Honor the Lieutenant Governor, and also by the Financial Commissioner of the Punjab, and I trust that those visits will have left impressions that so far as the Canal officers' duties are concerned, the real interests of the land holders are deeply consulted, and receive every attention at their hands. Captain Glover has thoroughly identified himself with the people he has had to deal with, and I feel convinced that while his efforts to do justice to all have been fully appreciated by them, his unvarying good nature and temper in listening to their complaints have left a strong impression for good upon their minds. It will be seen from the 29th and succeeding paragraphs of this report that Captain Glover has been actively engaged in the preparation of several projects of importance to the material benefit of the charge entrusted to him, while he has brought the Canal Revenue up to such a height as was never before reached. For these successful endeavours on his part to aid the Government and the country during such a trying season as the past, I consider him entitled to, and would venture to ask for, the special thanks of the Government.

37. Captain Glover brings to notice the exertions of the Officers and Overseers under his orders, who have all performed their duties carefully and intelligently. He mentions those of Captain Earle, who was formerly Superintendent in charge of the Delhi Canal, and is now in charge of the Hansi Branch; Lieutenant Jeffreys, Superintendent of the Rohtuk Canal; Lieutenant Moncrieff, Superintendent of the Delhi Branch; and Mr. Duncan in charge of the Upper or Northern Division of the Western Jumna canals; also Serjeants Corcoran, James Maloney, and Wilson, who have all been favorably noticed by the Officers under whom they have served. Captain Glover also mentions that Lieutenant Jeffreys, in addition to conducting his duties to his satisfaction, has also made himself particularly useful in lining out one or two additional works requiring a considerable amount of laborious application and judgment, which he has performed greatly to Captain Glover's satisfaction. I think that all these Officer and Overseers are entitled to the favorable notice of the Government.

A. D. TURNBULL, *Lieutenant-Colonel,*
Superintendent General of Irrigation,
N. W. Provinces.

P. S.—Since writing the above I have received from the Financial Commissioner of the Punjab, certain statements showing the additional value of the Western Jumna canals to the Government by reason of the increased assessments upon the land irrigated by them, and which has hitherto been credited only in the land Revenue Accounts.

These Statements condensed are as follows:—

Number of Villages.	Name of District.	Actual Assessment.	Assessment at Barani Rates.	Balance due to Presence of Canal.		
78	Delhie.	1,51,745	1,12,970	38,775	0	0
180	Kurnaul.	4,62,961	2,79,537-3-9	1,83,423	12	0
95	ik.	2,84,760	2,07,026	77,734	0	0
62	H. ir.	1,12,320	43,145	69,175	0	0
415		10,11,786	6,42,678-3-9	3,69,107	12	0

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Showing the net advantage derived by the Government from the presence of the Canals, in the land Revenue Accounts alone, after deducting the sum of Company's Rupees 22,802-15-3 for remissions permanently made for losses to certain lands from swamps arising from the proximity of the Canal.

Thus then in addition to securing the land revenue, amounting to upwards of 10 lacs of Rupees, during a very severe famine year, the advantages to the Government are during the past year:—

	RS.	A.	P.
Increased land assessment ...	3,69,107	12	0
Water Rent.....	4,63,344	9	2
Total.....	8,32,452	5	2

It would appear therefore from the foregoing that the Canal account is entitled to credit for the large sum annually of 369,103 Rupees with interest also at 5 per cent. (as we have paid the Government interest annually at the rate of 5 per cent. on the capital expended) since the several dates on which the existing settlements for the land revenue were made in the four districts through which the Canal passes.

I am not aware of these dates, but as the District of Hissar is now being re-settled, and as the last settlements were made for 20 years, I assume that the settlements in these adjoining districts all run for nearly this period. Hence we obtain a new credit to the Canal west of the Jumna of 3,69,107-12-0 x d. by 20 or 73,82,155 Rupees on account of land rent. As shown in the body of the report, the net profit to the Government derived from water rent, and other sources, after deducting all expenses for establishment (which includes all salaries), and maintenance, since the Canals were opened, amounts to 37,75,695-15-9 and the total of these two sums, viz., 1,11,57,850 Rupees will show the clear profit to the Government derived from these magnificent Canals. Much however still remains to be done on them, and with these large figures before the Government, I feel assured that the 10 or 12 lacs which will be required during the next few years will be willingly given to place them in first rate working order, and to render them even yet more productive, than they have been, and a still greater blessing to the country than they have proved to be during this severe year of famine of 1860-61.

A. D. TURNBULL, Lieut.-Colonel,
Supt. Genl. of Irrigation, N. W. Provinces.

APPENDIX I.
Statement showing the quantity of Land Irrigated and Water Rent levied in the various Districts of the Western Jumna Canals for 1860-61.

Zillah.	Water Rent.										Miscellaneous.										Grand Total.											
	1st Class.				2nd Class.				Total.		Revenue on Water Rent.		Rent on Water Mills.		Rent on Watering Cattle.		Rent on Raising Timbers.		Sale of Canal produce.			Fines for breach of Canal Regulations.		Total of Miscellaneous Revenue.								
	Tor.		Dal.		Tor.		Dal.		Beegahs.	Biswas.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.		Rs.	A. P.	Rs.	A. P.							
	Beegahs.	Biswas.	Beegahs.	Biswas.	Beegahs.	Biswas.	Beegahs.	Biswas.																								
Northern...	5,906	6	3,842	7	1,063	0	1,841	9	12,713	2	7,414	4	5	...	...	5,694	11	2	1,238	11	8	792	12	2	7,726	3	0	15,140	7	5		
Karnaul ...	48,142	2	19,575	0	19,660	1	12,226	15	99,603	18	57,906	9	11	...	...	1,954	15	5	1,220	0	0	218	11	1	3,474	5	11	61,380	15	10		
Paniput ...	54,078	11	19,522	7	14,118	8	9,068	15	96,783	11	59,034	13	10	...	...	1,954	15	5	555	0	0	204	7	0	812	3	5	59,847	1	3		
Soneput ...	70,827	3	5,166	18	24,139	12	6,493	18	1,06,627	11	67,791	5	1	...	...	...	...	...	663	9	9	224	9	0	920	10	9	68,711	15	10		
Delhie...	44,473	18	585	16	22,557	12	2,492	11	70,109	17	43,835	3	11	1,244	6	5	...	...	2,689	10	9	177	9	0	4,121	7	8	47,956	11	7		
Kohtuk ...	57,141	17	4,772	3	24,341	1	5,820	18	92,075	19	57,255	9	7	...	...	...	...	...	631	11	0	724	1	0	1,406	10	6	58,642	4	1		
Jheend ...	43,944	2	11,201	16	17,769	14	7,866	2	80,781	14	48,421	2	9	...	...	...	...	...	515	8	3	358	0	0	1,051	0	4	49,472	3	1		
Hanse ...	51,843	16	12,607	11	34,317	8	13,956	6	1,12,725	1	63,846	14	2	21	11	0	50	1	10	634	6	9	345	1	3	1,051	4	10	64,898	3	0	
Western ...	937	14	524	13	1,376	5	2,907	4	5,745	16	2,447	8	7	...	...	...	...	...	131	15	13	70	11	0	434	9	9	2,882	2	4		
Bootana ...	31,195	11	3,194	10	19,203	18	2,505	11	56,101	10	33,779	5	8	...	...	...	...	...	5	6	0	339	0	11	633	3	1	34,412	8	9		
Total ...	4,08,551	0	80,993	1	1,78,514	9	65,179	9	7,33,267	19	4,41,712	13	11	1,266	1	5	558	13	4	7,082	2	7	8,669	11	6	5	21,631	11	3	4,63,344	9	2

Supt. Genl. of Irrigation, N. W. P.

A. D. TURNBULL, Lieut.-Colonel,

Supt. Western Jumna Canals.

(Signed) T. G. GLOVER, Captain,

APPENDIX II.

COMPARATIVE Abstract of the Income and Current Expenditure of the Canals West of Juma for the Rubbee Crop of 1859-60 and 1860-61.
Canal Office West of Juma, 15th July, 1861.

Year.	Season.	Canal Income collected by the Superintendent.										Current Expenditure as per Bills.													
		What rent on irrigation of rubber crops.		Rent on watering cattle.		Rent on watermills.		Transit duties on rats of timber, &c.		Sale of produce of the canal bounds.		Sundry collections, viz., filling tanks, fishing nets, &c., &c.		Fines for breaches of the Canal regulations.		Total of the half-yearly income.		Establishment for superintendence of works, collections of revenue and all duties.		Cost of ordinary repairs, plantations, contingencies.		Total of half-yearly current expenditure of every description.			
Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.
1859-60.	Rubbee.	2,02,405	1 3	1,001	2 1	1,612	10 1	6,998	14 1	1,466	7 5	3 0	0	4,037	6 10	2,17,554	9	44,925	13	4 46,468	15 1	91,394	12 5		
1860-61.	Rubbee.	2,70,149	1 11	558	13 4	309	5 11	4,082	11 5	3,234	4 0	...	...	3,203	5 11	2,81,487	10	6 52,136	7 5	48,398	12 6	1,00,535	3 11		
Difference excess.		2,67,744	0 8	...	...	...	...	...	...	1,767	12 7	...	...	...	...	63,933	0 9	7,210	10 1	1,929	13 5	9,140	7 6		
Difference decrease.		...	...	2,442	4 5	1,333	4 2	2,966	2 8	...	...	3 0	0	834	0 11	...	...	...	...	...	...	...	...	...	

Remarks by the Superintendent Canals west of Juma.

The increase of watering is due to the great increase of demand for irrigation on the failure of the periodical rains. The decrease on watering cattle is due to the villages taking increased quantities of water which absorb them from this tax. Decrease on water mills due to the water being employed in the more important object of irrigation. Decrease on rafting timber is due to the exhaustion of the forests. Increase of sale of Canal produce accidental.

(Signed) T. G. GLOVER, Captain,
Supdt. Western Juma Canals.

A. D. TURNBULL, Lieut.-Colonel,
Supdt. General of Irrigation, N. W. P.

APPENDIX III.

COMPARATIVE ABSTRACT of the Income and Current Expenditure of the Western Juma Canals for the years 1859-60 and 1860-61.

Years.	Canal income collected by the Superintendent.										Current expenditure as per Bills.													
	Water rent on irri- gation.		Rent on watering cattle.		Rent on water mills.		Transit duties on rafts of timber, &c.		Sale of produce of the canal bounds.		Sundry collections, viz., filling tanks, fishing nets, &c., &c.		Fines for breaches of the Canal regula- tions.		Total of the yearly income.		Establishment for superintendence of work, collections of revenue and all duties.		Cost of ordinary re- pairs, plantations and contingencies		Total of yearly cur- rent expenditure of every descrip- tion.			
	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.	Rs.	A. P.
1859-60	3,38,958	8 9	1,001	2 1	3,532	10 5	11,514	5 0	5,262	4 11	601	1 6	5,464	5	23,66,334	5 10	81,773	7 2	97,570	6	61,79,345	13 8		
1860 61	4,41,712	13 11	558	13 4	1,266	1 5	7,682	2 7	6,688	5 3	12	0 0	5,424	4	84,63,344	9 2	96,894	8 4	1,88,857	10	72,03,752	2 11		
Difference excess	1,02,754	5 2	...	...	...	...	...	...	1,426	0 4	...	...	...	...	97,010	3 4	15,119	1 2	11,287	4 1	26,406	5 3		
Difference decrease	...	...	442	4 9	2,266	9 0	3,835	2 5	...	...	589	1 6	40	0 6	...	...	...	...	...	...	...	...	...	...

