Journal of Institution of Engineers Vol. 61 (1981); p. 67-74

UDC 628.16

Presedimentation Tanks for High Turbid Raw Waters

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River Ganges is the source of water supply to the Antibiotics Plant, Virbhadra. Intake well and raw water pumping station is provided on the river bank. There was water crisis and high maintenance expenditure due to heavy suspended solids contents and turbidity in the Ganges water during monsoon. This problems was overcome by providing two presedimentation tanks, which are functioning very satisfactorily. The author has narrated the events of its inception, design aspects and function based on its actual performance.

INTRODUCTION

River Ganges is the source of water supply to Antibiotics Plant, Virbhadra (Rishikesh) in Uttar Pradesh. Water intake point (WIP) is situated on the right bank of the Ganges. Cross-section of the intake well is shown in Fig 1.

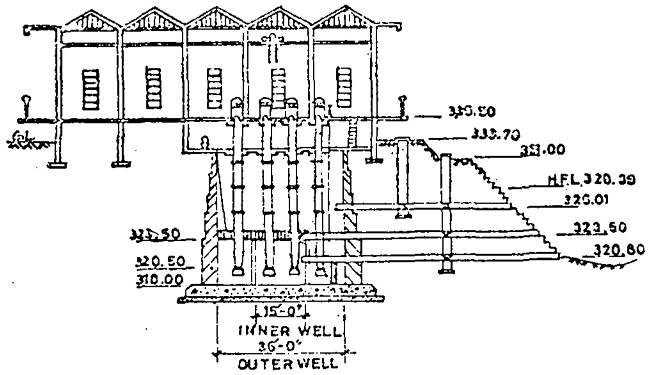

Fig 1 Cross-section of Water Intake Plant

Raw water is drawn from the river through three different channels at different elevations depending upon river water levels. Since the surface water contains less suspended solids compared to bottom layers surface water is drawn as far as possible.

Water intake was originally designed for pumping raw water as under :

Volume pumped	72 000 m³/day
Temperature	8 °C (Winter)
	24 °C (Summer)
Turbidity	8 mg/l (Min)
	3 000 mg/l (Max) assumed
River water level varied between	322.40 m (Min)
	327.60 m (Max)

RL's of Inlet Channel:

(i) Bottom	320.80 m
(ii) Middle	323.50 m
(iii) Top	326.05 m

Capacity of Pump	Discharge Q, m³/hr	Pressure Head, H, m
6×135 hp	690	33
2×110 hp	580	33

Naturally cool water has helped in reducing the cost of refrigeration system of plant during winter season since pumping of water depends on the temperature of river water. Raw water is pumped to water purification plant situated 2 km away through two 61 cm (24") diameter rising mains for purification, from where it is further pumped to main plant.

The distribution of water to the plant is

Clarified Water	Consumption, m³/day	Pressure, kg/cm²
Process water	36 000	4.6
Make up water for refrigeration	24 000	1.7
Filtered water	12 000	4.6

Inside the intake well there is inner circular well 5.5 m high. Two channels are connected to the inner well and two to the outer well. Purpose of providing two wells is to enable isolation of wells for cleaning alternatively.

While designing the water intake, the maximum turbidity of river water was assumed 3 000 mg/l but the suspended solids contents were not considered. Fine sand particles are held in suspension in the river water. During monsoon, it contains 5 000 mg/l to 10 000 mg/l during normal flood. In case of abnormal floods, higher suspended solids (S/S) contents of 30 000 to 36 000 mg/l have been observed.

During Alaknanda flood havoc maximum S/S contents were observed upto 36 000 mg/l on 21-7-1970 due to bursting of natural reservoirs at the catchment area.

H A Sabannavar is with Antibiotics Plant, Virbhadra, Rishikesh.

This paper was received on July 4, 1979 and was presented and discussed in the Semi-annual Paper Meeting held at Jaipur on September 11-12, 1980.

The effect is continued till now as seen from the data below.

Year	Turbidity, mg/l	Suspended Solids, mg/l
1971	3 200	26 000
1972	3 000	29 050
1973	2 850	20 971
1974	2 800	24 785
1975	2 700	14 088
1976	8 500	31 000

All of a sudden, there was abnormal rise of S/S contents to 31 000 mg/l on July 2, 1976 due to land slide in the upper catchment area.

DIFFICULTIES MET WITH WATER INTAKE POINT

Raw water pumping station (WIP) was commissioned on trials during December, 1966. Actual difficulties were, however, faced during the monsoon of 1967.

