PAPER No. 118.

WATER SUPPLIES TO TOWNS IN CANAL COLONIES.

By J. A. R. Bromage, Assoc. M. Inst. C.E.

Following upon the completion of irrigation canals one finds townships springing up at pre-determined points. The problem of providing such towns with a clear drinking water-supply is one which frequently confronts the Sanitary Engineer.

The writer proposes to outline herein the broad principles underlying the design and construction of such supplies and then to illustrate such principles with descriptions of three typical undertakings.

Financing.

The policy of Government as regards sanitary works being to help those who help themselves, responsibility for the initiative as regards paying for an urban water-supply rests with the local body concerned. The usual procedure is for the local body to ask the Sanitary Engineer to prepare a rough scheme for administrative approval. At the time the scheme is sent up for approval an application is made to the Urban Sanitary Board for a grant-in-aid. Such a grant usually amounts to half the total estimated cost of the scheme, but varies between wide limits in special cases. In the case of smaller towns first embarking on a project of this nature, funds are limited. It is then usual to give a limit to the Sanitary Engineer as to the amount that will be forthcoming. The Engineer, assuming that a grant-in-aid of an equal amount will be available, to the best of his ability prepares the project accordingly.

The limitation of funds may thus often tie the hands of the designing engineer and a better design could be prepared if he were not so limited. On the other hand the preparation in the first place of too comprehensive a scheme may result in its being abandoned with the result that the town concerned has to forego the amenities of a water-supply for a longer period.

Provision for Expansion.

It will be seen, therefore, that while in the first place the waterworks of a town may be of very modest dimensions, they should be so designed as to admit of easy expansion in the event of the town growing, or of its financial resources becoming such that a greater allowance of water per head can be given. Foresight in this matter will save considerable expense later and is a point worthy of consideration in the newer colonies.

Scope of the Scheme.

The allowance varies from 8 to 10 gallons per head daily in the smaller towns, where only a public standpost supply is to be given ; 12 to 16 gallons or even more may be allowed where there will be a number of private connections. The scheme should also be of such capacity as will enable it to cope with the demands of a prospective increase in population over the next ten to fifteen years.

Maintenance.

At the time the preliminary project is prepared an estimate for its annual maintenance is also framed. With this before them the civil authorities are able, when according or recommending administrative approval to verify that the annual income of the town concerned is sufficient to enable it properly to maintain the scheme.

It has been found advisable also, after completing the construction of a waterworks for a local body to arrange that the scheme be maintained and run for one year by the Public Works Department. The writer does not recommend a shorter period. Allegations of a scheme being defective are avoided and any minor improvements, the necessity for which may come to light during such running, can be made.

Source of Supplies.

Borings in irrigated tracts almost invariably show saline subsoil water conditions and so we have to fall back on the canal itself as the source of supply. The water of the larger channels, although often heavily charged with silt is of such volume that it is comparatively free from organic contamination. In all cases main channels are not available and we have to depend on the smaller watercourses where the chances of fouling are greater.

Principles of Design.

Although every project of this nature has to be designed on its merits and no type design is possible, the general principles of design do not vary to any great extent. The main parts of a scheme are as follows :—

(a) Sedimentation and storage tanks.
(b) Filters.
(c) High level tanks for supplying filters.
(d) Low level clear water reservoirs.
(e) Pumping plant.
(f) High level service reservoirs.
(g) Pipelines.

Item **(c)** can be omitted under circumstances to be explained later.

Sedimentation and Storage Tanks.

These tanks serve the double purpose of allowing the heavier silt in the crude canal water to settle and of storing sufficient water to carry over a canal closure. The total capacity has, therefore, to be equal to

the maximum demand of the town for a few days in excess of the longest possible canal closure. Thirty days' storage is a common allowance.

The tanks are open and, as a rule, have sloping sides pitched with masonry either dry or in cement mortar depending on the funds available. Evaporation and absorption losses are therefore considerable, and the usual practice when calculating the tank capacity is to add 20 to 25 per cent. or even more to the net requirements of storage to allow for these losses.

A common depth of water is 8 feet and to this is added a further $1\frac{1}{2}$ to 2 feet to provide for silt accumulation without the effective storage being reduced below that required.

A minimum of two tanks is desirable, so that one can be closed down for cleaning without interfering with the continuity of supply. This also makes the measurement of crude water easier as one tank can be filling while the other is being used for town supply. This is an important point as water is charged for by the Irrigation Department, as a rule, at the rate of Rs. 1 per 2,500 cubic feet.

As the top water of these reservoirs is the cleanest it is advisable to use the top layers for supplying the filters, and for this purpose floating draw-off arms are standard practice. These connect through swivel bends with the supply pipes to the filters. The draw-off of each tank is controlled by a separate sluice valve. A suitable stop arrangement is provided to prevent the floating arm descending into the bottom $1\frac{1}{2}$ or 2 feet provided for silt.

Storage tanks are usually below ground level although the writer has had cases where they have had to be made with embankments. The sides are carried up to about one foot above the full supply of the canal to prevent inadvertent overflowing. A parapet wall is made round the top of the embankment to a height of about a foot to prevent mud, etc., being washed down by rain into the tanks. Scour arrangements for emptying the storage tanks are advisable.

Filters.

The crude water, although much cleaner after leaving the sedimentation tanks, has to be filtered to render it potable and so far slow sand-filters have invariably been used.

The filtering medium is sand and a typical filling is as follows :—

18″ fine sand.

12″ coarse sand.

6″ stone $\frac{1}{4}$″ gauge.

6″ stone $\frac{1}{2}$″ gauge.

On the bottom are cross drains which lead off the filtered water to he main off-take channel.

Filters may be of any shape and in certain small schemes where a saving in cost has been necessary the writer has made them circular with a reduction in the amount of masonry in the walls.

Water passes through the filters throughout the 24 hours and a rate of filtration of 30 to 36 gallons per square foot daily is common practice. The sizes are calculated on this basis. If two filters are provided one must be capable of dealing with the whole demand to admit of the other being periodically cleaned. Where there are more than two 25 to 33 per cent. should be spare.

A certain depth of water over the top of the filtering medium is desirable (18 inches is common practice). The writer has always provided automatic float controlled valves to maintain the correct level. These prevent overflowing and allow filtration to continue through the night without supervision.

To force water through the filter a certain head is necessary and is represented by the difference between the water levels in the inlet and outlet chambers. As the filter continues in use it becomes clogged and arrangements to vary the head and so retain a constant filtration speed are desirable. This is done by means of an adjustable weir or similar arrangement in the outlet chamber. The level of the weir can be varied between limits.

In this way it is possible so to adjust the flow in the filter that it equals the demand of the town. The trouble in practice is, however, to arrange that such daily adjustments as are necessary are made. This is especially the case in smaller works with only a comparatively low paid man in charge.

Eventually, after continuous use the filter becomes so clogged that the top sand surface has to be scraped off and removed. It is replaced by clean washed sand. The dirty sand is then washed for future use.