(Signed) T. G. GLOVER, Captain,

Supdt. Western Juma Canals.

A. D. TURNBULL, Lieut.-Colonel,

Supdt. General of Irrigation, N. W. P.

APPENDIX IV.

Statement showing the area of Cultivation, and amount and value of produce on Lands irrigated by the Western Jumna Canals, during the year 1860-61.

	Khureef, 1860.		Rubbee, 1860-61.		Total areas 1860-61.		Estimate of Produce.			Average price in Bazar.	Total value of Crops.	
	Area in Beegahs.		Area in Beegahs.		Area in Beegahs.		Per Beegah.	Total.				
							Mds. S. C.	Mds. S. C.			Rs.	A. P.
Ajwain, ...	22 18		12 0		34 18		0 15 0	13 3 8	5 Seers per R.		104 11 2	
Barley, ...	...		33,022 13		33,022 13		12 0 0	306,271 32	0 10 1		975,438 4 5	
Cheenuab, ...	...		589 2		589 2		8 0 0	4,712 32	0 20		9,425 9 6	
Chillies, ...	0 2		...		0 2		1 0 0	0 4	0 8		0 8 0	
Churree, ...	...		1,156 17		1,156 17		Rs. per Bh.	1,156 17	0 3		3,470 8 10	
Cotton, ...	69,925 7		...		69,925 7		2 20 0	174,813 15	0 3 S. 6 C. p. R.		2,071,862 3 6	
Fruits, ...	3,024 4		3,289 2		6,313 6		Rs. per Bh.	6,313 6	0 50		3,15,665 0 0	
The measurements show the amount of												
Goor { Sugar-cane grown, and the produce is given in Sugar, ...	41,763 2		...		41,763 2		20 0 0	835,262 0	0 11 Seers,		30,37,316 5 10	
Gram, ...	...		1,11,678 12		1,11,678 12		12 0 0	13,40,143 8	0 14 1 Seers.		36,96,946 12 1	
Indian Corn, ...	3,192 18		...		3,192 18		15 0 0	47,893 20	0 15 1 Seers.		1,25,622 4 8	
Indigo, ...	2,236 3		...		2,236 3		0 10 0	559 1	8 100 R. per Md.		53,903 12 0	
Jowar, ...	71,802 17		...		71,802 17		12 0 0	8,61,634 8	0 12 1 Seers p. R.		28,13,459 6 10	
Koosumbah, ...	...		1 10		1 10		0 30 0	1 5	0 3 Seers,		15 0 0	
Lucerne and Country grass, ...	139 7		...		139 7		3 per Beegah.	139 7	0 3 Seers,		418 0 9	
Methee, ...	17 18		...		17 18		7 0 0	125 12	0 10 Seers,		501 3 3	
Marwah, ...	130 11		...		130 11		8 0 0	1,044 16	0 20 Seers,		2,0,8,12 6	

APPENDIX No. IV. — (Continued.)

	Khureef, 1860.		Rubbee, 1860-61.		Total areas 1860-61.		Estimate of Produce.			Average price in Bazar.	Total value of Crops.	
	Area in Beegahs.		Area in Beegahs.		Area in Beegahs.		Per Beegah.	Total.				
							Mds. S. C.	Mds. S. C.			Rs.	A. P.
Oats, ...	...		1,141 5		1,141 5		30 0 0	34,237 20	0 14 Md.		22,825 0 0	
Oorud, ...	0 18		...		0 18		8 0 0	7 8	10 Seers.		28 12 9	
Opium, ...	0 0		18 3		18 3		0 0 0	1 32	9 8 Rs. per Sr.		580 8 0	
Rice, ...	71,944 4		...		71,944 4		15 0 0	10,79,163 0	0 8 Seers per R.		53,95,815 0 0	
Singharrah, ...	284 19		...		284 19		50 0 0	14,247 20	0 2 Md.		7,123 12 0	
Tobacco, ...	...		88 0		88 0		5 0 0	440 0	0 12 Seers.		1,466 10 8	
Tona or Oil seed, ...	6 11		...		6 11		8 0 0	52 16	0 20 Seers.		104 12 9	
Uulsee, ...	...		0 8		0 8		8 0 0	180,332 1	8 16 Seers.		8 0 0	
Vegetables, ...	2,167 2		1,439 11		3,606 13		50 0 0	180,332 1	2 Mds.		90,166 4 0	
Wheat, ...	...		289,920 8		289,920 8		12 0 0	34,79,044 32	0 11 Seers.		12,651,072 0 0	
Total, ...	266,641		3,442,375		9,709,016 12		...	...	...		31,277,469 3 9	

(Signed) T. G. GLOVER, Captain,
Superintendent W. Jumna Canals.

A. D. TURNBULL, Lieut.-Colonel,
Supt. General of Irrigation, N. W. P.

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2nd May 1862.

FROM

No. 3,233.

SECRETARY TO GOVERNMENT, PUNJAB,

Public Works Department.

TO

THE SUPERINTENDENT GENERAL OF IRRIGATION,

N. W. PROVINCES.

Dated Lahore, 14th December, 1861.

Sir,—Your "Report on the operations of the Western Jumna canals during the year 1860-61," has been perused by his Honor the Lieutenant Governor with much interest. The results you have described are, in the highest degree, satisfactory, and fully establish the importance and great value of these canals. They have, by the successful operations of the past official year, though with a supply diminished by the drought of that season, afforded the means of cultivation over a very extended area, preserving it from the effects of the famine, which its produce helped to mitigate in surrounding districts.

2.—The progressive improvement of these canals, the extension of cultivation due to their agency, their success in a financial view, and the general results you have reported upon, may here be briefly reviewed.

3.—The area irrigated in 1859-60 amounted to 2,96,252 beegahs, (185157.5 acres or 289.3 square miles) and this is said to have been much in excess of ordinary years, while in 1860-61 it arose to 7,33,267 beegahs (458291.8 acres or 716 square miles) scattered over an area of probably ten times that extent of country, benefiting 695 villages in districts which bordered upon those where the famine was most severely felt.

4.—That this vast increase of irrigation was caused by the demand for water consequent on the failure of the periodical rains is doubtless the correct view; the circumstances were exceptional; and it is probable the increase may not be maintained, now that the occasion for such a demand has passed away; but it is satisfactory that these canals were capable of meeting such a drain at a period of such necessity, and this at a time when the effect of drought had been to reduce the ordinary discharge of the Jumna from nearly 3,500 cubic feet per second as determined by Colonel Abbott in February 1849, to about 1,900 cubic feet as calculated by Captain Glover in March 1861.

5.—The financial results of the above increase of irrigation are stated in the 13th para. of your report, which shows that the total income of these canals for the past year amounted to Rs. 4,63,344, (£46,334) an increase of nearly one lakh (£10,000) above the largest revenue realized since they were opened, and giving a *net* return, after payment of all charges, of Rs. 2,57,592 (£25,759) an amount said to be not far short of the gross income of ordinary years.

6.—That these canals in addition to the benefits they confer upon the Districts through which they run, afford a large return for the money spent upon their construction is exhibited by the figures in para. 14. An expenditure of Rs. 16,84,624-13-2 (£168,462) has been incurred upon the construction and improvement of these canals. This amount *has been repaid*; and a net profit has accrued to Government of Rs. 37,75,696 (£377,569) after reimbursing it for all outlay on account of original cost, subsequent improvement and maintenance. Government has thus been repaid 325 per cent. on original outlay; and direct taxation during the year under review, gave a profit of 18 per cent. on the Capital invested.

7.—From the following paragraph 15, taking the lowest estimate, it would appear that the value of the produce from the lands irrigated by these canals, must have been last year between 2½ and 2¾ millions of £ sterling, and the amount of the grain thrown into the market amounted

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to 72,51,685 maunds (5,179,775 cwt. or nearly 259,000 tons) sufficient for the support of 8,00,000 people for one year; or by a more sparing distribution, sufficient to keep 12,00,000 human beings alive for the same period. Important results, when it is borne in mind that in a year likely the past, the produce valued at so much, and capable of sustaining so many, might have been lost, but for the means of irrigation afforded by these canals.

8.—The produce also of sugar, grown to the value of more than 30 lakhs (£300,000) Indigo, 55,901 (£5,590) and Cotton, upwards of 20 lakhs, (£200,000) from important items in an estimate of benefits derived from these canals.

9.—The subject of Cotton growing alluded to in paragraph 17 is one of great interest at the present moment. His Honor will be glad to receive the promised specimens of the Cotton grown from the seed supplied by Mr. Berkeley, and they should be accompanied by some details of the sowing, treatment, picking, &c.

10.—Adverting to your 19th paragraph and examination of the water of the Ravee taken from the river at Madhopoor has led to an interesting report by Mr. Medicott of the Thomason College at Roorkee on the subject of "Reh" efflorescence, of which report a copy is forwarded for your information. At the suggestion of Captain Dyas, His Honor the Lieutenant Governor has directed Dr. Brown, the Chemical Examiner for the Punjab, to extend this examination to the waters of each of the Punjab rivers.

11.—It is doubtful whether this efflorescence can be accounted for in the ways suggested in your report. In the Lahore district it makes its appearance on lands irrigated from wells, where the water is very far from the surface. It appears probable that it is not due either to the water alone, or to the soil alone, but that water holding certain matters in solution or suspension, combining with soil containing certain constituents, produces in time a sufficient quantity of the Reh to interfere with cultivation.

12.—In para. 20 of the report, the *Reh* and *Shor* or Saltpetere appear to be considered similar in their effects, and are spoken of almost indiscriminately. But in this district, the latter is actually employed successfully to neutralize the former, being scraped up where it is found abundantly, and cast over fields suffering from *Kullur* or *Reh*. They thus appear to be in a measure antagonistic in their action on vegetation.

13.—It is not impossible that the growing of *Keekur** or other trees or plants on Reh lands may itself be found a remedy, and that after a time, the lands so used, may be restored to cultivation of grain or other ordinary crops. Meantime the *Keekur* sown over a considerable area will itself be valuable. In your letter of the 10 July last, you reported that you had directed Captain Glover to confine his experiment for the past season to the sowing of 50 beegahs of Reh land with *Keekur* seed. The approval of his Honor the Lieutenant Governor was communicated in my letter No. 653c, of the 19th July last.