Middle of top channels were used for drawing surface water of the river to restrict the entry of sand to minimum but large quantity of sand entered the intake well. During August, the rate of sand deposition inside the well was as high as 1 m depth/day. Since the bowl assembly of pumps are situated at 3 m above the floor level of wells, sand had to be removed within three days alternatively from each well. Abnormal increase in sand deposition within short time buries the pump suction, resulting in problems like (i) choking of pumps, (ii) high S/S contents reducing the efficiency of pumps to 60% of rated capacity requiring more pumps to be run, (iii) isolation of wells rendered not possible for cleaning, (iv) impellers getting worn out and cooling coil of bearings getting choked endangering the safety of bearings, (v) cleaning of wells becoming impossible as adequate pumps were not available to meet the plant's water supply (W/S) demand, (vi) due to frequent starting and stopping of pump with above conditions, impellers, shaft sleeves and other costly parts of pumps got worn out necessitating their replacements and sometimes pump had to be kept idle for repairs and (vii) inspite of very careful operation of system by drawing just the required water, supplying adequate pressure of lubricating water and frequent checking of sand deposition inside the well, smooth operation of pumps was not possible.

PROBLEMS AT WATER PURIFICATION PLANT (WPP)

1. Large volume of sand carried with the raw water through rising main deposits inside the clariflocculators at purification station alongwith the sludge. This has got a tendency to choke the bottom sludge pipe, which cannot be stopped even with a high wastage of water for flushing.

2. Clariflocculator has to be shut down frequently for cleaning purpose, which is not only costly but also creates interruption in water supply to plant.

3. When the sludge pipe gets choked the quality of clarified water gets impaired and turbidity increases, even with high alum dosing.

4. Choking of sludge pipe is so compact that it is not removed even with the help of compressed air.

5. Continuation of operation, with such condition, leads to the damages of its mechanical parts, such as scraper arms, blades etc and require immediate repairs.

6. Turbid clarified water further chokes the filter beds.

7. All the above difficulties are time consuming for rectification and entail high recurring expenditure.

The entry of sand inside the intake well was so much that it could not be removed quickly and hence intake well had to be stopped during July 1967. For the removal of sand from the well, military help from the Bengal Engineering Group was sought, in addition to engaging local contractor for speedy removal of sand.

The basic cause of this problem is accumulation of sand. It was therefore obvious that if the sand is removed before its entry into the intake well, then all the above problems would be automatically solved.

EARLIER MODIFICATIONS

After the experience of large sand deposition inside the intake well and subsequent failure of pumps during 1967, a number of suggestions were made by experts from Central Water and Power Commission, Irrigation Research Institute, Roorkee and Roorkee University for improvements and implemented. These were :

1. Large undulations in river bed, which acted like coffer dam, were removed; due to this the pocket formation sand deposition in front of the channel mouth was reduced.

2. The projections of the river bank on the up- and down-stream of intake point were cut; due to this the main water current of river Ganges was diverted towards the intake. This has further reduced the sand deposition in front of the channel mouth.

3. Operation at intake was also done very carefully. Bottom channels were kept closed during monsoon and only the surface water was drawn to the possible extent by installing the pumps on pontoon, for which military help was sought.

4. Water jets were provided at suction of each pump to agitate and pump it alongwith raw water to reduce sand deposition.

5. *Additional platform pumps were installed to pump* the raw water directly to WIP to reduce the wear and tear of intake well pumps.

The first two modifications could not materially affect the deposition of sand inside the well. However, other modifications did help to some extent to reduce sand deposition. This arrangement was continued upto 1969 but always there was tension to meet the emergent situation that might arise due to heavy suspended solid content in river water. Therefore, provision of presedimentation tank (PST) was conceived to remove the sand contents before its entry to intake well.

PROPOSAL OF PRESEDIMENTATION TANK

DESIGN ASPECTS

When the river is in spate it contains high turbidity and suspended solids contents. Typical variation of S/S and turbidity in raw water during monsoon period, is shown in Fig 2.

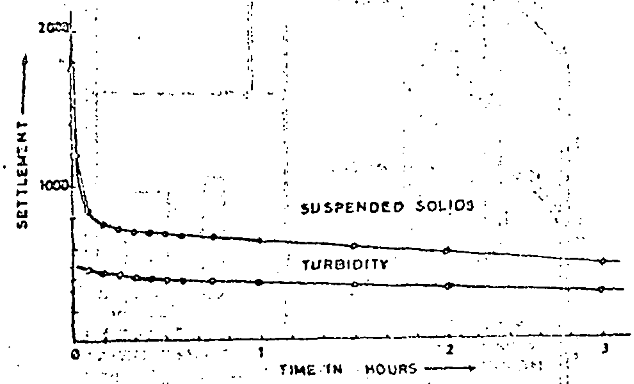

Fig 2 Settlement of S/S and turbidity

Laboratory tests were conducted on raw water and the settling characteristics of turbidity and S/S were determined, Figs 2 to 4.

