Selection of Hydraulic Machines for Scarp Tubewells

By

1. SARDAR ALLAH BAKHSH

Managing Director, Sabasun Technical Services

2. DR. AKMAL HUSSAIN

Chief Mechanical & Electrical Engineer, Sabasun Technical Services

SELECTION OF HYDRAULIC MACHINES FOR SCARP TUBEWELLS

By

1. SARDAR ALLAH BAKHSH

Managing Director,
Sabasun Technical Services

2. DR. AKMAL HUSSAIN

Chief Mechanical & Electrical Engineer,
Sabasun Technical Services

Centrifugal and Vertical turbine pumps manufactured by leading Pakistani firms compare favourably with international standards.

Submersible pumps are not being manufactured in Pakistan as yet and hence these have not been considered in our study. The performance of centrifugal and vertical turbine pumps in the field depends not only on their inherent design but also to a great extent on their proper selection, setting, operation and maintenance.

A centrifugal pump has a limited sphere of operation while the turbine pump has no such limitations. A name commonly given to a turbine pump is the deepwell turbine pump as it is capable of pumping water economically from deep wells, which is not possible with a centrifugal pump. It would, however, be wrong to infer that a turbine pump cannot be used or should not be used for shallow wells. A turbine pump can be used equally efficiently as much for a deep well as for a shallow well. Before deciding which pump type should be used in a particular situation, technical as well as financial evaluation of each type should be made.

There are primarily two main considerations which would influence the decision on the selection of a pump type.

1. Technical considerations.
2. Financial considetations.

Technical considerations are subject to objectives of a project, which in our consideration may be taken as stated below.

The tubewells are to be installed in the fresh water zone of the project so as to :

1. Lower the permanent water table to about 10 to 15 ft. below the natural surface level.
2. To supplement the canal irrigation supplies with tubewell water so as to increase the cropping intensities.
3. By generous application of water, wash down salts which are present in the soil crust to enable the soils to produce even sensitive crops.
4. By elimination of water-logging and salinity and re-use of the pumped water optimise agriculture in the project area.

In our effort to achieve the above objectives we have also to be cautious to avoid the following hazards :

1. That the lower saline water layers do not rise high enough so as to deteriorate the sweet water zone.
2. The saline waters in the adjoining areas do not intrude on the sweet water zone of the project area to render it unfit for use.
3. That injurious quality of water containing either high concentration of total dissolved salts or high percentage of sodium or boron is not used.

Keeping the above criteria of achieving our objectives and avoiding the hazards we now proceed to discuss the hydraulic parameters under which the pumps are required to operate.

TECHNICAL CONSIDERATIONS

The following technical aspects have to be kept in view while deciding the pump type to be used in any location.

1. Pump capacity.
2. Specific draw-down and anticipated deterioration in specific draw-down.
3. Seasonal variations in the sub-soil water level.
4. Original and ultimate sub-soil water level.
5. Cavitation limit.

A typical setting of a centrifugal pump in the pump house of a tubewell is

shown in Annexure-I. The bottom of the pump house is about 4½ ft. below initial sub-soil water level and the centre of the pump is 3 ft. above the sub-soil water level. The pump and the prime-mover are mounted on a plain concrete pedestal.

Annexure-II shows the typical setting of a turbine pump inside a housing pipe. The pump is completely submerged and set below the sub-soil water level. The prime mover is mounted on a concrete pedestal on the natural surface level.

We will now consider the behaviour of horizontally mounted centrifugal pumps and vertical shaft turbine pumps in the light of the above technical aspects.

1. Pump Capacity.

To achieve our objective of supplementing the canal irrigation supplies with tubewell water we must ensure that the pump used is capable of delivering the required quantity of water under all variations of Head. Subject to cavitation limit, the centrifugal pump can deliver the designed discharge in the same way as the deep well turbine pump, therefore both the pumps i.e. centrifugal as well as turbine can be designed to meet the pumping requirements. This consideration, therefore, offers no difficulty in exercising the choice in favour of one or the other type of pump. It must, however, be kept in view that smaller the capacity of the pump, higher will be the capital cost per cusec discharge. The operational costs per cusec will also be higher in case of 1 cs or 1.5 cs pump as compared to 2-3 cs pumps. Therefore, installing a low capacity pump in the public sector is not a good investment. There is no economic advantage in installing irrigation wells of less than 2 cusecs discharge. In exceptional cases where the outlet capacity or other aquifer conditions place a restraint we may use pumps of lower capacity.

2. Specific Draw-down and Anticipated Deterioration in the Specific Draw-down.

Generally the tubewells are designed on the basis of 7 ft. draw-down per cusec discharge. Experience on the on-going projects has shown that the specific draw-down deteriorates in the course of time and we have known instances where a well designed at 7 ft. per cusec has deteriorated to a draw-down of 10 ft. per cusec. Under such circumstances the suction head increases and also the total head increases placing heavier duty on the pumping equipment. Choice of the pump, therefore, is to be exercised with great caution. We have to ensure that the pump selected for a particular site must not only meet the designed draw-down

conditions but also any anticipated conditions of further deterioration in the draw-down. The centrifugal pump has limitations in this regard where as the deep well turbine pump is more suitable to meet such contingencies. In the above context the following quotations from L.I.P. Report will be of interest.

L. I. P. REPORT VOL. 19

"The optimum draw-down in any well appears to be in the range of 17 to 25 ft. Increase in draw-down with time due to screen blockage and incrustation is thought to be about 6 ft. or approximately 25% of the new condition draw-down, at a time when the screens become 50% blocked. If this stage is accepted as a desirable time for screen cleaning, then the maximum draw-down to be allowed for is in the range of 27 to 31 ft."

3. Seasonal Variation in the Sub-soil Water Level.

Most of the recharge to the aquifer comes from the seepage from the rivers, canals, field irrigation and rainfall. Generally the heaviest pumpage will occur in Rabi season in the month of September. During Kharif season and Monsoons; the rivers are in flood, the non-perennial canals are in flow and Monsoon showers are also expected. During this season ground water aquifer gets recharged and the water table rises substantially and the pumpage is also relatively low. Such conditions sometimes cause abnormal rise in SSWL. Either due to unusually monsoon rains or due to the floods, the centrifugal pump and motor are liable to be submerged under water and thus the motor will get damaged. There is no such danger if a turbine pump is used. Evidently a turbine pump has a great advantage over the centrifugal pump in this respect.

4. Original and the ultimate Sub-soil Water Level.

We have assumed that the water table is to be lowered upto about 10 to 15 ft. below the natural surface. This objective can be achieved by using either type of hydraulic machine such as centrifugal or turbine pumps. However, this is not the only objective to be achieved. The other objectives are to supplement the canal supplies so as to increase cropping intensity and also give generous applications of water to eradicate salinity. In such circumstances, it will not be wise to shut down the pump after reaching the required level of depletion, if crops require water at the same time. It must be explained here clearly that under a planned

pumpage the depletion will occur between the limits of 10 ft. to 30 ft. below the natural surface depending on the season and the requirements of consumptive uses of water. It is not possible to shut down the pump the moment we reach the proposed level. If we do so we will be losing the crops which required water at that particular time. Therefore, while the tubewells are in operation the minimum and the maximum limits of pumpage could be fixed only after giving due consideration to the cropping pattern. The pumping machinery suitable to cater for such contingencies should be capable of producing the designed discharge without frequent adjustments in setting. A deep well turbine pump evidently appears to be more suitable choice under such circumstances.

5. Cavitation.

Centrifugal pump is under vacuum on the suction side. It, therefore, cannot meet in general a suction lift of more than 22 ft. beyond which cavitation occurs.

Let us consider the performance of 1, 2 and 3 cusecs centrifugal pumps. The pump setting has to be at least 3 ft. above the SSWL and assume a Draw-down = 7 ftes. The graphs in Annexure III show the cavitation limit for 1, 2 and 3 cusecs centrifugal pumps. Graphs at Annexure III & IV were obtained from Messrs KSB Pump Manufacturing Company (Pakistan) Limited. These graphs help us to evaluate the performance of centrifugal and turbine pumps.

(*i*) ONE CUSEC CENTRIFUGAL PUMP.
Suction lift = 3 + 7 = 10 ft,

It can be seen from Annexure III that a 1 cusec centrifugal pump will be subject to cavitation at a suction head of 24.8 ft. provided its discharge is regulated at 1 cusec.

The same pump can operate free of cavitation upto a discharge of 1.5 cusecs for specific draw-down of 10 ft. per cusec.

However, under these conditions cavitation will begin at a suction head of 18.6 ft.

Thus suction lift available before the cavitation limit is reached
= 24.8 — 10 = 14.1 ft. (for 1 cusec discharge)
= 18.6 — 10 = 8.6 ft. (fot 1.5 cusecs discharge)
Therefore, a 1 cusec centrifugal pump has sufficient margin of suction lift to operate free of cavitation.

(*ii*) TWO CUSECS CENTRIFUGAL PUMP.

Suction lift = 3 + 14 = 17 ft.

It can be seen from the graph for 2 cusecs Centrifugal Pump in Annexure III that the pump can operate free of cavitation upto a suction lift of 21.8 ft. provided the discharge is controlled by means of a sluice valve at 2 cusecs. The pump can operate upto a maximum discharge of 2.5 cusecs, but the cavitation limit is reached at a suction head of 14 ft.

Suction lift available before the cavitation limit is reached
= 21·8 − 17 = 4.8 ft. (for a discharge of 2 cusecs)
= 17 − 14 = 3 ft. (for a discharge of 2.5 cusecs)

It is, therefore, quite clear that if a 2 cusecs centrifugal pump is allowed to run uncontrolled by a sluice valve cavitation will take place at a discharge of about 2.25 cs. If the discharge is controlled at 2 cusecs the suction lift available before the cavitation limit is reached is only 4.8 ft. see stage I, Annexure V.

As a result of large scale planned pumpage the SSWL will fall. When the SSWL gets depleted by a depth of 5 ft. the suction lift becomes 22 ft. and so the cavitation limit is reached and the pump has to be lowered by 5 ft. for efficient working see stage (ii), Annexure V. When the ultimate SSWL is reached, the water level will have gone down by another 5 ft. and the pump is again working at the cavitation limit and has, therefore, to be lowered again, see stage III, Annexure V.

It is assumed that the specific draw-down is still 7 ft. per cusec. In actual practice it is likely to deteriorate due to changes in the filter as well as the screen and may have the value of 8-10 ft./cusec.

If it so happens the pump will reach the cavitation limit much earlier than anticipated and will have to be lowered earlier. Thus a 2 cusecs centrifugal pump will have to be repeatedly lowered for working free of cavitation. Controlling the discharge by a sluice valve means imposing additional head on the pump which only represents energy lost to that extent.

(*iii*) THREE CUSECS CENTRIFUGAL PUMP.

Suction lift = 3 + 20 = 23 ft.

It can be seen from the graph for 3 cusecs pump in Annexure III that

the pump can operate free of cavitation upto a suction lift of 23.5 ft. provided the discharge is controlled at 3 cusecs. Thus a 3 cusecs centrifugal pump is working at the cavitation limit right from the start.

The above analysis shows that a 3 cusecs centrifugal pump is not at all suitable for installation in SCARPS. The 2 cusecs centrifugal pump is also not suitable as the suction lift available before the cavitation limit is reacned is only 4.8 ft. and the pump has to be lowered every time the SSWL falls by 5 ft.

A 1.5 cusecs centrifugal pump will have a suction lift = 3 + 10.5 = 13.5 ft. If the discharge is controlled at 1.5 cusecs, cavitation will take place at a suction head of 23 ft. Thus there is sufficient margin of about 9.5 ft. for the pump to operate free of cavitation.

Therefore, a centrifugal pump may be used upto 1.5 cusecs capacity well.

Vertical turbine pumps must be used for wells of 2 cusecs capacity and above. There is no problem of cavitation and therefore, no lowering of pump setting would be necessary. Once the turbine bowl assembly is appropriately placed, the pump will continue to operate in its initial setting. Annexure VI shows the setting of the pump for three different levels of of SSWL. The pump setting unlike the centrifugal pump remains the same for every position of the SSWL,

The various factors which infuence the setting depth of the bowl assembly are as follows :

(*i*) Ultimate static water level. Let us consider it to be 15 ft. in a particular case.

