DRAINS ON THE LOWER CHENAB CANAL.

By W. P. THOMPSON.

Executive Engineer, Irrigation Branch, Punjab.

Introduction—General—History—The original scheme—Defects—Remodelling—Tributary drains—Further schemes—Water-logged areas—Defects of the further scheme—The design of the drain section—Conclusions—Irrigation from drains—Bridges on drains—Maintenance of drains.

Introduction.

By the end of the year 1919, there were ninety-five miles of main drains and fifty-seven miles of branch drains on the Lower Chenab Canal, and the expenditure on them up to then was :—

	Rs.
Construction	4,03,478
Special Maintenance	77,751
Annual Maintenance, 1916 to 1919 ...	19,338
Total Rs.	5,00,567

A detail of the drains and of their cost is given in appendix I, at the end of the paper.

General.

Necessity for drainage was first felt on this canal when water, leaking from the bed of the canal, filled the soil and appeared above the surface on both banks in the reach from mile nineteen to mile twenty-six of the main line ; and in the year 1903, the right and left Jhattanwali drains were constructed under an estimate sanctioned by the Government of India for Rs. 40,235.

Drainage on the Lower Chenab from that time to the present has been undertaken in connection with the unwatering of swamps and jheels formed in the proximity of the canal, which have been caused by the water leaking from the canal, not finding a sufficient outfall to the nearest river, the Chenab River, which is obviously the main open drain for the locality. No field drainage has yet been done, as the necessity has not arisen for this class of work.

The construction of main drains leading from the canal to the river, with branch or tributary drains in the valleys between distributaries, has removed the standing water from the swamps and afforded protection against further swamping. This, so far, has been all that was necessary.

History.

The scheme for constructing the Jhattanwali drain did not go further than provide that the water collected by the drain, should be poured into the natural drainage, which crosses the canal in the twenty-sixth mile at the Ahmedpur Syphon. The next step, namely the removal of this water rom 'he natural drainage to the river, was forced upon the canal authorities, although he necessity for it had been foreseen by Mr. R. E. Purves who was in executive charge at Khanki.

A petition, dated September 1904, from the land-owners in the village Batera, stated :—

"The Canal Department has ruined us by not making proper arrangements in connection with the discharge of seepage water running from Jhattanwali, Muradian and Ahmedpur, which has spoiled hundreds of acres of our land. The standing crops have been damaged owing to excess of water running all day and night from the above source. Instead of showing sympathy with the zimindars the Canal Patwari has been threatening us with heavy water dues, and as we have been suffering this loss owing to the negligence of the Canal Department, we pray that the land tax may kindly be remitted and damage done to our crops and land may be made good."

A severe indictment, on which Mr. R. E. Purves, after inspection, reported in September 1904 as follows :—

"The accident of this supply has enabled the affected villages to sow rice in the drainage. During the rains of August the supply passing down the drainage was greatly increased and probably caused severe damage in village Dhanoe. Moreover it is too early to estimate damage to crops. It is possible the people of Batera, fearing that some kind of water-rate may be applied to them, have sent in this petition to establish a bias in their favour. It is almost certain that we must, in course of time, open up this drainage channel, if we are not to create pastilential swamp. I advocated this in 1902, but the Chief

Engineer over-ruled my proposal with the result that we are pouring water into an indifferent drainage depression, which cannot act efficiently in carrying off the seepage."

The Original Scheme.

