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TECHNICAL ASSISTANCE IN THE MANUFACTURE AND QUALITY CONTROL OF THE AID/BATTELLE HANDPUMP IN THE DOMINICAN REPUBLIC

WASH FIELD REPORT NO. 20

JUNE 1981

Prepared For:
USAID
Mission to Santo Domingo
Order of Technical Direction No. 1

WATER AND SANITATION
FOR HEALTH PROJECT

WASH

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24 June 1981 P3-10 (1)

Mr. Phillip Schwab
USAID Mission Director
USAID
Santo Domingo

Attn: Dr. Oscar Rivera, M.D.

Dear Mr. Schwab:

On behalf of the WASH Project, I am pleased to provide you with fifteen copies of a report on Technical Assistance in the Manufacture and Quality Control of the AID/Battelle Handpump in the Dominican Republic. This is a final report by Mr. Robert Knight, and his recommendations are included in the report.

This assistance was requested by the Mission on 30 June 1980. The WASH Project was authorized to undertake the work by USAID/Washington, DS/HEA, in order of Technical Direction No. 1, dated 23 September 1980.

We look forward to your comments and will be pleased to discuss any questions you may have regarding the findings or recommendations contained in this report.

Sincerely,

Dennis B. Warner

Dennis B. Warner, Ph.D., P.E.
Acting Project Director

DBW/RS

WASH FIELD REPORT NO. 20

DOMINICAN REPUBLIC

TECHNICAL ASSISTANCE IN THE MANUFACTURE AND QUALITY CONTROL OF THE AID/BATTELLE HANDPUMP IN THE DOMINICAN REPUBLIC

Prepared for USAID Mission Santo Domingo
under Order of Technical Direction No. 1

Prepared by:
Robert Knight
Consultant

June 1981

Contract No. AID/DSPE-C-0080
Project No. 931-1176

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ACKNOWLEDGEMENTS

The writer wishes to express his gratitude for the assistance of Oscar Rivera Rivera, M.D. and his staff in the Office of Health and Nutrition USAID Mission in Santo Domingo, who, in spite of their own workload, graciously gave of their time and helped in countless ways.

I also wish to take this opportunity to thank Dr. Pedro Albrecht of the University of Maryland for his interest and assistance in testing and collecting data on the tensile strength of solvent welded PVC pipe joints.

Chapter 1

INTRODUCTION

The U.S. Agency for International Development (USAID), through its Office of Health and its Mission in Santo Domingo initiated a rural water supply project as part of a wider public effort in the Dominican Republic. One component of the project was the local manufacture, installation and maintenance of handpumps in rural communities. Initially 21 pumps were pilot tested in selected areas and an additional 25 pumps were installed after this initial testing. The current order of 1,000 pumps (approximately 200 of which have been installed) is to be supplemented by an additional order of 1,600. Manufacture of the latter has not yet begun, but lists of materials required are being compiled.

In order to promote the local manufacture of handpumps, two manufacturing companies in Santo Domingo were awarded contracts by USAID to produce 46 AID/Battelle hand-operated water pumps. One of the companies, Industroquel, C. por A., is essentially a machine shop where the pumps were manufactured by substituting welded steel components for what ordinarily would be iron castings. The second company, Astilleros Navales Domincanos, C. por A., whose facilities are more sophisticated, has a well-equipped machine shop and foundry.

In August 1978 both companies began manufacturing the pumps and by January 1979 all 46 pumps had been delivered to the AID Mission in Santo Domingo.

As part of a pilot program, 21 of the pumps were installed in the Cibao Valley Region. This was completed by January 1979.

From observations on field trips over a five-month period from October 1980 to February 1981 it was apparent that the program was fairly successful -- the degree of success in almost every instance being dependent on the amount of care and maintenance the pump received from the users.

The AID/Battelle pump had obviously been regarded favorably in the Dominican Republic as an additional 1000 handpumps were ordered by the Government of the Dominican Republic in conjunction with USAID. In this instance, all interested manufacturers were invited to submit bids, and a third company, Equipo Tecnico Industrial, was awarded the contract.