(*ii*) Draw-down to be assumed taking into a consideration its possible deterioation in due course of time. For a 2 cusec pump it may be taken as 20 ft.

(*iii*) Seasonal fluctuation. The SSWL may go down by 5 ft. in a draught year.

(*iv*) Submergence of the top of the bowl assembly. It is generally taken from 5 ft. to 10 ft. Let us take it to be 5 ft.

Thus for a 2 cusecs turbine pump the proper setting depth of the bowl assembly would be 15 + 20 + 5 + 5 = 45 ft.

Controlled pumpage by a sulice valve is neither necessary from cavitation stand point as the pumps operate with a built in margin for the NPSH available on

its entire range of operation, nor it is necessitated from the stand point of overloading the prime mover as the pumps are basically of non-overloading characteristics. Thus no unnecessary waste of energy takes place.

Graphs in Annexure IV show system head characteristics for sub-soil water from 10 ft. to 30 ft. below the NSL based on a specific draw-down of 7 ft./cusec and a 2 cusecs discharge both for a centrifugal pump and a vertical turbine pump.

These curves show :

(*i*) Relation between system head and discharge as a characteristic of the bore hole.

(*ii*) Comparative discharge head curve of a typical centrifugal pump and a vertical turbine pump at 2 cusecs rating capacity.

(*iii*) Corresponding efficiency characteristics.

(*iv*) Corresponding input characteristics.

A pump has to be designed to give efficiency at a particular head and discharge.

The efficiencies of the two types within the system head curves are tabulated below on the basis that the centrifugal pump operates with a controlled capacity at a constant total head and the turbine pump operates uncontrolled within the system head ourves. Both pumps are designed for optimum operation at the final point of sub-soil water level.

SSWL	Efficiency % Centuifugal Pump	Efficiency % Turbine Pump
10	48	77.3
15	56	79
20	53	80
25	70.5	81.3
30	78	81.3
	63.1	79.78

Difference in average efficiency = 79.78 − 63.1 = 16. 68

Thus over the depletion period the turbine pump has 16.68% higher efficiency than the corresponding centrifugal pump.

Each time the centrifugal pump is controlled at 2.0 cs discharge it operates at 78 % efficiency, but the head lost in throttling results in deterioration of the overall efficiency. It could, therefore, amount to saying that even if the efficiencies of the two types of pumps may be equal at their optimum operation the head lost in the process of throttling makes a marked difference

We have seen above that if the water table depletion is from SSWL of 10 ft. to 30 ft. the turbine efficiency is 16.68 % higher than the centrifugel pump.

Let us compare the operational efficiencies of 2 cusecs pump when the depletion is from SSWL of 10 ft. to 20 ft.

Assume :

(1)	Initial SSWL	= 10 ft, below NSL
(2)	Target depletion	= 10 ft.
(3)	SP D. D. at the initial stage	= 7 ft /cusec
(4)	SP D. D. of the well at the time of ultimate condition	= 10 ft./cusec
(5)	Capacity	= 2 cusecs
(6)	Discharge centre line	= 3 ft. above NSL
	Static Head	= 20+10+10+3 = 43 ft.
	Column loss 50 ft. length	= 1.3 ft.
	Discharge Head loss	= 0.8 ft.
	$V^2/2g$ at exit 8" ϕ	= 1.0 ft.
	Total Head loss	= 3,1 ft.
	Pump total head	= 46.1 ft.
	Say	= 47 ft.

at the point of ultimate SSWL

SELECTION OF PUMP

TURBINE PUMP

B 12 B – 2 stages = 1450 RPM
Efficiency = 81,0 %
Imp ϕ = 192/182 mm

CENTRIFUGAL PUMP

ETA 125 – 26

ϕ = 233 mm

Efficiency = 79 %

Complete characteristics of these pumps are thus plotted on one graph to see their relative performance (See Annexure VII).

The necessary data for the graphs are as tabulated below :

	Q	1.0	1.5	1.75	2.0	2.25	2.5	cs
	H	66	59	54	47	43	36	ft.
TURBINE	M	60	79	81	81	79	74	%
B-12-B	BHP	12.5	12.71	13.2	13.2	13.9	13.8	HP
	H	57	53	51	47	41	35	ft.
ETA	M	69	79	80	79	74	67	%
125-26	BHP	9.4	11.5	12.7	13.5	14.2	14.8	HP

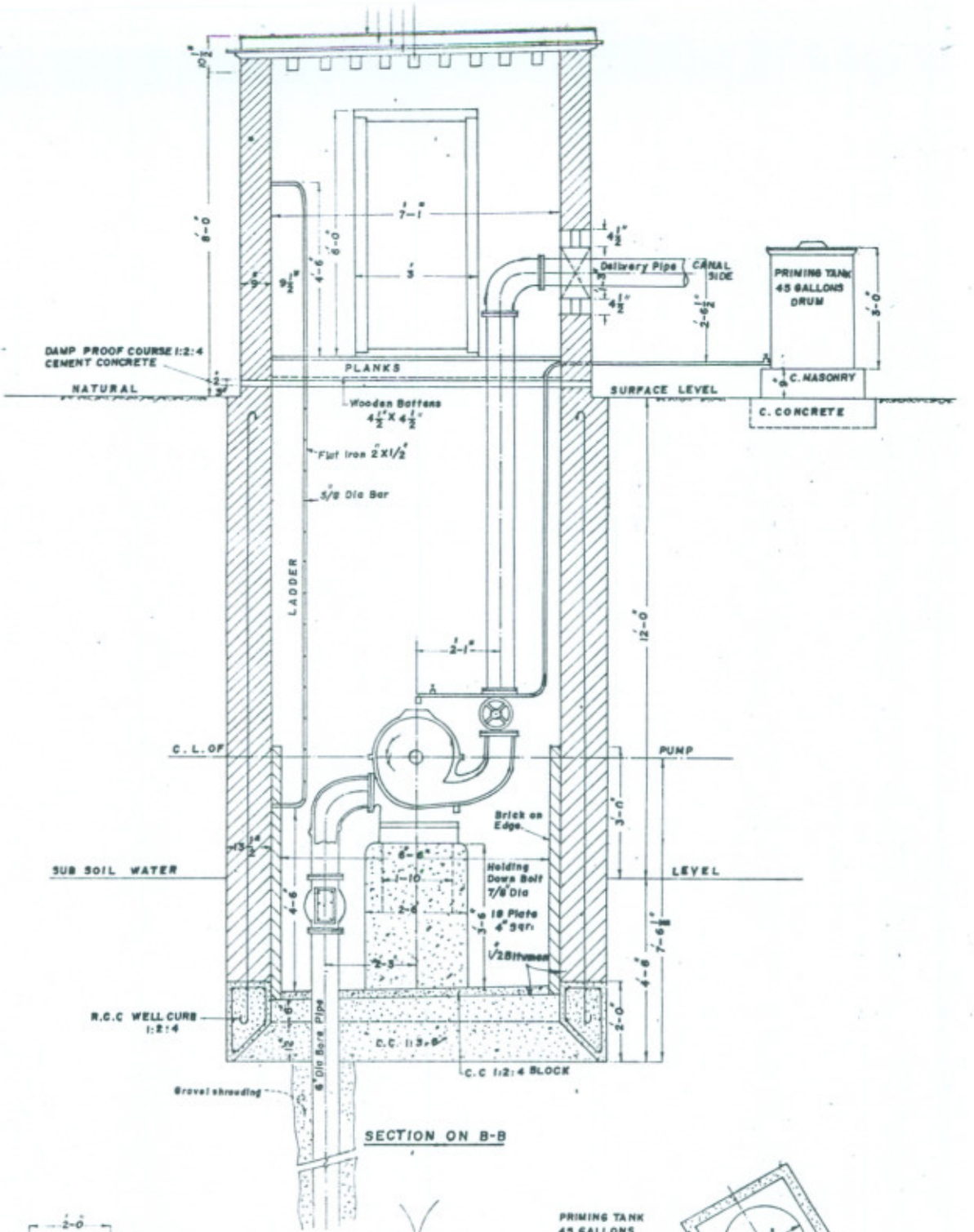
OPERATIONAL EFFICIENCY

TURBINE VS. CENTRIFUGAL

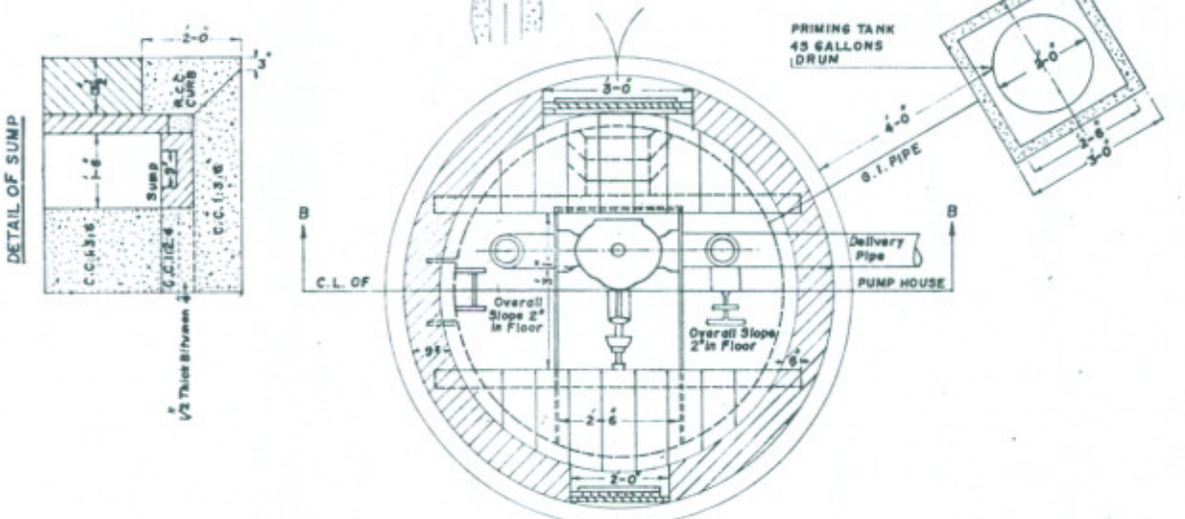
SSWL		CENTRIFUGAL CONTROLLED AT 2 CUSECS			
BELOW NSL	M Turbine	Useful Head	WHP	BHP	M %
10′	77.4	37	8.4	13.5	62.2
15′	79.6	42	9.55	13.5	70.7
20′	81.0	47	10.68	13.5	79
	79.3	—	Average	—	70.6

Difference = 8.7 %

In this case the turbine pump has 8.7 % higher efficiency than a centrifugal pump. It may be further noted that the initial suction lift is 3 + 14 = 17 ft. and the ultimate suction lift. 3 + 10 + 20 = 33 ft. Thus the centrifugal pump will have to be lowered at least twice to work satisfactorily over the specified range of operation.