After subsequent surveys and investigation, Mr. Purves submitted a report proposing that a channel be constructed, 20 feet wide, 1·5 feet deep, and graded at 1 in 3636 from a bed level of 692·5 at the Ahmedpur Syphon. This channel was to be 155,000 feet long and to terminate in the then existing Kot Nikka Escape, the length of which up to the rivers, was 96,000 feet. This length of the escape channel was subsequently graded and excavated in 1914-15, and the whole length of 251,000 feet is now known as the Ahmedpur Kot Nikka Drain. The Drainage was notified in the Punjab Government Gazette on October 12th, 1904, and an estimate, prepared after approval to Mr. Purves's proposal, was submitted in 1905, and sanctioned in July of that year for Rs. 24,444 This estimate, besides 41,00,000 cubic feet of excavation, included distance marks, boundary pillars and five metalled ramps for district roads. It was not then proposed to make other arrangements for the village roads, except cut approach ramps down to bed level. Work was started in November 1905, and by March 1906, the drain was reported ready from reduced distance 26,000 feet to 155,000 feet, but the reach 36,000 to 37,000 feet had been excavated with much difficulty in standing water, and the reaches 0—10,000 feet and 16,000—26,000 feet being under water were left to be undertaken as closure works. By August 1906, the reach 16,000—26,000 feet had been excavated.

Defects.

The defects of the drain as designed were felt before construction was complete. The drain had little effect in the head reach, where the bed was at natural surface or sometimes even slightly higher than natural surface, and the water was kept off the fields by bunds, which the cultivators breached when in very dry months, they wished to irrigate their fields, while the water flowing down the drain began to cause swamps near reduced distance 67,000 feet.

The drain was more or less completed in 1907, at a cost of nearly Rs. 30,000 or Rs. 5,556 greater than originally estimated, but was never dug in the first two miles, various bunds

being attempted in order to localize, as much as possible, the water accumulating at the Ahmedpur Syphon.

Remodelling.

Between 1907 and 1914, the drain is mentioned in correspondence on one occasion only, and from a report on an estimate submitted in 1914 for regrading and deepening the drain, it is gathered that swamps had been formed all along the alignment, at likely places.

The drain was very inefficient and conditions were perhaps worst in the last ten miles, from reduced distance 45,000 feet of the Kot Nikka Escape to the river.

In 1914 two estimates were sanctioned for Rs. 54,922 and Rs. 6,325 for dealing respectively with the drain in the reaches from the Ahmedpur Syphon to reduced distance 45,000 feet of Kot Nikka Escape, and from the latter site to the river, and in the estimate for Rs. 54,922, allowance was made for seven Irish bridges, but these were not constructed, while the Irish bridges built in 1908, had all to be dismantled when the deepening was done in 1915.

From the time these estimates were sanctioned increased activity on drain construction and maintenance has been apparent.

The work done in 1914-15 was done under stress, the unwatering of the swamp and the grading of an efficient drain was a forced measure. The work had to be done quickly to be done at all and the help of the cultivators was called in. This zimindari labour, being inefficiently controlled, did the work very roughly, in this sense, that the spoil, which was probably wet, was thrown as close to the edge of the excavation as possible and the channel was not straight. Rs. 28,000 were spent subsequently on completing the work left by the zimindari labour.

The reach, reduced distance 45,000 feet of the Kot Nikka Escape to 65,000 feet, was further deepened in 1917 to provide an outfall for water which came in from the Thata Raika Jheel on the right bank of the Jhang Branch. The head reach of the drain was deepened in 1918, when the slope, from the head to reduced distance 18,000 feet, was reduced from 1 in 2,000 to 1 in 3,000 and the bed level at the head lowered from 692·5 to 689·5. Finally in 1918 an attempt was made to connect the end of the drain with the river bed. To an

outsider, it might well appear that this last step might have been taken earlier, in order to achieve a drain which would lead to the river, but the conditions at the river end are, unfortunately, unstable.

In the beginning it was considered sufficient to terminate the drain in a creek, the bed of which was considerably above the low water level in the river in the winter; this creek meets a branch of the river which is liable to a changing silt regime and through the silted bed of which it is necessary to excavate an outfall once a year, if the full value of the difference between low water level in the river and water level in the drain is to be taken advantage of. The length of channel through creek and river branch is about one mile. The creek itself which only flows when the river is in flood is a settled channel and the path of least resistance was certainly to terminate the drain at the creek.

Tributary Drains.

After the completion of the main drain in 1915, several tributary drains were constructed, a list of these is given, they were constructed by contract, and most of them required two working seasons to be completed.