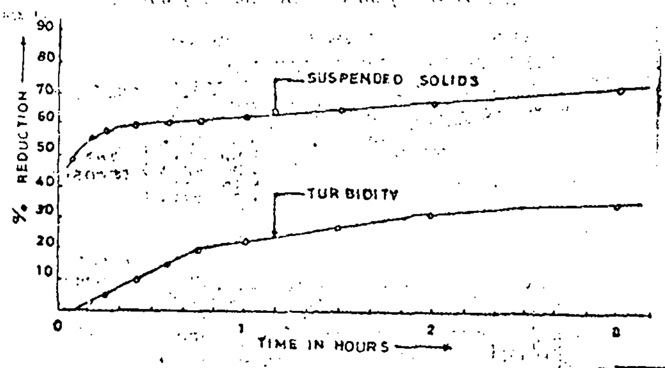

Fig 3 Reduction of S/S and turbidity

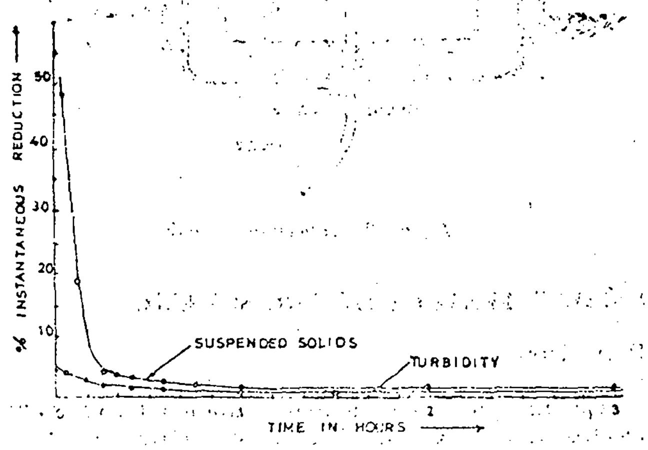

Fig 4 Percentage reduction of S/S and turbidity

Fig 2 shows the settlement of S/S for different raw waters Most of the sand is removed within the first half-an-hour to 1 hr depending upon type of silt. But the reduction of turbidity is effective only is the first 30 min.

Fig 3 shows the % reduction. There is high reduction in the first 30 to 45 min; afterwards it is only slow and gradual.

Fig 4 shows the instantaneous reduction. The rate of instantaneous reduction is more only during the first 30 min.

CAPACITY

Above tests suggest that half-an hour capacity of the tank is sufficient to serve the purpose for removal of sand/silt up to 0.05 mm size but this makes, the size of tank small and continuous sludge removal will be essential.

As per the tests results conducted by IRI, Roorkee, a minimum velocity of 3.96 m/sec is required to be maintained at sludge pipe for removal of sand without choking of pipe but at this velocity, the wastage of water is more than 50%. On economical point this proposal was not preferred.

To reduce the wastage of water alongwith sludge and to avoid choking of sludge pipe, it is preferable to store the sludge inside the tank itself during the flood season. This sediment can be removed conveniently at intervals and after flood season without facing any emergency and without incurring maintenance charges. This proposal was found feasible and convenient and was, therefore, adopted.

DESIGN OF PRESEDIMENTATION TANK

From the records of river statistics maintained at WIP, the flood period having high percentage of S/S contents is broadly divided as under: during May, 4 day, June, 30 day, July, 31 day, August, 31 day and September, 30 day, that is, in total 126 day.

During this period, the S/S contents of river water fluctuates in wide range.

Maximum S/S contents = 26 000 mg/l

Minimum S/S contents = 1 500 mg/l

Average value = 5 000 mg/l

Rate of deposition of sediment during monsoon with avg S/S contents of 4 000 mg/l (Assuming the specific gravity of sand deposited in heaps = 1.5)

$$= \frac{3\,500 \times 24 \times 4\,000}{1.5 \times 10^6} = 224 \text{ m}^3\text{/day}$$

If the average S/S contents is 8 000 mg/l, the rate of deposition during this month

$$= 448 \text{ m}^3\text{/day}$$

Restricting the deposition of sand inside the PS tank to be 4 000 m^3 (max) the tank shall have to be cleaned between 10 to 20 days depending upon the value of incoming sand.