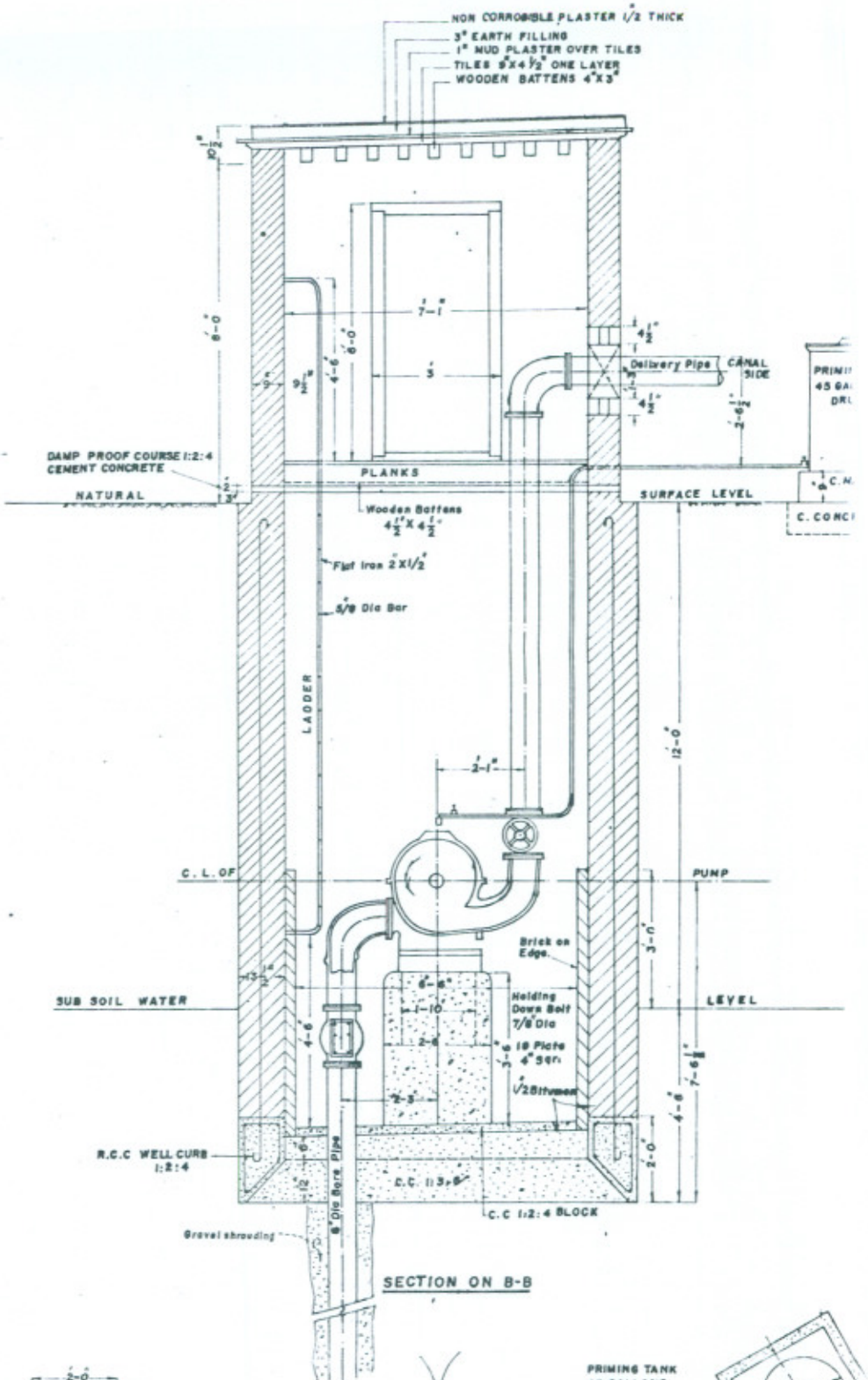
SECTION ON B-B



PLAN

SCALE ~ 3/8" = ONE FOOT

WATER AND POWER DEVELOPMENT AUTHORITY
SABASUN TECHNICAL SERVICES (TTS) 2007



NO	DESCRIPTION	DATE	BY

WATER AND POWER DEVELOPMENT A
SABASUN TECHNICAL SERVICES (
SALINITY CONTROL & RECLAMATION P

TUBEWELL WITH CONTRIFUGAL P

PUMP HOUSE TYPE DESIGN.

DRAWN. SHAMIM
TRACED
CHECKED
APPROVED
PROJEC

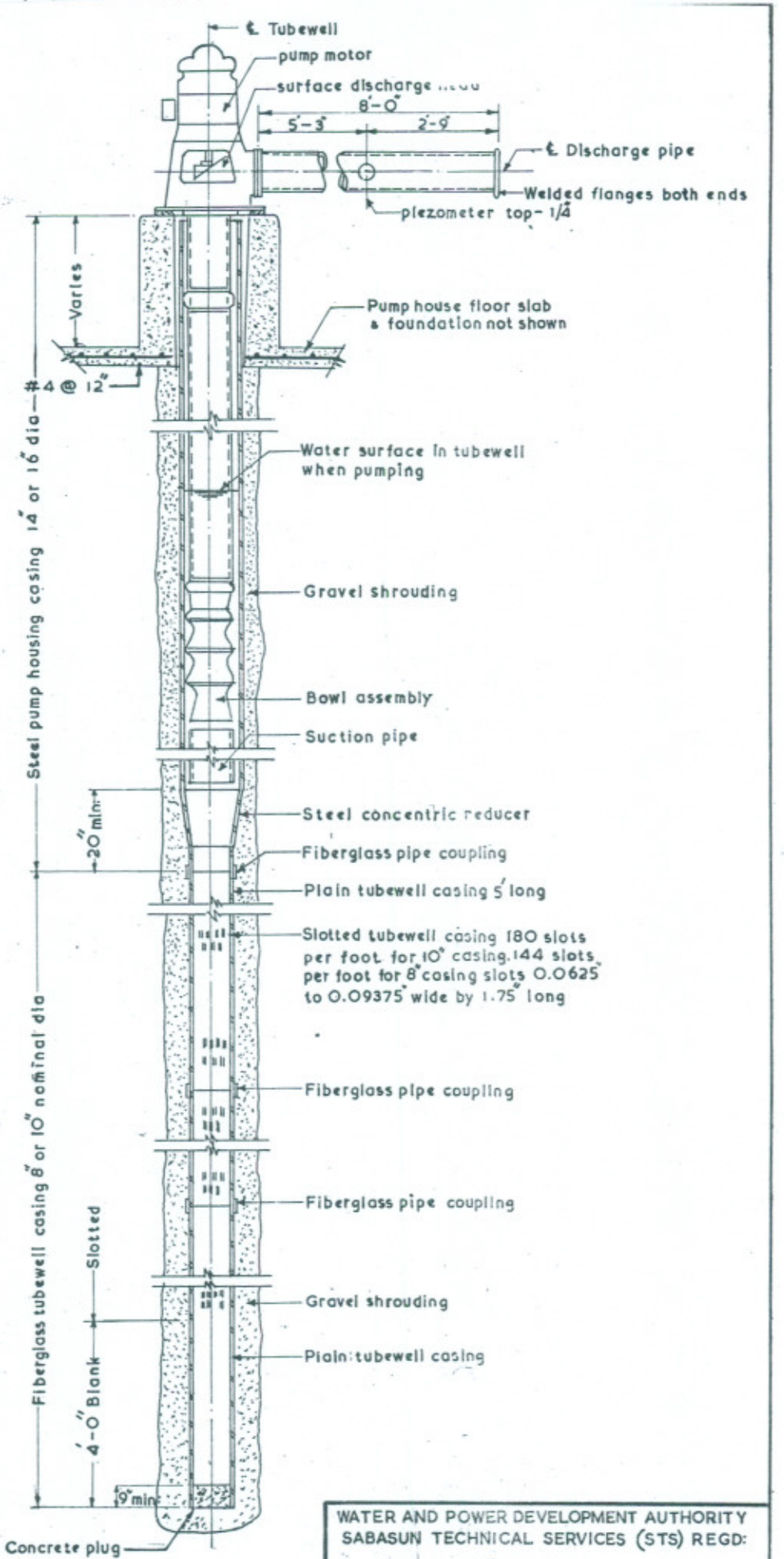
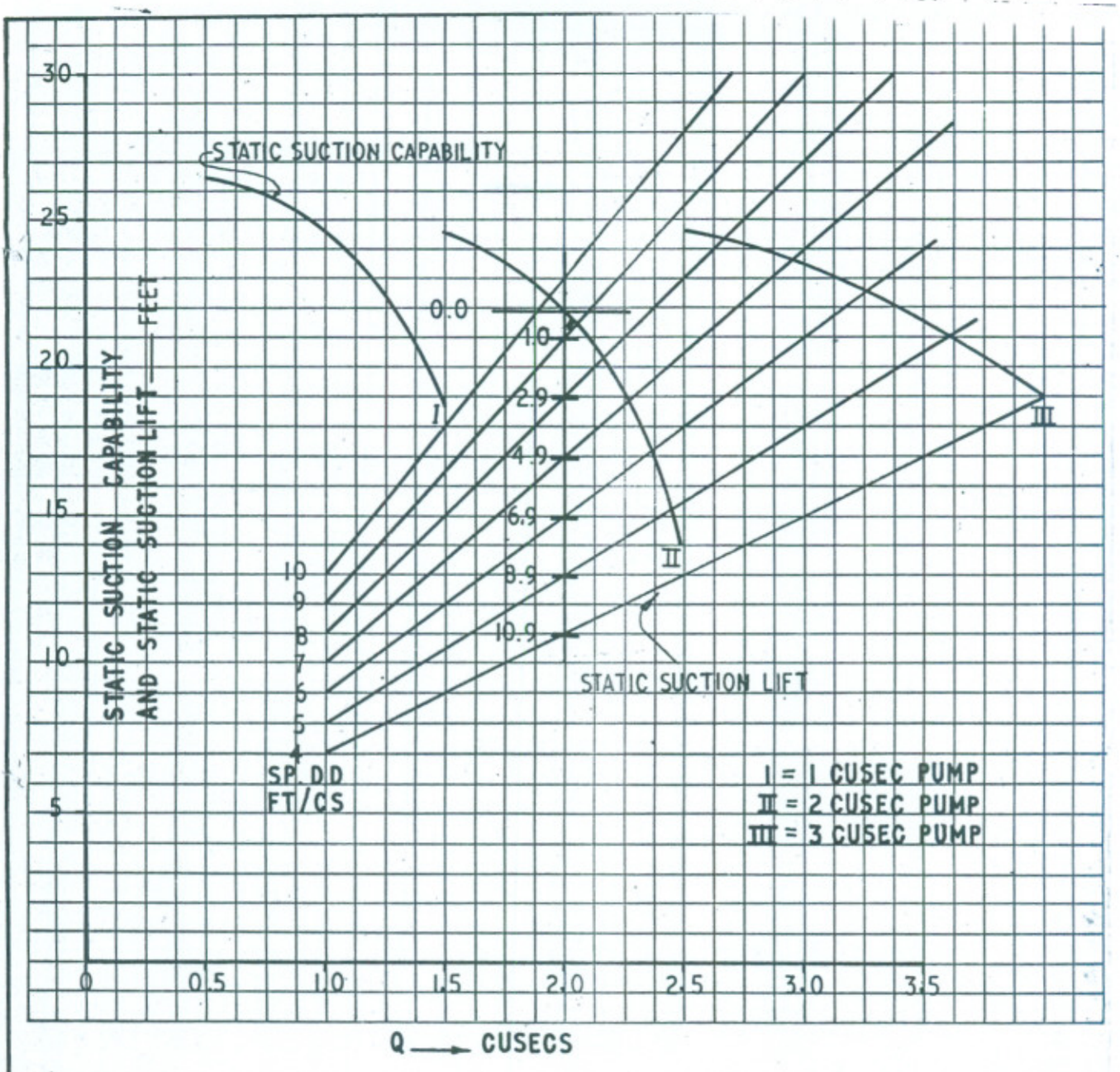
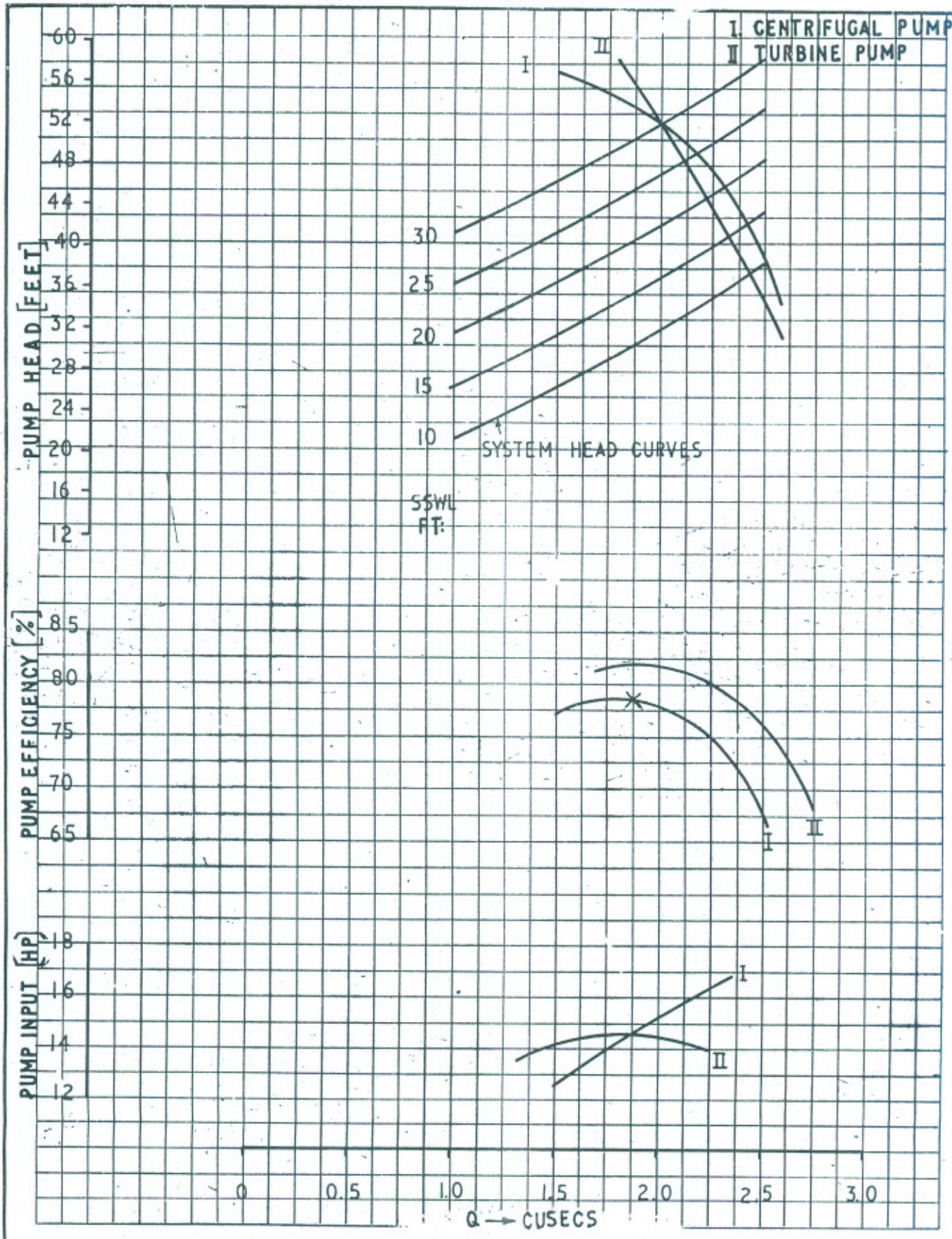