As the filters are fed from the storage tanks it is desirable, if possible, that full supply level of the former be below floor level or, at any rate, lowest draw off level of the latter. In this case gravity flow from one to the other is possible. Filters are thus invariably in excavation. On the level sites one usually gets in the Punjab plains it is seldom possible to get a sufficient fall and so, only a portion of the water in the storage tanks can gravitate and it is therefore necessary to lift the remaining water (which will be drawn upon at times of canal closure) to the filters. The filters work throughout the 24 hours and it would not be an economical proposition to run pumps continuously. Low-lift pumps running intermittently are, therefore, installed to lift the crude water into tanks with floor level a few feet bove filter-full-supply level, whence the water gravitates to the filters. As the main pumping plant is usually run for one shift of 10 hours the capacity of these low-lift pumps should be sufficient to deal with a full day's supply in the same period. The high level tanks therefore must have a capacity equal to from $\frac{3}{5}$ to $\frac{3}{4}$ of a day's flow to enable continuous filtration to be maintained. The

construction of these tanks calls for no special comment. In one or two cases the writer has been fortunate in being able to get sufficient falls between the storage tanks and the filters to obviate the necessity of high level tanks, but this is the exception.

Low Level Clear-water Reservoir.

From the filters to the consumer the clear water has to be carefully guarded against contamination. Owing to the pumping plants of schemes of the kind under review being run for about 10 hours only daily a reservoir between the filters and pumps is essential. Such a reservoir must be capable of equalizing the variation between the filter flow and the discharge of the pumps. Two-thirds of a day's supply is a usual capacity. The site being invariably level this reservoir is always below ground and is covered to prevent contamination. Suitable ventilation openings are provided.

Where possible such reservoirs should be in duplicate to admit of one being cleaned without interfering with the supply. Water-level gauges to be read from the outside of the tank are also a necessity.

Pumping Plant.

This is the heart of the whole scheme and on its successful working the efficiency of the undertaking depends. For small schemes the writer favours machinery of the simplest nature which may be supplemented by more efficient but more elaborate plant as the undertaking gets larger and receives correspondingly better supervision.

With oil readily obtainable in the Province, oil engines have been found in practice most suitable as prime movers and for sizes up to 8 horse-power the writer favours kerosene engines, while the lamp-starting crude-oil engine on account of its higher efficiency is suitable for horse-powers from 8 to 15. Over 15 horse-power the writer recommends the use of Cold Starting Crude (or more correctly Heavy) oil engines. This is his personal view based on the design, construction and running of ten water-supply undertakings for Punjab municipalities over the last six years, and giving supplies varying respectively from twenty thousand to one-and-three-quarter million gallons daily.

Centrifugal pumps are the simplest and cheapest both in first cost and maintenance. There are on the market, however, several kinds of ram pumps direct-coupled to oil engines on one baseplate, and where there is only one lift this makes a compact arrangement. One such plant in duplicate has been installed by the writer. Lifts in schemes of the kind under review are not high and consist only of the difference in levels between the underground clear-water reservoir and the elevated service reservoir. Forty feet may be considered a fair average.

For large undertakings serving populations of, say, 20,000 and over, a workshop at the pumping station is desirable, but in small schemes this is hardly practicable. Much might, however, be done by co-operation. For example, in every canal colony there is the chief town with a

comparatively large water-supply. Here a workshop could be installed and the municipality might undertake all running repairs for waterworks of the smaller mandi-towns of the colony.

It is desirable to have a meter on the supply to the town, or on the pump delivery, as this forms a check on running costs provided a log book is accurately maintained, and even if incorrectly maintained, the costs can be checked by a test run for half a day, fuel consumption, etc., being checked against meter readings. If all costs are then reduced to annas or fractions of an anna per thousand gallons supplied to the town, a monthly check on the efficiency of the scheme as a whole is possible. The writer found in the case of certain undertakings that a careful analysis of running costs thus obtained every month enabled remarkable savings to be effected.

In the short time for which the Department usually runs these schemes it is not possible to effect the fullest economies and the writer is of opinion that all contribution water-supply schemes constructed by the Department should be maintained by it for at least one year.

Service Reservoir.

As the storage provided in other portions of the scheme is always considerable, this reservoir must be of sufficient size to equalize only the difference between the rate of flow to the town and that of pumping. In the past, with intermittent supplies open to the town for a few hours daily these tanks have been quite small. Modern needs, however, demand a 24 hours' supply, and that it can be given under Punjab conditions, has been proved. In such cases, however, the capacity of the service reservoirs will have to be greater and amount to two-thirds of a day's supply. As an alternative the pumping plant can be run in two shifts.

The height of the service reservoir depends on the terminal head that is to be given throughout the area of supply.

Tanks of various designs have been tried by the writer ; probably reinforced concrete is the most suitable. If tanks are of large size, however, steel or cast iron is quite satisfactory. Contrary to what might be expected, large metal tanks do not result in a rise in water temperature in the hot weather to any great extent. In a series of tests extending over nine months in 1927 on a steel tank, the writer found that the difference in temperature of the water before entering and in the tank never exceeded one degree Fahrenheit.

Pipelines.

There is no variation from standard practice as regards pipelines in the case of colony towns. Owing to such towns, however, having a regular layout, it has been found that the proportion of special pipes such as bends, is much less than in the case of older towns with twisting and irregular streets,

There are various factors which will affect the sizes of pipe in future water-supply schemes in the Province. One is the growing demand for water connections to first floors of houses. This will mean increasing the minimum terminal head from about 15 feet as at present to about 30 feet. A second is the demand for an efficient fire-fighting installation. This means both an increase in pressure and also in the volume which can be delivered and sustained at such pressure. If the necessary fire service can be given direct off the mains so much the better, as the organizing and maintaining of a proper fire-engine brigade by a small local body is rather beyond practical politics.

For mandi-towns with houses of one or two stories the fire-service demands could be met if hydrants were capable of giving 80 gallons per minute at a sustained head of 35 feet. This the writer believes is not beyond possibility in future schemes. When entering a mandi-town while the harvest is being brought in one is forcibly struck by the necessity for an efficient fire-fighting service.

In canal colony towns, as in all towns in the Province, metering of all private connections is most necessary. This, however, is a very big subject and if discussed would unduly lengthen this paper.

Description of Undertakings in Detail.

For purposes of illustration the following schemes will be described in detail :—

Tandlianwala	..	.. Lower Chenab Colony.
Sillanwali	..	.. Lower Jhelum Colony.
Sargodha	..	.. Lower Jhelum Colony.

The first relates to a town with a population of 4,000, the second to a small town of 2,000 population, while the third which concerns a town of population over 20,000 and still increasing, is an example of how a waterworks with a modest start has been expanded and of the provision made for further expansion.

Tandlianwala Water-supply.