Tributary Drain.		Cost. Rs.
Sagar Branch Drain	...	10,630
Pirkot Kariala ,,	...	16,928
Kariala Lakhia ,,	...	17,121
Hafizabad ,,	...	9,516
Shori Vagh ,,	...	23,730
Ram Garh Nawan ,,	...	4,179
Pindi Bhatian ,,	...	6,284
Chiniot Road ,,	...	1,696
Killa Bakhsha Jangala Drain	...	5,767
Kallarwala Drain	...	5,553
Gajargola ,,	...	5,947

The Ahmedpur Kot Nikka Drain and its tributaries described above, lie in the valley between the Jhang and Kot Nikka Branches. It was found, even after the grading in 1906, inadequate to deal with the swamp round the Ahmedpur Syphon, which was fed by the Jhattanwali Drain, where in

1910, it was reported that 15 cusecs were entering the swamp and only 4 cusecs were passing down the drain at reduced distance 18,000 feet.

Further Schemes.

A project was prepared in 1910, for taking the water of the right Jhattanwali Drain by means of a drain starting near the twenty-fourth mile of the main canal going through the Shori Chamb, a large jheel on the right of the Kot Nikka Branch, and ending in a branch of the Vagh Nalla. This drain was to be sixteen miles long. An estimate was sanctioned in 1912, and excavation was started. Meanwhile an alternative drain commencing at the Ahmedpur Syphon, crossing the Kot Nikka Branch and the Gajargola Distributary and only seven miles in length, to the Vagh Nalla, called the Ahmedpur Vagh Drain was investigated. A drain along this alignment was preferred and an estimate was sanctioned in lieu of the first one. The head reach of the drain, first proposed, from the twenty-fourth mile of the main canal was retained as a branch of the Ahmedpur Vagh Drain and it served to connect the right Jhattanwali Drain with it.

The bed level of the Ahmedpur Vagh Drain at the Ahmedpur Syphon was 690·0 compared with 692·5 of the Ahmedpur Kot Nikka Drain, which had been found inadequate. The original estimated cost of the Ahmedpur Vagh Drain was Rs. 54,934 and the revised estimate amounted to Rs. 96,040, but it actually cost Rs. 99,000 to construct.

Water-logged Areas.

In order to find out the effect of regrading the Ahmedpur Kot Nikka Drain and of the construction of the Ahmedpur Vagh Drain, a field survey was undertaken in February 1917. Out of 11,637 acres which were water-logged in 1914, 1,831 acres remained so in 1916, nearly 10,000 acres having been reclaimed, which were distributed between 54 villages. The 1,831 acres remaining unreclaimed, were situated in 19 villages.

Defects of the Further Scheme.

Since 1916, the drains have been maintained and cleaned and have served as a check to the possibility of any more water-logging in the area they traverse. The Ahmedpur Vagh Drain, however, which was made to terminate in the Vagh Nalla at a point thirty-seven miles from the river, has not been an

unmixed blessing. The natural Vagh Nala as a drainage, is probably more inefficient than was the Kot Nikka drainage previous to its grading.

Certain it is that during and after the rains large areas along its course are swamps. Moreover, owing to inefficient drainage, a large area beyond the swamp boundary is affected with alkali.

Proposals have been made since 1917 for the grading of the drainage throughout its length. In 1918 an estimate was sanctioned, the scope of which was curtailed and limited. Such work as was sanctioned was started in the autumn and winter of 1918. Subsequent to the survey of 1917, the heavy monsoon in 1917, following on that in 1916, increased the areas subject to water-logging along the Vagh Nalla and between the Jalalpur and Medora Distributaries. It is important to have the main drains as efficient as possible, in order to permit the rain water to be taken off the land in time to permit of cultivation for the rabi. This aspect of the situation does not appear to be sufficiently realized, and there is scope for much useful work to be done.

The Design of the Drain Section.