14.—I am to request you will report what has been done, and take into consideration whether it would be advisable to sow *Keekur* over a larger area, or whether it would be well to try other seeds. In the Lahore district, Tobacco and some kinds of vegetables, are grown on land affected with "Reh." The experiment might also be tried with these on the land so effected in the neighbourhood of the Western Jumna canals.

15.—His Honor desires that Captain Glover's recommendation to have the discharge of the Jumna measured annually in February should be attended to. He fully enters into the difficulties adverted to in your 5th paragraph with regard to the regulating the proportion of the waters to be taken from the Jumna for the Eastern and Western Canals. The arrangements for this described by you are probably the best that can be made under present circumstances. It is presumed that the distribution would be much facilitated by the construction of the masonry dam and head works for both canals proposed by you in April last.

* *Acacia Arabica*,

18 *Proceedings of the Madras Government, Public Works Department,*
2nd May 1862.

16.—It is observed in paragraph 10 of your report that the demand for water for the use of the mills at Hansi has declined considerably of late years, since it ceased to be a military station. As mills are useful, and profitable appendages of a canal, His honor would wish you to consider and report, whether there are any other places where new ones might advantageously be established.

17.—In the same paragraph is noticed the diminution in the amount of fees on timber rafted down the canal, in consequence of the exhaustion of the forests on the Jumna; which also rendered it necessary for you on a late occasion to send to the Ganges for Sal.* It is suggested that Deodar† might be brought into general use on the canal, as it is believed that it could be obtained with less difficulty and at a smaller cost from the Simla hills. The Commissioner Cis-Sutlej States has reported that arrangements are in preparation for procuring supplies of Deodar from the valleys of the Pubhur and Tonse, and floating it down the Jumna to Delhi. If these arrangements are carried out, the canal will obtain timber readily, and may be able to aid and encourage this endeavour to establish a regular supply.

18.—Allusion is made in your 32nd para. to Captain Glover's project for a new supplementary head for the canal, leaving the Jumna near the village of Kulsowra: but no reference is made to my letter No. 589 C. of the 1st July last, returning the project, and pointing out that this was a work attempted by Colonel Colvin in 1828, and abandoned after some progress had been made with the preliminary operations, in consequence of the river at that part being found unsuitable for the construction of a canal head. It was asked whether there was reason to believe that the circumstances were in any way changed, so that the scheme which Colonel Colvin was obliged to relinquish might now be undertaken with good prospect of success. This has not yet been replied to.

19.—There can be little doubt of the great advantage of the improvements contemplated in your 34th para.

20.—His Honor the Lieutenant Governor in expressing his satisfaction with the favorable results reported upon, fully concurs in the commendation bestowed upon Captain Glover in para. 36. This Officer has shown a hearty and right appreciation of the importance of his position, and his opportunities of usefulness in relation alike to the welfare of the people, and to the interests of Government. He bestowed much earnest care and labour on the work whilst he was Superintendent of these Canals, to which he may still, in his new position, have an opportunity of giving some attention.

21.—I am also desired to convey His Honor's acknowledgments to those officers and subordinates, of whom Captain Glover has reported so favorably, and have to request that you will communicate this recognition of their services to

Captain Earle, as Superintendent Delhi Canal and subsequently of the Hansi branch.

Lieutenant Jeffreys, Superintendent Rohtuk branch.

Lieutenant Moncrieff, Superintendent Delhi branch.

Mr. Duncan, in charge of the Upper Division,

as also to Sergeants Corcoran, James Malony, and Wilson.

22.—In conclusion I am to express His Honor's high sense of the services you have rendered in the general supervision of these Canals, to which in no slight degree is due those results which have called forth his satisfaction, and the successful working of the establishments to whom he has tendered his acknowledgments.

I have, &c.,
ROBERT MACLAGAN, Lieutenant-Colonel,
Secretary, Government of Punjab,
Public Works Department.

* Shorea Robusta.
† Cedrus Deodora.

Proceedings of the Madras Government, Public Works Department,
2nd May 1862.

Copy of a letter, dated 21st May 1861, from Mr. H. B. Medlicott, Professor of Geology, Thomason College, to Director of Canals Punjab, (referred to in paragraph 10 of the above letter.)

With reference to your letters Nos. 1,478 and 1,590 of 28th March and 11th April, I will not delay the following memorandum any longer, that it may be in time, as you desire for your Annual Report in June. Such analyses are, you must be aware, very tedious. I could, by taking a larger quantity of water, and spending much more time over it, give a more exact account of its contents, but I have already done enough to give a clue to the question you proposed, namely, the possible injurious effects of the water upon vegetation. Should you think it worth while to quote my remarks, I would recommend that it be done in full, so that any future examiner may know how far they are reliable.

One gallon of the water taken from the Head Regulator in equal portions on the 1st and 18th of September, 3rd and 15th October, 15th November, and 1st and 15th December 1860, filtered and evaporated, gave 7.14 grains of matter that had been in solution. Of this 3.44 was re-dissolved by water. This latter quantity gave 0.50 chloride of sodium, equivalent to 0.20 of table salt in the water. It gave a further precipitate of sulphate of soda 2.36, equivalent to 1.43 of glauber salt, or to 1.22 of anhydrous soda alum, or to 2.31 of the hydrous alum. Even taking the latter value, it leaves .93 of the 3.44 unaccounted for. I had not time to repeat the operation, or, I believe, I could have traced this deficit to insufficient burning of the total residue, the quantity 3.44 being in consequence too high. I believe the sulphates in the water to be glauber salt and alum, principally the former.

The portion of the residue not re-dissolved in water, consisted of 3.16 carbonate of lime and about 40 sulphate of lime. The soluble ingredients then are in 70,000 grains of water.

Common Salt, Glauber Salt (Sulphate of Soda), with some Alum (Sulphate of	1.43
Alumina and Soda).....	3.16
Carbonate of Lime.....	.44
Sulphate of Lime.....	5.23

Besides the source of deficit above pointed out, there are the numerous infinitesimal quantities of other substances that exist in all waters. I believe I have fixed those that can be of any influence in the present question.

The salt separated from the gallon of water by filtration, only amounted to 16.11 grains dried at 212°. In burning it lost .69:—boiled for two hours in dilute hydrochloric acid, there was an insoluble residue 12.89; the 2.53 dissolved consisting of 2 of peroxide of iron with a little silver and alumina, and .53 of lime,

Water, ...	70,000
Silt, ...	16.11
Organic matter or water, ...	.69
Peroxide of iron, silica, alumina, ...	2.0
Lime, ...	.53
Insoluble residue, ...	12.89
	16.11

It is only in the soluble element that any possible noxious substance is looked for; and there I confess the result has surprised me. After the carbonate and sulphate of lime which are harmless, there are the two highly soluble alkaline salts in the proportion of 88 per cent. glauber salt and 12 per cent. culinary salt. Now this is the constitution of the well known Rêh, that does so much damage in certain districts along the Western Jumna Canals. Two samples that I analysed from these, gave one but 3 per cent. of the chloride, and the other 25 per cent., the proportions varying greatly.

20 *Proceedings of the Madras Government, Public Works Department,*
2nd May 1862.

The source of this Rêh has always been a puzzle, but we now seem to have got a clue to it; at least to a source of it. The quantity of it in the Ravee water is but $\frac{23}{1,000,000}$. I cannot give my own authority, nor can I quote any other upon the possible effects upon vegetation of so very diluted a poison, but it may be very serious, and by accumulation from evaporation almost must become so. Nothing but a careful study on the ground can settle the point, and a most interesting question it is for the canal officers of these provinces. I will at once examine the Ganges and Jumna waters to see if they contain the same ingredient.

Copy of demi-official letter from Mr. Medlicott, dated Roorkee, 30th May 1861.

I have just completed my examination of the Ganges water, and find it has practically the same composition as that of the Ravee, viz., common salt 25 grains per gallon, and sulphate of soda 1.12 or of Rêh 1.46, being $\frac{23}{1,000,000}$.

The other ingredients are also equivalent. It is more than probable that this is about the constant composition of the waters of these rivers. In working out this case, it must be easy to settle on the ground if the injury complained of proceeds from Rêh or not, and if not, there is no other ingredient in the water that could possibly do injury.

No. 42.

ORDER THEREON, 2nd May 1862, No. 910.

Ordered to be recorded.

(Signed) W. H. HORSLEY, Lieut.-Colonel,
Secretary to Government.

Govt. No. 63

No. 1901 of 1861-62.

From LIEUTENANT-COLONEL A. D. TURNBULL,
Supdt. Genl. of Irrigation N. W. Provinces,
To THE SECRETARY TO GOVERNMENT, PUNJAB.

Roorkee, 4th September 1861.

SIR,

I have the honor to forward herewith for submission to His Honor the Lieutenant Governor, my report on the operations of the Western Jumna Canals for the year 1860-61, with appendices as follow:—

- 1.—Statement shewing land irrigated and water rent levied in the various districts of the Western Jumna Canals during 1860-61.
- 2.—Comparative abstract of income and current expenditure for Rubbee 1859-60 and 1860-61.
- 3.—Comparative abstract of income and current expenditure for the years 1859-60 and 1860-61.
- 4.—Statement showing area of cultivation and amount and value of produce on lands irrigated during 1860-61.

2.—I regret that I am unable to accompany this Report with the Annual Statement of remunerative works as I am most anxious to adjust the outstanding balance against original works, by bills, which cannot be prepared or submitted till completion of Survey reports reach me. The expenditure on works as shown in my Progress report differs slightly from that given by Captain Glover in the accompanying Statement, as his calculations for materials expended on works vary in a few instances from those adapted by the central office, but the totals in either case are approximately correct, and will answer all purposes, till such time as the exact sum is shown in my statement of remunerative works, which will be submitted at the earliest possible date.

I have the honor to be,

Sir,

Your most obedient servant,

A. D. TURNBULL, Lt.-Colonel.

Supdt. Genl. of Irrigation N. W. Provinces,

Punjab.

No 4471

Copy of above forwarded to the Secretary to Govt. Madras for information.

W. H. HORSLEY
As Secy Lieut. Govt.
Secy to Government Punjab
P. H. D.

Lahore
5th Feb. 1862

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REPORT
ON THE
OPERATIONS OF THE WESTERN JUMNA CANALS,
DURING THE YEAR 1860-61.

THE Report of operations of this Canal during the last year, may be peculiarly interesting at the present time, when from the failure of the periodical rainy season, the suspension of all cultivation over an immense tract of country in the Punjab and the North Western Provinces has immersed thousands in the horrors of famine, which visitation has been averted by this canal over an area of about 4,500 square miles through which it flows, and which tract, from the produce it has been enabled to rear, has been the means of mitigating the evil in no inconsiderable degree in its own immediate neighbourhood.