FIG: No. 3

WATER AND POWER DEVELOPMENT AUTHORITY SABASUN TECHNICAL SERVICES (STS) REGD:			
TYPICAL SECTION OF WELL			
DRAWN. RAFIQ TRACED ASLAM CHECKED RAFIQ	DESIGN ENGINEER APPROVED Project Manager		
Lahore Pakistan MAY 1974	JOB No STS-3	FILE No.	DRG: No. T-02



CAVITATION LIMIT VS SUCTION LIFT
FOR CENTRIFUGAL PUMPS

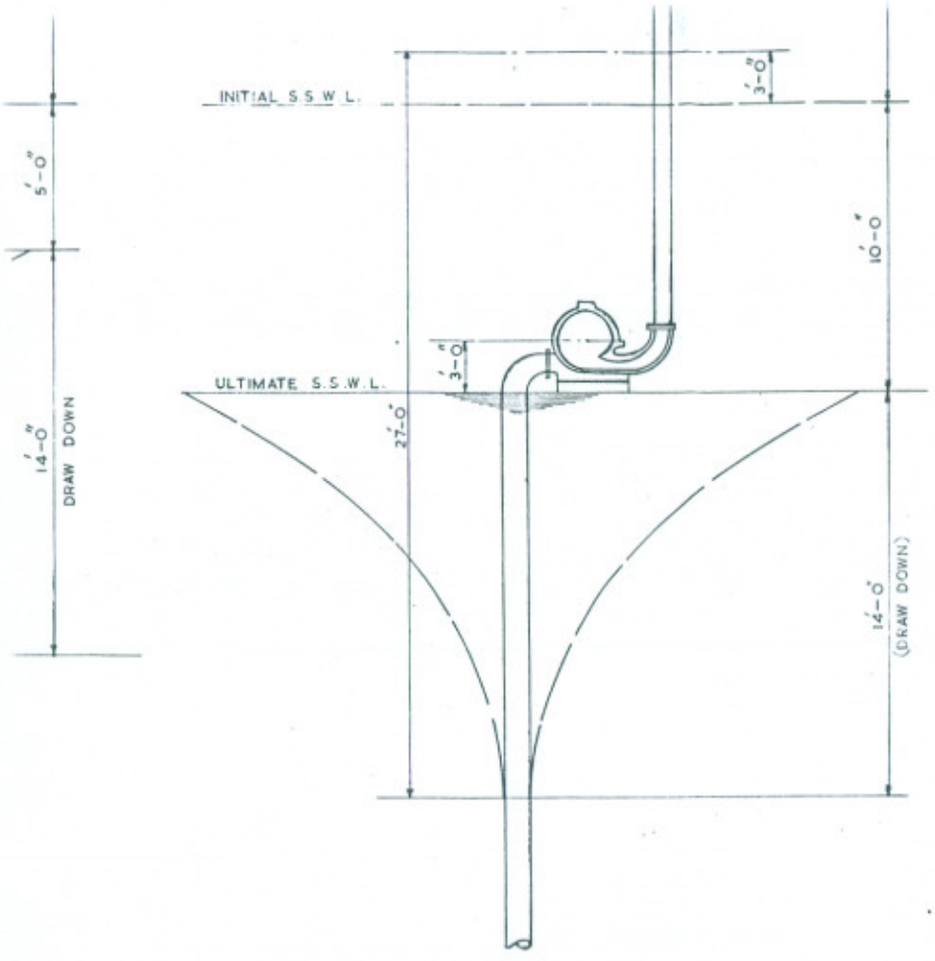


PUMPING EQUILIBRIUM FOR CENTRIFUGAL AND TURBINE PUMPS

ANNEXURE IV

ASLAM

CHECKED EHSAN



3RD. STAGE WHEN THE S.S.W.L.
HAS DEPLETED BY 10'.0"

SUCTION LIFT IF THE PUMP WAS NOT LOWERED 27'-0"

ANNEXURE VI

WATER AND POWER DEVELOPMENT AUTHORITY
SABASUN TECHNICAL SERVICES (STS) REGD:
SALINITY CONTROL & RECLAMATION PROJECT VI
SETTING OF A 2CS CENTRIFUGAL PUMP SHOWING THE DRAW DOWN FOR VARIOUS DEPTH OF THE S.S.W.L

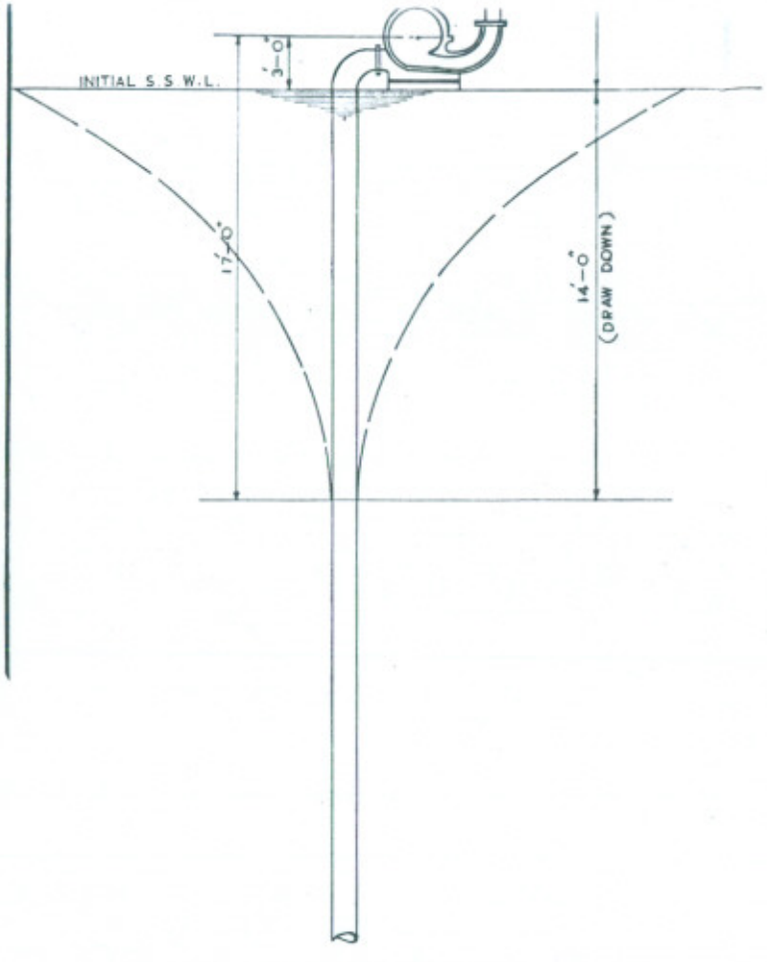
DRAWN RAFIQ	SR: ENGINEER E & M
TRACED M. ASLAM	
CHECKED RAFIQ	APPROVED PROJECT MANAGER

No	DESCRIPTION	DATE	BY

REVISION

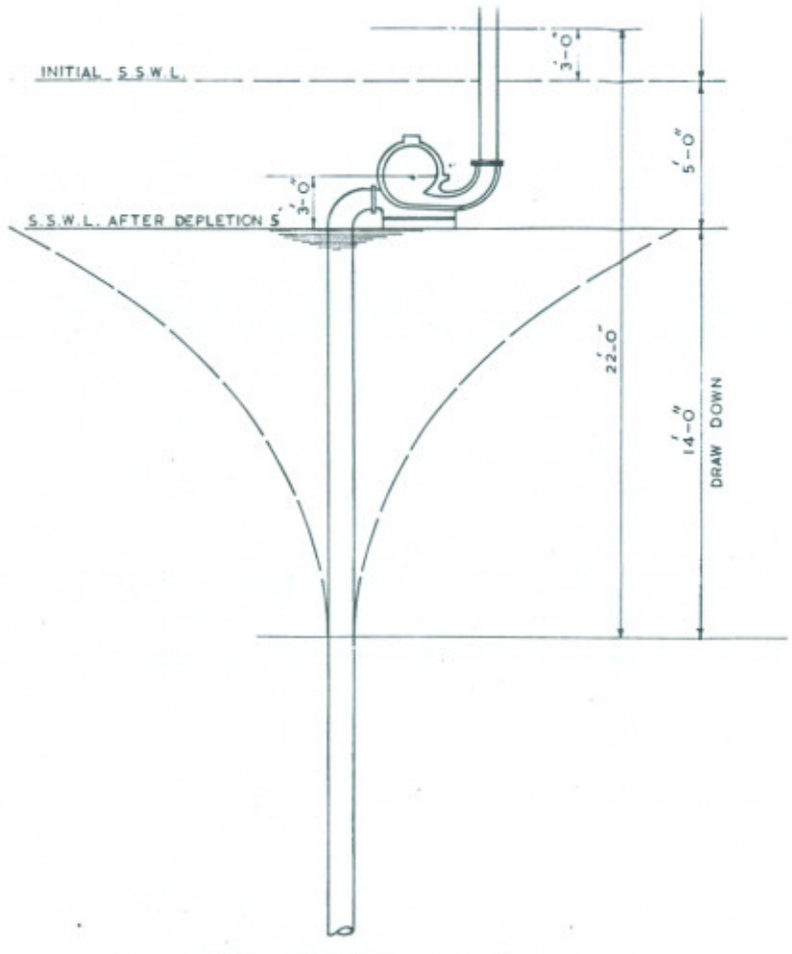
LAHORE PAKISTAN | JOB: No. | FILE No. | DRG: No.