Equipo Tecnico Industrial, C. por A.
Calle San Juan de la Maguana #102
Tel. 566-8776, Apartado No. 158-12
Villas Agricolas, Santo Domingo, R.D.

Equipo Tecnico Industrial, C. por A., is a place of high caliber. It is medium sized, orderly and efficient without high overhead costs. There are 65 employees, and the plant is equipped as follows:

Foundry: cupola 26 inch Dia. (1)
oven (1)
bronze furnace (1)
bronze oven (1)
pattern making facilities
a large variety of aluminum and wooden molds and mold boxes

Handpump output per week - 75

Machine shop:

lathes (4)
gearcutter (1)
cylinder grinder (1)
hydraulic press (1)
cut-off saws (3)
punch press (1)
radial drill (1)
drill presses (6)
air compressor
gas welding equipment
spot welder
welding machine

Handpump output per week - 50

The original manufacturers were given technical assistance by Georgia Institute of Technology. However, Equipo Tecnico Industrial started production without experience specific to the manufacture of handpumps or the benefit of technical assistance. Although the quality of the castings and of the work done in the machine shop was very good, the lack of handpump experience was evident and numerous minor problems were encountered.

USAID Santo Domingo then requested from AID/Washington technical assistance for the continuing manufacture of handpumps at Equipo Tecnico Industrial. This request was forwarded to the WASH Project which requested my services in the Dominican Republic to provide technical assistance to the pump manufacturers.

In the course of this assignment, which was performed under WASH Order of Technical Direction No. 1, the writer made four trips to the Dominican Republic. The dates of these trips were:

October 6-11, 1980
November 17-22, 1980
February 1-14, 1981
April 19 - May 2,1981

The findings, conclusions, and recommendations in this report have been drawn from all four of the above trips.

Chapter 2

TECHNICAL FINDINGS

2.1 Pump Manufacturing

On my first visit to the Dominican Republic in October 7, 1980 I met with Dr. Oscar Rivera Rivera and his staff at the USAID Mission in Santo Domingo and was brought up to date on the project and future plans. We also discussed some of the problems being encountered in the manufacturing of the pumps at Equipo Tecnico Industrial.

That same day Eng. Elpidio Caba, of the AID Mission Office of Health and Nutrition went with me to Equipo Tecnico Industrial, where we met with the owner-operators of the foundry, Messrs. Tobias and Freddie Fernandez. We discussed the problems they were having and then were given a tour of the plant.

The problems included:

1) One of the handle pivot pins was found to be too short. This resulted in a longer pivot pin being cut down to size and substituted for the original. The problem was traced to a casting error in the pump cap. The manufacturers claimed responsibility for the error and agreed to rectify it before continuing production.

2) An inconsistency in the location of the holes in the leather flapper for the check valve was noted and pointed out to the manufacturers who have since made the necessary changes to correct the problem by modifying the drilling jig.

3) There was a problem with the plunger spacer edge at the junction of the 2-1/2 inch diameter surface and the lower face. The drawing calls for a 1/8 inch radius of the junction of the 2-1/2 inch diameter surface and the lower face. This may have been the result of an error in interpretation of the drawing as the dimension had to be derived from a note on the drawing. This was brought to the attention of the manufacturers, who are now closely following the drawing. (This sharp edge at the junction of the 2-1/2 inch diameter surface and the lower face could cut and shorten the life of the leather cup.)

4) The lower valve housing was made from a standard 3 inch to 1-1/4 inch pipe reducer. The reducers being used were manufactured in the United States and are quite different from the ones used in other projects in Costa Rica, Nicaragua, Indonesia, Sri Lanka and Ecuador.

Although they function well as pipe reducers, the deep cavity below the 3 inch thread presents a problem when used as a valve housing. The deep cavity allows the piston to pass all the way through the cylinder liner before bottoming on the check valve. When this happens, the leather cups expand to a diameter greater than the cylinder liner, making it impossible to return the piston to its working position. This makes it necessary to disassemble the cylinder completely in order to retrieve the piston. Installation and maintenance would be almost impossible under such conditions. As 200 deep well cylinder assemblies had already been completed, I suggested that to salvage them, two pins could be inserted through the wall of the reducers 180° apart and just below the thread. This would prevent the piston from passing all the way through the cylinder lining. This was not a design change, but did, however, receive authorization from USAID/SESPAS before being introduced.