DESIGN DATA FOR TANK

Daily Discharge of Water Required for Plant = 70 000 m^3/day

Max Volume of Sand Deposition Allowed inside the Tank = 4 000 m^3

Water Depth for Free Passage Over the Sand Deposition = 2 m

Length : Breadth Ratio = 2 : 1

Side Solpe (horizontal to vertical) = 1.5 : 1

Slope of Floor for Washing = 1 : 40

Maximum Depth of Tank = 4.5 m

Size of Tank

Let X is width of tank, and $2X$ its length . Assume the volume of sludge in sloped floor as 300 m³. Effective sludge volume = 4 000 — 300 = 3 700 m³. This is stored in 2.5 m depth of tank.

Bottom area = $2X^2$
Top area = $(X+7.5)(2X+7.5)$
(With side slope of 1.5 : 1 ratio)

$$\text{Volume of tank} = \frac{2X^2 + (X+7.5)(2X+7.5) \times 2.5}{2}$$

$$= 3\,700 \text{ m}^3$$

Hence, width is 24 m and length, 48 m.

Area on plan at top of sludge = 31.5×55.5 m²
(assuming 2 m depth of water over sand)

Area on plan at the top = 37.5 m × 61.5 m
(with this size of tank, actual volumes provided)

Volume of sludge = 4 018 m³

Volume of water = 4 050 m³

Total volume of water = 8 068 m³

With this volume of tank, the capacity provided shall be of 2.75 hr detention time.

Inlet Channel and Weir

For carrying above discharge with velocity 0.9 m/sec

Width = 1 m (water flows with force, so less width is provided)

Heading over the weir = 0.07 m

Length of weir = 30.0 m

Outlet Channel and Weir

Heading over the weir = 0.07 m
Length of weir = 30 m
Width of outlet channel = 1.25 m (more width is necessary as water flows under gravity)
Depth of water inside channel = 0.75 m
1 m depth of channel will suffice.

Outfall Channel

Length = 60 m
Width = 1.25 m

A slope of 1 in 200 is provided inside this channel to avoid flooding at out-let weir.

General layout and cross-section of PS tank are given in Fig 5.

Accordingly PS tank 1 was constructed in 1970, Fig 6.

