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September 28, 1973

Mr. A. Dale Swisher, P. E.
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Office of Health
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Agency for International Development
Washington, D. C. 20523

Dear Mr. Swisher:

Ninth Quarterly Progress Report on
Phase III "Field Research and
Testing of a Water Hand Pump for
Use in Developing Countries"
AID/csd-3305
June 29 through September 29, 1973

Effort this past quarter was directed toward starting pump production in Bangladesh and completing the new deep well pump cap patterns and sample pumps for operation in our testing areas. A rather complete program status report from Bangladesh is included in this report, as well as a record of the total expenditures through June, 1973.

The UNICEF Program

As part of the UNICEF Program, 4 sample pumps were sent to Dacca for the purpose of demonstration to and examination by UNICEF staff, Bengali government personnel, and manufacturer representatives. Several of the pumps were set out in a high density area of Dacca where the water table had dropped to 25-28 feet and where the existing pumps were not functioning. Because of these conditions the pumps were very heavily used. For example, whenever the pumps were visited by the Battelle Foundry Technician over a 3-month period, no fewer than 24 persons were observed waiting for water.

After about 50 days of operation, the pumps were examined and the wearing parts of the pump measured. Quite unexpectedly, it was found that holes in the pump base which supported the fixed fulcrum showed some wear.

The pumps were then placed back in use and examined again, just before the Battelle Foundry Technician returned home. The wear at these pinned joints had continued. Through examination of enlarged color photographs and discussions with the Battelle Foundry Technician examining the pumps, it was concluded that the wear is probably the result of fretting. Fretting commonly occurs under repeated cyclic loading of non-rotating, but slightly moving parts.

This type of wear has not been encountered before. However, most of the prior pumps had been of the deep-well type rather than the shallow-well type being used in Bangladesh. Several solutions to this problem have been considered. The first would include modification of the design to eliminate the motion and loading causing the fretting. This can be done by making the fulcrum part of the body or part of the cover. Since we are striving for long life and easy maintenance, we have suggested that the fulcrum be a part of the easily replaced cap which would be bolted on the pump body. Alternatively, since the pumps subjected to extreme duty, as described above, will be small in number, modification of the design to accommodate such situations might be unwise. Subsequent effort on the UNICEF program should resolve this question. An excerpt from a larger report, Addendum I, which starts with page 10, is an excellent review of the program in Bangladesh and appears in Appendix A. Some comments should be noted.

In Addendum I, on page 11, 12, and 13 there is a discussion of using 3 inch PVC pipe in a dual role of casing and cylinder for "shallow" deep wells. Such an arrangement is quite feasible and a possible foot valve system has been designed, mocked-up and sent to Dacca for review. It should be pointed out, however, that "bare" plastic pipe and a bamboo pole handle as illustrated in the drawing would be quite vulnerable to accidental impact and that a cast iron pump head is believed to be needed for long term service.

Item Number 3 on page 15 of the document discusses the pump head cover with fulcrum. Many of these covers must be replaced not only because of the worn fulcrum holes, but also because of fracturers between the cover and the fulcrum. A stronger design is needed (in solving this problem and eliminating the use of nuts and bolts, fretting became the problem).

Raw materials and production problems are discussed on page 18. The report states that "The Battelle pump presents a series of production problems". The Battelle pump is larger and two of the parts, the body and the handle, would have to be cast in new boxes for most of the foundries. Machining is no more difficult than that required for the old pump.

The UNICEF report describing desired modifications, is in keeping with our original comments made in our first report, September 29, 1967. (Contract No. AID/csd-1434) In essence, our comments state that the design must be flexible enough to permit each country to redesign on the basis of acceptable aesthetics, available materials, and manufacturing

capabilities (See "Analysis of Foreign Surveys and Observations", last paragraph and "Pump Design", first half of discussion, 1967 report). The Battelle Design is now going through local design modifications, and the final arrangement with the changes will soon be acceptable to all. Only after local input is satisfied can production be started. As far as the material shortage is concerned, arrangements for pig iron might be made through UNICEF.

Other Field Reports

No additional information from that given in the last reports has been received concerning the work in Thailand and Nigeria. Letters were written describing a new deep well pump cap that was being considered and that experimental caps would be sent to them in the near future. It is expected that activity will increase as soon as the new caps are received.