5) The holes in the pump stand for bolting it to its base were too small for ease of installation. The drawing calls for a 17/32 inch diameter hole for a 1/2 inch bolt. This is unnecessary precision and makes the installers' task very difficult. It was recommended that the hole size be increased to at least 9/16 inch diameter. A further recommendation would be to countersink the underside of the hole to 45° x 1/8 inch.

This first trip to the Dominican Republic was concluded with a second visit to the foundry to meet with Mr. Fernandez and his staff to ascertain that there was accord with respect to any changes, interpretation of the drawings, or minor modifications. It appeared that the manufacture of the AID handpump would be a success here. The people at Equipo Tecnico Industrial are capable and have a good attitude. They listen attentively and are obviously anxious to do a good job.

On the second trip to the Dominican Republic in November 1980, after reporting to USAID, Eng. Caba and I visited the foundry where the handpumps were being manufactured as there seemed to be some problems with pump parts. The first problem concerned the piston. The early drawings called for the material to be cast iron. As the poppet valve cage carries a considerable tensile load, particularly in a deep well, the cast iron had failed on several of the recently installed pumps. It was decided to change to brass. Within a few days Equipo Tecnico Industrial constructed a new tobera (furnace) for processing brass. They also had the molds ready for casting 80 piston cages at one pouring. They anticipated no trouble with the pistons in the future.

The second problem was with the foot valve. Most of them leaked, and some leaked beyond an acceptable level. During assembly of the pumps the leathers had been placed with the smooth, harder side in contact with the valve seat.

It was found that the performance of the valves improved greatly when the leathers were reversed and the rough, softer side came in contact with the valve seat. All foot valves will now be assembled with the soft side of the leather in contact with the valve seat. All of the earlier problems seemed to have been solved and by November 1980 180 pumps had been completed.

On February 1, 1981 I returned to Santo Domingo and it appeared that production of the handpump was progressing favorably. Some 600 pumps had been completed, and about fifty of them were already installed. Inspection revealed that some of the pumps had an alignment problem in the handle, pump cap, and fulcrum assembly.

Considerable time was spent checking the drill jigs and fixtures. Nothing was found that might cause such misalignment. Two days later, Mr. Fernandez (of Equipo Tecnico) showed us some of the bushes being used in the pump. There was an eccentricity problem. The wall thickness varied from 0.038 inch to 0.080 inch. This ended the misalignment mystery. (Incidentally, the bushes were supplied by the Gulf Stream Steel Corporation, Miami, Florida.) The people at the plant then had to painstakingly match up the bushes, lefts and rights, in order to continue production.

One day when I was visiting the plant in February, Congressman Clarence Long was also there. Fortunately, there was considerable activity in handpump production at that time. Congressman Long was given an informative tour of the plant, foundry, machine shop and assembly area. For a finale, an employee of the foundry had all the parts of the handpump laid out on a table and assembled it completely before the interested visitors. I did not time it, but this seemed to take about 10 or 15 minutes. From the time spent and the questions asked, it appeared that the Congressman was very interested and favorably impressed.

In February we also visited the Torpedo Hardware and Supply Company. They carried quite a variety of pump parts including a stock of leather cups from one inch to five inch in 1/4 inch increments. They also had in stock two handpumps made by the Baker Manufacturing Company of Evansville, Wisconsin. The retail cost of the Wisconsin pump was RD$720. The deep well cylinders cost RD$200 for a 2 inch model and RD$360 for a 2-3/4 inch unit. This makes the locally made AID pump very competitive at RD$130 and $30 for the deep well cylinder.

The previously mentioned problem with stripped screw threads prompted a visit to the foundry one more time for a spot check of the various threaded pump parts. Everything we checked was acceptable and of good quality.