2.—The amount of rain which fell during the last year was only 16.51 inches according to the Register kept at Dadoopoor, at the head of this canal; which amount is less than has been recorded during any year, since 1834, at which date the register commences. The largest recorded fall of rain was in 1856, when 60.75 inches fell, but the average quantity is about 40 inches, so that not more than between one-half and one-third of the usual quantity has fallen this year. There are two other years of failure of rain recorded, viz. in 1837, when 22.25 inches only fell, and 1848, when 20.68 inches fell, but it will be seen that they are neither so small as the last year's fall. Both these years were famine years, or years in which great distress prevailed, and it is a fact worthy of note that the dearth which periodically visits this country appears to be increasing in intensity, or, in other words that the recurring period of such visitation shows a less amount of rain fall than the preceding one showed.

3.—It may be found also that the river supply will be similarly affected, and that the periodical deficiency of rain will be accompanied by a decreased volume in the rivers. The supply of water in the Jumna was particularly small during the last year, its surface being much lower than was ever known by any one residing in its vicinity. Captain Glover almost immediately after assuming charge of these canals, finding the supply failing, and having had his attention drawn to the subject, ascertained the discharge of the Jumna on the first February 1860, to be 2,854 cubic feet per second from actual measurement. It was determined by Colonel Abbott in February 1849, to be 3,483 cubic feet. In November 1860, Captain Glover again measured the discharge of the river in conjunction with Major Brownlow, Superintendent Eastern Jumna canal, and found it to be only 2,570 cubic feet, at that early period of the season, and it subsequently fell very considerably, but owing to his presence being required on other parts of the canal he was unfortunately unable to make any more measurements at the season of lowest supply, which would have determined the minimum discharge on record. Captain Glover does not think, however, that it could have exceeded 1,900 cubic feet per second in March 1861, which according to his judgement allows 1,250 cubic feet as the discharge of the Western Jumna, and 650 cubic feet for that of the Eastern Jumna canal at that time.

4.—As the irrigation of this, as also of the Eastern Jumna canal, has extended very considerably of late years, and the amount of water carried by each has been consequently increased, and as the river invariably fails in affording a full supply to each canal according to the present standard, the measurement of the river becomes an important object, and Captain Glover recommends that the discharge be ascertained annually about February and recorded. Such measurements would doubtless be valuable, and, I shall, in future years, endeavour to obtain them, but as the work at the heads is generally over by the month of February, and the Superintendent is visiting other portions of the canal where his presence is urgently required during this month, he may not often be able to make them.

5.—The proportion of the river's supply due to each canal has been a source of considerable difficulty for some years, and rules have been laid down from time to time regulating the division, but as the supply in each canal was due, above a certain limit, to the exertions of the individual establishments, it followed that a constant straining arose to benefit one canal at the expense of the others, leading to increased and unnecessary expense without any corresponding benefit to Government, as any gain on the one was counterbalanced by a loss on the other. During the last year, therefore, finding the supply likely to fail to an unprecedented extent, Major Brownlow and Captain Glover agreed to a mutual scale of regulation; any fall in the supply of one canal being adjusted by a corresponding decrease of supply in the other. As there were no correct returns of the respective discharges of the two canals at different heights of water surface, these officers were obliged to arrive only at a rough conclusion, but it has been found to work very well, and owing to the low state of the river it may be considered to have had a fair trial. By the present agreement the regulation is left in the hands of the Eastern Jumna canal establishment, who, by opening their escape dam at Fyzabad, are enabled to send down more water to the lower heads of the Western Jumna, and thus increase the supply. If requisite reports of the height of water in each canal are exchanged daily by the officials entrusted with its regulation, and according to these reports the supply in the Eastern Jumna canal is either increased or lowered, every fall of one inch of surface below full supply in these Canals being met by a fall of 2 inches on their gauge.

6.—The gauge at Dadoopoor, with full supply in the canal, stands at 4 feet 4 inches, shewing a discharge of 2,514 cubic feet per second, but during a great part of January and February last, the gauge only showed 3 feet one inch, and during the latter part of February, and first half of March, it fell even to 2 feet 10 inches, so that Captain Glover calculates that during the very height of the Rubbee crop the discharge of the canal was not more than one-half its full amount. The failure of supply moreover commenced unusually early, about the middle of October, and no increase took place till the middle of April, so that it will be seen that during the most important crop of the year the supply has been most lamentably deficient.

7.—During the last year the extension of irrigation has been very great, no doubt caused by the demand for water consequent on the failure of the periodical rainy season. Cultivators had been attracted in very large numbers from all the surrounding districts to the various villages which have been in the habit of using canal water, every available spot in each village had been rented in order to rear a small crop for the support of their families, moreover owing to the great drought many plots which formerly were mere swamps had dried up, and advantage was taken to put them under cultivation so that crops were raised in places where none had been seen for many years.

8.—The benefits of the canal have been felt to a very great degree in 635 villages, bordering its course, and situate in the districts of Umballa, Thaneysur, Kurnaul, Delhie, Rohtak, Hissar, and the independent territory of Jheend. The total amount of land brought under cultivation, and for which irrigation has been afforded from the canal during the past year is the large number of 7,33,267 beeghas, or about 730 square miles, scattered over an area of about 10 times that extent, estimating the sphere of irrigation to extend on an average about 5 or 6 miles in width on each side of the canal throughout its whole length.

9.—The amount of irrigation during the Rubbee crop was 4,62,377 beeghas, and Captain Glover calculates that the discharge of the canal during a great part of the time did not exceed 1,250 cubic feet per second, so that we are enabled to arrive at a close approximation of the amount of land that can be irrigated by one cubic foot of water per second for one crop, which in this case is about 370 beeghas, a fair conclusion and sufficiently accurate to serve as a basis for future calculations. Captain Glover proposes to ascertain the discharge of this canal for every decrease of one inch in height of surface, in the hope of being able annually to calculate the value of a cubic foot of water, and to ascertain whether it has been employed to the full advantage by comparison with former years.

10.—In addition to the water-rent there are other sources of revenue on the canal, consisting of mill rent, fees on navigation, and rafting of timber, and sale of canal produce, each of which Captain Glover notices as follows:—

"The mill rent is levied by letting out the corn mills constructed in the city of Delhie and town of Hansie, the revenue from this source has, however, fallen off this year on account of the great demand for water for the more important object of irrigation not admitting of a constant supply being sent into the city of Delhie where it is employed as a motive power for these mills, and afterwards allowed to run to waste into the Jumna. At Hansie the demand for the use of the mills has declined considerably of late years since the breaking up of the Military Cantonments there."

"Fees are levied agreeably to the scale laid down in the Government Gazette of 1st July 1815, on all timber which is rafted down the canal from the forests, where it is cut in the hills near the banks of the Jumna; the amount realized on this account has, however, fallen off very considerably of late years owing to the exhaustion of these forests, the extent of which may be inferred from the fact that sal timber of larger scantling than 6 inches square, and that only in small quantity, is not now procurable at Dadoopoor near the head of the canal whereas formerly the largest timbers were obtainable there. On a late occasion I was obliged to send to the Ganges, a distance of 40 or 50 miles, for timber which was required for the use of the canal."

"The revenue realized by the sale of canal produce is very precarious, and varies considerably in amount, it is derived from the sale of timber and grass grown on the canal banks."

"Fines are inflicted for the infringement of Canal regulations, and are credited to Government. I have, however, endeavored to decrease their amount as much as possible, but in a year like the last when water was worth its weight in silver, the crime of water stealing became more than usually frequent, so that I was not able to reduce the amount of the fine account so much as I could have wished, but I think that the total sum levied under this head is very moderate. The total of the fines levied last year amounted only to rupees 5,124-4-8, of which rupees 249-1-0 were inflicted on the canal."

establishment, so that rupees 5,175-3-8 only are due to the breach of Canal regulations, and are spread over 695 villages, giving an average of rupees 7-7-1 only to each."

"Water rent is levied on the actual area irrigated, and is assessed at different rates according to whether the water is capable of flowing naturally over the ground irrigated, or whether it is raised artificially. The crops usually grown are divided into two classes and are charged at different rates according to their classification, the amount of water rent per beegah, under different circumstances, being laid down in the *Government Gazette North-Western Provinces, 1st July 1815*."

11.—The total amount of water rent is determined twice annually at the expiry of each half-yearly crop, and is ascertained by the actual measurement of each field irrigated. These measurements are made under the superintendence of 3 darogahs, or superior officers, assisted by a staff of moonshees and chainmen. Formerly a great number of villages took water by paying a certain fixed sum, according to the number and sizes of their water courses, but these contracts which were made in 1840, for a period of 20 years, expired at the commencement of the past year, and as Captain Glover did not wish to renew them without thorough investigation, he has been obliged to measure all lands irrigated during this year, which has greatly increased the amount of work. In 1859-60, when contracts were in operation, the area of land to be measured amounted to 296,252 beegahs only, and this was much in excess of ordinary years, whereas in 1860-61 it amounted to 733,267 beegahs; in consequence of this great increased area, Captain Glover was obliged to entertain some extra ameens and chainmen for a few months. The total cost of the measuring establishment for the year 1860-61 amounted to rupees 6,078-2-8, giving a cost for measurement of rupees 0082, or about 1½ pies per beegah, or 1.37 rupees per cent on actual total amount of water rent collected.

12.—Owing to the great increase of area to be measured, great delay has occurred in completing the measurements of irrigated areas. The establishment commenced their field operations in September, which was very early in the season, and when they suffered much from fever; the last measurement not being completed till the end of June, during the whole of which period they have been solely employed in measuring the irrigation. Captain Glover had the subject of expediting the measurements constantly under his consideration; and early in the year recommended that the village field Maps or Shujrahs should be made use of, and authority was obtained for copies to be made of them for the use of this department. In these maps each field is marked and numbered, and the area is ascertained from other documents kept by the village accountant or patwarie; it appears, however, that the maps now in use in the greater part of the districts through which the canal flows are very old, and were made at the time of the settlement some 20 years ago, since when considerable changes have taken place in the distribution of land, and the boundaries of the fields, so that in most cases these maps are useless for the purpose to which he proposed to put them. In the Hissar district however a new settlement is now being made, and new maps are being prepared in the Rohitua and Delhi districts also. I believe many of the maps were destroyed in 1857, so that new ones are required and are now being made. Captain Glover proposes therefore as soon as they are completed to obtain copies from the district officers, and trusts no difficulty may then be experienced in introducing the new system. By the old plan each moonshee was accompanied by a chaining party, and he was only able to measure and calculate the contents of about 200 beegahs daily in the Khureef and 300 beegahs in the Rubbee, but by the new system nearly all chaining and calculation will be avoided, and he will merely have to walk over the ground with his map in his hand, taking down the numbers of the fields irrigated and the nature of the crops, and on his return to his tent in the evening, he will, by looking at the

Khurrah or Index, be able to ascertain the area of each field. Captain Glover calculates therefore, that he will be able to do from 800 to 1000 beegahs daily, which will reduce the time of measurement to between 2 and 3 months only annually. During the last year Captain Glover attempted to introduce this system by using the Collectory maps, but owing to the changes that had taken place which have been before referred to, in the boundaries of fields, and the want of acquaintance on the part of the establishment with maps, he did not succeed as he had wished, but he intends to keep the Darogahs and Moonshees hard at work during the recess between their working seasons in learning the construction of maps of this description and also the use of the plane table, and he trusts that with a little practice they may be able to introduce the system as soon as the new maps may be ready in the different districts, should it be found practicable to use these village field maps, and that the annual measurement of irrigation is expedited to the extent anticipated. Captain Glover is of opinion that the system of measurements of actual area of irrigation is the fairest mode of levying a water tax that can be introduced and in this opinion I entirely concur.