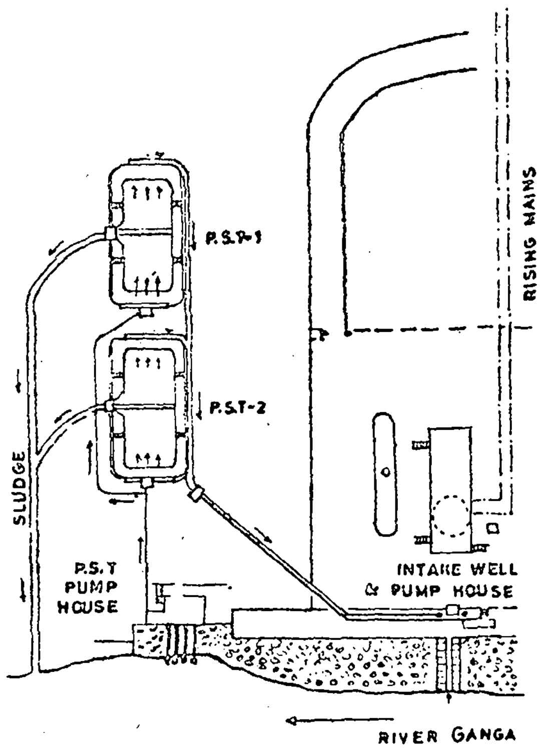

Fig 5 Layout plan of water intake point

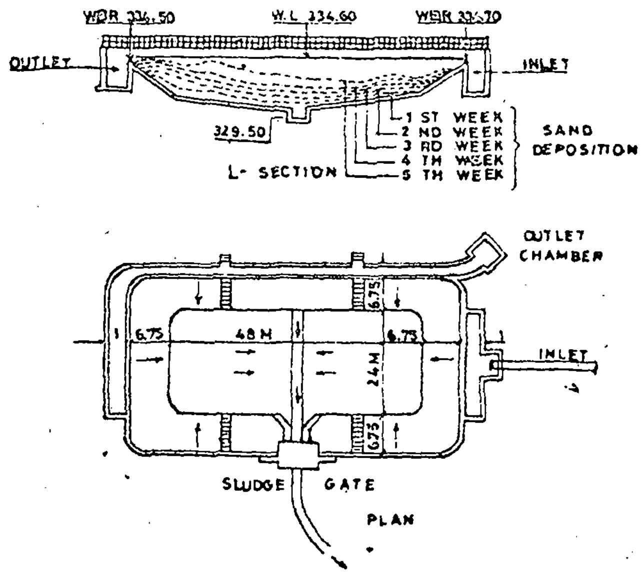

Fig 6 Presedimentation tank

SALIENT FEATURE OF THE SCHEME

Pump House

Separate raw water pumping station on river bank located near the existing WTP at RL 327.50 above the highest flood level (HFL) has been provided for pumping river water to the presedimentation tank. It houses four centrifugal pumps: two 150 hp and two 100 hp with discharges 1 700 m³/hr and 1 100 m³/hr, respectively, at a head of 17 m, the total pumping capacity being 4 000 m³/hr at that head.

The suction pipe of each pumps are laid sloping along the bank. Strainers are fixed at the bottom ends to avoid entry of solids, such as shingle and floating matters. Arrangements are made to draw surface water through sections located at different elevations and back wash it when strainers get choked with floating materials.

Priming of pumps is done by creating vacuum on suction sides of each pump for which vacuum is provided.

Rising Main

MS pipe of 820 mm diameter is laid from pump house to PS tank. It is laid 2 m above floor level of pump house, for proper tappings of delivery pipes of pumps. Since the profile of ground level involves sloping and filled up ground, welded joints are provided with MS delivery pipes.

Main Tank

Raw water pumped first enters the inlet chamber of size 2.5 m × 2.5 m × 2.7 m which acts as a stilling chamber to reduce the impact and turbulance of incoming water, which further helps an uniform distribution of water through the inlet channel over the inlet weir. Inlet weir is kept 22.8 cm above the outlet weir to ensure free fall uniform distribution and avoid flooding.

Main tank portion (Fig 7) is constructed with the specifications given below :

First layer with 15 mm thick plaster in cement mortar (CM) 1:5 on a well compacted bed.
Second layer with first class brick laid in flat in CM 1:5.
Third layer with 23 mm thick sandwich plaster with CM 1:3, (1 Cement : 3 coarse sand) mixed with water proofing compound.
Fourth layer with first class brick, laid in flat in CM 1:3, (1 Cement : 3 coarse sand) and flush pointed.

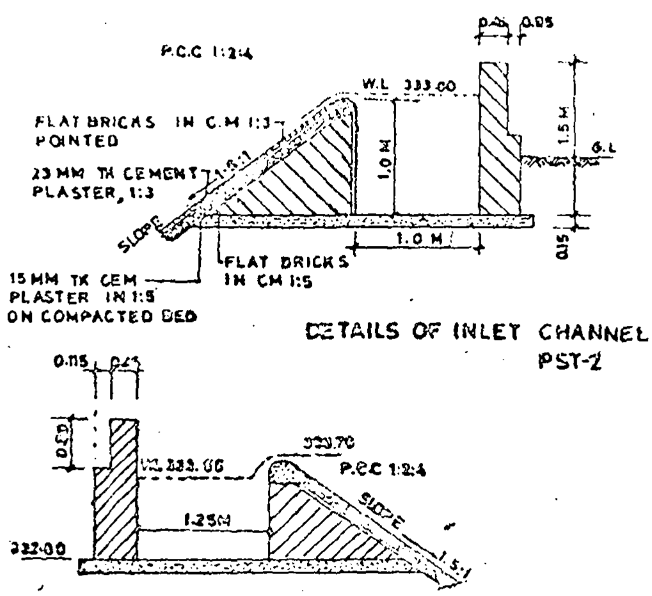

Fig 7 Construction details of channels

Flat bricks are laid in layers on herringbone system so as to break the joints. This has prevented seepage through hair cracks.

Part of the tank rests on filled up ground. Its elevation is fixed in such a way as to effect economy in excavation and to provide out-let drain above HFL of river.

In filled up portion of sloping ground sides, slit boulder masonary has been provided to avoid settlement of ground and to prevent cracks.

All along the junction of bottom floor and sloping side, it is reinforced with MS bars to take care of direct thrust from sloping sides and to prevent cracks that may develope due to side thrust and unequal settlement.

Adequate slope has been provided in the bottom floor, towards the central drain of size 1 m wide which is connected to the outfall drain.

Four stairs are provided on the sloping portions for easy access to facilitate cleaning of tanks for maintenance job.