2.2 Pump Installations

In October 1980 the first field trip to well sites was to the district of La Vega in the Cibao Valley where part of the original handpump pilot project in the Dominican Republic took place. The first site was in Guaco where an AID handpump had been serving 70 families for approximately 18 months. The pump was still working and was relatively efficient. It was apparent, however, that this pump had not been lubricated and the fulcrum bush in the handle was almost worn out. The handle pivot pin was also about 70 percent worn (see Plate 1). Early replacement of pin and bush would give the pump a greatly extended working life. Without replacing these parts, it would soon be useless. It will also defeat the purpose of saving the handle by the use of a low cost pin. The original idea had been for the bush to wear out the pin rather than the pin wear out the more expensive handle.

The second site, in Santo Cerro, had an AID handpump. It worked, but the check valve seemed to have failed as it took a considerable amount of pumping to get any water. There also seemed to be something wrong with the plunger poppet valve as occasionally there would be no resistance felt during the pumping stroke, and, of course, no water discharge when this happened. There were traces of lubrication of this pump, and the handle, fulcrum and pump cap assembly was in good condition.

In Sabaneta there was a pump which, from a distance, resembled the old AID shallow-well pump. A closer look revealed that it was quite different. Instead of cast iron, it was made mainly of welded steel components and was one of the pumps manufactured by Industroquel.

The pump was inoperative at this time. Closer inspection after the pump body was separated from the base revealed that the piston assembly had worked loose and was lying in the bottom of the cylinder. This was true of several pumps, mostly among shallow-well pumps, and should be investigated. After the pump was reassembled it again pumped water.

A second field trip was to the Azua region to witness various stages of well preparation, including drilling, casing, and the building of concrete platforms. This was part of the second stage of the AID pump installation program.

This visit included sites in Los Tramojos, Palmarejo, El Cerro, Clavellina, and Las Lomas. It was very encouraging to see how much preparation was being made, and to see the degree of community participation. It appeared that a good effort was being made toward the goal of one handpump per ten households.

The first field trip in November 1980 was a return to the Azua region. The progress made since the last visit five weeks before was quite impressive. Where there had been nothing but short lengths of well casing sticking out of the ground, there were hand-pumps installed and working. At some of them, villagers were lined up with containers awaiting their turn.

Seventeen pumps had been installed in this region at this time. Some of the well casings had not been cut close enough to the concrete base which resulted in bad installation. The pump bases were resting on the casings with little or no contact with the concrete. The installation crew were well aware of this and were taking immediate steps to rectify the situation.

During the observation of one pump installation it was noted that the bearing points were being oiled before the pump was put into operation. Unfortunately, there was no evidence of further lubrication on the pumps already in service. All the pumps inspected were working well, and each produced a good volume of water.

The only criticism with respect to the pump installations, other than the excessively protuding casings was the alignment. A number of the pumps were tilted a few degrees.

A pump that is installed vertically will exert light tension and compressive loads on the drop-pipe. Under such conditions, the pipe should last indefinitely. When a pump is installed at an angle, there will be pounding and bending loads exerted on the drop-pipe. This will almost surely result in fatigue, and the fracture will most likely occur at the thread where the drop-pipe is screwed into the base of the pump. Therefore, every effort should be made to install the pump vertically.

We also visited a gravity flow system under construction in San Jose de Ocoa. This was quite a large undertaking. However, there seemed to be considerable community participation. The goal is to have one stand pipe for every ten houses. At the source, a collector and sand filter will be constructed. The water will be routed to a reservoir (which has already been built) with two inch diameter PVC pipe. From the reservoir, a two inch PVC pipe will channel the water to the village. Here the two inch pipe will be tapped with 1/2 inch PVC to the stand pipes. (A possible site for Robovalves.)

In February 1981 another field trip was made to La Vega, the site of the pilot project of 1978. The first stop was in Guaco where on a previous visit an AID pump was found to have a badly worn handle pivot pin and an almost nonexistent bush. This time the pump was not operational. The problem was not due to the pin, as might be expected, but was caused by a broken fulcrum link (Plate 2). It was reassuring to learn that this was not a design problem, but due

PLATE 1: Worn pivot pin and bush (Guaco).