So far the dimensions to be adopted have been proposed from considerations of expediency and cost, and not from any theoretical considerations. The engineer has had to use hard common sense and experience where he had any. In designing the branch drains, a minimum bed width of 2 feet and an average depth of 6 feet below natural surface was adopted.

During the monsoon rains, the drains all flow to full capacity and many of them overflow. The main drains keep in flow at about one quarter of their capacity for about two months after the rains. The branch drains dry up completely, but the main drain generally only dries up in the spring.

Conclusions.

It will be seen that, at first, the problems of dealing with the drainage of water-logged tracts were forced upon the Department. Those in authority seemed unwilling to consider the work as within their province. After 1914 interest in the matter became more pronounced and tentative programmes of work

were formed, but, even then, the work that was sanctioned and done, was generally much less than that provided for in the estimates submitted by the local officers.

There has not been the comprehensive grasp of the whole situation and the formation of a programme of work, starting with the most important and essential part of the scheme, as one would have liked to see.

Irrigation from Drains.

Attempts have been made to get the cultivators of the fields bordering on the drains to take water by lift.

A few outlet pipes were installed, but no lift was ever constructed ; probably the supply is too precarious to tempt the cultivator to erect a lift.

Bridges on Drains.

The metalled road from Sukheki to Pindi Bhattian crosses the Ahmedpur Kot Nikka drain at reduced distance 200,000 feet and a masonry bridge has existed since 1906. The foundations and floors of which were lowered in 1914. Since 1914, seven other cart bridges have been constructed, one screw pile bridge, five timber pile bridges and one rail pile bridge, and there are also several foot bridges of simple design. On the branch drains seven masonry bridges have been constructed. On the natural drainages two bridges exist, one for the Hafizabad-Vanike Road and the other for the Jalalpur-Vanike Road. They are very old and the waterway is quite insufficient during a flood.

The railway crosses the Ahmedpur Kot Nikka and the Ahmedpur Vagh drains on girder bridges, the abutments of which are built on wells. The Ahmedpur Vagh drain crosses the Kot Nikka Branch and the Gajargola Distributary, by means of masonry syphons. The drains, except, perhaps, the Ahmedpur Vagh drain, are, so far, inadequately supplied with bridges and this increases the difficulty of maintenance.

Maintenance of Drains.

The maintenance of the drains, crossed as they are at every few chains by village paths, used by graziers with cattle and others, is no easy matter. At each of these crossings the already flat slope receives a kink. In the rains, earth is washed into the drains and as soon as the supply in the autumn and winter diminishes to a trickle, a thick growth of slime forms along the wetted perimeter and almost chokes the drain.

APPENDIX I.

Statement of Cost of Drains up to 1919.

Name of Drain.	Length in miles.	Cost of Construction.		Cost of Maintenance.	Miscellaneous.	Total.
		Works.	Earthwork.			
		Rs.	Rs.	Rs.	Rs.	Rs.
Ahmedpur Kot Nikka ..	51	30,503	1,07,878	43,605	3,103	1,85,089
Ahmedpur Vagh ...	7	1,084	99,757	6,102	474	1,07,417
Natural Vagh (Past Grading) ...	37	...	16,500	...	...	16,500
Pindi Bhattian ...	2½	...	3,203	1,735	1,346	6,284
Hafizabad ...	2½	4,495	4,527	324	170	9,516
Ramgarh Nawan ...	3	...	2,891	833	...	4,179
Pirkot Kariala ...	6½	2,983	13,406	363	176	16,928
Kariala Lakhia ...	4	...	17,121	...	...	17,121
Shori Vagh ...	3	...	18,334	5,396	...	23,730
Chiniot Road ...	2½	...	548	148	...	1,696
Killa Bakhsha Jangla ...	5	...	4,225	1,473	69	5,767
Kalerwala ...	2½	...	4,425	1,128	...	5,553
Gajergola ...	2	1,491	3,344	1,112	...	5,947
Sagar Branch ...	3	...	8,859	1,771	...	10,630
Sagar Compound ...	3	...	1,341	944	...	2,285
Jhattanwala (R and L) ...	10	...	29,142	10,736	...	39,878
Thata Raika ...	4	...	9,222	1,881	...	11,103
Kubrika ...	4	...	11,258	...	...	11,258
Other General Expenditure	...	...	1,603	200	...	1,803
Annual Maintenance in 1916-17 ...	...	...	...	1,221	...	...
Annual Maintenance in 1917-18 ...	...	...	...	4,354	...	4,354
Annual Maintenance in 1918-19 ...	...	...	...	13,763	...	13,763
Total ...		40,556	3,57,584	96,089	5,338	5,00,56