Sludge Gate

An opening of 1 m × 2 m has been provided at the center of one side of the tank. Above this opening an RCC wall is provided upto the top landing slab to fill up the opening gap. Two RCC columns are provided on both sides of the opening on which guides are fixed for lifting of sliding MS gate. Columns rest on RCC raft which is designed to withstand over-turning action due to water pressure. Adequate dead weight has also been provided to counter balance and to prevent lifting of RCC raft.

MS sliding gate has been provided for closing the opening. Lifting device has been provided on the top of landing, Fig 6.

Outlet weir is similar to the inlet weir which ensures uniform flow without short circuits. Outlet channel of size 1.25 m is provided along the tank with a slope of 1 in 200 and is connected to the outlet chamber of size 2.5 × 2.5 × 3.5 m from where water is supplied through two 61 cm diameter pipe to the existing intake well and to the platform pumps, Fig 5.

Outfall drain of 1m wide is provided from the gate opening upto river bed on down-stream side with a slope of 1 in 40 as to prevent sand deposition inside it, Fig 5.

Operation of PS Tank 1

PS Tank 1 was commissioned during 1970. Due to Alaknanda disaster there was abnormal rise in turbidity and suspended solids contents in the river water, which gradually reduced during the subsequent years as stated earlier. Due to this there was heavy sand deposition inside the tank and quick sand removal from the tank was, therefore, necessary. Nature of actual sand deposition observed during the operation of tank is shown in Fig 6. Since there was no standby unit at that time the following methods were adopted for sand removal, when the tank was in operation.

1. Sludge gate was crack opened and water jet used near its mouth to agitate and flush the sand deposition on the bed; about 300 m^3 of sand was removed.

2. Heavy sand particles partly deposited inside the inlet channel and partly near the weir. 500 m^3 sand was removed through contractual agency during the season.

3. For removing the sand deposited near the inlet weir crane with clamp-shell grab arrangement was used in shifts; 2 064 m^3 was removed during one season.

4. Dredger mounted on a bost was used to remove sand from the tank continuously and the maximum percentage of sand removed in the form of slurry was 5% (by weight) of solids. 4 769 m^3 sand was removed during one season.

Thus the total sand removed by various methods was 50% of the sand deposited per day. So, 50% of sand still deposited per day. The situation was aggravated when the crane and the dredgers went out of order and had to be set right on emergency basis.

During the operation of PS Tank, it was observed that with a normal discharge of 3 500 m^3/hr, the efficiency of the tank for S/S removal was between 55 and 85% and for turbidity removal between 5 to 10% depending upon nature of solid contents.

Cost of operation and maintenance of PS Tank 1 during the monsoon period of 1971 are given below (excluding electricity charges):

Contractual agency (for removal of sand deposited inside the inlet channel, inlet weir and also to dispose off the sand removed by the crane)	= 25 000
Operation and maintenance charged of crane	= 5 000
Operation and maintenance charges of dredger	= 6 000
Cleaning of PS tank after emptying	= 500
Total	= 36 500

High expenditure was incurred as the sand was removed during running condition. On the other hand expenditure for cleaning tank, when idle, is very nominal. It was, therefore, conceived that if a second PS tank is constructed as a standby unit, maintenance charges and emergency situations could be avoided.

Second PS tank was constructed during 1972 with a modification on outlet weir side, Fig 8. General layout of units is shown in Fig 5.

Modification on outlet weir side has increased the efficiency of suspended solids removal, Fig 9.

Both the tanks are operated alternatively every year during monsoon period (June to September); one tank is operated for one month at a time.

Fire hydrants are fixed along the PS tanks. Tanks are cleaned by hose pipe, with the help of only one helper. Hence the maintenance charge incurred is negligible.

CAPITAL EXPENDITURE INCURRED ON CONSTRUCTION

	Rs
Pumping machinery with valves and starters (diverted from main plant during year 1970)	200 000
Pump house	30 000
Presedimentation Tank 1 with MS gates and outfall drain etc	300 000
Presedimentation Tank 2 with MS gates and outfall drain etc	400 000
Total	930 000

Table 1 shows that high expenditure was incurred in removal of sand before the construction of the second PS tank. The expenditure has reduced to bare minimum after the construction of both the PS tanks.

TABLE 1 VOLUME OF SAND REMOVED FROM INTAKE WELL AND WPP

Year	Sand Removed, m^3, from WIP	Sand Removed, m^3, from WPP	Remarks
1967	1 000	300	
1968	471	270	
1969	428	250	
1970	500	3 000	Alaknanda flood havoc on July, 1970
1971	350	200	PS tank 1, commissioned on July, 1970
1972	212	200	PS tank 2, commissioned on August, 1972
1973	121	160	
1974	120	150	
1975	120	140	

Table 2 shows that heavy expenditure was incurred due to high wear and tear of costly spare parts. This was, however, reduced considerably after commissioning of the second PS tank.