The New Deep Well Pump Cap Design

After an unbelievable long delay components for three experimental pump caps have been received from the foundry. As soon as possible the parts will be machined, assembled,and sent to the three test areas. It is hoped that a good response can be received by the end of this program.

Program Review

The major lesson learned during our previous work on pump development and work with manufacturer/user country personnel has been reemphasized. The manufacturer/user country must be permitted latitude to make minor changes on the pump to suit their own use pattern and adapt to their own manufacturing and maintenance capabilities.

As the result of field tests to date, the following points should be made:

(1) Under extremely heavy use consisting of 24-hour operation and a lift of around 25 feet, wear has been noted in pinned joints. Two approaches to this problem can be taken. Since the problem is unique to pumps experiencing extreme duty cycles, perhaps these relatively few pumps can be modified to include a wear-resistant bearing material for the joints or even replaced completely when wear is excessive. (This would occur after several years operation under the most extreme conditions encountered.) The second approach to the problem would be to modify all of the production pumps to suit them to this extreme duty cycle.

(2) Plastic cylinder liners have proven most satisfactory giving no problems whatsoever.

(3) The simple guide rod and upper bushing used on the deep well pump does not seem satisfactory. Excessive wear on the bushing and rod were experienced in field testing.

(4) Test data on cup and valve material are incomplete, so it is not possible to make positive recommendations at this time.

As mentioned above, the very uniqueness of each country renders it very difficult to make definite statements. What works in one country may not be satisfactory elsewhere. In view of this situation, we must expect to modify the basic design many times to suit any and all counditions.

Program Review

Originally, we set out to provide a pump with the following specifications:

(1) Low production costs

(2) Long life under severe conditions

(3) Easy to maintain with simple tools and unskilled labor

(4) Suitable for shallow or deep well installation with only minor changes

(5) Capable of being manufactured in developing countries with a minimum of capital investment

(6) Easily operated by small people, including women and children

(7) Include design features which will discourage pilfering and vandalism.

We see no reason at this time that all of these objections can not be met. At present, we are seriously considering a bolted-down cover with provisions for a fixed or moveable fulcrum for use in certain areas where the present design is showing wear. We had hoped that nuts and bolts could be eliminated, mostly because at one time threaded fasteners were so poor and there was temptation to steal them. However, the solid attachment of the cover will eliminate the wear associated with slight motions between the parts and will make replacement simple if wear is excessive. Replacement of the cover will, of course, be much less expensive than replacement of the complete pump body. In addition, a design with threaded fasteners would be more conventional and more acceptable to the user country.

Financial Statement

Total expenditures through June, 1973, were not available in time for the "Second Annual Research Report", therefore, the costs through May were used and June expenditures estimated. Costs through June, 1973, were as follows:

Direct Salaries	$13,645.71
BCL General Overhead	10,356.95
Departmental Burden Overhead	3,620.26
Travel	4,621.26
Other Direct Costs	1,958.46
Materials and Supplies	7,190.49
Total	$41,393.13

A corrected statement of estimated expenditures for the remainder of the program through April, 1972, are as follows:

Direct Salaries	$ 1,400.00
BCL General Overhead	1,100.00
Departmental Burden Overhead	380.00
Travel	0.00
Other Direct Costs	350.00
Materials and Supplies	2,000.00
Total	$ 5,230.00

Future Work

During the coming quarter, work will continue with UNICEF to help get tl program underway. It is also anticipated that three new deep well pump caps will be sent to the three areas in the next two or three weeks. Hopefully, by the end of the year a second report will be available from Bangladesh and encouraging news received from Thailand and Nigeria concerning the new deep well arrangement.

If you have any questions concerning this report, please call us.

Sincerely,

Robert D. Fannon Jr.

Robert D. Fannon, Jr.
Research Engineer
Equipment Development Section

RDF:ban

Encl. (25)

cc: Mr. V. C. Perelli

Addendum 1

The Bangladesh Handpump

(some technical, economic and social considerations)

The following is an attempt to present the Bangladesh point of view on a number of both detailed points and general principles which have recently been the subject of correspondence among many of the persons directly or indirectly involved in the programme.

Introduction

At the outset, the liberty has been taken for the sake of clarity of dividing the discussion between the Deep Well pump and the Shallow Well pump. First, the terms should be defined.