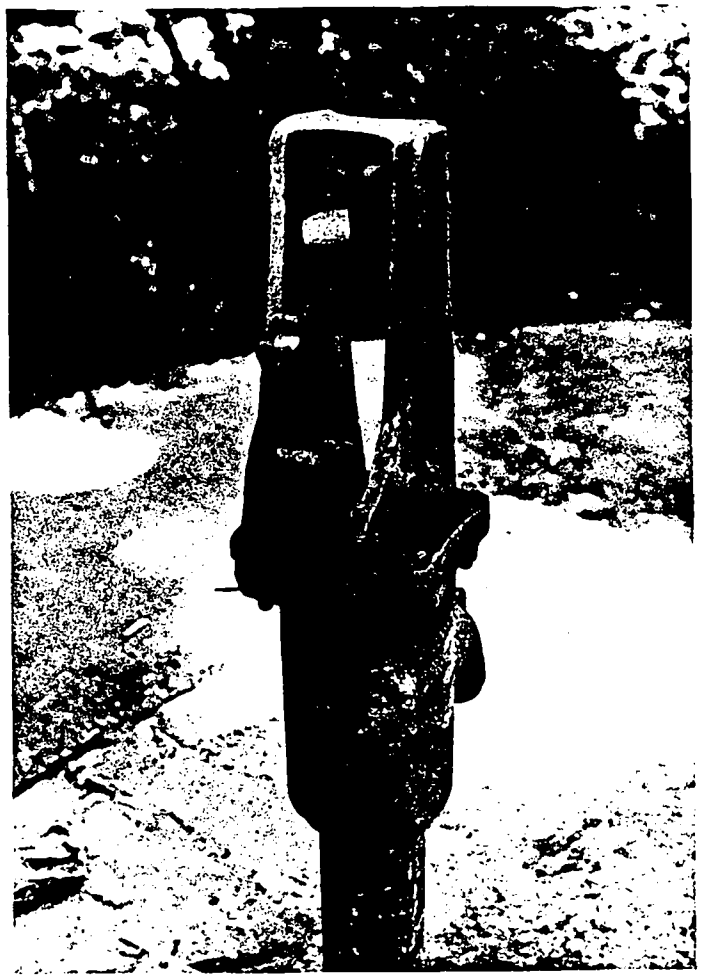

PLATE 2: Broken fulcrum link (Guaco).

to a void in the casting. It was possible to install a new fulcrum while there, but the replacement handle did not fit into the pump cap because the parts were not standardized. This needs investigating. In addition, the plunger fell apart because of a stripped screw thread. It was possible to reassemble the unit by removing one of the leather cups and matching up two good portions of the thread.

Later we visited Sabaneta where we had repaired a pump on a previous trip. It was still working.

We saw another pump in this community where the people were not so fortunate. This pump had a broken drop-pipe (PVC) and the leather flapper valve had been severed from its mounting. This meant a trip back to town to purchase a PVC adaptor, a can of cement, and a piece of shoe leather. Equipped with this, we were able to get the pump running again.

Next day we made another field trip, this time it was to Azua. The first well site visited was at El Barro. We arrived in time to see the pump being installed (Plate 3). It was evident that the concrete was of inferior quality. The hold-down bolts used to mount the pump had a tendency to crack the concrete base when the nuts were tightened. There may have been two factors causing this: one, there had not been enough time for the new concrete to cure; and, two, the sandy appearance of the slab suggested that not enough cement was being used in the concrete mixture. This well was 95 feet deep with a three inch cylinder. Although the water came readily, considerable force was required on the pump handle. Perhaps the two inch cylinder of the future modified pump will relieve this problem with the deeper wells.

Next stop was El Medio for another installation. I had the opportunity to test an all-PVC deep well cylinder with a PVC check valve which I had prepared in Maryland. I had the new cylinder installed with the approval of the SESPAS engineers who were present. The pump worked well and feedback is anticipated on the performance of the cylinder. This well is around 65 feet deep. While we were there a woman and a child each operated the pump (Plate 4). Pumping was relatively easy. It should also be noted that prior to this installation the villagers had to walk two kilometers to the river for water.

The next visit was to Iguarto where we saw a recently installed pump that was drawing water from a depth of 75 feet. Pumping was very easy, even for small children. It was interesting to note that the villagers had modified the pump outlet with the neck of a soft drink bottle in order to enable them to fill small mouth containers (Plate 5). (The possibility of such a modification has been of interest to Dr. Rivera for some time.) Prior to this, the villagers

PLATE 3: Pump being installed at El Barro.