13.—The total income of the canal from all sources for the past year amounts to rupees 463,344-9-2 being an increase of rupees 97,010-3-4 above the greatest revenue yet realized since the opening of the canal. The expenditure for maintenance, repairs, and establishment for the year amounts to rupees 203,732-2-11 or 44.4 per cent. on the revenue; so that net revenue after deduction of all charges amounts to rupees 257,592-6-3, which is not far short of the gross income of ordinary years, a most gratifying result when it is considered that during a great portion of the most important crop, the volume of water was but little more than half of the full supply of the canal, and proving I think most clearly that the water has been turned to the utmost account during this year of drought and famine.

14.—Since the opening of the canal in 1821, the total expenditure incurred in construction and improvement has amounted to rupees 16,84,634-13-2 and the net profit derived by the Government after repaying its original cost, and deducting the amount of the annual expenses of maintenance and establishment, has amounted to Rs. 37,75,695-15-9, so that this Canal has actually repaid 325 per cent. on the original outlay, and the profit returned to Government for the last year in direct taxation amounted to 18 per cent. on the capital invested. This does not, however, represent one-tenth of the indirect benefit accruing to Government from the increased land tax, and the general improvement in the prosperity and wealth of the country.

15.—The total value of staple products of the canal irrigation will be seen from the return annexed, vide appendix, and Captain Glover estimates it at no less a sum than 312½ lacs of Rupees or upwards of 3 millions of £ sterling, the whole of which we may fairly assume would have been lost to the country in a year like the last, had it not been for the influence of these canals. I think Captain Glover's estimate is somewhat high when we consider the vast space over which, and the inferiority of much of the land upon which, these crops are raised, and I would reduce their value to about 2½ or 2 millions of £ sterling, a sum sufficiently large to show the enormous advantages derived by the community from these canals in a famine year. The amount of grain affording food for man thrown into the market amounts to 72,51,685 maunds; and allowing a man to consume 1 seer daily, the canal will have raised sufficient food to support about 8,00,000 people for one year; or, allowing 2½ lb to a man and child, will have kept at least 12,00,000 of people alive for the same period, to say nothing of the fodder thus obtained for the cattle. These facts speak for themselves, and serve to show the importance to the coun-

try of even so primitive a canal as this. But when it is shewn that the Government can combine a benefit to the country with actual gain to themselves by establishing works of irrigation it is to be hoped that the subject may receive the great attention which it undoubtedly deserves.

16.—Among the more valuable products may be observed, sugar, which has been grown to the value of nearly 30½ lacs of rupees, Indigo 55,901 rupees, and cotton upwards of 20 lacs of rupees. With reference to that last named, I may mention that some improved descriptions of seed have been kindly furnished to me by Mr. L. Berkeley, Extra Assistant of the Delhi Division, forwarded on to Captain Glover who will distribute them amongst the Zemindars for sowing during the present season, and will forward specimens of their produce when the crops shall have arrived at maturity. Captain Glover thinks it may be worthy of consideration, "whether with the increased facilities of transport afforded by the Railroad now rapidly approaching Delhi, advantage might not be taken of a means of irrigation such as the canal guarantees to establish a large cotton growing country in this neighbourhood; the subject might be worthy the attention of those interested in it."

17.—To shew the benefits conferred by the canal on individual communities, Captain Glover instances the village of Bhutgaun in the Sonapat district where the area of land under rice cultivation, amounted last year to 3,094 beegahs, yielding an estimated outturn of 46,410 maunds which, supposing it sold at the rate of 12 seers to the rupee, bears a money value of upwards of 1½ lacs of rupees for this one village alone; and for which the amount of water rent taken by the canals amounts to the inconsiderable sum of 2,469 rupees or 16 per cent. only on the value of crop.

18.—It is a most remarkable fact which should be well remembered, that this village of Bhutgaun was the first, and foremost among the 3 villages which petitioned the Commissioner in the previous year to have the canal stopped, in consequence of the supposed loss which they had sustained by it from over saturation in ordinary seasons. There is no doubt that this village suffers from supersaturation for five out of six, or, perhaps six out of eight years, but a remission of the land revenue has been made to it on this account, and in ordinary years therefore its gains are not nearly such as have been shewn above. But when the moist land is rendered fit for cultivation by drought, and the rates at which grain sells are high, as they are always in a season like the last, the village profits accordingly, and I believe last year was enabled to pay off debts which had been hanging over it for many years past. The case of Bhutgaun is not solitary, but many villages on the canals have similarly profited by last years increased produce and enhanced prices.

19.—Of late years a white efflorescence commonly called by the Natives "Rêh" but whose chemical name is Sulphate of Soda has been observed to make its appearance in the neighbourhood of the canal, rendering the land on which it is observed, quite unfit for cultivation. The subject has received considerable attention from time to time, but no remedy of practical value has apparently been adopted. Captain Glover considers "that this salt exists in the ground itself, but having a great antipathy to damp, it has in order to escape, forced itself to the surface, as the height of the water level of springs has been raised by the influence of the canal; and that the only real remedy is to provide complete surface drainage, so as to allow the water during the rainy season to flow off readily, washing the soil and carrying away with itself this efflorescence, by which means the supply would in course of time become exhausted. This however is a very difficult and expensive operation and must be the work of time."

20.—Mr. Edward Brandreth the Commissioner of the Delhi Division writes as follows on the subject: "In Mr. Sherer's report; the injury to the land is principally ascribed to the salt being brought near the surface from below, where it has always existed, by the raising of the springs. This theory no doubt accounts for a good deal of the damage which has been sustained, but there are other parts that have been injured by "Shor" where the springs are so deep especially in the neighbourhood of Delhi where the canal is very shallow, that the origin of the saline efflorescence cannot be accounted for in this way. In these cases it is to be attributed, it appears to me, to excessive irrigation, the soil is damp for several feet below the surface, and its mere dampness is sufficient to cause the salt to rise to the surface. Saltpetre, in the same way, may often be observed to get into the lower parts of the walls of houses, especially in damp situations."

21.—I believe myself that the causes of the appearance of this destructive salt, are the great height of canal supply above the level of the country, and defective drainage due to obstructions formed by the ill-constructed water courses which cover this tract, and, therefore, that lowering the bed of the canal, placing the water's surface under soil, where now it runs far above soil, a redistribution and a re-alignment of the numerous water-courses which are led off from this line, added to careful and proper arrangements for passing off surface drainage under them, will either entirely remedy or at all events arrest the progress of the evil; and in reference to Mr. Brandreth's remark "that there are other parts that have been injured by "Shor" especially in the neighbourhood of Delhi," I would observe that however much these parts may be affected now, and may be suffering from the injurious effects of "Shor," many of the lands in the lower part of the Delhi canal from below Gungatowlee, on both sides of it, and especially in the neighbourhood of the Najufgurb jheel have much improved of late years; lands which in my recollection bore only the most scanty crop, have of late years yielded crops far above the average.

22.—The keekur or *Mimosa Arabica* being well known as a most hardy tree, common in that part of the country, and capable of growing in land infected to a certain extent with "Rêh," Captain Glover recommended that plots of waste land should be taken up enclosed and sown with the seeds of this tree, and the Government has accorded sanction to the experiment being made on a small scale.

23.—One of the great difficulties in establishing the Railroad between Delhi and Lahore is the great want of fuel existing along the whole line, and if therefore we can succeed in sowing this tree in large quantities at a trifling expense, we should be securing a large supply of this commodity which would have arrived at maturity, simultaneously with the completion of the Railroad, moreover Captain Glover considers "that the large increased amount of vegetation would have a salutary effect on the country in decreasing the excessive heat by the protection and shade afforded, and also in preserving the natural humidity by preventing evaporation." If convenient seasons, such as the periodical rains, are seized, the experiment might be carried on in any part of the country, while on the canal it might be commenced at any time. Captain Glover's object in bringing this subject to notice was "to shew that these lands partially infected with "Rêh" are still capable of being turned to practical use and are not entirely useless as is supposed."

24.—The total cost of all establishment employed on these canals during the last year including the pay of officers and office establishment, amounts to Rupees, 96,894-8-4 of which Rupees 61,787-11-1 are chargeable to the Executive Department, leaving Rupees 35,106-13-3, or about 7-5 per cent only on the income for the expenses of measure.

ment, collection of Revenue, and Police, which is a most satisfactory result; and which I can conceive no method of reducing, as the different duties are so intimately connected that the removal of any one description would not admit of a reduction of Establishment.

25.—The total expenditure on works of all kinds on these canals for the last year amounts to Rupees 165,950-4-0, and the establishment employed to 61,787-11-1, or 37 per cent on the expenditure; which appears a large proportion, but when it is considered that this included the pay of all the Officers, Overseers, and office establishment, usually chargeable to the Public Works Department, it will, I hope, be seen that the charge is not large. It must be considered that constant supervision has to be maintained over a length of canal of 435 miles, of which both the banks have to be patrolled and kept in repairs, besides a considerable length of Rajbuhas and drainage lines, which probably double this extent. And as an accident to any portion of the line would entail heavy losses to Government in reimbursing the country for damages committed by the water, and entail a direct loss in canal revenue, it will be seen that heavy interests are at stake, and that it would be false economy to reduce the present scale of establishment; last year the Government sanctioned the division of the whole line into 4 executive charges and I have little doubt that the extra supervision thus obtained, and the more ready means of access to European officers thus afforded to the cultivators has greatly tended to bring about the splendid results of the past season.

26.—The expenditure on original works for the past year amounts to Rs. 31,964-13-4. The principal works are a large cut in the Jumna at Dadoooor for carrying off the floods of the Sonbe and Patralla rivers into the branch of the Jumna, commonly called Blane's cut; a new cut in the Kanjnoon Escape channel, nearly a mile in length, giving improved length for removing the swamps existing on the left bank of the canal between Indree and Kurnaul; and the regulating bridge at Rer has been considerably improved. On the Delhi line upwards of a mile of new canal in different places has been excavated: a new 2nd class chowkee has been erected at Durriapoor; and the Poolchnadder Aqueduct near Delhi, as well as several bridges destroyed by the British Forces in 1857, have been repaired.