Shallow well pump: This may be used when the water level is not more than 25 feet below the ground surface. The piston is contained within the pump head body. Water is pulled up through the tube by suction created by moving the piston up and down in the cylinder.

Deep well pump: If the water level is more than 25 feet below the ground surface, the force of suction will not be sufficient to pull the water up the tube. In this case, the cylinder must be actually submerged below the water surface. Water is then lifted to the surface by the up and down motion of the cylinder.

Deep wells with Shallow pumps

In the coastal areas of Bangladesh, the water surface is sometimes less than five feet below the ground surface. So a shallow well pump works just fine. The only difficulty is that the water available in the shallow depths contains so much iron and salt that not even stray dogs will drink the water. There is a layer of sweet water about 900 feet below the surface. Fortunately that water is under pressure and will rise of its own accord without the assistance of any pump to within a few feet of the surface. A handpump is needed only to raise it the last few feet into the spout and out into the pitcher or bucket. Thus in these areas we have what is truly a deep well but with what is technically still called a shallow well pump.

Shallow well pumps are generally satisfactory in deltaic areas, of which Bangladesh comprises one of the worlds largest. Other similar areas are few in existence. The problem as stated is the quality of the water obtained.

There are pockets of Bangladesh, mainly hilly areas and land adjacent to major rivers, where the deep well pump must be used. A recent DPHE [illegible], however, has in[illegible] [illegible] less than 3% of the total need. This is partly due to the fact

that deep well pump areas happen to coinride with sparse population settlements.

Authoritative sources on ground water hydrology in Bangladesh are of the opinion that this situation is not likely to be significantly affected by the large scale irrigation tubewells planned for Bangladesh. Such wells will be pumped only 4 - 5 months a year, during the dry season. It is expected that the ground water reservoir will be sufficiently recharged during the balance of the year to prevent any permanent lowering of the water table.

There will of course be problems for shallow handpump tubewells in the immediate vicinity of a big irrigation tubewell while it is pumping. But this is expected to be a localized administrative problem rather than a natinal calamity.

Bangladesh being a hydrologic exception to the rule, the handpump is used to provide a source of safe drinking water whereas in other parts of the world a deep well pump may have to be used. For this reason, Bangladesh is not particularly well suited as a testing ground for a pump desired for univeral use.

The Deep Well Pump

In continuation of the remarks just made in the introduction, the following discussion is offered relating particularly to the deep well pump.