DISCUSSION.

MR. W. P. THOMPSON in introducing his paper mentioned that it was descriptive of what had been accomplished on the Lower Chenab Canal and differed in that respect from the papers on the theories of water-logging with their various panacea for the cure thereof. He drew attention to the articles which had appeared in the February numbers of *Indian Engineering*, the author of which had stated that the views of Engineers were very hazy in matters relating to subsoil water and water-logging, and had ended with the conclusion that surface drains were the least satisfactory method of preventing water-logging.

The surface drains which had been dug were never looked upon as a preventive measure, but as the only available means of unwatering a large swamp into which water could accumulate and could lodge to the detriment of cultivation.

The Ahmadpur Kot Nikka Drain described in the paper formed part of a net-work of drains which were excavated in accordance with a settled policy of drain construction, the object being to protect a certain tract from the evil results attendant on the imperfect drainage of rainfall in a locality where subsoil water was high.

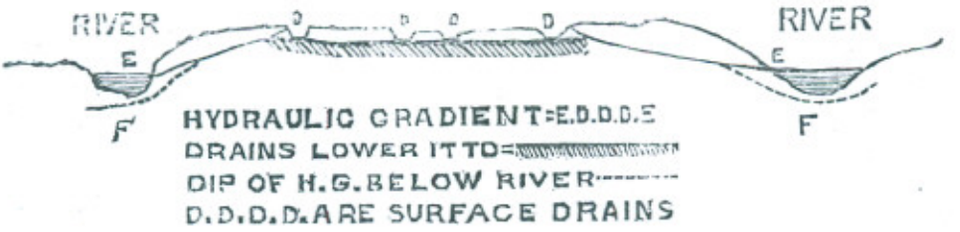
The construction of a drain was not a preventive measure but was in the nature of a surgical operation which was performed in order to remove the accumulation of water which interferes with cultivation.

Mr. C. QUINN YOUNG said he had not had much time to study the subject, so his remarks would be rather crude. On page 11 the following occurred "in connection with the unwatering of swamps....., and then a river is obviously the main open drain of the locality". If this was so, why was the outfall insufficient? The reason was that subsoil water did not flow, at least it had not been demonstrated that there w[illegible] any flow. Subsoil water found its way into a river ju[illegible]t water trickled away from the exterior of a supersa[illegible]ions sponge. [illegible] years

[illegible] a very

Because contours showed slopes in the [illegible] main drainage, it was argued that there must be a flow [illegible]ow, would have been correct? [illegible], perhaps as much as 10 [illegible] canal as now aligned. From

Reverting to this sketch, figure 1, why should the subsoil water not dip below the bed of a river, especially a soaked,



sandy bed offering little resistance to flow ? That was instead of the hydraulic dip being as DE, why should it not be as DF ?

In his opinion the more that water was poured into, or on to, the soil, the greater the density of saturation became ; or, in other words, the greater the percolation from canals and other sources, the greater was the amount of moisture that a unit volume of soil contained ; also the saturation extended deeper down the greater the amount of water the soil received ; this seemed logical because the head was greater.

Where surface saturation resulted, as in figure 1, it meant that the sponge was thoroughly soaked. Drains DDD meant breaks in continuity of the sponge, and all the influence they exerted was to lower the hydraulic gradient as shown by the hatched line below the drains.