PLATE 4: New installation at El Medio.

here had to walk three kilometers to a river for water. It was learned here from the village leader that drilling has started near San Juan de la Maguana where people now walk 12 kilometers for water.

At Los Tramojos 11 pumps had been installed, ten of which were operational. The remaining one appeared to have plunger trouble. The low resistance felt on the handle when pumping suggested that the plunger had become disengaged, and probably only the plunger cage was still connected to the pump rod. (This is a common problem, and should be remedied.)

Another problem encountered in this community was brackish water. The average pumping depth for handpumps is 50 feet. Interestingly, within 100 yards of the disabled pump there was a windmill-driven pump which was drawing water from a depth of 200 feet. The water from this pump was of very good quality. This community is about three kilometers from the coast line.

The only disappointment on this field trip was to see that the pumps that had been installed some three months earlier still had not been vertically aligned. It is obvious that a pump installed and working will not receive the same kind of attention as one waiting to be installed for villagers who are eagerly anticipating a water supply close to home. Unfortunately, one day there may be a number of pump breakdowns that could have been avoided with a few extra minutes spent during installation.

Another site visit was made to La Vega -- first to the pump at Guaco where we installed a new plunger and a handle trimmed down to fit the pump cap (Plate 6). With a promise from the villagers that this pump would now be lubricated at least once a week, we left, satisfied that this pump had a new lease on life.

The next well site was at Santo Cerro. This pump was hopelessly out of order. The plunger rod had worked loose from the rod end because of another stripped thread and the sliding blocks were missing. It was not possible for us to repair the pump in the field.

Canca La Reina was the next stop where a handpump also had a bad thread coupling between the plunger rod and the rod end. The pump had been made operational temporarily by wrapping a rag around the rod to take up the slack between the threads. The sliding blocks were wearing on the side nearest the handle, and we recommended that they be turned around. This would be almost as good as fitting new blocks. The hold-down bolts were becoming loose from the concrete. No other problems were detected. The pump, which is drawing water from a depth of 33 feet, has served 15 families for two and a half years, and has not even required a leather cup change. The pump showed evidence of lubrication. All in all, it is a very satisfactory pump.

PLATE 5: Locally modified outlet——Intended to facilitate filling small mouthed water containers (Iguarto).

PLATE 6: The pump at Guaco after replacement parts had been installed.

At Canca Reparaciones the pump was a gem. It was as tight and smooth as the day it was built. Pumping from a depth of 28 feet, it had served 25 to 30 families for two and a half years without a breakdown, and it also did not require a leather cup change. Here also there was evidence that the pump was well lubricated during its years of operation.

At Ceiba de Madera the pump has served 25 families for two and a half years, pumping from 34 feet, without breakdown nor a cup change. There were, however, signs of general wear around the pump cap and handle area (pins, bushes, etc.). It is obvious that the pump is being lubricated, but it is possible that the wear occurred before the benefits of lubrication were realized.

In San Francisco Arriba, we came across two pumps of the welded steel variety. They were a combination of the Battelle pump and another type of pump. One did not work for the want of a leather cup (one of which we happened to have with us). The other was inoperative because the plunger had come apart. We were able to put both pumps back in working order before returning to Santo Domingo.

From this visit to pilot program sites, two things were obvious. One we already know: maintenance does pay dividends. The other is the remarkable performance of the leather cups. This suggests that the leather bearing on the PVC cylinder wall is an excellent combination.

A further site visit to the Azua region proved to be very interesting. Two communities very close to each other had very different attitudes toward the handpumps. In Palmarejo, six of the seven pumps inspected were functioning well, each with a good delivery of water. The seventh pump was intentionally immobilized because of a drainage problem. The health committee in Palmarejo here has assumed the responsibility for maintenance of the pumps and each one was well lubricated and in very good condition. In Los Tramajos, on the other hand, two of the six pumps inspected were inoperative and all were dry and rusting.

All of the above pumps were installed at approximately the same time.