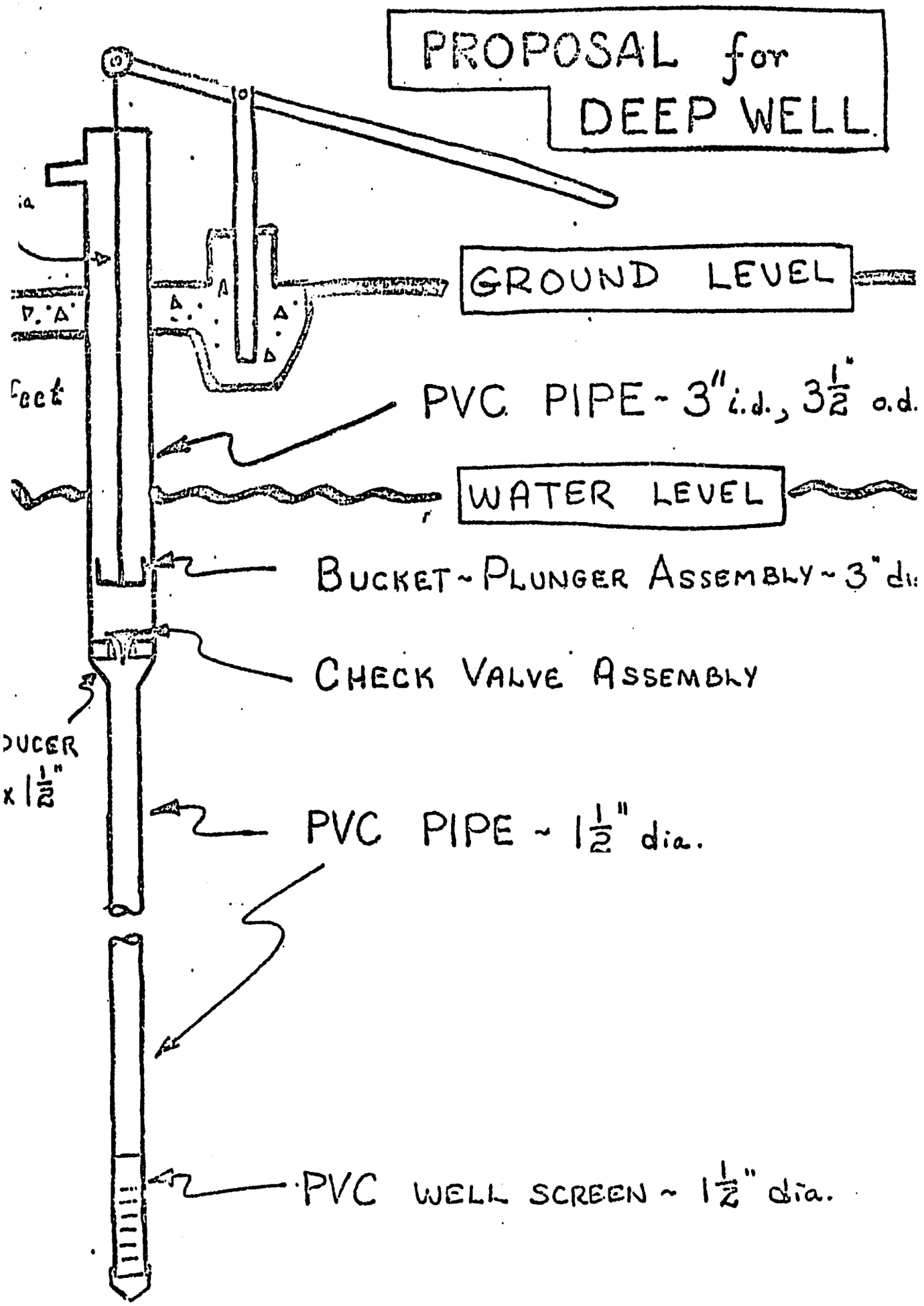
Even if Bangladesh were a suitable area for testing the deep well version of the Battelle pump, there is no deep well pump in hand to test. This fact has a bit of history.

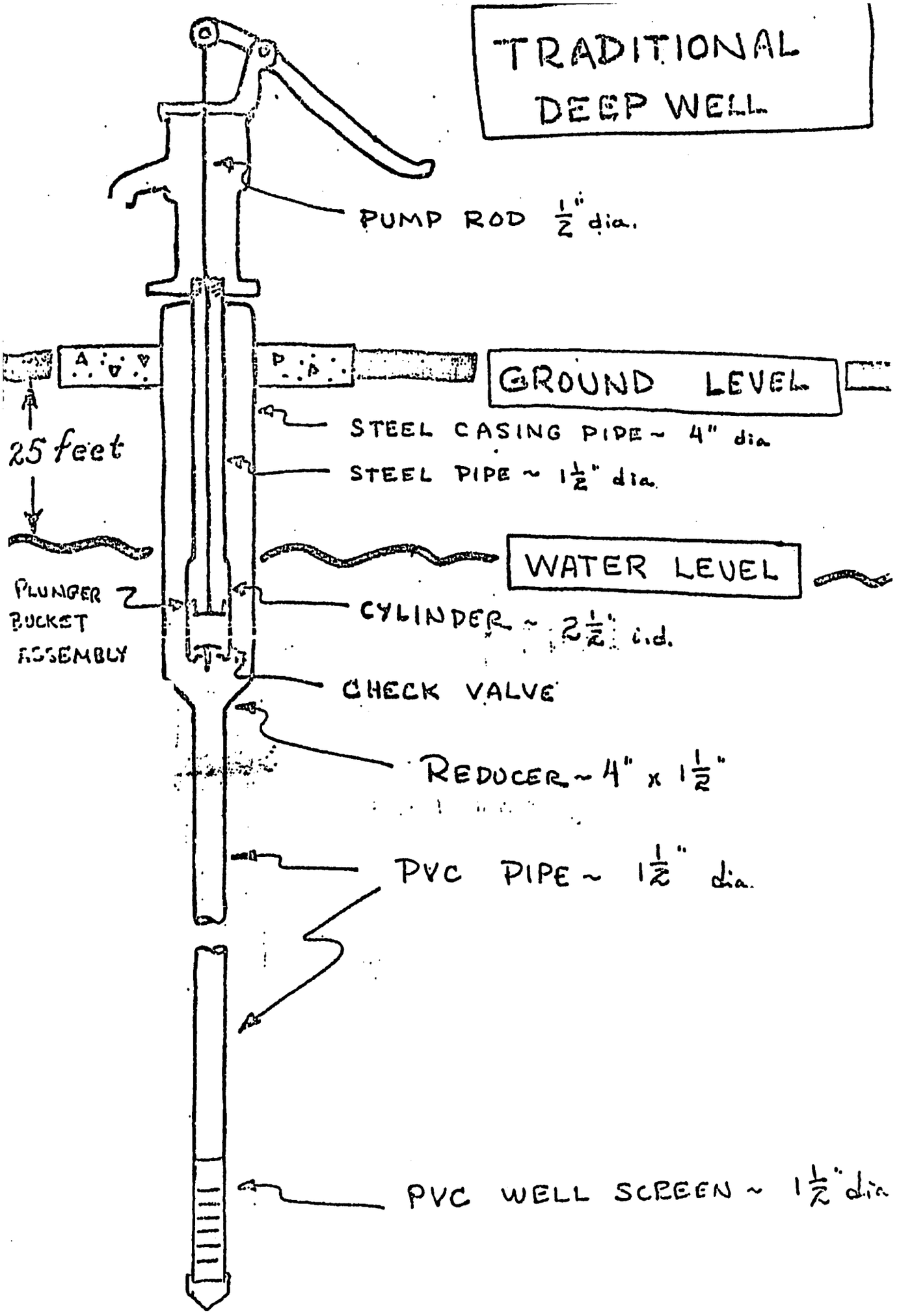
Battelle has already put a deep well version of its pump to test in Thailand and Nigeria, and perhaps other countries as well. In Nigeria the pump was produced in co-operation with CARE a few years ago. Perhaps Nigeria would be a fruitful source of information on the viability of the deep well version of the Battelle pump.