27.—On the Hansi branch a new cut of nearly a mile in length has been excavated, and a bathing ghat constructed for the village of Shera. The new cut above referred to, is in substitution of an old tortuous channel at the head of the Rohtuc canal, which used to collect silt in such vast quantities, that silt clearances were constantly required to keep the head of the Rohtuc branch open. These silt clearances which had to be excavated in running water were very expensive, and even in spite of them it was a matter of extreme difficulty to maintain the supply of water in that canal. The new cut will, I trust, entirely remedy this serious evil, and enable the supply of the Rohtuc canal to be maintained with regularity. The cost of all these works is chargeable to the original construction of the canal, thereby increasing the amount of the capital.

28.—The total cost on annual repairs, including plantations and contingencies, amounts to rupees 108,857-10-7, giving a cost of about rupees 250 per mile for the cost of maintenance and repair, a charge susceptible of considerable reduction, as the state of the canal generally becomes improved. This charge includes repairs to banks, masonry works, and canal bed itself.

29.—There are several new projects under consideration, some of which have been submitted to Government, and some are still awaiting details, to admit of their being

forwarded. Among the principal may be noticed a new line of about 40 miles in length on the Delhi branch, the details of which are being elaborated, and by which it is hoped to reduce the surface level of the water, and get rid of many of the evils to which the present high level gives rise.

30.—The next project is for a new line about 12 miles in length between Indree and Booda Khara, by which it is hoped to effect a saving of about 8 miles in the length of the canal, and to bring into utility about 300 cubic feet per second of water which now runs to waste in feeding jheels, bordering the present line of canal. The cost of this project is estimated at rupees 1,75,000, and it is anticipated that it will return a direct income of rupees 50,000 annually. This has received conditional sanction from Government, and is now under construction.

31.—In conjunction with the above Captain Glover suggests a new line of Rajbuh of 20 or 25 feet of width of bottom to leave the canal at Indree, the head of the cut referred to in the last paragraph, and run along the high land, skirting Kurnal and re-entering the canal in the Bullah branch near Moonuk, this would afford irrigation to a considerable tract of country where it would be much appreciated. I believe this line to be perfectly practicable, though the excavation at the head where it enters the Bangur or high land may be deep, and its cost may therefore be somewhat high, but the value of 300 cubic feet per second of water is too great to be thrown away, and would very soon cover the cost of the Rajbuh required for distributing it over the country. The superintendent of the Western Jumna canals has therefore been requested to pay his attention to this line of Rajbuh or branch canal, at an early period of the next working season, when the project will be submitted to the Government.

32.—Captain Glover has also submitted a project for a new supplementary head leaving the Jumna near the village of Kulsowra and entering the canal near Booda Khara above Kurnaul. The cost of this is estimated at about rupees 40,000, and it is calculated that in the lowest seasons of the river supply it would throw about 300 cubic feet of water per second into the canal, and be a most valuable aid to irrigation just at the time it was most required. Had this head been in existence during the last year, its assistance would have been incalculable.

33.—The upper portion of the Rohtuk branch for about 20 miles in length requires remodelling, and instructions have been issued to have the line examined early next cold weather.

34.—In the Northern division, Captain Glover proposes to alter the whole line and to divide the alteration into 3 or 4 portions, starting from the various bridges as obligatory points and remodelling the portions of canal between them. Great wastage of water occurs in this portion of the canal and great good effect would result from its improvement.

35.—In the Hansi branch also, much has to be done to bring it to perfection, and the improvements of this line will receive the attention of the officer in charge of it.

36.—I feel assured that the result of Captain Glover's operations during the past year will be considered highly satisfactory by the Punjab Government. Captain Glover from the time he took charge of the Western Jumna canals has labored most zealously and efficiently both for the welfare of agricultural community, with whom in this important charge he is thrown into such constant communication, and also for the interests of Government. We were visited last year both by His Honor the Lieutenant Governor, and also by the Financial Commissioner of the Punjab, and I trust that those visits will have left impressions that so far as the Canal officers' duties are concerned, the real in-

terests of the land holders are deeply consulted, and receive every attention at their hands. Captain Glover has thoroughly identified himself with the people he has had to deal with, and I feel convinced that while his efforts to do justice to all have been fully appreciated by them, his unvarying good nature and temper in listening to their complaints have left a strong impression for good upon their minds. It will be seen from the 29th and succeeding paragraphs of this report that Captain Glover has been actively engaged in the preparation of several projects of importance to the material benefit of the charge intrusted to him, while he has brought the Canal Revenue up to such a height as was never before reached. For these successful endeavours on his part to aid the Government and the country during such a trying season as the past, I consider him entitled to, and would venture to ask for, the special thanks of the Government.

27.—Captain Glover brings to notice the exertions of the Officers and Overseers under his orders, who have all performed their duties carefully and intelligently. He mentions those of Captain Earle, who was formerly superintendent in charge of the Delhi Canal, and is now in charge of the Hansi Branch; Lieutenant Jeffreys, Superintendent of the Rohtuk Canal; Lieutenant Moncrieff, Superintendent of the Delhi Branch; and Mr. Duncan in charge of the Upper or Northern Division of the Western Jumna canals; also Serjeants Corcoran, James Maloney, and Wilson, who have all been favorably noticed by the Officers under whom they have served. Captain Glover also mentions that Lieutenant Jeffreys, in addition to conducting his duties to his satisfaction, has also made himself particularly useful in lining out one or two additional works requiring a considerable amount of laborious application and judgment, which he has performed greatly to Captain Glover's satisfaction. I think that all these Officers and Overseers are entitled to the favorable notice of the Government.

A. D. TURNBULL, *Lieutenant-Colonel,*
Superintendent General of Irrigation,
N. W. Provinces.

P. S.—Since writing the above I have received from the Financial Commissioner of the Punjab, certain statements showing the additional value of the Western Jumna canals to the Government by reason of the increased assessments upon the land irrigated by them, and which has hitherto been credited only in the land Revenue Accounts.

These Statements condensed are as follows:—

NUMBER OF VILLAGES.	NAME OF DISTRICT.	ACTUAL ASSESSMENT.	ASSESSMENT AT BARANI RATES.	BALANCE DUE TO PRESENCE OF CANAL.		
78	Delhi.	1,51,745	1,12,970	38,775	0	0
180	Kurnaul.	4,62,961	2,79,537-3-9	1,83,423	12	0
95	Rohtuk.	2,81,760	2,07,026	77,734	0	0
62	Hissar.	1,12,320	43,145	69,175	0	0
415		10,11,786	6,42,678-3-9	3,69,107	12	0

Shewing the net advantage derived by the Government from the presence of the Canals, in the land Revenue Accounts alone, after deducting the sum of Co.'s Rupees 22,802-15-3 for remissions permanently made for losses to certain lands from swamps arising from the proximity of the Canal.

Thus then in addition to securing the land revenue, amounting to upwards of 10 Lacs of Rupees, during a very severe famine year, the advantages to the Government are during the past year:

Increased land assessment,...	3,69,107	12	0
Water Rent, ...	4,63,344	9	2

Total Rupees,..... 8,32,452 5 2

It would appear therefore from the foregoing that the Canal account is entitled to credit for the large sum annually of 369,103 rupees with interest also at 5 per cent (as we have paid the Government interest annually at the rate of 5 per cent on the capital expended) since the several dates on which the existing settlements for the land revenue were made in the four districts through which the canal passes.

I am not aware of these dates, but as the District of Hissar is now being resettled, and as the last settlements were made for 20 years, I assume that the settlements in these adjoining districts all run for nearly this period. Hence we obtain a new credit to the canal west of the Jumna of 3,69,107-12-0 $\times$ d. by 20 or 73,82,155 rupees on account of land rent. As shewn in the body of the report, the net profit to the Government derived from water rent, and other sources, after deducting all expenses for establishment (which includes all salaries) and maintenance, since the canals were opened, amounts to 37,75,695-15-9 and the total of these two sums, viz. 1,11,57,850 rupees will shew the clear profit to the Government derived from these magnificent canals. Much however still remains to be done on them, and with these large figures before the Government, I feel assured that the 10 or 12 Lacs which will be required during the next few years will be willingly given to place them in first rate working order, and to render them even yet more productive, than they have been, and a still greater blessing to the country than they have proved to be during this severe year of famine of 1860-61.

A. D. TURNBULL, *Lieutenant-Colonel,*
Superintendent General of Irrigation,
N. W. Provinces.

APPENDIX I.

STATEMENT showing the quantity of Land Irrigated and Water Rent levied in the various Districts of the Western Jumna Canals for 1860-61.

ZILLA II.	WATER RENT.						MISCELLANEOUS.						GRAND TOTAL.													
	1st CLASS.		2nd CLASS.		Total.		Revenue on Water Rent.		Rent on Water Mills.	Rent on Watling Cattle.	Rent on Rafting Timbers.	Sale of Canal produce.		Fines for breach of Canal Regulations.	Total of Miscellaneous Revenue.											
	Tor.	Dut.	Tor.	Dal.	Total.	Rs.	A. P.																			
								Beehives.								Beehives.	Beehives.	Beehives.	Beehives.							
																				Beehives.	Beehives.	Beehives.	Beehives.	Beehives.		
Northern, ...	5,866	6,384	7,106	1,941	9,127	2	7,414	4,5	...	...	5,694	11	2,123	11	8	792	12	2	7,726	5...	15,140	7	5			
Karnaul, ...	48,132	9,19,575	19,600	112,326	15,99,603	18	57,905	9,11	...	...	5,194	15	5,122	...	...	218	11	1	3,474	5,11	61,380	15	10			
Paniput, ...	54,078	11,19,522	14,113	18,9,068	15,96,783	11	59,084	13,10	...	...	...	...	...	...	...	3	204	7	...	812	3	59,847	1	3		
Soneput, ...	70,827	3,5,166	24,139	12,6,498	18,106,627	11	67,791	5,1	...	...	32	8	...	...	...	663	9	9	...	920	10	68,711	15	10		
Delhi, ...	44,473	18,535	23,557	12,2,492	11,70,100	17	43,835	3,11	1,244	6,5	9	13	6	...	...	2,689	10	9	...	4,121	7	47,956	11	7		
Kohlnk, ...	57,141	17,4,772	21,341	1,5,820	18,92,075	19	57,255	9,7	...	...	...	...	...	...	...	631	11	...	...	1,406	10	58,642	4	1		
Jheend, ...	43,944	21,1,201	17,769	14,7,866	2,80,781	14	43,421	2,9	...	...	...	...	...	...	...	515	8	3	...	1,051	...	49,472	3	1		
Hansee, ...	51,843	16,12,607	33,317	8,13,956	11,57,355	1	63,846	14,2	21	11	...	...	...	...	...	634	6	9	345	1	3	1,051	4,10	64,898	9	...
Western, ...	987	14,524	1,376	5,2,907	4,5,745	16	2,447	8,7	...	...	...	...	...	...	...	231	14	11	70	11	434	9	9	2,882	2	4
Bootana, ...	31,105	1,3,194	19,205	18,2,505	11,55,101	10	33,779	5,8	...	...	...	...	...	...	...	289	2	2	339	11	633	3	1	34,412	8	9
Total, ...	4,08,551	80,993	1,17,854	9,65,179	97,33,267	194,41,123	11,209	1,5	558	13	4,768	2	7,869	11	6	3,454	14	5	521,631	11	34,63,344	9	2			

(Sd.) T. G. GLOVER, Captain.