In his opinion there was no cure for supersaturation except stopping the source of supply, and this could be done by closing the canal and distributaries, or else by lining them internally. The latter process presented innumerable problems, as the complete design of an established canal was affected. With projected canals the problem was easier.

In conclusion he asked Mr. Thompson—

(*i*) to what depths drains lowered the saturated levels, and

(*ii*) what velocities and depths of water were necessary to prevent weed growths in the drains ?

MR. W. ROBERTS observed that Mr. Thompson had emphasised, in introducing his paper, that surface drains were the most expensive method of curing water-logging, and moreover

it was a cure applicable only after the damage was done. If made with the object of lowering the water-table on an extensive scale and at distances such as are used in England, they would cost at least 150 rupees per acre which was prohibitive. He wished also to emphasise the danger from "kallar". Even if the water-table was only four feet from the surface cultivation was possible, provided salt incrustation was absent. Accumulation of salt started when the water-table was 10 to 12 feet from the surface in dry tracts. This salt incrustation was a prominent feature all round the water-logged area at Hafizabad.

MR. J. H. T. MIDDLETON said that there was a moral to be drawn from Mr. Thompson's interesting history of drains on the Lower Chenab Canal, and that was if water-logging appeared in any locality, it was of little use to confine efforts to that locality only. The first essential was a good outfall into some channel which always had water in it, the more the better, as the addition of seepage water from elsewhere did not materially increase the percolation from that channel. It must be remembered that what was a seepage channel in one place was in most cases a channel from which percolation went on in another, and therefore added an additional supply to the subsoil water there, and if the conditions were such that an extra supply would be likely to cause water-logging it would be preferable to adopt another method of combatting the evil at the original site, unless, of course, fresh duck and snipe shooting grounds were required. There was another point which was not so clearly denoted by Mr. Thompson's paper, and that was if what was a seepage drain in one place was a channel from which percolation went on in another, it should be as short as possible in such lengths to reduce the additional source of water supply to the subsoil instead of carrying the water in channel which meandered through miles and miles of country before finally entering a natural channel which carried a supply of water apart from that artificially let into it.

Mr. F. T. BATES said that as his experience of that tract of the Lower Chenab Canal extended over 20 years it might interest members if he gave a brief history of the seepage conditions there. Had the country in that tract been seen some years before the canal was built it would have presented a very different aspect from what it was now. The main drainage, instead of being a single channel as it was now, would have been seen to have several branches crossing perhaps as much as 10 miles and more of the reach of the canal as now aligned. From

one cause and another many of the branch drains appeared to have been levelled up with the adjacent ground, and when subsequently the canal survey was made, the drainage channels existing at the time of survey were alone noted. For a period of 8 years from the opening of the canal things appeared quite normal. The tract in question was in fact dry enough to afford grouse shooting. Later on signs of supersaturation began to appear adjacent to the canal in its right bank. It was noticed at the time that the tract was not uniformly affected but that excessive saturation appeared in certain localities only extending down towards the river from the canal. Investigation showed that it was the branch drainages which had previously existed and had filled up that were now the sites of excessive moisture. It was not until these investigations were being made that it came to be realized that the Ahmedpur drainage was a far larger drainage system than was first thought to be the case, and that it must in former times have had several large branches affording irrigation and grazing to the large town of Hafizabad, the site of which could not otherwise have met the needs of its large population with their extensive herds of cattle. It was now clear from the patches of excessive moisture that were gradually coming to view that the obliterated drainage channels were receiving excess percolation from the canal, and that the light texture of the soil that had filled into them allowed the moisture to travel down them faster than through natural soil elsewhere. The existence of kankar beds in these drainages some 8 feet or so below natural surface prevented the moisture from penetrating into the subsoil, and the result was the formation of surface *jheels* along these drainages, which subsequently became a marked feature of the Ahmedpur Crossing. There came the question of treatment. The obliterated drainages were not easy to find except by linking up the *jheels* and tracing the line between them more or less by guess work guided to some extent by noting the patches of excessive saturation. These lines did not always coincide with the contours of the country as visible at the time. Progress too was necessarily slow, as they were endeavouring to drain patches of supersaturation by cutting along where signs of coming saturation lead them rather than where contours of surface indicated. Hence the appearance of lack of finality complained of by Mr. Thompson. Mr. Bates thought that the experience he had briefly narrated would be the experience of others too. He recommended that where supersaturation had to be dealt with it was desirable to get hold of