2.3 Proposed Modifications in Pump Design

The possibility of making some changes in the present pump design had been discussed with Dr. Rivera. The changes were planned with ease of maintenance in mind. The possibility of locally manufacturing plastic faucets and the PVC wellscreen was also discussed.

Dr. Rivera agreed with these suggestions. As he is interested in providing every household being served by the project with five-

gallon plastic carrying jugs and 20-gallon indoor water storage containers, he perceived a future need for the faucet. This, together with the order for 1,600 additional handpumps, suggested it would be wise to meet with SESPAS. The meeting was arranged and attended by representatives of SESPAS and USAID during my February visit to the Dominican Republic. The faucets and well screens are not new, therefore do not require further mention here. The pump changes are similar to the changes incorporated in the pumps presently being made in Tunisia (see Figure 1).

In February 1981 there were further discussions with the USAID Mission on the proposed pump changes and the manufacture of the plastic faucet, screens, and check valves. All indications were that we should proceed. The foundry was already experimenting with a mold for the new pump base. The plastics manufacturer, Tuberias y Materiales Plasticos (see below), could supply the two inch schedule 40 pipe within seven days of receiving an order and was in a position to make the faucets and check valves as soon as the injection molds were ready.

2.3.1 Local Suppliers of Plastic Parts

In November 1980 considerable time was spent visiting plastic manufacturing companies. However, one factory only, Tuberias y Materiales Plasticos, C. por A., appeared to be able to meet the needs of the project. It was, in fact, the first time, outside the United States, in the writer's experience that a company claiming to make Schedule 40 PVC pipe makes pipes that really are Schedule 40 and meets American Standards for Testing of Materials (A.S.T.M.) specifications.

We met with vice-president Orlando Pannocchia. He had in stock some of the three inch pipe that would be needed if the project were to adopt the PVC deep well cylinder. He also showed a great deal of interest in manufacturing the plastic faucet and the well screen.

In February 1981 we again visited Tuberias y Materiales Plasticos, C. por A., and talked with Mr. Orlando Pannocchia, vice-president. Mr. Pannocchia studied the faucet samples and was undoubtedly willing and able to manufacture them.

2.3.2 Pilot Testing the Modified Pumps

In February 1981 we discussed with Dr. Rivera the possibility of a mini-test program. The idea was to install ten handpumps having all the recently suggested changes incorporated at a site close to Santo Domingo. This would provide the opportunity to observe any possible weakness before the newly ordered 1,600 pumps were ready for installation. Everybody was in agreement. We visited SESPAS headquarters and learned that a site for the ten test pumps would be