Supt. Western Jumna Canals.

A. D. TURNBELL, Lt. Colonel,

Supt. Genl. of Irrigation N. W. P.

APPENDIX III.

COMPARATIVE ABSTRACT of the Income and Current Expenditure of the Western Jumna Canals for the years 1850-60 and 1860-61.

YEARS.	CANAL INCOME COLLECTED BY THE SUPERINTENDENT.										CURRENT EXPENDITURE AS PER BILLS.			
	Water rent on Irr.		Rent on watering cattle.		Rent on water mills.		Transit duties on bullocks of timber &c.		Sale of produce of the canal lands.		Sundry collections viz. fishing tanks, &c. &c.		Fines for breaches of the canal regulations.	
	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.
1850-60	3,28,958	8,91,001	2,13,532	10,511,514	5,05,262	4,11,001	1,6,546	5,23,663	5,10,81,775	7,2,97,570	6,61,79,345	13,8	...	...
1860-61	4,41,712	13,11,558	13,4,1,266	1,3,7,682	2,7,6,638	5,3,12	0,5,424	4,84,63,344	9,2,96,894	8,41,89,557	10,72,05,752	2,11	...	...
Difference excess,	1,02,754	5,2	...	...	...	1,426	0,4	...	...	...	...	...	1,21,987	4,1
Difference decrease,	...	...	442	4,9,2,266	9,0,3,932	2,5	...	...	...	...	...	...	...	...
Total of yearly current expenditure of every description.	...	...	...	...	...	...	...	...	...	...	...	...	...	...

(Signed) T. G. GLOVER, Captain,

Supt. Western Jumna Canals.

A. D. TURNBELL, Lt. Colonel,

Supt. General of Irrigation N. W. P.

APPENDIX II.

COMPARATIVE Abstract of the Income and Current Expenditure of the Canals West of Junna for the Rubbee Crop of 1859-60 and 1860-61.

Canal Office West of Junna, 13th July, 1861.

Year.	Season.	CANAL INCOME COLLECTED BY THE SUPERINTENDENT.										CURRENT EXPENDITURE AS PER BILLS.													
		Water rent on cultivation of rubber crops.		Rent on watering cattle.		Rent on water mills.		Transfer duties on rubber &c.		Sale of produce of the various works.		Sundry collections, viz. filling tanks, fielding nets, &c.		Fines for breaches of the canal regulations.		Total of the half yearly income.		Establishment for superintendence of works, collections of Revenue and all duties.		Cost of ordinary repairs, plantations, &c.		Total of half yearly current expenditure of every description.			
Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.	Rs.	A.P.
1859-60.	Rubber ..	2,02,405	13	1,001	2	1,642	104	6,998	14	1,486	75	3	4,087	610	2,17,554	9	41,925	13	46,468	15	1	91,294	12	5	
1860-61.	Rubber ..	2,70,149	11	568	13	309	5	4,032	11	3,234	1	2,203	511	2,61,437	10	52,136	7	5	48,398	12	6	1,00,535	3	11	
Difference excess, ...		67,744	8	...	...	...	...	...	...	1,767	12	7	...	...	63,988	9	7,210	10	1	1,929	13	5	9,140	7	6
Difference decrease, ...		...	...	2,422	4	5	1,333	4	2	2,968	2	8	...	...	...	...	...	...	...	...	...	...	...	...	...

Remarks by the Superintendent Canals west of Junna. The increase of watering is due to the great increase of demand for irrigation on the failure of the periodical rains. The decrease on watering cattle is due to the villages taking increased quantities of water which absorb them from this tax. Decrease on water mills due to the water being employed in the more important object of irrigation. Decrease on watering timber is due to the exhaustion of the forests. Increase of sale of canal produce accidental.

(Signed) T. G. GLOVER, Captain,

Supdt. Western Junna Canals.

A. D. TURNBULL, Lieut. Colonel,

Supdt. General of Irrigation N. W. P.

STATEMENT showing the area of Cultivation, and amount and value of produce on Lands irrigated by the Western Junna Canals, during the year 1860-61.

	Khureef, 1860.	Rabbee, 1860-61.	Total areas, 1860-61.	ESTIMATE OF PRODUCE.				Average price in Bazaar.	Total value of Crops.			
				Area in Beegahs.	Area in Beegahs.	Area in Beegahs.	Total.		Per Beegah.			
										Mds.	S.	C.
Alwain,	22 18	12 0	34 18	0 15	0 13	3 8	5 Seers per R.	104	11	2		
Barley,	33,024 13	33,022 13	33,022 13	12 0	0 396,271	32 0	164	975,438	4	5		
Cheenan,	550 2	550 2	550 2	8 0	0 4,712	32 0	20	9,425	9	6		
Chilies,	0 2	0 2	0 2	1 0	0 0	4 0	8	0	8	0		
Chuttee,	1,156 17	1,156 17	1,156 17	3 Rs. per Bh.	1,156	17 0	3	3,470	8	10		
Cotton,	68,925 7	68,925 7	68,925 7	2 20	0 174,813	15 0	3 S. 6 C. P. R.	2,071,862	3	6		
Fruits,	3,024 4	3,024 4	3,024 4	50 Rs. per Bh.	6,313	6 0	50	3,15,665	0	0		
Goor { (The measurements show the amount of Sugar-cane grown, and the produce is given in Sugar.)	41,763 2	41,763 2	41,763 2	20 0	0 835,262	0 0	11 Seers,	30,37,316	6	10		
Gram,	111,673 12	111,673 12	111,673 12	12 0	0 13,40,143	8 0	14 Seers,	36,96,946	12	1		
Indian Corn,	3,192 18	3,192 18	3,192 18	15 0	0 47,893	20 0	15 Seers,	1,25,622	4	8		
Indigo,	2,236 3	2,236 3	2,236 3	0 10	0 569	1 8	100 R. per Md.	55,903	12	0		
Jowar,	71,802 17	71,802 17	71,802 17	12 0	0 861,634	8 0	124 Seers p. R.	28,13,469	6	10		
Koosumbah,	110	110	110	0 30	0 1	5 0	3 Seers,	15	0	0		
Lucerne and Country grass,	139 7	139 7	139 7	3 per Deegah.	139	7 0	3 Seers,	418	0	9		
Methee,	17 18	17 18	17 18	7 0	0 125	12 0	10 Seers,	501	3	3		
Murwah,	130 11	130 11	130 11	3 0	0 1,044	16 0	20 Seers,	2,088	12	9		

APPENDIX NO. IV.—(Continued.)

	Khareef, 1860.		Rabi, 1860-61.		Total areas 1860-61.		ESTIMATE OF PRODUCE.				Average price in Bazar.	Total value of Crops.
	Area in Beegahs.		Area in Beegahs.		Area in Beegahs.		Per Beegah.		Total.			
	Mds.	S. C.	Mds.	S. C.	Mds.	S. C.	Mds.	S. C.	Mds.	S. C.		
Oats, ...	...	...	1,14 5	1,14 5	30 0	0	34,237	20 0	15	Md.	25,825	...
Orchard, ...	...	...	...	...	...	...	...	...	...	...	...	...
Opium, ...	...	...	...	...	...	...	...	...	...	...	...	...
Rice, ...	...	...	...	...	...	...	...	...	...	...	...	...
Singharah, ...	...	...	...	...	...	...	...	...	...	...	...	...
Tobacco, ...	...	...	...	...	...	...	...	...	...	...	...	...
Tona or Oil seed, ...	...	...	...	...	...	...	...	...	...	...	...	...
Use, ...	...	...	...	...	...	...	...	...	...	...	...	...
Vegetables, ...	...	...	...	...	...	...	...	...	...	...	...	...
Wheat, ...	...	...	...	...	...	...	...	...	...	...	...	...
TOTAL	266,641 3	442,375 9	709,016 12	...	...	...	...	...	...	...	31,277,469 3	9

(Signed) T. G. GLOVER, Captain.

Superintendent of Jumna Canals.

A. D. TURNBULL Lieutenant Colonel,

Supt. General of Irrigation N. W. P.

Roorkie,

4th September 1861.

FROM

SECRETARY TO GOVERNMENT, PUNJAB,

Public Works Department.

To

THE SUPERINTENDENT GENERAL OF IRRIGATION

N. W. PROVINCES.

Dated Lahore, 14th December, 1861.

SIR,—Your Report on the operations of the Western Jumna canals during the year 1860-61, has been received by His Honor the Lieutenant Governor with much interest. The results you have described are, in the highest degree, satisfactory, and fully establish the importance and great value of these canals. They have, by the successful operations of the past official year, though with a supply diminished by the drought of that season, afforded the means of cultivation over a very extended area, preserving it from the effects of the famine, which its produce helped to mitigate in surrounding districts.

2.—The progressive improvement of these canals, the extension of cultivation due to their agency, their success in a financial view, and the general results you have reported upon, may here be briefly reviewed.

3.—The area irrigated in 1859-60 amounted to 2,96,252 beegahs, (185,157.5 acres or 289.3 square miles) and this is said to have been much in excess of ordinary years, while in 1860-61 it arose to 7,33,267 beegahs (458,291.8 acres or 716 square miles) scattered over an area of probably ten times that extent of country, benefiting 695 villages in districts which bordered upon those where the famine was most severely felt.

4.—That this vast increase of irrigation was caused by the demand for water consequent on the failure of the periodical rains is doubtless the correct view; the circumstances were exceptional; and it is probable the increase may not be maintained, now that the occasion for such a demand has passed away; but it is satisfactory that these canals were capable of meeting such a drain at a period of such necessity, and this at a time when the effect of drought had been to reduce the ordinary discharge of the Jumna from nearly 3,500 cubic feet per second as determined by Colonel Abbott in February 1849, to about 1,900 cubic feet as calculated by Captain Glover in March 1861.

5.—The financial results of the above increase of irrigation are stated in the 13th para. of your report, which shews that the total income of these canals for the past year amounted to Rs. 4,63,341, (£16,334) an increase of nearly one lakh (£10,000) above the largest revenue realized since they were opened, and giving a net return, after payment of all charges, of Rs. 2,57,592 (£25,759) an amount said to be not far short of the gross income of ordinary years.

6.—That these canals in addition to the benefits they confer upon the Districts through which they run, afford a large return for the money spent upon their construction is exhibited by the figures in para. 14. An expenditure of Rs. 16,94,624-13-2 (£1,68,462) has been incurred upon the construction and improvement of these canals. This amount has been repaid; and a net profit has accrued to Government of Rs. 37,75,696 (£377,569) after reimbursing it for all outlay on account of original cost, subsequent improvement and maintenance. Government has thus been repaid 325 per cent on original outlay; and direct taxation during the year under review, gave a profit of 18 per cent on the Capital invested.