JULY 1974



1st. STAGE WHEN THE PUMPING STARTS

SUCTION LIFT 17'-0"



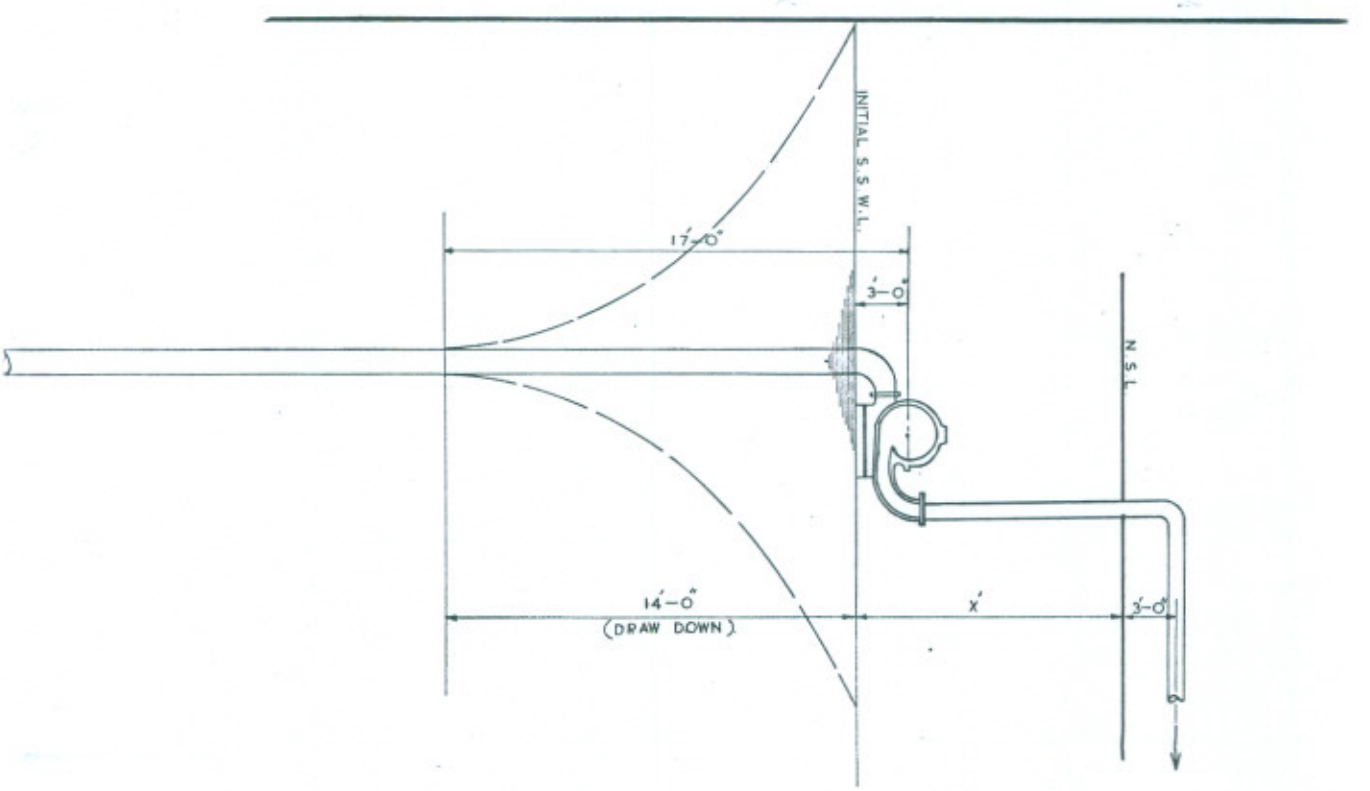
2ND. STAGE WHEN THE S.S.W.L. HAS DEPLETED BY 5'.0"

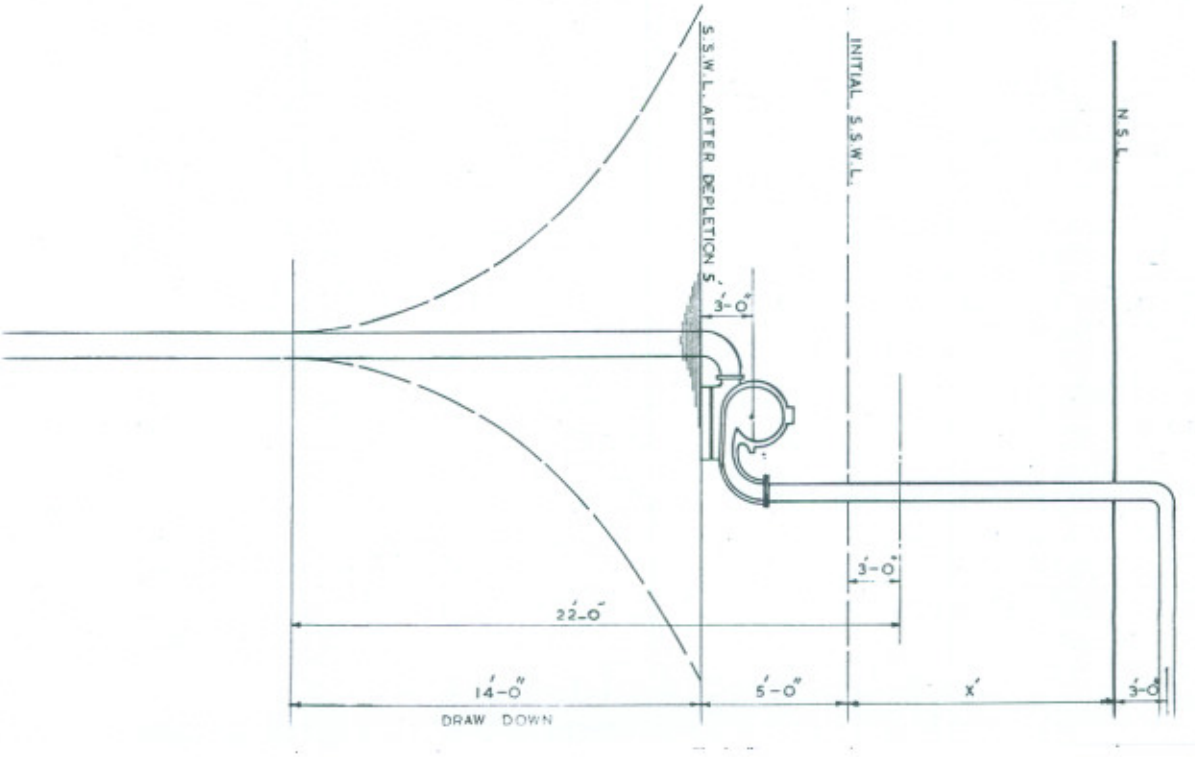
SUCTION LIFT IF THE PUMP WAS NOT LOWERED 22'-0"