The first attempt to provide Tandlianwala with a drinking water-supply was made in 1906 and the project consisted merely of a settling tank drawing water from the Burala Branch of the Lower Chenab Canal, from which after settlement of silt, it was delivered through a 5-inch main to an open reservoir near the town. The public drew its supply from this tank in open vessels. Such an arrangement could be regarded only as temporary and a project for a proper piped supply was prepared by the Sanitary Engineer in 1922 and was completed in 1924.

This scheme provides 10 gallons per head daily for a population of 5,000. The design is such that the whole can readily be expanded as the demand of the town increases. The population according to the 1921 census was 3,674.

The old storage tank has been used as the basis of the waterworks, and together with a second tank of equal size provides for 40 days' storage after allowing 30 per cent. for evaporation and 2 feet of silt. Such storage

is in excess of usual practice and present requirements but will be a boon to the town when extensions have to be taken in hand.

Two filters are provided and a third or fourth can readily be built when necessary. The area of each is 1,750 square feet and the normal rate of filtration 28 gallons per square foot daily. The draw off chamber (which will also take the flow from any future filters) is provided with a telescopic draw-off pipe. This admits of the filtration head being varied between predetermined limits with the greatest ease.

The clear water reservoir at present has only one compartment and a capacity of 28,200 gallons or rather more than half-a-day's supply.

As the site is level, it has not been possible to place the filters at such a level that the whole contents of the storage tanks can reach them by gravity, and so, for use at times of canal closure when the storage tank water level falls, a high level tank is provided. This has a capacity of 40,000 gallons or about four-fifths of a day's supply.

The pumping plant is in duplicate and each set consists of a 7 b.h.p. Tangye Kerosene Engine driving, through countershafting, centrifugal pumps for both the low and high lifts. The low level pump is capable of filling the high level tank in 6 hours and the high lift pump can deliver the full day's supply in 6½ hours. It will thus be seen that the pumping plant working on a full shift of 10 hours can deal with a 45 per cent. greater supply than that at present given. It is unlikely that, during the life of the present plant, the demand will rise beyond this. There is sufficient room in the pumping station to take engines and pumps of larger size when these become necessary.

The service reservoir is of reinforced brick on a brick tower with a capacity of 23,000 gallons or rather less than half-a-day's supply. The roof is a self-supporting reinforced concrete dome. Trouble from leaking has been experienced in this tank but has been overcome by lining with bitumastic compound. The leak developed between the floor and the walls and the writer would prefer that tanks in future be constructed throughout of reinforced concrete as a better bond between the floor and walls is possible. The extra expense is well worth while.

The headworks of this supply are some little distance from the town and on account of the long main from the waterworks to the town, the distribution has cost more than usual.

The estimated cost of the work including departmental charges was Rs. 1,10,996 and the actual cost Rs. 1,12,085.

The following figures based on one year's running (54 weeks actually) may be of interest :—

Population served	4,000.
Water supplied	40,000 gallons daily.
Gallons per head daily	10.
Hours of supply daily	10.
Total cost of running (excluding depreciation and interest charges) ..	Rs. 5,082
Cost per 1,000 gallons supplied ..	annas 5·3

Sillanwali Water-supply.

This supply was first asked for in 1923 and the resources of the town being very small, the greatest care had to be exercised in the design of the scheme to keep the cost within the limits imposed. The work, although started by the writer, was completed during his absence on leave in 1926.

The present population is under 2,000 and provision has been made for 8 gallons per head daily for a population of 3,000 or a daily total of 24,000 gallons.

Although of such modest proportions it has been possible to use cement-mortar masonry throughout and it is hoped that this will be justified by lower maintenance costs during the next ten years.

The storage tanks have a capacity of 900,000 gallons or sufficient, allowing 25 per cent. for evaporation and the usual amount for silt for 30 days' storage.

There are two filters each capable of dealing with the total flow at a rate of 30 gallons per square foot daily. This is a low rate and was given as the supply came from a long and small watercourse and was highly charged with silt. For economy the side walls of the filters were made battered. The filtration area was calculated at top sand level, although the area below was, of course, less. As the effective portion of the filter is at the top there would seem to be no objection to this design. The saving in masonry is considerable.

The site being level a high level tank for supplying the filters at times of canal closure is provided. This is circular and has a capacity of 13,500 gallons or over half-a-day's supply.

For reasons of economy the pumping station forms the ground floor of the service reservoir staging a place usually made into a store godown. At a later date when funds become available a separate godown and drivers' quarters will be built.

The pumps for both the high and low-lifts are of the centrifugal type by Tangyes and are driven by 4 b.h.p. kerosene engines by the same makers. The high-lift pumps deliver 3,500 gallons hourly and thus deal with the full supply in 7 hours.

The service reservoir is of reinforced concrete and is rectangular. The job has proved most satisfactory.

From the reservoir a 5-inch main runs to the town where it breaks up into a network of 4, 3 and 2-inch mains, serving 12 public standposts and a number of hydrants. The latter are so situated as to be suitable for drain flushing in addition to fire purposes.

The total cost of the scheme was under Rs. 50,000.

The undertaking was run by the Department for six months with the following results :—

Average daily supply	.. ..	24,000 gallons.
Hours of daily supply	.. ..	$8\frac{1}{2}$
Average pumping hours	.. ..	$3\frac{1}{4}$
Cost of six months' running	.. ..	Rs. 1,279.
Cost per 1,000 gallons	.. ..	annas 10.

The construction of both this work and of Sargodha Water-supply to be described next was in the immediate charge of L. Guranditta Mal Khosla, Assistant Engineer.

Sargodha Water-supply.

A piped water-supply was first given to Sargodha in 1906 and the scheme as then constructed gave a supply of 80,000 gallons daily. This was based on an allowance of 8 gallons per head daily for a population in the city of 6,000 leaving 32,000 gallons daily for the requirements of the civil station.

The town expanded rapidly and the supply soon became inadequate. During the war various proposals were put forward by the Sanitary Engineer, but it was not until 1923 that the project for the enlarged scheme was sanctioned. This first started to function in 1926. It provides 12 gallons per head daily for a population of 21,150 or a daily total of 242,000 gallons. Even now the undertaking, although working over its designed capacity, is only just meeting the demands put upon it and extensions are contemplated. The whole scheme as it now stands readily admits of further expansion. To attain this end considerable thought was given to the layout at the headworks.

There are three raw-water storage tanks with a total effective capacity of 5,226,000 gallons. This is now being increased by joining the original tanks Nos. 1 and 2 and the total effective storage will be 7,100,000 gallons or sufficient for 24 days at 296,000 gallons daily.

The total filter area is now 6,040 square feet after allowing 25 per cent. spare, sufficient for dealing with 242,000 gallons daily at 40 gallons per square foot per 24 hours. An additional filter can be added to the present ones with a minima of additional pipelines.

The total clear water reservoir capacity is 168,000 gallons or two-thirds of a day's supply. An additional compartment to the new clear water reservoir can be built without disturbing any existing work. In the same way the high level tanks can be extended. A diagram (Plate 3) shows how the extended scheme incorporates the original work.