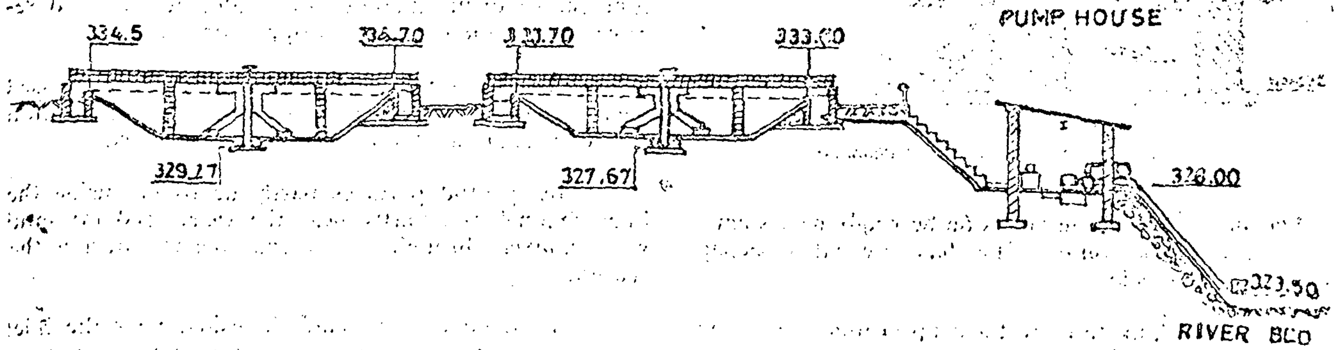

Fig 8 Longitudinal section through PS tanks 1 and 2 and pump house

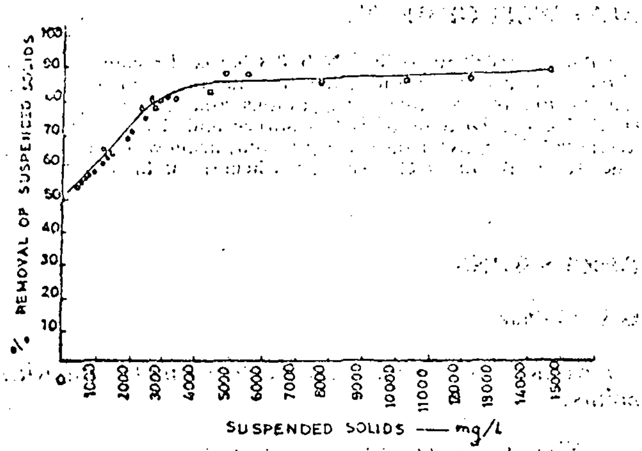

Fig 9 Percentage removal of suspended solids

Table 3 shows that the expenditure on alum dosing reduced considerably after starting of PS tanks due to reduction in turbidity.

TABLE 2 EXPENSES ON SPARE PARTS OF PUMPS AT WIP

Year	Expenses Rs	Remarks
1967	93 000	
1968	41 079	Expenditure on spare parts includes charges of impellers, bushes sleeves, shafts etc
1969	27 278	
1970	33 092	PS tank 1 commissioned
1971	38 741	
1972	14 420	PS tank 2 commissioned
1973	9 850	
1974	13 850	
1975	19 500	

TABLE 3 CONSUMPTION OF ALUM AT WPP

Year	Average Alum to Treat Water, kg/1000 m³	Volume of Water Treated in a Season (May to October), m³	Remarks
1967	36.00	5 000 000	
1968	35.00	6 000 000	
1969	34.50	7 500 000	
1970	40.00	7 000 000	PS tank 1 started in July 19, 1970
1971	28.00	8 000 000	Alaknanda disaster
1972	24.50	8 863 820	PS tank 2 started in August 19, 1972, both the PS tanks in operation
1973	23.4	10 464 340	As above
1974	19.70	9 672 600	As above
1975	18.5	13 081 180	As above

SPECIAL FEATURES ON PERFORMANCE OF PS TANK

During the operation of PS tanks, suspended solids contents and turbidity of raw water were daily observed from samples before and after PS tank. Sand deposition was checked once in a week. When the efficiency of tank reduced due to excessive deposition of sand inside it, it was stopped and emptied for cleaning. Study on samples during 1975 are give below :