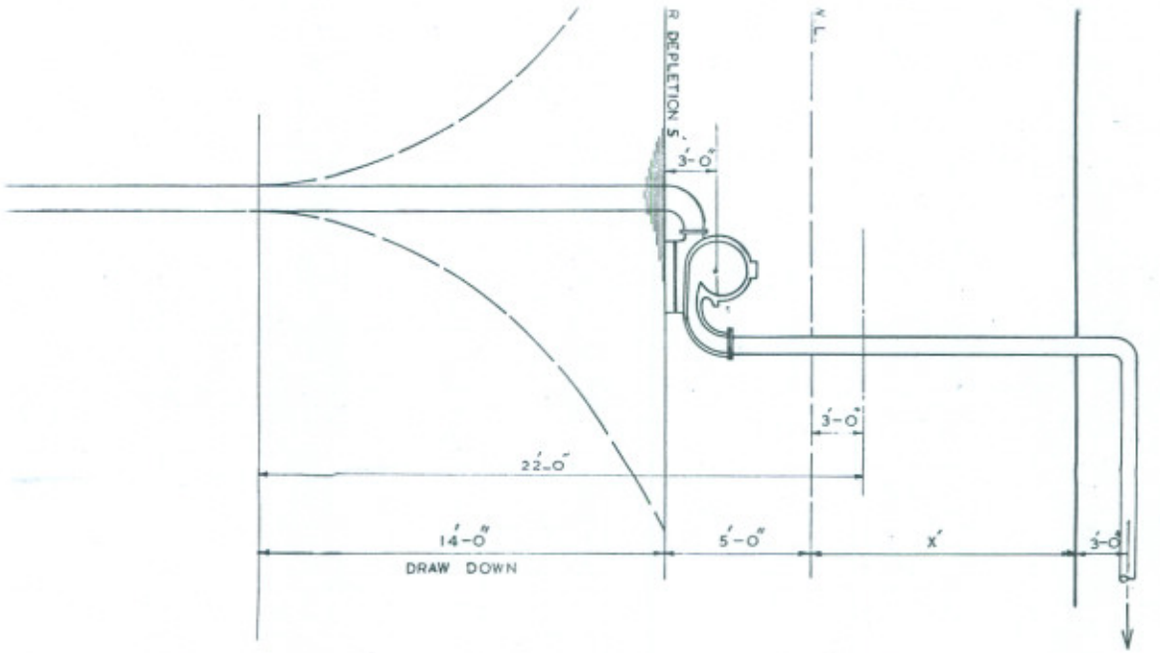


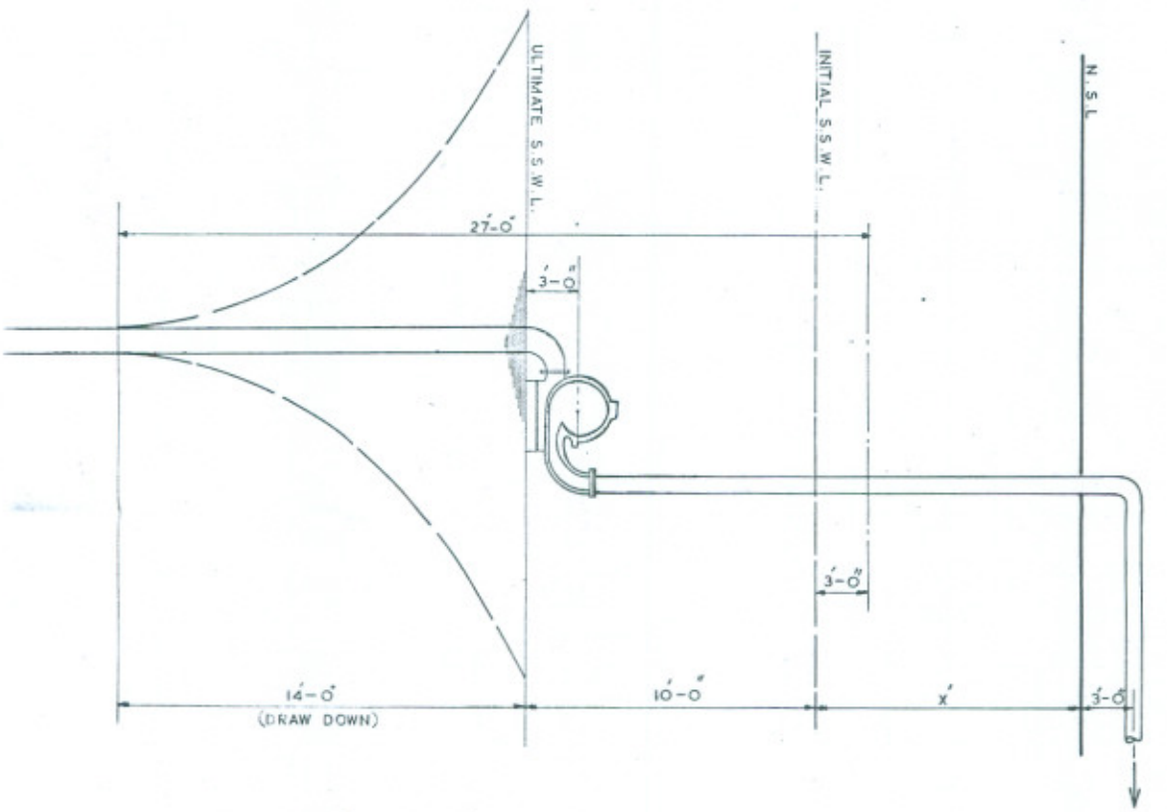
3RD. STA
H/

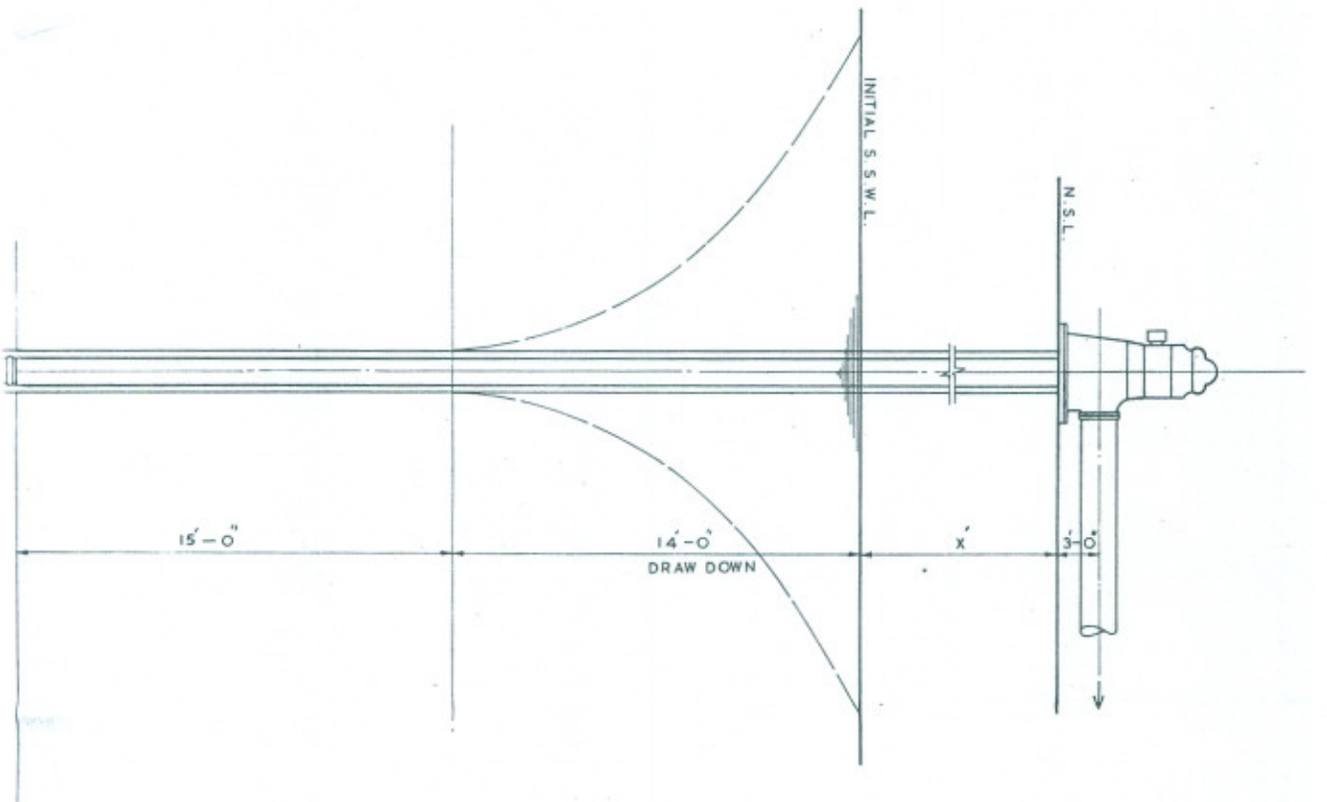
SUCTION LIFT

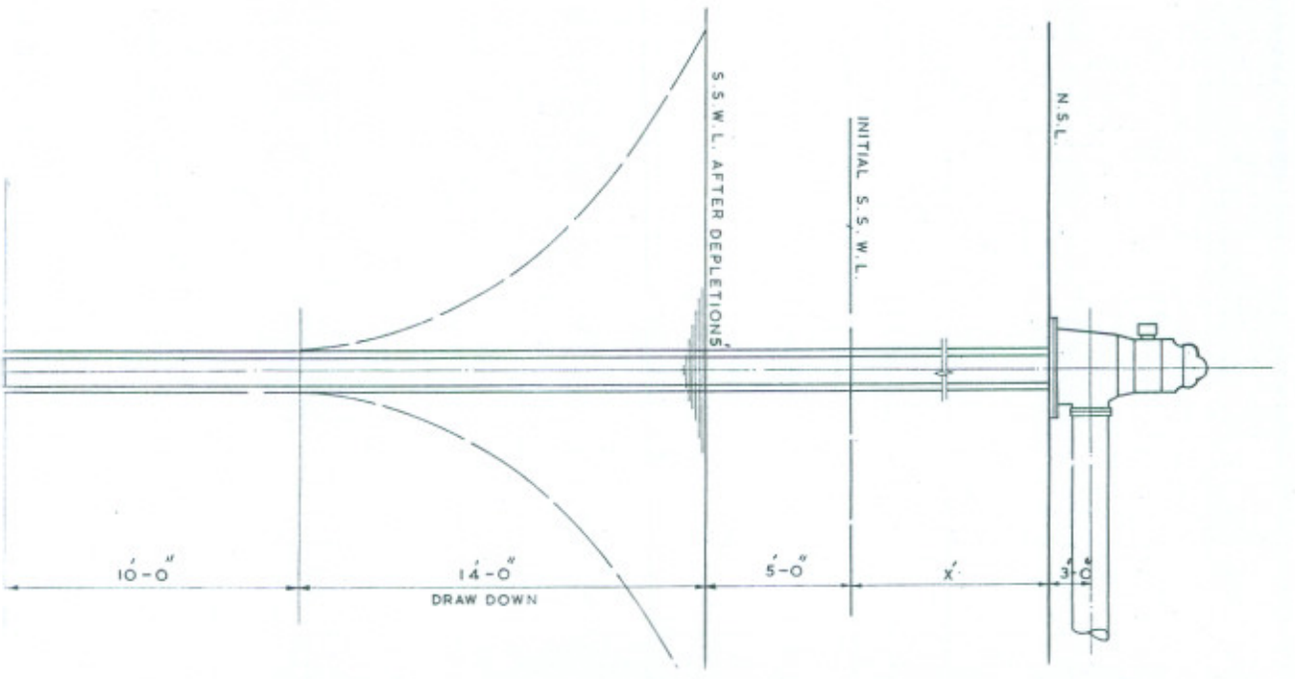

INITIAL S.S.W.L.
17'-0"
3'-0"
N.S.L.
14'-0"
(DRAW DOWN)
X'
3'-0"

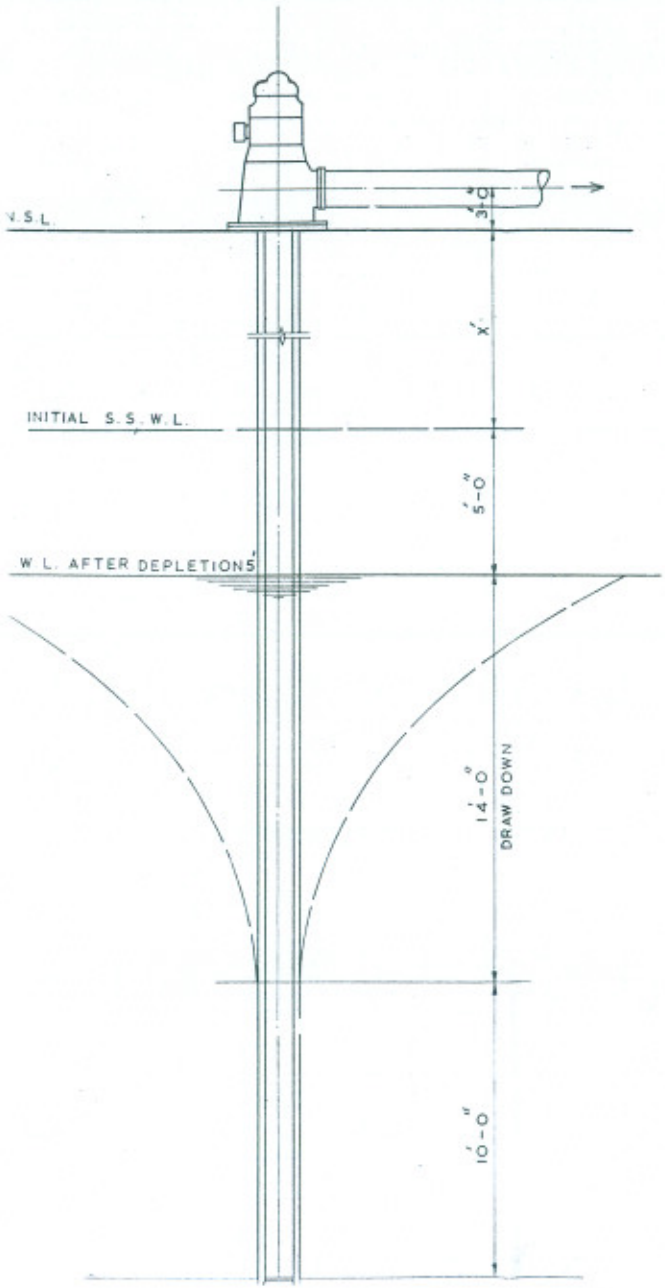

S.S.W.L. AFTER DEPLETION
INITIAL S.S.W.L.
N.S.L.
3'-0"
3'-0"
22'-0"
14'-0"
DRAW DOWN
5'-0"
X'
3'-0"