The original pumping plant consisted of a number of Worthington Duplex Steam Pumps but the condition of these in 1922 was such that it was decided to provide an entirely new plant for the extended scheme and to build a new pumping station. This station forms the centre of the headworks.

Pumps for both high and low lifts are mounted on one baseplate and are driven direct from Ruston Cold-Starting crude oil engines of 35 b.h.p. through double helical gearing. The pumping plant is in duplicate and each set can deal with the whole supply. A flange coupling on the shaft connecting the two pumps enables the low-lift pump to be disconnected when not required.

The high-lift pumps are designed to deliver 24,200 gallons hourly and thus deal with the present allowed demand in 10 hours. Actually they can deliver 35,000 gallons per hour. When the demand increases still further it can be met by working the pumps in two shifts of 8 hours each. It is unlikely that during the life of the present plant the demand will rise above this.

As the cast iron pipes already laid in the town were still in good condition it was necessary to utilize them to the best advantage. The existing 6-inch rising main 9,000 feet long from the pumps to the city reservoirs was replaced by one of 9 inches and was relaid to replace 4-inch pipes elsewhere which, finally, were laid in an area previously without water. This work required a considerable amount of forethought in order not to interfere with the continuity of supply.

The scheme after completion was run by the Department for six months. There were considerable savings which are now being utilized for further extensions.

The following information is compiled from the results of six months' running experience :—

Period of running—17 May to 16 November 1926.
Gallons pumped—48,665,100.
Average daily supply—264,000 gallons.
Cost of 6 months' running including departmental charges but excluding depreciation—Rs. 8,774.
Revenue from private connections—Rs. 3,152.
Cost per 1,000 gallons—annas 2·9.

From these figures it will be seen that although water taken from the canal has to be paid for, the running costs are comparatively low, owing to the lift of the pumps being small. From deep wells pumping charges would be higher but the capital cost would be less. On occasions therefore where a deep level fresh water-supply is found in a canal colony, one has to make a careful comparison between the relative costs of water from deep wells and from canals, balancing the increased interest charges on the higher capital of the latter against the higher fuel costs of the former. With a rising subsoil water-table this matter merits considerable attention.

A point which may here be noted is the extent by which departmental charges increase the cost of contribution works. They are at present 19 per cent. and are a serious set-back to further development of schemes of the kind reviewed for towns of small size whose financial resources are meagre.

The experience gained in the design and administration of the older colony towns should be invaluable when the mandi towns of the Sutlej Valley Project ask for piped water supplies.

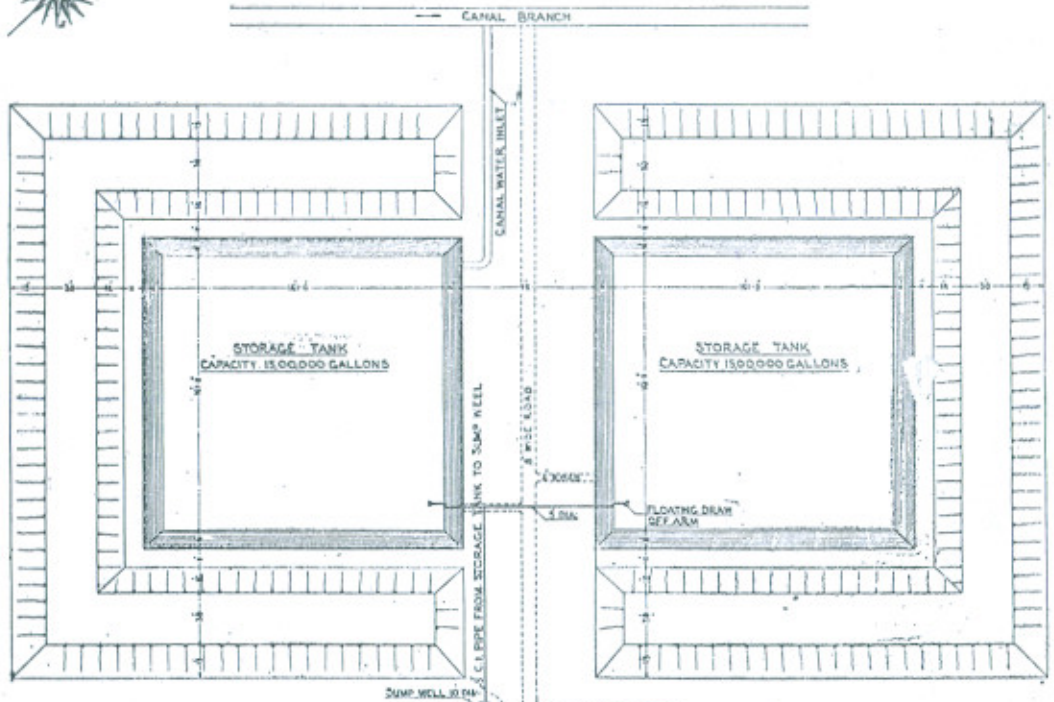
In the older canals the rapid rise of the subsoil water-table will possibly necessitate the converting of perennial canals into *kharif* canals only. This will affect vitally the design of urban water-supply schemes in canal colonies, as, if the towns remain inhabited during the winter season and water supplies have to be maintained, greatly increased storage will be necessary.

On the other hand if the subsoil water is likely to be affected to such a great extent by canal water the possibility of using wells will increase. I conclude with these remarks as I hope they will, in discussion, bring forth points worthy of note from members of the Irrigation Service.

TANDLIAN WALA HEAD WORKS

SCALE

PLATE I.