7.—From the following para. (15), taking the lowest estimate, it would appear that the value of the produce from the lands irrigated by these canals, must have been last year between 2½ and 2¾ millions of £ sterling, and the amount of the grain thrown into the market amounted to 72,51,085 maunds (5,179,775 cwt. or nearly 259,000 tons) sufficient for the support of 8,00,000 people for one year; or by a more sparing distribution, sufficient to keep 12,00,000 human beings alive for the same period. Important results, when it is borne in mind that in a year like the past, the produce valued at so much, and capable of sustaining so many, might have been lost, but for the means of irrigation afforded by these canals.

8.—The produce also of sugar, grown to the value of more than 30 lakhs (£3,00,000) Indigo, 53,901 (£3,590) and Cotton, upwards of 20 lakhs, (£200,000) form important items in an estimate of benefits derived from these canals.

9.—The subject of Cotton growing alluded to in para. 17 is one of great interest at the present moment. His Honor will be glad to receive the promised specimens of the Cotton grown from the seed supplied by Mr. Berkeley, and they should be accompanied by some details of the sowing, treatment, picking, &c.

10.—Adverting to your 19th para. an examination of the water of the Ravee taken from the river at Madhopoor has led to an interesting report by Mr. Medlicott of the Thomason College at Roorkee on the subject of "Reh" efflorescence, of which report a copy is forwarded for your information. At the suggestion of Captain Dyas, His Honor the Lieutenant Governor has directed Dr. Brown, the Chemical Examiner for the Punjab, to extend this examination to the waters of each of the Punjab rivers.

11.—It is doubtful whether this efflorescence can be accounted for in the ways suggested in your report. In the Lahore district it makes its appearance on lands irrigated from wells, where the water is very far from the surface. It appears probable that it is not due either to the water alone, or to the soil alone, but that water holding certain matters in solution or suspension, combining with soil containing certain constituents, produces in time a sufficient quantity of the Reh to interfere with cultivation.

12.—In para. 20 of the report, the *Reh* and *Shor* or Saltpetre appear to be considered similar in their effects, and are spoken of almost indiscriminately. But in this district, the latter is actually employed successfully to neutralize the former, being scraped up where it is found abundantly, and cast over fields suffering from *Kullur* or *Reh*. They thus appear to be in a measure antagonistic in their action on vegetation.

13.—It is not impossible that the growing of *Keekur** or other trees or plants on Reh lands may itself be found a remedy, and that after a time, the lands so used, may be restored to cultivation of grain or other ordinary crops. Meantime the *Keekur* sown over a considerable area will itself be valuable. In your letter of the 10th July last, you reported that you had directed Captain Glover to confine his experiment for the past season to the sowing of 50 beegahs of Reh land with *Keekur* seed. The approval of His Honor the Lieutenant Governor was communicated in my letter No. 653c, of the 10th July last.

14.—I am to request that you will report what has been done, and take into consideration whether it would be advisable to sow *Keekur* over a larger area, or whether it would be well to try other seeds. In the Lahore district, Tobacco and some kinds of vegetables, are grown on land affected with "Reh." The experiment might also be tried with these on the land so affected in the neighbourhood of the Western Jumna canals.

* *Acacia Arabica*.

15.—His Honor desires that Captain Glover's recommendation to have the discharge of the Jumna measured annually in February should be attended to. He fully enters into the difficulties adverted to in your 5th para. with regard to the regulating the proportion of the waters to be taken from the Jumna for the Eastern and Western Canals. The arrangements for this described by you are probably the best that can be made under present circumstances. It is presumed that the distribution would be much facilitated by the construction of the masonry dam and head works for both canals proposed by you in April last.

16.—It is observed in para. 10 of your report that the demand for water for the use of the mills at Hansi has declined considerably of late years, since it ceased to be a military station. As mills are useful and profitable appendages of a canal, His Honor would wish you to consider and report, whether there are any other places where new ones might advantageously be established.

17.—In the same para. is noticed the diminution in the amount of fees on timber rafted down the canal, in consequence of the exhaustion of the forests on the Jumna; which also rendered it necessary for you on a late occasion to send to the Ganges for Sal.* It is suggested that Deodar† might be brought into general use on the canal, as it is believed that it could be obtained with less difficulty and at a smaller cost from the Simla hills. The Commissioner Cis-Sutlej States has reported that arrangements are in preparation for procuring supplies of Deodar from the valleys of the Pubhur and Tonse, and floating it down the Jumna to Delhi. If these arrangements are carried out, the canal will obtain timber readily, and may be able to aid and encourage this endeavour to establish a regular supply.

18.—Allusion is made in your 32nd para. to Captain Glover's project for a new supplementary head for the canal, leaving the Jumna near the village of Kulsowra: but no reference is made to my letter No. 589 C. of the 1st July last, returning the project, and pointing out that this was a work attempted by Colonel Colvin in 1828, and abandoned after some progress had been made with the preliminary operations, in consequence of the river at that part being found unsuitable for the construction of a canal head. It was asked whether there was reason to believe that the circumstances were in any way changed, so that the scheme which Colonel Colvin was obliged to relinquish might now be undertaken with good prospect of success. This has not yet been replied to.

19.—There can be little doubt of the great advantage of the improvements contemplated in your 34th para.

20.—His Honor the Lieutenant Governor in expressing his satisfaction with the favorable results reported upon, fully concurs in the commendation bestowed upon Captain Glover in para. 36. This Officer has shown a hearty and right appreciation of the importance of his position, and his opportunities of usefulness in relation alike to the welfare of the people, and to the interests of Government. He bestowed much earnest care and labour on the work whilst he was Superintendent of these Canals, to which he may still, in his new position, have an opportunity of giving some attention.

21.—I am also desired to convey His Honor's acknowledgments to those officers and subordinates, of whom Captain Glover has reported so favorably, and have to request that you will communicate this recognition of their services to

Captain Earle, as Superintendent Delhi Canal and subsequently of the Hansi branch.
Lieutenant Jeffreys, Superintendent Rohituk branch.

* *Shorea Robusta*.
† *Cedrus Deodara*.

Lieutenant Moneriff, Superintendent Delhi branch.

Mr. Duncan, in charge of the Upper Division,
as also to Sergeants Corcoran, James Malony, and Wilson.

22.—In conclusion I am to express His Honor's high sense of the services you have rendered in the general supervision of these Canals, to which in no slight degree is due those results which have called forth his satisfaction, and the successful working of the establishments to whom he has tendered his acknowledgments.

I have, &c.,

ROBERT MACLAGAN, *Lieutenant Colonel,*

Secretary, Government of Punjab,

Public Works Department.

Copy of a letter, dated 21st May 1861, from Mr. H. B. Medlicott, Professor of Geology, Thomason College, to Director of Canals Punjab, (referred to in para. 10 of the above letter.)

With reference to your letters Nos. 1478 and 1590 of 28th March and 11th April, I will not delay the following memo. any longer, that it may be in time, as you desire, for your Annual Report in June. Such analyses as you must be aware, very tedious. I could, by taking a larger quantity of water, and spending much more time over it, give a more exact account of its contents, but I have already done enough to give a clue to the question you proposed, namely, the possible injurious effects of the water upon vegetation. Should you think it worth while to quote my remarks, I would recommend that it be done in full, so that any future examiner may know how far they are reliable.

One gallon of the water taken from the Head Regulator in equal portions on the 1st and 18th of September, 3rd and 15th October, 15th November, and 1st and 15th December 1860, filtered and evaporated, gave 7.14 grains of matter that had been in solution. Of this 3.44 was re-dissolved by water. This latter quantity gave 0.50 chloride of sodium, equivalent to 0.20 of table salt in the water. It gave a further precipitate of sulphate of soda 2.36, equivalent to 1.43 of glauber salt, or to 1.22 of anhydrous soda alum, or to 2.31 of the hydrous alum. Even taking the latter value, it leaves .93 of the 3.44 unaccounted for. I had not time to repeat the operation, or, I believe, I could have traced this deficit to insufficient burning of the total residue, the quantity 3.44 being in consequence too high. I believe the sulphates in the water to be glauber salt and alum, principally the former.

The portion of the residue not re-dissolved in water, consisted of 3.16 carbonate of lime, and about .40 sulphate of lime. The soluble ingredients then are in 70,000 grains of water.

Common salt, Glauber Salt (Sulphate of Soda), with some alum (Sulphate of Alumina and Soda)	1.43
Carbonate of Lime, ...	3.16
Sulphate of Lime, ...	.41
	5.23

Besides the source of deficit above pointed out, there are the numerous infinitesimal quantities of other substances that exist in all waters. I believe I have fixed those that can be of any influence in the present question.

The salt separated from the gallon of water by filtration, only amounted to 16.11 grains dried at 212°. In burning it lost .69 :—boiled for two hours in dilute hydrochloric acid, there was an insoluble residue 12.89; the 2.53 dissolved consisting of 2 of peroxide of iron with a little silver and alumina, and .53 of lime.

Water, ...	70,000
Silt, ...	16.11
Organic matter or Water, ...	.69
Peroxide of iron, silica, alumina, ...	2.0
Lime, ...	.53
Insoluble residue	12.89
	16.11

It is only in the soluble element that any possible noxious substance is looked for, and there I confess the result has surprised me. After the carbonate and sulphate of lime which are harmless, there are the two highly soluble alkaline salts in the proportion of 88 per cent glauber salt and 12 per cent culinary salt. Now this is the constitution of the well known Rêh, that does so much damage in certain districts along the Western Jumna Canals. Two samples that I analysed from these, gave one but 3 per cent of the chloride, and the other 25 per cent, the proportions varying greatly.

The source of this Rêh has always been a puzzle, but we now seem to have got a clue to it; at least to a source of it. The quantity of it in the Ravee water is but 23. I cannot give my own authority, nor can I quote any other upon the possible effects upon vegetation of so very diluted a poison, but it may be very serious, and by accumulation from evaporation almost must become so. Nothing but a careful study on the ground can settle the point, and a most interesting question it is for the canal officers of these provinces. I will at once examine the Ganges and Jumna waters to see if they contain the same ingredient.

Copy of demi-official letter from Mr. Medlicott, dated Roortec, 30th May, 1861.

I have just completed my examination of the Ganges water, and find it has practically the same composition as that of the Ravee, viz., common salt 25 grains per gallon, and sulphate of soda 1.12, or of Rêh 1.46, being $\frac{1}{1,000,000}$.

The other ingredients are also equivalent. It is more than probable that this is about the constant composition of the waters of these rivers. In working out this case, it must be easy to settle on the ground if the injury complained of proceeds from Rêh or not, and if not, there is no other ingredient in the water that could possibly do injury.

226 Steady 11/12 March

1861-42

Chapman
2 May 1862

Heard 10-11
12/11/11

Towards the report
on the operations of the
Western Furman Canal
for the year 1860-61.

①
Wm. J. G. D. D. D.
to the Government of
the United States
1861-42

41-42