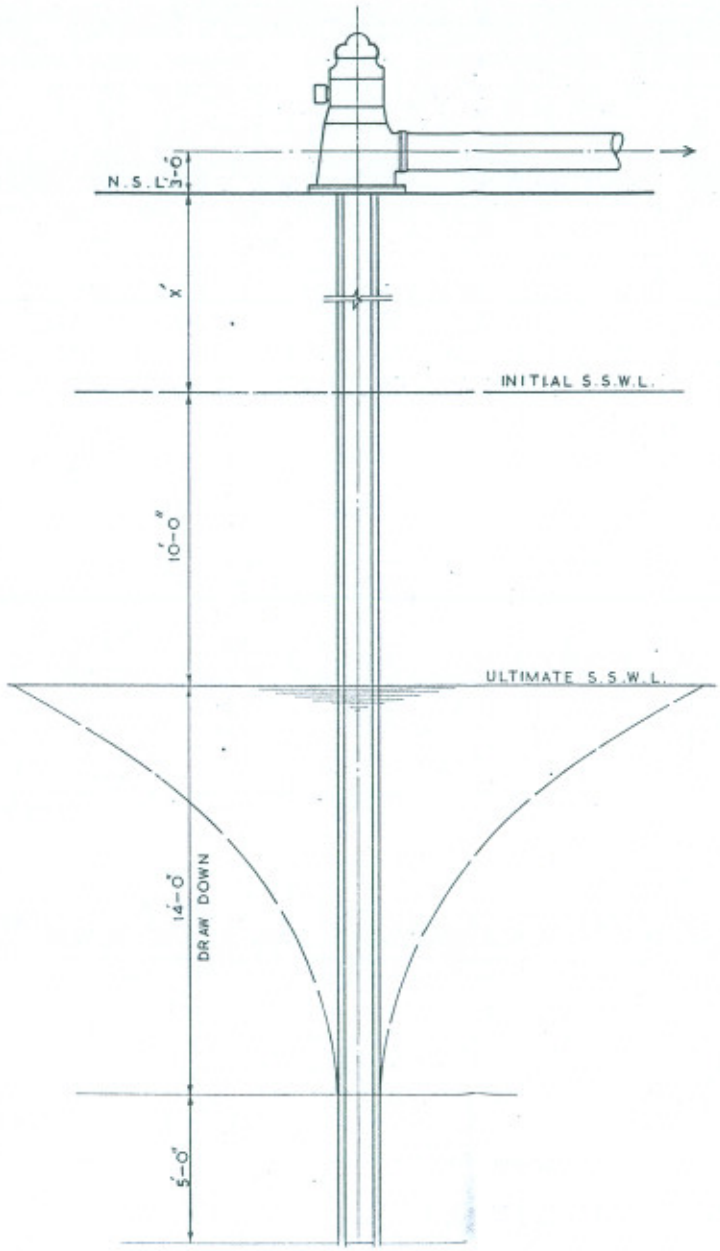

R. DEPLETION S.
3'-0"
N.L.
3'-0"
22'-0"
14'-0"
DRAW DOWN
5'-0"
X'
3'-0"

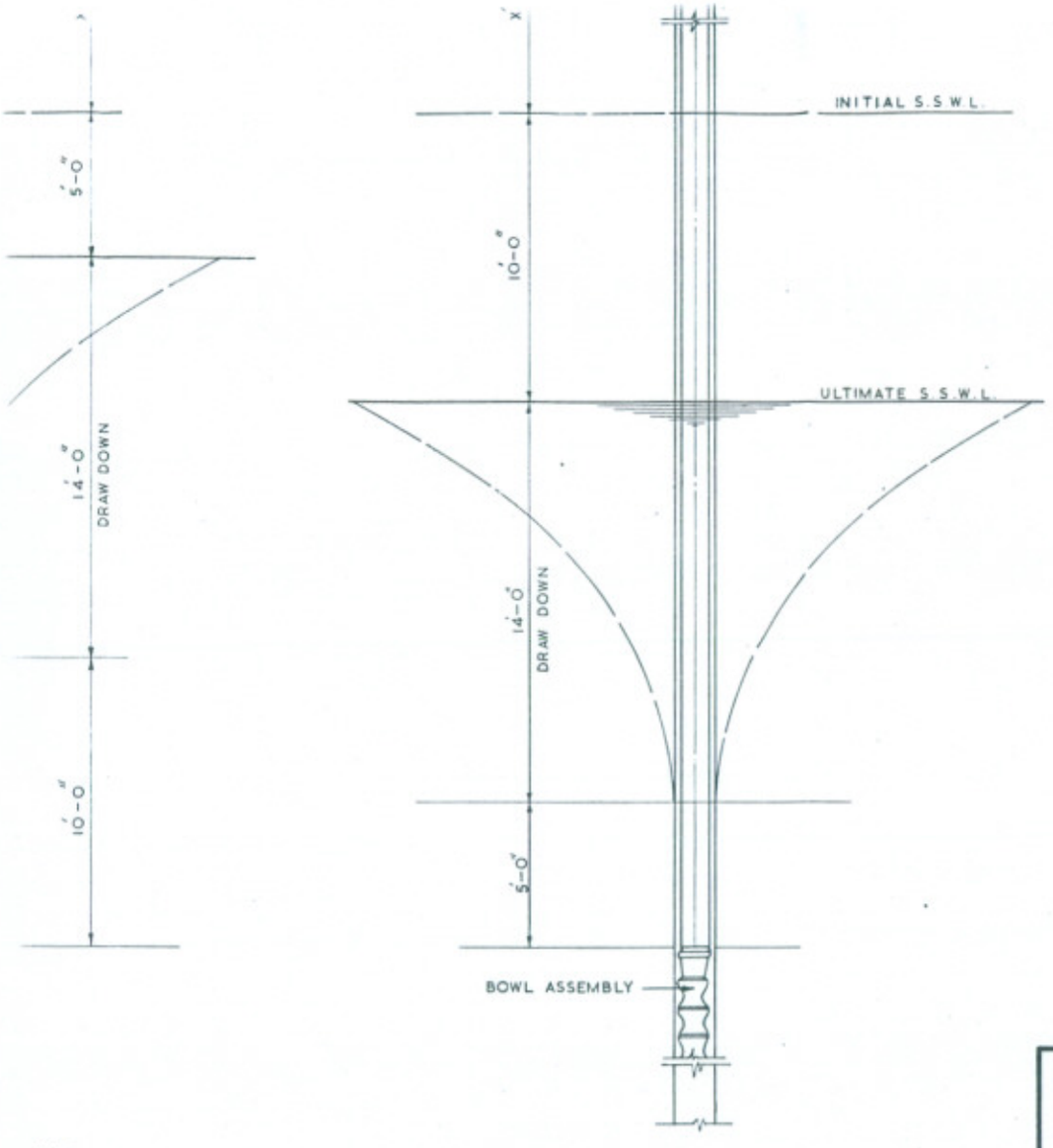

ULTIMATE S.S.W.L.
INITIAL S.S.W.L.
N.S.L.
27'-0"
3'-0"
3'-0"
14'-0"
(DRAW DOWN)
10'-0"
X'
3'-0"


INITIAL S.S.W.L.
N.S.L.
15'-0"
14'-0"
DRAW DOWN
X'
3'-0"


S.S.W.L. AFTER DEPLETIONS
INITIAL S.S.W.L.
N.S.L.
10'-0"
14'-0"
DRAW DOWN
5'-0"
X'
3'-0"


N.S.L.
3'-0"
X'
INITIAL S.S.W.L.
5'-0"
W.L. AFTER DEPLETION
14'-0"
DRAW DOWN
10'-0"


N.S.L.
3'-0"
X'
INITIAL S.S.W.L.
10'-0"
ULTIMATE S.S.W.L.
14'-0"
DRAW DOWN
5'-0"



.W.L.
.0"

3RD. STAGE WHEN THE S.S.W.L.
HAS DEPLETED BY 10.0"

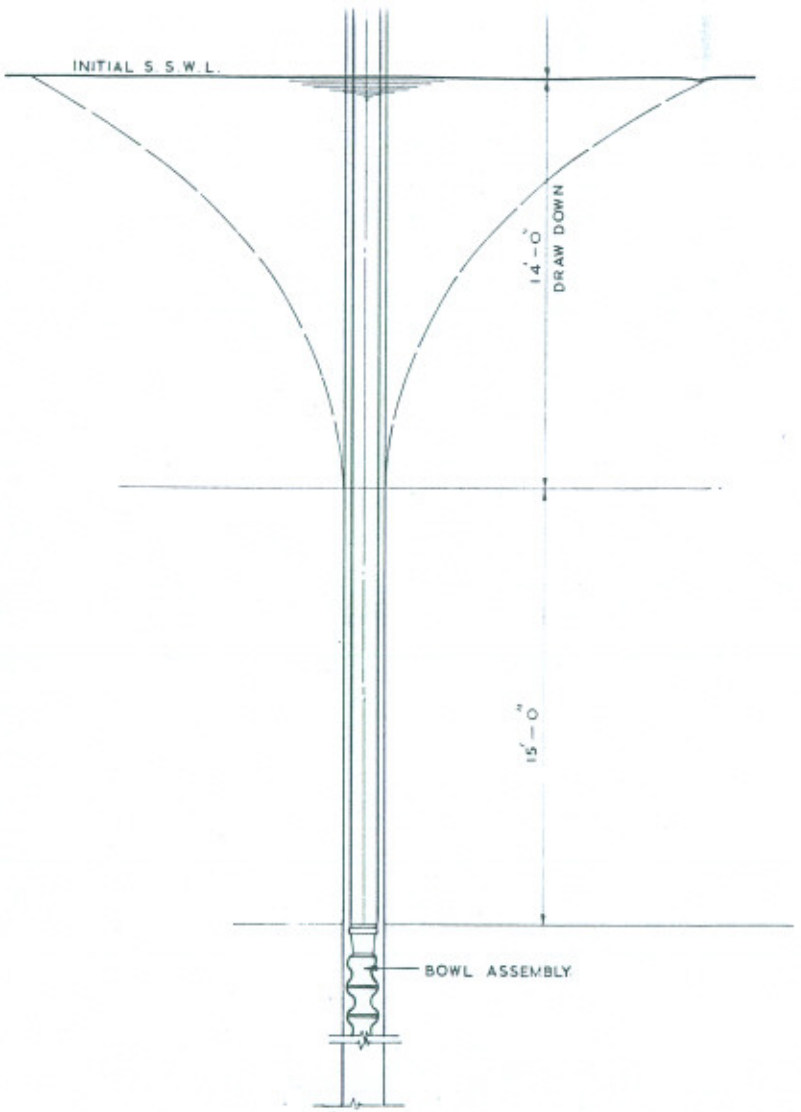
ANNEXURE VII

WATER AND POWER DEVELOPMENT AUTHORITY
SABASUN TECHNICAL SERVICES (STS) REGD:
SALINITY CONTROL & RECLAMATION
PROJECT VI
SETTING OF A 2 CS TURBINE PUMP SHOWING THE
DRAW DOWN FOR VARIOUS DEPTH OF THE S.S.W.L.

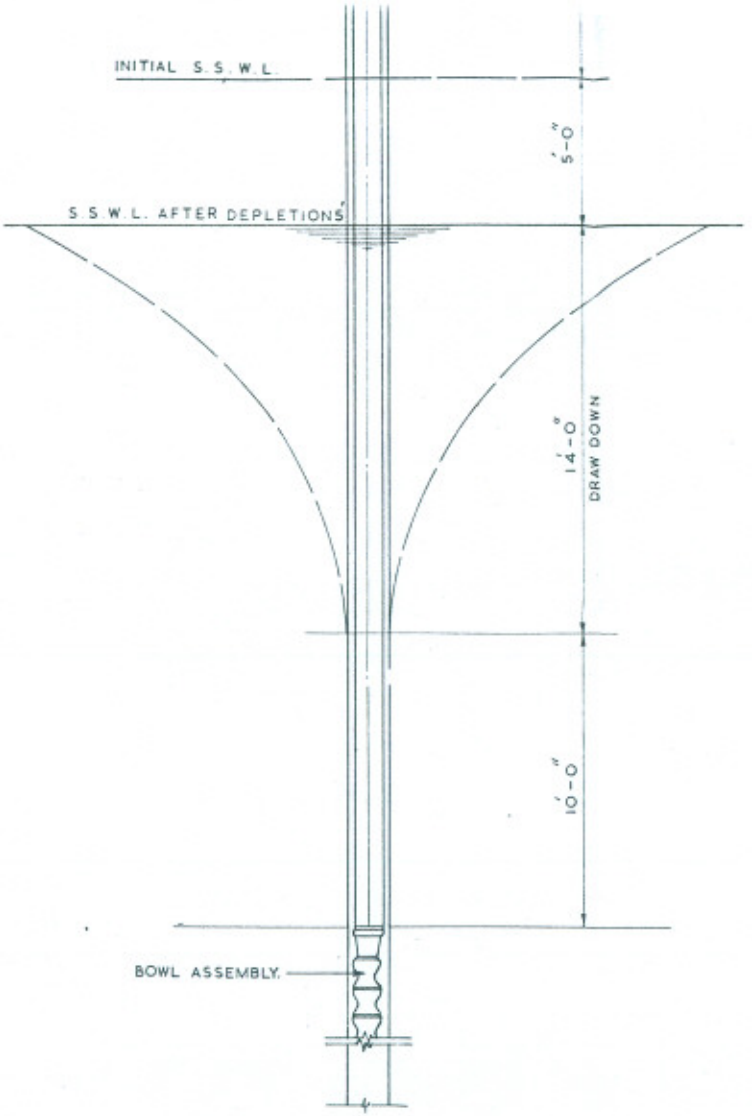
DRAWN RAFIQ	SR: ENGINEER E & M
TRACED M. ASLAM	
CHECKED RAFIQ	APPROVED RROJECT MANAGER

No.	DESCRIPTION	DATE	BY

LAHORE PAKISTAN | JOB No. | FILE No. | DRG: No.