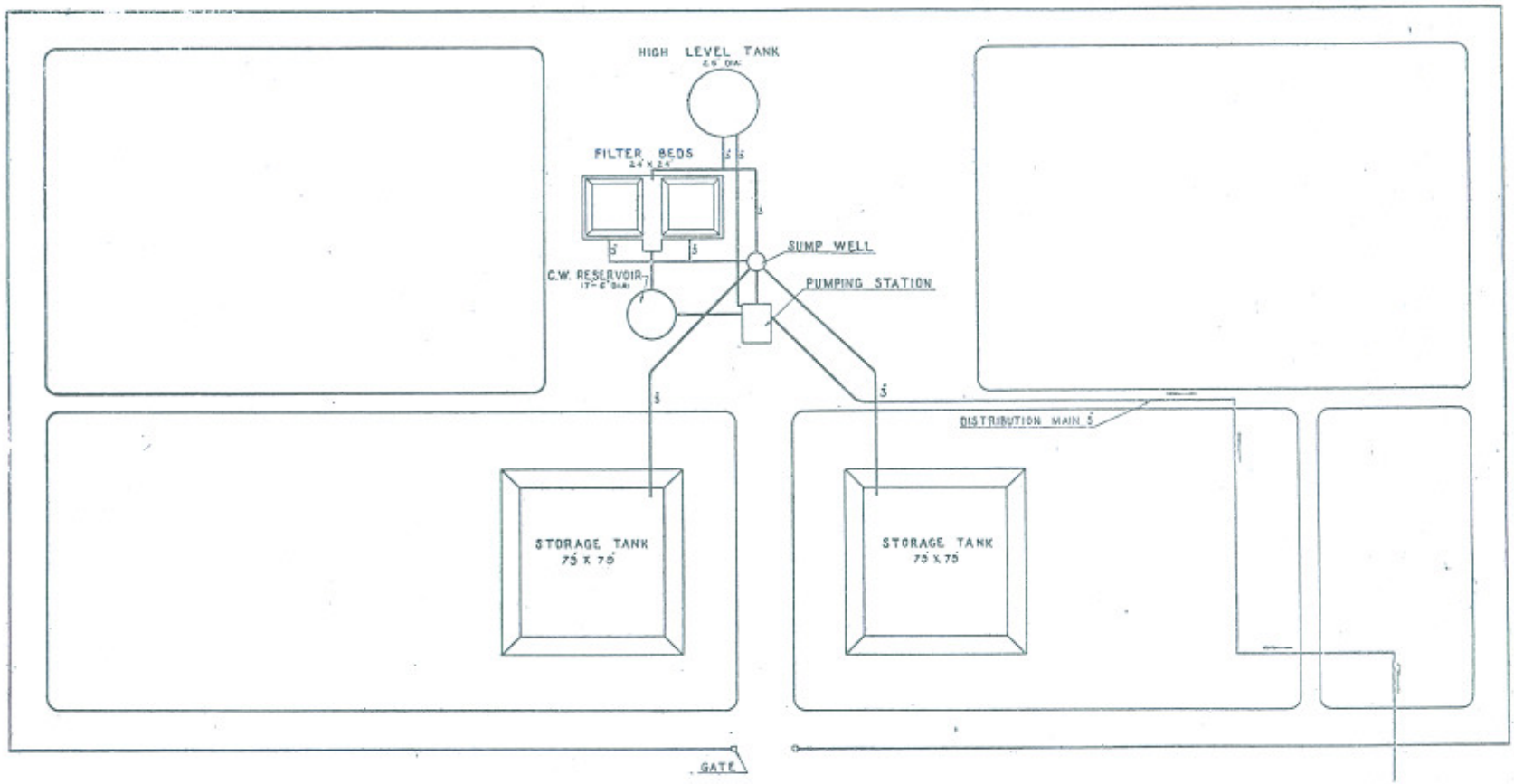
Proc. I.E. Congress Vol XIII - 1918.

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ALI HEAD WORKS

SCALE

PLATE 2.



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INUNDATION CANAL PRACTICE.

Fig. 1.



TYPICAL DIAGRAM OF RIVER.

SCALES.

Fig. 4.—Scale in Miles

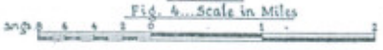


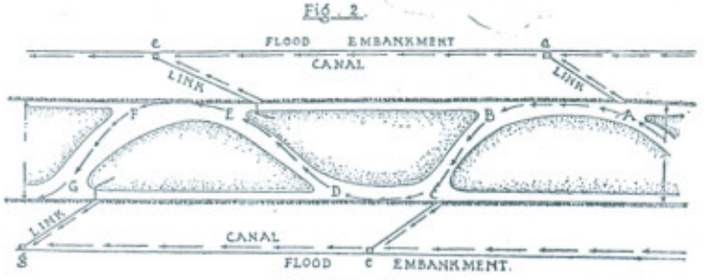
Fig. 8.—Scale in Feet



Figs. 9.—Scale in feet



Fig. 2.



TYPICAL DIAGRAM
SHOWING.
FLOOD ADMINISTRATION & CONTROL.

Fig. 4.

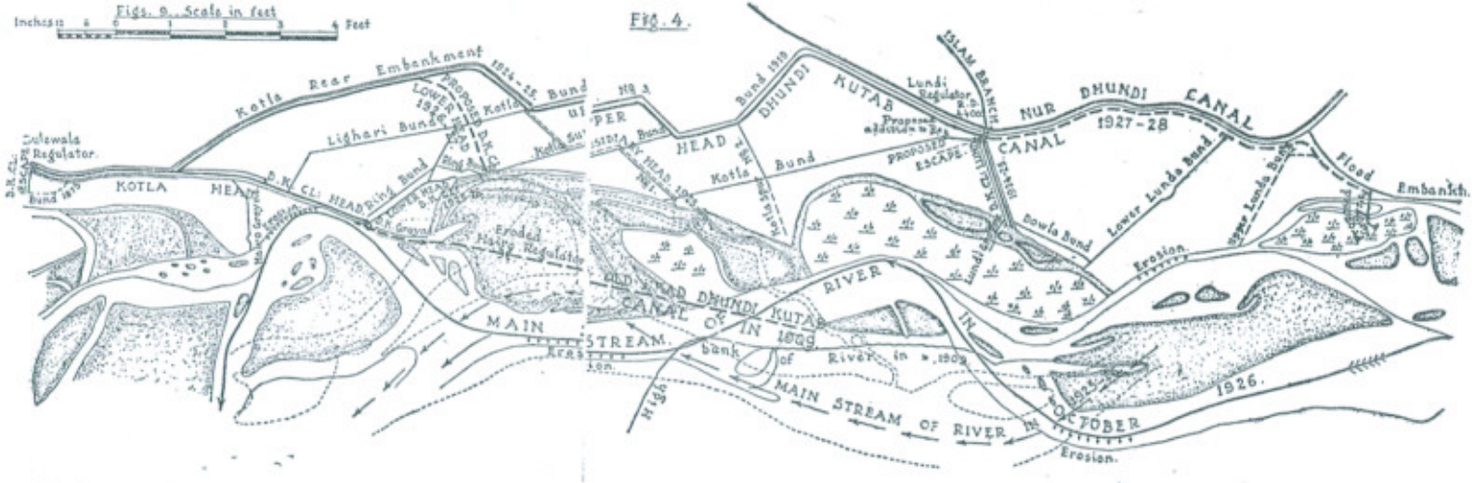
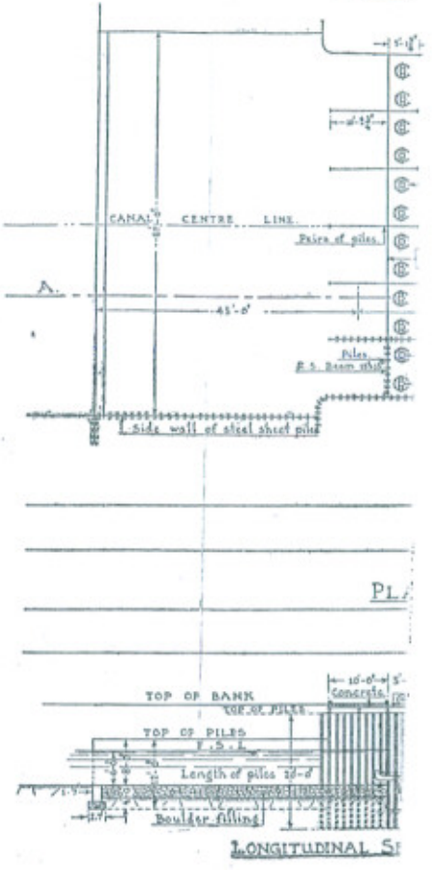


Fig. 8.