Only a few deep well pumps were installed in Thailand. A recent inspection of these pumps by Battelle engineers revealed a serious technical problem. The pump rod guide was wearing out prematurely. This discovery prompted Battelle to redesign the pump rod guide.

The redesigned deep well version is still under test at Battelle Columbus. That is why the deep well version of the Battelle pump is not available at UNICEF Dacca.

Even if it were available, it might not ever be necessary. Recent brainstorming sessions which took place in [illegible] on the occasion of the last Battelle visit have postulated that both the pump head, the cylinder and the very costly large diameter casing pipe may be eliminated altogether in deep well pump installations.


PROPOSAL for DEEP WELL
GROUND LEVEL
PVC PIPE - 3" i.d., 3½" o.d.
WATER LEVEL
BUCKET - PLUNGER ASSEMBLY - 3" di
CHECK VALVE ASSEMBLY
PVC PIPE - 1½" dia.
PVC WELL SCREEN - 1½" dia.


TRADITIONAL DEEP WELL
PUMP ROD 1/2" dia.
GROUND LEVEL
STEEL CASING PIPE ~ 4" dia
STEEL PIPE ~ 1 1/2" dia.
25 feet
WATER LEVEL
PLUNGER BUCKET ASSEMBLY
CYLINDER ~ 2 1/2" i.d.
CHECK VALVE
REDUCER ~ 4" x 1 1/2"
PVC PIPE ~ 1 1/2" dia.
PVC WELL SCREEN ~ 1 1/2" dia

As may be seen in the sketch a length of PVC plastic pipe which has an inside diameter of 3" serves the dual purpose of both a well casing and pump cylinder wall. This is identical to the 3" liner used in the shallow pumps.

The only technical problem which needs brushing up is the check valve.

It may also be seen that a pump head is not needed at all. The only thing needed is a mechanical device to move the piston up and down. A fulcrum set in concrete may be used. The handle can be a bamboo pole. It can be 20 feet long if desired to give as much mechanical leverage as required.

Also a chain linkage on a roller may be used to connect the lever to the piston rod. This would eliminate altogether the pin which normally wears out very quickly.