the oldest survey maps of the tract to see if any drainages existed in the locality. He noticed that old drain bridges existed where no drains were now visible, as these latter had been levelled off for cultivation. He also noticed that old drainages almost invariably had kankar beds, and for this reason when cut through by large canals carried percolation water a long way down and satuated a larger area of country along their banks than the mere size of drain indicated. All these points had been observed in the course of investigation made on the Lower Chenab Canal, where he thought that efforts to reduce over-saturation of the soil in the Hafizabad tract had met with some measure of success. The question as to whether canals should be lined at sites of drainage crossings was one for members to consider.

MR. W. P. THOMPSON, replying to Mr. Quinn-Young's question why an outfall to the river was not sufficient, stated that the drain had to deal with water in a large pond which had to be removed and taken to the river. This water could not pass away without a constructed drain. Previous to this the natural drainage was cultivated over and the outfall was obstructed. The flow off after rainfall had to be removed in time to permit of cultivation for the *rabi*.

Mr. Quinn-Young had asked to what depth the water-level was lowered. Previous to the excavation of the drain the water lay 2·0′ deep over the natural surface and the drain had been dug with a bed on the average 5·0′ below natural surface.

About the growth of weeds this would take place when the depth of water was small and the flow small, whatever the section.

From Mr. Bates the Congress had learnt the reasons for the tentative progress of the earlier days.

Mr. Middleton had enquired whether a shorter drain to the river would not have been better. To this Mr. Thompson replied that the shortest drain would no doubt be the best, but by following the valleys between distributaries the drain was able to take up on its way other areas requiring to be unwatered. The Engineer had to decide on the spot which alignment he should adopt. Mr. Roberts had alluded to the formation of alkali in lands where the sub-soil level was close to the natural surface.

The lands bordering on the Vagh Nala in the Hafizabad Division were of that description, and the area under alkali seemed to be increasing.

The Vagh Nala was a natural drain which was now in the same condition that the Ahmadpur Kot Nikka Drain was many years ago.

It was inefficient in its disposal of flow off from rainfall, and this caused deterioration of a large area where owing to the advent of the canal spring level had risen to within 3 or 4 feet of natural surface.

It was the business of the Engineer to make it efficient so as to avoid the formation of lakes or water-logged areas which did not dry up in time for cultivation.

Mr. Thompson concluded by saying that he had accepted the position of one having a brief on behalf of the cultivators when he proposed any schemes for drainage work. Mr. Bates who was then in charge of the Lower Chenab Canal, had taken a sympathetic view of the proposals. But those in whose hands lay the financial sanction were more difficult to convince, and in one notable case had only sanctioned half measures.

The scheme proposed should have been examined more carefully, and either rejected as unsuitable or accepted as suitable, and prosecuted with some vigour.

CORRESPONDENCE.

MR. W. G. QUINTON, referring to page 14, "the Zemindars' labour being inefficiently controlled, &c.," stated that this seemed an unjustified statement, as the author of the paper was not then in charge of the work.

The facts were that they had to excavate parts of the drain in four and five feet of water. This specially applied to the reach just above the Chiniot road and to the portion near the bridge for the metalled road, Pindi Bhattian to Sukheki, near a village called Shori, so far as he remembered.

The control was not so much at fault as the insuperable difficulty of a good alignment under such conditions with dense jungle growing in very deep water.

MR. W. P. THOMPSON, replying to Mr. Quinton, wrote that he was not there on the work, but judged from the work as it was left after excavation.

No disparagement was intended. The staff required efficiently to control a mob of zamindars could not have been available. The difficulties of the work of construction were further described by Mr. Quinton.