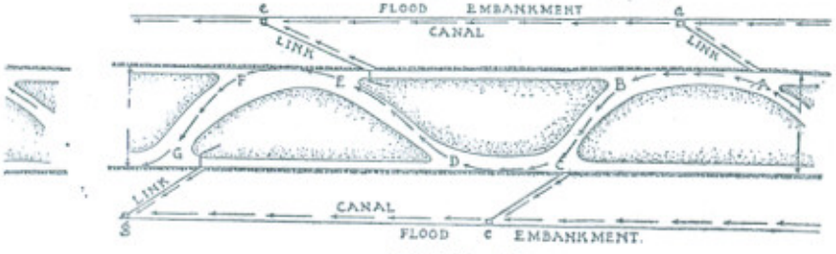
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PLATE I.

Fig. 2.



TYPICAL DIAGRAM
SHOWING.
FLOOD ADMINISTRATION & CONTROL.

Fig. 4.

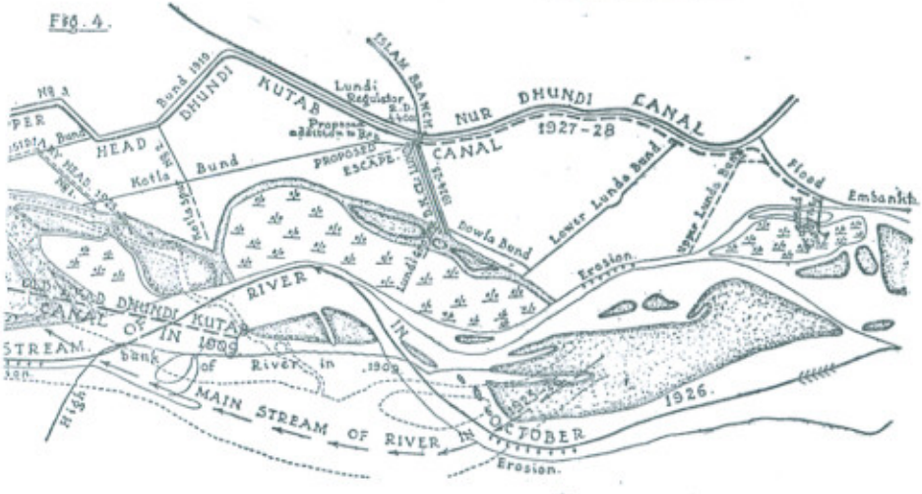
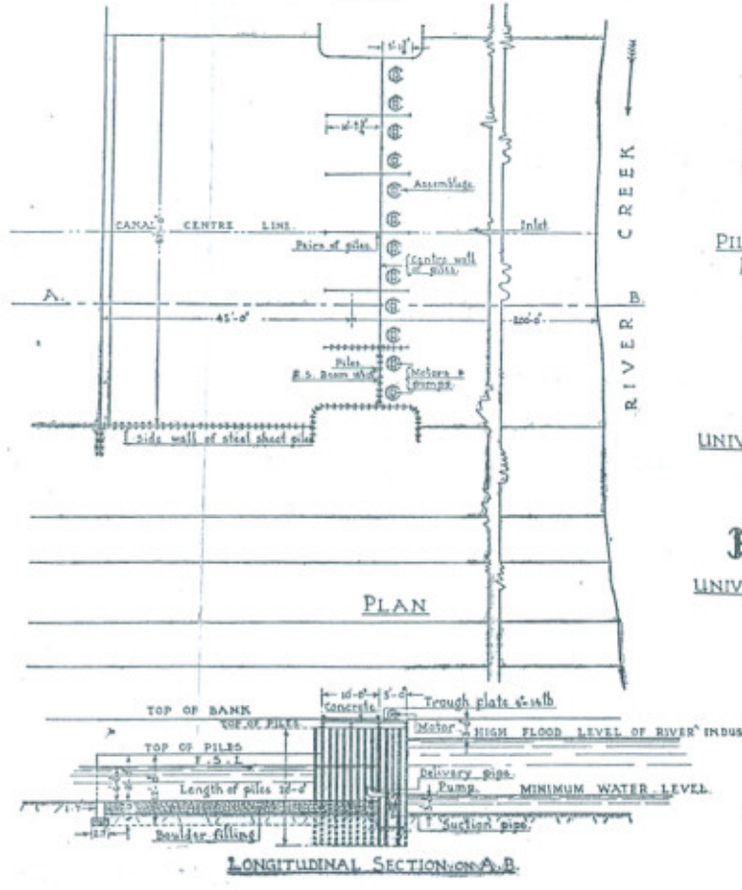
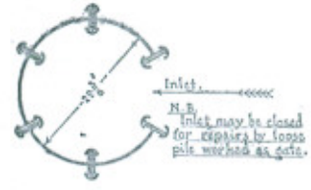


Fig. 8.



LONGITUDINAL SECTION ON A.B.

Figs. 9.



PILES FOR CARRYING MOTOR & PUMP.



UNIVERSAL JOIST JUNCTION



UNIVERSAL JOIST PILING.