In conclusion, the question of deep well pump should be looked at afresh by imaginative designers with practical experience of field conditions. Trying to develop a single pump which may have universal acceptability may not be unlike imposing a universal religion or ideology. The general principles may well apply. But account must be taken of local variations in condition.

The Shallow Well Pump

Turning our attention to the shallow well pump, there does seem to be unanimity amongst UNICEF staff that it was a sound decision for Bangladesh to concentrate on a shallow well pump suited to the needs of Bangladesh - rather than producing a pump which would be interchangeable between deep and shallow.

UNICEF Bangladesh staff would like to re-emphasize a major position regarding the Battelle pump. The Battelle pump unquestionably represents a major step forward in handpump design (with the possible exception of the independent fulcrum, which Battelle appears ready to abandon). Any modification of this pump would definitely attempt to retain all the functional improvements in the Battelle pump.

It should be remembered that an economic constraint was not written into Battelle's terms of reference. It should also be noted that the desirability of having deep/shallow interchangeability arose out of joint UNICEF-CDM-DPHE (emphasis on first two) discussions during the Battelle visit of September 1972.

The recent decisions were brought about only later on in the light of new information which indicated that major changes would be desirable in the design assumptions related to the need for deep well pumps and the critical nature of the financial constraint.

With these general thoughts in mind, the discussion now turns to a round-up of a variety of specific topics which have been the subject of controversy.

The Bangladesh Pump Design. Whatever the final details of the design, the main principle is that neither the functional nor structural advantages of the Battelle pump have been lost.

Design Life. It has been suggested that the life expectancy of various pump components be projected. This is a basic requirement because such data are essential to good practical design work. The following schedule is offered as a rough suggestion as to what is both practical and desirable in Bangladesh.

1. Body : 25 years

   This was the basis for questioning the efficacy of the Battelle fulcrum. The pump body in having a wear point associated with it became vulnerable to failure where it never was before. It is not unreasonable to expect 25 years useful life from a pump barrel. There are pump bodies functioning in Bangladesh today installed during British India. The possibility of adopting a design with even the remote possibility of a shorter service life seemed like a major step backwards.

2. Handle : 10 years

   It is a tragedy that in Bangladesh being so short of pig iron, handles fail the way they do. Most handles which are replaced are structurally sound. The only problem is that the holes become too large because of the movement.

Bushings have been mentioned as a solution in New York and Dacca. But there is the practical problem of fitting them properly in the first instance. Then there is the still greater problem of replacing the worn bushings. If the worn bushings are not replaced before they fail, then there will be a gaping hole. With the elementary maintenance system now in effect, bushings are not yet a practical solution. If an improved maintenance system can be developed bushings may well be part of the answer to the problem.

What is a practical solution? Larger bearing surfaces at wearing locations. This is provided by wider cross sections in the casting and larger diameter smooth surfaced steel pins. Preventing rotation of the pins is another answer.

Hardened bearing surfaces have not been considered feasible by local suppliers. Perhaps more work could be done in this area, but it would not seem to present a practical solution for the present.

Nor does lubrication. No one doubts that lubrication would improve the life of moving parts. Getting an oil can and a regular lubricating job institutionalized at some 300,000 well sites is a human organizational, social, cultural - in short, administrative problem - rather than an engineering hypothesis to be verified by field testing.

Lubrication may indeed be one way to go towards improvement of the life of the pump. It may take a little time however to get it regularly established. Headquarters has mentioned that lubrication has worked in other countries. If so. perhaps the details could be supplied to Dacca.

Returning the pumps to workshops for overhauls has been proposed. This proposal is much too sophisticated at the moment for the maintenance system as it is presently administered. Hopefully, some day, all the old pumps could be pulled off and replaced by new pumps.

But as has just been described, most parts do not fail, but the holes get too big and it is not possible to weld up the holes.

3. Headcover - cum fulcrum : 10 years

   Same problem as the handle. The entire headcover may be intact save for over worn holes. But ones the holes become too big, the entire piece must be replaced. Salvage is practiced only to the extent of using the worn parts for scrap in casting new parts.

4. Base plate : 15 years

   The only wear is a gradual erosion of the valve seat. The proposed new design might take care of this.

5. Bucket 3" diameter : 1 year

   Previously buckets lasted 3 - 4 months so this would be a major improvement. The change is possible because of the PVC liner and changing from a 3½" diameter to a 3" diameter size.