	P S tank 1	P S tank 2
Tank started on	June 15, 1975	July 30, 1975
Tank stopped on	July 30, 1975	October 11, 1975
Total water passed through the tank	3 240 000 (in 45 days)	3 520 000 (in 44 days)
S/S varied between, mg/l	3 523 to 912	3 975 to 200
Turbidity varied between, mg/l	1 100 to 300	1 020 to 100
Total sand coming with raw water, m³	5 191	7 885
Total sand-silt deposited inside tank, m³	4 029	6 631
Percentage of sand deposited	78%	84%
Percentage of silt going with water in the form of turbidity	22%	16%

DISCUSSION AND CONCLUSIONS

1. In water supply and sewerage systems, sedimentation tanks are designed for particular detention periods to achieve the desired percentage removal efficiencies.

Theoretically, (a) 90% suspended solids can be removed within the first ½ to 1 hr and (b) 10% turbidity can be removed within the first 30 min.

Tanks with this detention period requires continuous sand removal, which is costly and impracticable. Therefore in such cases practical aspects should be taken into consideration.

2. Where the river water contains high suspended solids (especially sand particles over 0.1 mm size and over 2 200 mg/l and above) provision of presedimentation tank before raw water pumping station is desired. This will prolong the life of raw water pumping sets.

3. Provision of two PS tanks can handle raw water with suspended solids contents upto 15 000 mg/l (max) during monsoon. Shock loading may be allowed upto 20 000 mg/l for a few hours. One unit is to be used as a standby unit for alternate use. The effectiveness of PS tanks were tested when there was abnormal suspended solids contents in river water of 31 000 mg/l on July 2, 1976. The efficiency of the tank was upto 85%.

4. One tank can be conveniently used in operation for one month at a time.

5. PS tank 2 has shown high percentage removal of suspended solids. Hence the outlet weir should have vertical face as far as possible to achieve maximum efficiency.

6. Efficiency of percentage removal of suspended solids in PS tanks depends on nature of sand particle. In general tank provides high percentage removal with high suspended solids contents as shown in Fig 9.

7. For practical purposes the efficiency of PS tanks can be assumed as 85% for suspended solids removal and 10% for removal of turbidity. Therefore for the removal of turbidity from raw water, use of coagulant followed by sedimentation in clariflocculator, is essential at purification station.

8. When the river is in spate the bottom layer of water contains higher suspended solids contents as compared to surface layer. Therefore attempt should be made to draw surface water. For this purpose suction pipes of pumps should be located at different elevations.

9. Location of suction pipes on river banks should be such that it hugs the main current; pocket formations should be avoided as sand deposition takes places at such locations and may choke the pipe.

10. Provision for priming of pumps should be done by vacuum pumps as it enables to conveniently lay the suction pipe on slopes. Moreover provision of foot valves on suction side is impracticable for big pumps.

11. Wherever higher elevation is available for location of PS tanks, cleaning of tanks is most economical. One helper can clean the tank with two hose pipes within 7 to 10 days. Where two PS tanks are provided, shut-down of one unit for cleaning is possible.

12. Construction of PS tanks with the specifications given in Fig 5 is the most economical and convenient one. There is practically no seepage less. When the tank is idle it should be kept filled up with water to avoid development of hair cracks due to temperature variations.

13. When the tank is to be located in either soil having low bearing capacity or where water table is low, special precautions should be taken for its structural safety.

ACNOWLEDGEMENTS

Author is indebted to Shri N S P Chawla, Executive Director (Projects) who inspired and guided the author for the design and construction of PS tanks. Suggestions and guidance given by Dr S P Garg, Director of IRI, Roorkee and Dr H D Sharma, Research Officer, IRI, Roorkee is gratefully acknowledged. Author wishes to thank Mr H C Joshi, Jr Chemist for his assistance.

DISCUSSIONS

G L Mathur

I would like to have clarification on the following points:

1. Size of the presedimentation tank.
2. If pressure relief valves are provided.
3. If any tendency of uplifting of bed-lining has been noticed.

S Bandyopadhyay

I would request the author to clarify whether the cooling of the water was necessitated for removal of suspended solids and turbidity.

Author

Thanking both Shri Mathur and Shri Bandyopadhyay, I like to point out the followings:

1. The size of PS tank provided is 37.5 m × 61.5 m on plan at the top.
2. No pressure relief valve is provided as the tank is located on elevated ground.
3. The tanks being located on elevated portion of the river bank, no uplifting of the bed lining has been noticed so far.
4. Cold water is required in the production processes of the Antibiotic Plant. This is not required for removal of suspended solids and turbidity.