P. CLAXTON.

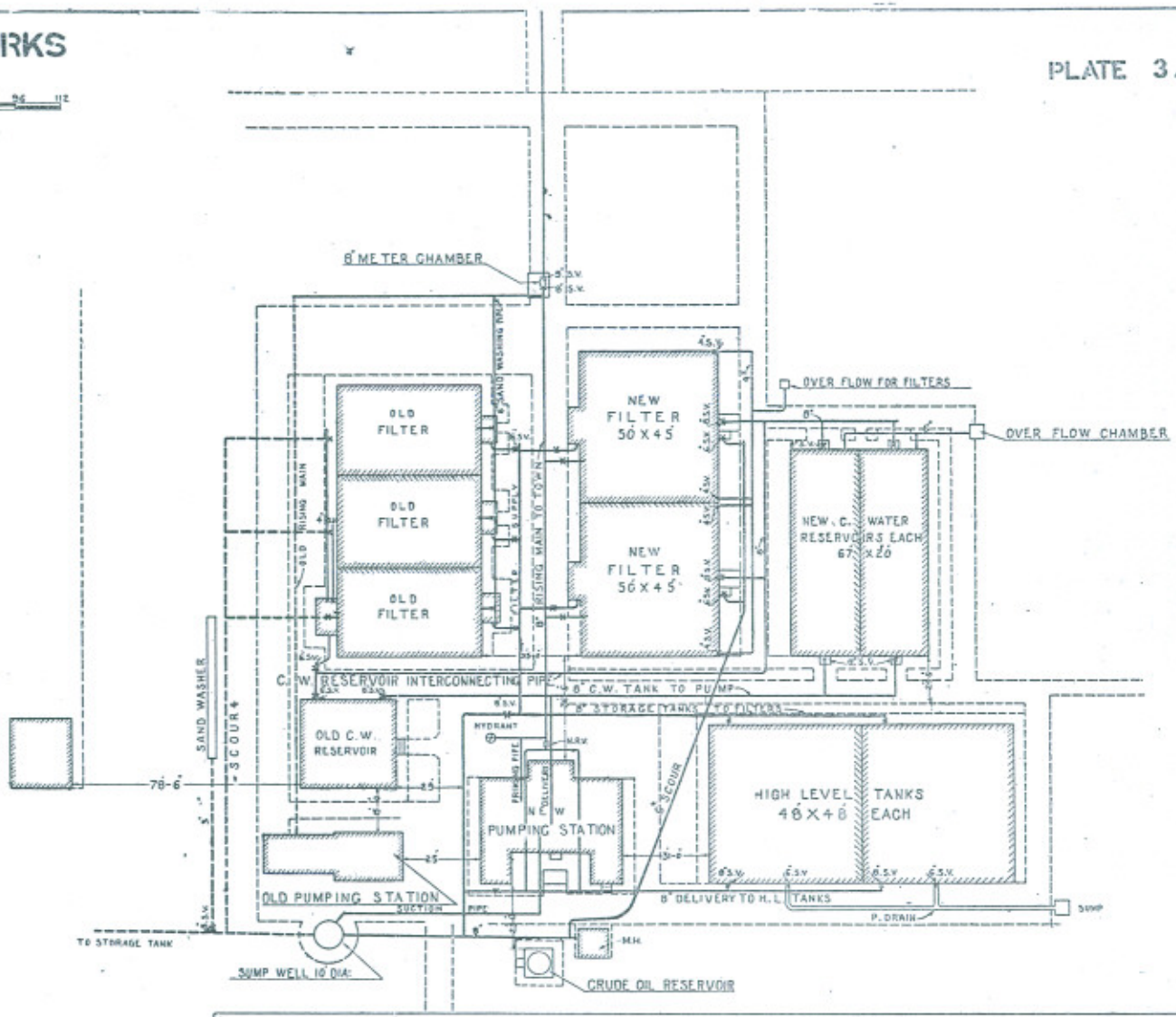
SARGODHA HEAD WORKS

PLATE 3.

SCALE'

REFERECES

BUILDINGS
ROADS
FINISHED PIPELINE
OLD PIPE LINE
SLUICE VALVE



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J.A.R. BROMAGE

DISCUSSIONS.

The Author introducing his paper remarked that as time was short he would just say that he had written his paper in such a manner as to draw criticism and provoke discussion particularly in the matter of storage tanks required to tide over periods of canal closures and he hoped that Irrigation Engineers would freely give their views.

MR. D. A. HOWELL remarked that to Water Works Engineers unacquainted with Indian conditions, the figures of daily water supply per head laid down in the paper, would appear inadequate and even ridiculous as compared with the usual allowances made for schemes in Europe and America. There had, in the Punjab, been failures in connection with Water Supply Schemes designed on such meagre allowances but it had undoubtedly been proved by other works designed on similar allowances which were operating successfully that it was possible to work schemes based on a supply of water from 10 to 16 gallons per head per diem, in such a manner that a continuous and adequate supply of water for the population was given.

It was entirely a question of maintenance and control whether such schemes were a success or a failure. The main object in maintenance and control of water supply consisted in giving an adequate supply with no waste of water and this turned on the effective control of private house connections.

There were 2 methods of controlling house connections, *viz.*, by systematic inspection of all house connections and fittings from time to time and educating the consumers that water cost money and that any water wasted had the same meaning as throwing money away, or by metering all private connections and thus recovering from each consumer the monetary value of the water consumed or wasted by him in which event the consumer was made to quickly realise the truth of the above precepts, by actual example and took steps to prevent waste.

In Great Britain, the usual method adopted was that of systematic inspection to prevent waste.

The speaker when he came to India first, thought that this system could be operated satisfactorily in India but he soon realised that the question of " purdah " and the want of strong public opinion condemning wastage of water as well as the fact that wastage of water both due to defective pipes and fittings, and owing to carelessness of the consumer occurred universally in the most aggravated form and far worse than could possibly be imagined by any body not acquainted with local conditions, made this method of attacking the problem absolutely useless and he had come to the opinion that the only method of achieving the desired results was by the adoption of metering of all private services.

It was true that there were a number of objections to this such as cost of meters, need for systematic inspection and repair, and the objections of consumers to the institution of metered control in the case of

schemes which had been operated in the past on the principle of unrestricted wastage of water through private connections. These objections however were of small moment, compared with the valuable advantages derived from metering, not the least being that the introduction of universal metering would undoubtedly convert a number of water supply schemes now distributing water for only a few hours daily into continuous water supplies.

Recently a water supply scheme based on a daily supply of 12 gallons per head had been carried out for Muktsar, a town in the Southern Punjab, population about 12,000, and it had been decided that all house connections were to be metered. The average supply per head per day through the first 50 odd metered connections was less than 12 gallons with a continuous supply which indicated that all the houses of the town could be provided with metered house connections with a daily supply of 12 gallons per head.

On page 46 the Author stated that boring in irrigated tracts almost invariably show saline subsoil water conditions. This was not quite true as in some canal-irrigated areas sweet water was obtainable from the subsoil.

The paper mentioned that the water of the larger canals is of such volume that it is comparatively free from organic contamination. It was not only a question of volume however and the speaker thought that the fact that canals were generally aligned on the ridges and not in the valley lines, contributed largely to the comparatively good quality of the water.

In regard to periods of storage, although 30 days might be considered an average, there were cases where owing to possible closures on the canal system the period of storage had to be increased. In the case of a scheme for Rohtak in the Southern Punjab it had been found necessary to provide 75 days' storage for this reason.

Linings for storage tanks of dry brick pitching in the case of large reservoirs were unsatisfactory and did not withstand wave action, and pitching in good kankar lime mortar or cement mortar was better.

In other countries Water Works Engineers generally went in for a far more expensive type of construction for storage reservoirs which almost invariably included some form of water tight lining such as bitumen sheeting or bitumen applied hot as rendering or plastering over the internal surface of the reservoir or beneath the pitching. The retentive qualities of the Punjab soil generally however did not necessitate these precautionary measures and tanks of the type described by the Author, 10 to 12 feet deep were comparatively water tight after about 12 months or so from first filling, although when first put into operation water losses due to percolation might be very heavy. In a recent water works for example the initial total percolation and evaporation losses were about 6″ depth of water per diem while 12 months afterwards these had decreased to about 1″ per diem, in spite of the fact that the puddle clay

generally employed for lining the tank under the pitching was of poor quality, being too sandy. It was not always advisable to attempt to keep the levels of storage tanks at the same level as the canal channel itself, although it was necessary to do so when the Water Works were situated close to the canal. Slow sand filters were generally adopted for the reason that they were the simplest, although they certainly were not fool proof against defective Municipal Administration. A common form of misuse of filters in Punjab Towns consisted in digging holes through the thin layer of silt covering the beds in order to restore the filtering capacity of the filter without "skimming" it, while another was to increase the filtering head through the filter, thereby forcing more water through the filter thereby forcing more water through than the filter could safely deal with. In view of this practice, it was inadvisable to instal telescopic draw off pipes or adjustable weirs in the outlet chambers which might easily permit the people in charge of the filters to exceed the permissible maximum filtering head.