6. 5/8" diameter steel pins : 1 year

   The whole objective of the design exercise was to produce a pump capable of funtioning trouble free for twelve months. This would be of tremendous advantage because the same number of mechanics could cope with greater numbers of wells.

   Schedules for the other parts could be worked out, but perhaps the above samples will suffice for this discussion.

Convenience

Headquarters has raised the convenience of the Battelle pump as one of the smaller gains it would prefer not to lose. The technical committee which made the major decisions regarding Pump Design addressed itself to this very question in some detail. The highlights are worthy of repeating here.

First of all, there are rather few concentrations of population in the rural areas. Small clusters of homes are dispersed across the rice fields, marshes, and river networks somewhat like the stars across the Milky Way. Consequently the question of queues does not arise.

The picture is more like a woman strolling a quarter of a mile or so to the local pump with a pitcher on her hip. At the pump she meets a few other women. As most Bengalee women, particularly the Moslems, normally focus their daily activity within the household, the daily trip to the pump provides a rare opportunity to socialize and gossip.

The actual pumping will probably only consume about 5 minutes in the daily round of the typical villager. It should be remembered that since all the water must be hand carried, only the minimum quantity of water needed for drinking is normally brought from a tubewell.

Moreover, a large part of the waking life of the rural Bengalee is spent bending over. So if he or she must bend over a little bit more for a few minutes a day to pump water - what is the harm? Or if the output of the pump is only 6 gallons per minute rather than 8, what again is the harm since the average pot which a woman carries can only hold four gallons anyway. This is the official posture of the Government.

With so much of the rural population engaged in a struggle for survival, the vital need is vastly more numbers of tubewells for the masses rather than a super pump for a privileged few.

The dispersion population pattern as it prevails in the rural areas of Bangladesh means that each pump serves perhaps at most 100 - 150 people. Beyond that range of proximity, it becomes too far to walk. Thus it is not without logic that the policy of the Government is more smaller pumps.

The implication of Battelle's statement, "It is better to make fewer better pumps than a larger number of unusable pumps", is not correct.

UNICEF's goal is better pumps AND more of them.

Handle length, barrel length, platform design

These factors are all part of the convenience equation. They are equally disposed of in light of Government policy.

It is not under consideration to construct a concrete pedestal. It is planned that the water fetchers will have to bend over four more inches.

Here again convenience must be taken into account in the context of rural Bangladesh. By producing a lower cost pump unit, it will be possible to install more tubewells, thereby saving the village perhaps a quarter mile walk. So five inches more in one direction for a quarter mile saved in another.

Incidentally, the handle design being considered for the new pump is structurally identical to the Battelle pump. It is only shorter. This will save about seven pounds of pig iron. A' shorter handle will also be less likely to break.

A totally new platform has been designed. The one or two foot stub of steel pipe referred to by H.Q. will actually ba a 27" length of 1½" diameter steel pipe anchored in 18" of solid concrete. A copy of the design is being sent to UNICEF H.Q.

The new platform is required for the PVC pipe. If the platform is not successful, the joint between the PVC pipe and the 27" length of steel pipe will surely fail when pressure is applied on the pump.

Good platform design is futile without the proper technical supervision to ensure that contractors actually do the job properly. It is noted that cement is not available in the open market. Whatever cement does find its way into the market sells for Taka 50 per bag.

Spout. The new spout may be shorter. It may be lighter. But it will deliver the same amount of water. And buckets could be hung on it if they became available.

The Question of Economy

The discussion on pump design tends to divide itself into two categories -- technical questions of function and questions of economy. Most of the discussion so far has related to the more purely technical aspects. Now a few notes on economy.

The Battelle pump was let out to bid. Quotations were received averaging Taka 190 per pump when UNICEF was then purchasing the more conventional pump at Taka 109.

It may be argued that the Battelle pump is so much better than the standard pump that the extra expenditure is justified. Very possibly that may be true.

The question is however, is the extra expenditure necessary? The hypothesis behind the new pump design is that a better pump - equal in performance to the Battelle pump - can be produced not only at less cost than the Battelle pump, but at less cost than the conventional pump.

Why was the Battelle pump so expensive? There were two basic reasons - the amount of raw materials used and difficulty of production.