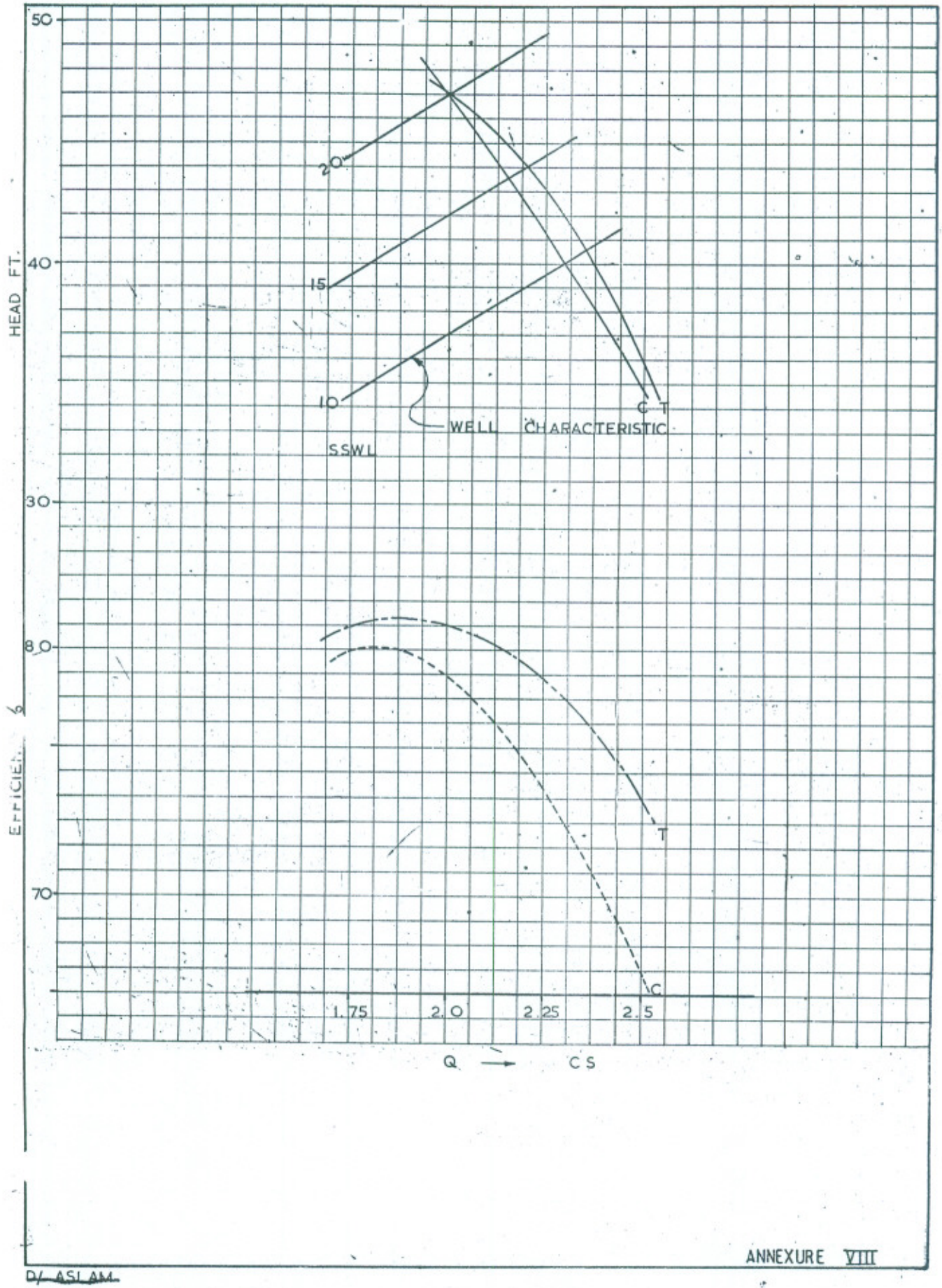
1ST: STAGE WHEN THE PUMPING STARTS



2ND. STAGE WHEN THE S.S.W.L. HAS DEPLETED BY 5'.0"



3RD. S



ANNEXURE VIII

D/ ASLAM

T/ EHSAN

The above comparison of efficiencies in the two cases considered is factual only when it is foreseen that the centrifugal pump will be successively lowered in its installation level as the sub-soil water level recedes as a result of planned depletion of the sub-soil reservoir. See Annexure V. If the centrifugal pump is not lowered it would cease to discharge as soon as cavitation limit is reached,

Thus lowering would take the form of a continuous process of reconstruction of pumping facilities at quite considerable cost, besides it would prevent attaining the objectives of the project.

It can be seen that the centrifugal pump will operate with rather low efficiency in the initial stages of its operations.

In order to improve the efficiency, lower head centrifugal pumps have to be used in the initial stage and must be subsequently replaced with higher head pumps as the sub-soil water level recedes which will be accompanied with lowering of the installation level of the pumps as well.

In the initial stages controlled pumpage has to be restored to in order to maintain the rated discharge or else the pumps would run into cavitation on account of uncontrolled operation as explained from graphs in Annexure III.

Controlled pumpage with centrifugal pumps is uneconomical as stated earlier, while controlled pumpage is not necessary for turbine pumps as their broad base peak efficiency range and steepness of characteristics would to a great extent avoid uneconomical pumpage within the system head curves.

As there is no necessity to consider suction limitation in turbine pumps their mounting level is generally 3 ft. above the ground level. The centrifugal pump has to be installed about 3 ft. above the SSWL which is quite a few feet below the ground level. It is thus likely to be damaged by floods which are not uncommon in the Punjab plains.

Turbine pump is a dynamically balanced machine as compared against a conventional centrifugal pump, as no portion of its rotor is designed to run in a free flying condition. However, rotor of a turbine pump is 40 ft. to 70 ft. long and is more susceptible to dynamic unbalance if it is not installed or mainained in a proper manner. Based on their respective features, and the experience of the industry, both pump types have equal lives if they are properly maintained.

Operational conditions of a centrifugal pump are such that it has to work under vacuum on its suction side, if the gland is not duly maintained it results in

loss of vacuum. A technically acceptable practice is to flood the gland zone with high pressure internal connection, which effectively maintains the vacuum on the suction flange, but in this process a further loss of efficiency occurs.

FINANCIAL CONSIDERATION

It has already been shown that if the depletion of the SSWL is from 10 ft. to 30 ft. the efficiency of the turbine pump is 16.6 % higher than the efficiency of the centrifugal pump. If the depletion of the SSWL is from 10 ft. to 20 ft. the efficiency difference is 8.7%. Assuming the depletion to fluctuate between 10 ft. to 15 ft. the average efficiency of the turbine pump will be 10% higher than the centrifugal pump This efficiency difference can be looked upon in two ways. We can either say that the turbine pump will deliver 10 % more water for the same power consumption or the turbine pump will consume 10 % less power per unit discharge as compared to a centrifugal pump. Taking the latter basis for evaluation we proceed as below :

Let us consider a 2 cusecs centrifugal pump and a turbine pump of the same rated capacity.

Comparing the capital cost of a centrifugal pump and a turbine pump including the pump house and other auxiliaries which go along with the two pumps upto a depth of 65 feet which is taken to be the length of the housing pipe for the turbine pump, we have the costs as follows :

Turbine Pump = Rs. 36.300/-) See details in
Centrifugal Pump = Rs. 30,600/-) Annexure VIII

Power Consumption.

Power unit to be used in both the cases = 20 H. P. = 15 K. W.

Motor Efficiency = 0.85

Power consumed $= \frac{15}{0.85}$ 17.65 K. W.

Assuming an operating factor = 0.6

Total operational hours/year = $24 \times 365 \times 0.6 = 5256$ hours

Assume a power factor = 0.85

Power units consumed/year $= \frac{17.65 \times 5256}{0.85}$

$= 109139$ hours

Total power bill/year $= 109139 \times 0.072 + 5.5 \times 15 \times 12$

$=$ Rs. 8,838

The turbine pump power bill will be 10 % less

Turbine pump power bill/year = Rs. 7,954/-

Saving in power bill/year = Rs. 884/-

Net capital cost of a centrifugal pump and auxiliaries is Rs. 30, 600/-
Initial capital cost of turbine pump and auxiliaries is Rs. 36,300/-

Present extra cost of turbine pump installation is Rs. 5,700/- This sum, over a period of 15 years at 10 % compound interest, would accumulate to Rs. 23,800/- This means that the turbine pump would have eventually cost Rs. 23,800/- more than the centrifugal pump ; but the electric power economy of the former at Rs. 884/- per year would, in the course of 15 years, the life of the pump, capitalise, at 10 % interest, to a sum of Rs. 30,900/- Hence the use of the turbine pump will result in a net saving of Rs. 7,100/- (Rs. 30,900 - Rs. 23,800) in 15 years. Looking up on it in a different way as a service ad-infinitum.

Capitalised value of turbine pump

installation $= P + \frac{C}{1} = 36300 + \frac{7954}{0.1}$

$= 36300 + 79540 =$ Rs. 1,15,840/-

Capitalised value of centrifugal

pump installation : $= P' + \frac{C'}{1} = 30600 + \frac{8838}{0.1}$

$= 30600 + 88380 =$ Rs. 1,18,980/-

Thus considered either way turbine pump is financially a better proposition in the long run.

Since this paper was prepared, the cost structure has completely changed and is still continuing to change. However it is presumed that the financial analysis still holds good.

RECOMMENDATIONS

For planned pumpage in SCARPS, we make the following recommendations.

1. Installation of low capacity pumps in the public sector is not a good investment. There is no economic advantage in installing irrigation wells of less than 2 cusecs capacity However, taking other factors into consideratlon, we recommend instaliation of irrigation wells from 1.5 to 2 cusecs capacity. In special cases where the outlet capacity or other aquifer conditions place a restraint we may use pumps of one cusec capacity.

2. The verticle turbine pumps are ideally suited for wells of capacities 2 cusecs and above. Our technical as well as financial appraisal has proved in favour of the use of turbine pumps for wells of 2 cusecs and higher capacities.

3. For wells upto 1.5 cusecs discharge both types of pumps i.e. centrifugal as well as turbine can be used. Centrifugal pumps of 1.5 cusecs capacity may be used as those are technically and financially feasible.

4. (*i*) The technical aspects of Hydraulic machines enumerated in the paper are applicable in all cases where a tubewell is to be installed.

   (*ii*) The financial consideration may not be applicable to all situations. Each case has to be independently evaluated as laid out in the paper.

———

COMPARISON OF INITIAL COST FOR THE CONSTRUCTION OF PUMP HOUSE FOR INSTALLATION OF 2 CUSECS CENTRIFUGAL PUMP AND INSTALLATION OF TURIBINE PUMP IN STEEL HOUSING PIPE

Cost as in July, 1974

Sr. No.	Detail	Quantity	Centrifugal Pump I Rate	Centrifugal Pump I Amount	Turbine Pump II Rate	Turbine Pump II Amount
1.	Construction of Pump House	—	—	12,500.00	—	3,800.00
2.	Providing priming tank of 45 gallons drum with LID & Fittings	1 No.	250	250.00	—	—
3.	Bend 8" dia	2 No,	180	360.00	—	—
4.	Gravel Shrouding	53 Lrt.	30	1,590.00	—	—
5.	Suction valve	1 No.	270	270.00	—	—
6.	Sluice valve	1 No.	700	700.00	—	—
7.	Differential cost of steel houing pipe 14" dia including steel concentric reducer 20" long and suction and delivery pipe 8" dia in C.P. Rs. 200—115 = Rs. 85/-	61 Lft.	—	—	85.00	5.185.00
8.	Gravel Shrouding	61 Lft.	—	—	30.00	1,830.00
9.	Bed Plate	1 No.	500	500.00	—	—
10.	Cost of 2 adjustments in setting of centrifugal pump	L.S.	500	2,400.00	—	—
11.	Pump, Motor, Controls	L.S.	12,000	12,000.00	L.S.	25,500.00
		Total Rs.		30,570 00	Rs.	36,315.00
		Say Rs.		30,600.00	Rs.	36,300.00

The cost of two adjustments of centrifugal pump one at Rs. 2.000.00 at the end of five years and another at Rs. 3,000.00 at the end of 10 years with 10 % compound interest comes to Rs. 2,400.00 approximetely at its present value