The speaker preferred a fixed notch outlet in the outlet chamber, with a pipe connection between the filter and the outlet chamber in which a sluice valve was fitted. The position of the fixed notch controlled the maximum filtering head while by partially closing the sluice valve the actual filtering head could be reduced to any desired extent to suit working conditions.

In connection with the notch outlet it was desirable to provide a simple dial recorder on which the actual discharge of the filter could be seen at any time and this should be suitably calibrated to show the maximum safe capacity of the filter in gallons per hour so that the man incharge of the filter might see at a glance whether the filter was working properly.

Lastly, it was necessary to provide facilities for washing filtering sand. The speaker had found for this purpose that a mechanical sand washer driven by a small water motor from the delivery main from the Head-works, such as the "Peebles" sand washer of Messrs. Glenfield and Kennedy was suitable for this purpose.

R. B. DIWAN AMAR NATH NANDA, remarked that the Author had described the broad principles underlying the design and construction of water supply schemes for towns in canal colonies, in an excellent manner and he had nothing more to add except a few remarks here and there.

The first point was about financing of the schemes. In this connection, there was no doubt that the first steps in initiating a sanitary scheme such as a waterworks or drainage works must come from the Local Body. He had noticed, however, that each completed sanitary scheme acted as an important piece of propaganda in itself and its value as a means of educating, and awakening public opinion in its favour was such that demands were soon received for similar schemes in the more important adjoining towns. For example it was the Phullerwan Water Supply

Scheme which opened the eyes of the people of Sillanwali and the latter scheme in its turn made the people of Bhalwal move heaven and earth to have a water supply scheme of their own and thus escape the scourge of cholera. Similarly the Abohar Drainage and Water Supply Schemes gave an impetus to Moga and Ferozepore and these latter towns were now vieing with the former in equipping themselves with these essential amenities of life.

To meet half way the important call for sanitary reform all over the Punjab, they had adopted certain elastic principles which were productive of good results. For instance, if a local body found itself unable to finance a tip-top water supply scheme based on a daily allowance of say 10 to 15 gallons of water per head, the Sanitary Department would be prepared to give them the benefit of a protected water supply on less expensive and less ambitious lines, to suit their financial capacity, with a daily allowance even as low as 5 to 7 gallons per head.

Thus their principle was that a second class scheme was no enemy of a first class scheme and their watch word was to go ahead slowly from stage to stage, even if they could not accomplish the whole journey in one continuous march. As remarked by Mr. Bromage on page 45 of his paper, it was necessary to see that though in the first place, the water works of a town might be of very modest dimensions, these should be so designed as to admit of easy expansion in the event of the town growing.

He fully agreed that all schemes should be maintained for a period of not less than one year after completion, by the Public Works Department. Local Bodies as a rule were very hyper-critical and it was best to establish a full working regime of the scheme and hand it over to the Local body after operation for at least a year or so. In regard to filters, it was necessary to go in for slow sand filters because these were economical and easy to work. The rate of filtration in these schemes varied from 28 to 40 gallons per square foot of filter surface per diem, while in the case of hill stations like Simla it was higher say 50 gallons, due of course to the fact that the solid contents of the water in such cases were less.

The adjustable weir method of regulation of filtering head was quite correct in theory but in actual practice it was faulty due to the frequent dereliction of duty of the men in charge.

On page 52 the author mentions telescopic draw off pipes. The speaker did not believe in these also, and once in the course of an inspection at Lyallpur water-works where such an arrangement was installed, he found that the upper bellmouth was missing, the Engineer-in-Charge explaining that it had been removed to enable the safe speed of filtration to be exceeded because otherwise the filter would not pass the required amount of water to meet the public demand.

He preferred the arrangement provided on the Muktsar Water Supply works by Mr. Howell, where the filtered water from the effluent chamber passed over a cast iron V notch to the outlet pipes and a pillar pattern water level dial recorder, graduated in gallons per hour was

fitted on the roof of the outlet chamber with a danger mark at the maximum safe capacity of the filter.

In regard to oil engines for water supplies of small towns he thought that small cold starting Crude Oil Engines although available in the market were not to be recommended and agreed with the Author that upto 6 or 8 B. H. P. Kerosene Oil Engines were preferable. From this size upto about 16 B. H. P. lamp starting Crude Oil Engines might be used and o er 16 B. H. P. cold starting Crude Oil Engines, preferably of the 4 stroke horizontal pattern. They had built a number of elevated Reservoir for water storage and he agreed generally with Mr. Bromage's conclusions that reinforced concrete reservoirs were very suitable.

In regard to storage and sedimentation tanks, it was necessary to provide these of such capacity as to tide over periods of canal closures. In regard to these, there was a possibility that in the older canal colony areas, the rise of spring level in the sub-soil due to irrigation m.y well result in the near future in the conversion of perennial canals into "Kharif channels," with correspondingly longer periods of closures and in this event if water supply schemes based on canal water were to be retained the storage capacities of sedimentation tanks would require to be increased considerably. He was not sure whether it would be safe to keep a large volume of water under storage for an indefinite length of time and the Public Health Department would need to be consulted as to whether such extra storage might have a deleterious effect on the health of the people.

The cost of water in schemes of the type described in paper varied from 5 to 10 annas depending on the size of the scheme. In the case of Sillanwali, a small scheme, the cost was high, *viz.*, 10 annas per 1,000 gallons whereas in the case of Sargodha and Tandlianwala the cost was 5 annas. At Muktsar also the cost was 5 annas per 1,000 gallons inclusive of depreciation.

Finally he referred to the "bogey" of Departmental charges levied on contribution works carried out on behalf of Local bodies by the Public Works Department. These amounted to 19 per cent. at present and he considered them to be very high and hoped that something would be done to reduce them with a vi.w to encourage Local bodies to go in on a more extensive scale, for sanitary works.

The speaker congratulated Mr. Bromage on producing an excellent paper.

THE AUTHOR in replying said there was practically nothing to reply to.

The crux of the matter in regard to water supply in the Punjab whether in canal colony towns or elsewhere was efficient maintenance. As long as the maintenance of the water supply scheme remained in charge of the Public Works Department, there were no complaints but as soon as maintenance was handed over the Municipal authority complaints were soon forthcoming. This was really the beginning and the end of the problem and it was necessary to so carefully design water supply projects so that they might be not only fool proof but rogue proof.