Raw Materials. UNICEF H.Q. recently searched the world market place in vain trying to get quotations for 5,000tons of pig iron. The pig iron crisis in Bangladesh is not how much pig iron, or what quality pig iron but that of getting any at all. Many of Bangladesh's largest foundries are completely shut down because they have no pig iron.

The Trading Corporation of Bangladesh is presently totally reliant on a barter agreement with India for whatever pig iron it can get. Foundries with contracts with UNICEF for pumps get first preference for any pig iron that comes into the country.

In these circumstances, every pound counts.! And it is repeated for emphasis that savings are not being made at the expense of performance.

At any rate, the pump under consideration would be about 45 - 50 pounds in weight. The Battelle pump weighs nearly 80 lbs. The present standard pump being purchased by UNICEF weighs about 70 pounds.

Production problems. The Battelle pump presents a series of production problems. There are casting problems, machining problems, assembly problems. Suffice it to say without further detail, that this was the major factor in the high cost, moreso than the amount of pig iron.

The new design is being developed in close association with the local foundries whose points of view are being given sympathetic consideration. Every effort is being made to simplify production.

This does not mean that UNICEF is coddling the foundries or accepting low standards. It does mean that unnecessary complications are to be avoided if possible and the practical realities of the state of the foundry in Bangladesh taken into account.

Engineering. H.Q. wondered what sort of engineering expertise was going into the new design. CDM engineers are in close touch with the pump development. Highly qualified local foundries' engineers are also contributing. Basically however, it is still the Battelle engineers at work behind the scenes. Most of the basic concepts are being taken directly from the

Battelle pump and being reformed into a pump better suited to Bangladesh.

Regarding Engineering drawings - there are very few people in Bangladesh who can read them let alone produce them. The development of the design is being done through the medium of prototype models - metal, wood, aluminium and cast iron.

Testing Programme

A test programme is being set up. A variety of pumps will be observed under a variety of conditions. A limited attempt will be made to quantify the water use per pump and the amount of wear. The practical problems will, it is hoped, be fully appreciated by all concerned.

The following pumps will be observed:

1) Battelle pump made in U.S.A.
2) Battelle pump made in Dacca
3) DPHE No. 6 pump with PVC liner
4) DPHE No. 6 pump
5) Pitcher type pump with PVC liner.

Both typical rural settings and heavily congested urban areas will be used.

Addendum II

Rough Cost Estimate

Imported Materials for 100,000 Shallow Tubewells

Cost of Materials for one shallow tubewell : (Average total depth 150 feet)

1.	1½" dia. PVC pipe solvent welded joints including solvent cement & adaptors	135 feet @ $0.15	$ 20.25
2.	1½" dia. PVC well screen with spigot socket joints. Each piece 2 meters long	2 pieces @ $4.00	$ 8.00
3.	Cement for platform	2 bags @ $1.75	$ 3.50
4.	1½" dia. galvanized steel pipe to BSS-1387 (1967) heavy series for pump connection	3 feet @ $0.50	$ 1.50
	Total cost of imported materials for one shallow tubewell		$ 33.25
	Total cost imported materials for 100,000 shallow tubewells		$ 3,325,000.00
	Add 5% contingency for extra materials		$ 166,250.00
			$ 3,491,250.00
	GRAND TOTAL COST : Imported materials for 100,000 shallow tubewells Rounded to		$ 3,500,000.00

Addendum III

Rough Cost Estimate

Imported Materials for 9,500 Deep Wells

Cost of Materials for one Deep Tubewell : (Average total depth 900 feet)

1.	1½" dia. PVC pipe with threaded joints	879 feet @ $0.28	$	246.12
2.	1½" dia. PVC well screen with threaded joints, each piece 2 meters long	3 pieces @ $4.00	$	12.00
3.	Cement for platform	2 bags @ $1.75	$	3.50
4.	1½" dia. steel pipe for pump platform connection BS 1387 (1967) - heavy series	3 feet @ $0.50	$	1.50
5.	4" dia. m.s. casing pipe	10 feet @ $1.00	$	10.00

Total cost of imported materials for one deep well	$ 273.12
Total cost of imported materials for 9,500 deep wells	$ 2,594,640.00
Add 5% contingency for extra materials	$ 129,732.00
	$ 2,724,372.00
GRAND TOTAL COST ; Imported materials for 9,500 deep tubewells Rounded to	$ 2,724,380.00

/..