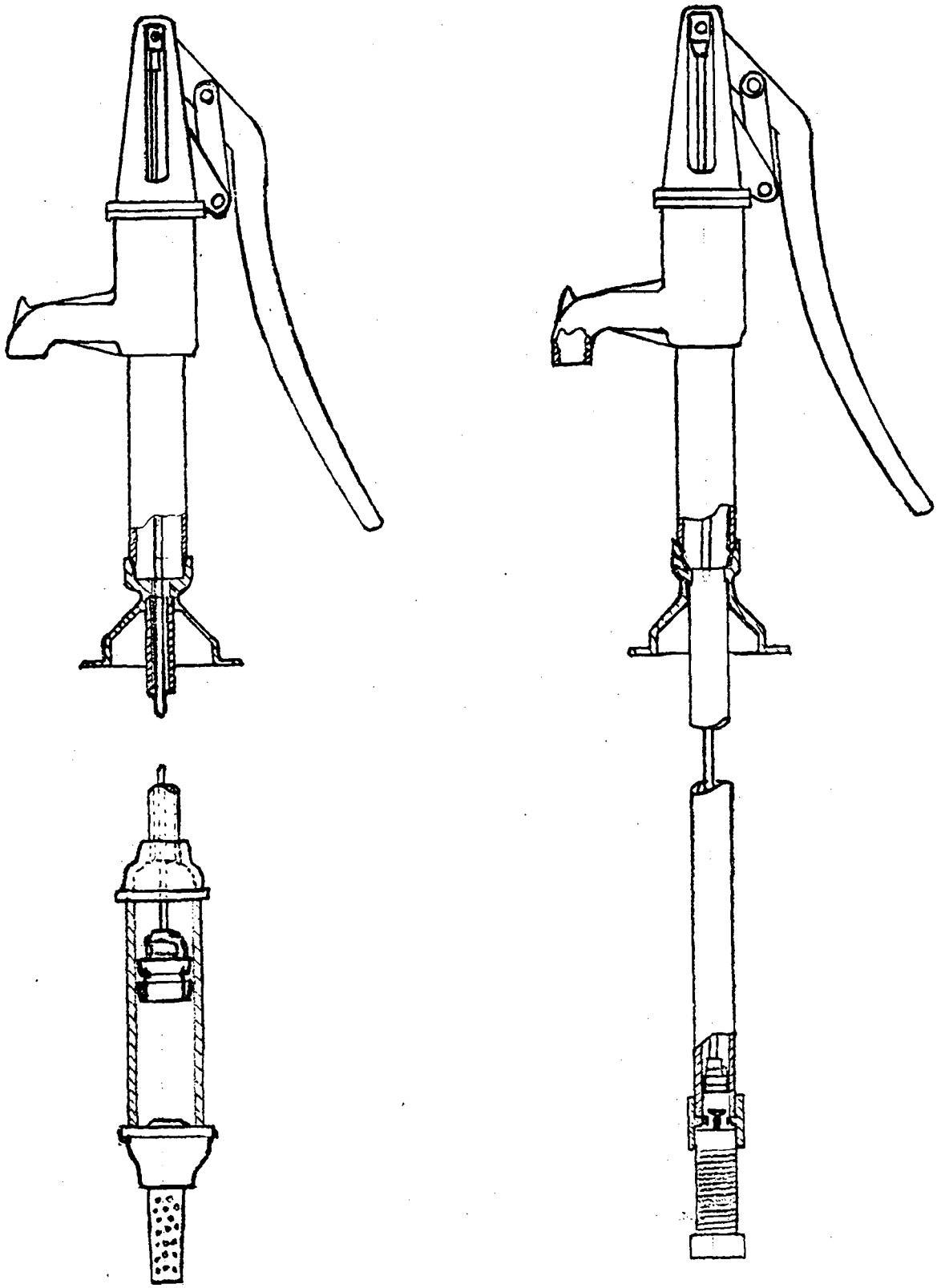

Figure 1

Proposed Changes in Current Pump Design

available close to San Cristobal, some 30 kilometers from Santo Domingo.

In addition, in February the people at the foundry (Equipo Tecnico) said they would be happy to provide us with ten of everything needed for the new pumps. It seemed then that it was only a matter of timing.

The tool and die maker had prepared the estimates for the cost of the mold for the plastic faucet which was US$4,000. This mold was for both the water container type and the household or patio model.

During the fourth and final visit of OTD #1, I had the opportunity to take part in the installation of three handpumps at one of the test sites near Azua. I met with the Health Impact Evaluation Team comprised of Messrs. Paul Howard, Robert Struba, and Charles Llewellyn, and discussed issues of mutual interest. Although I invited the team to accompany us on a field trip to witness at least one pump being installed, only Paul Howard was able to make the trip. This, nevertheless, served the team well, as he had a very enlightening day, and was able to relate to his colleagues an account of his day in the field.

Two modified pumps were installed that day. Other than the fact that the dimensions of the PVC pipe we had on hand were very irregular and had to be heated and stretched to fit adaptors and couplings, etc., the relative ease of installation was obvious.

At a later date, another modified pump was installed. This time 60 feet of 2 inch schedule 40 PVC pipe which met ASTM specifications was used. It was supplied by Tuberias y Materiales Plasticos. This time the installation was very easy. It took 45 minutes from the beginning of the installation until the first water flowed from the pump outlet.

It is recommended from this experience that the pump rod be restricted to 10-foot lengths in the future because 20-foot lengths are difficult for two-person maintenance crews to handle.

It is also recommended that if the 2 inch PVC drop-pipe cylinder model is adopted, future wells should be drilled for 4 inch casings. This will be adequate and will further cut costs, both in the drilling and in the casing material.

The broaching and slotting equipment was delivered to Equipo Tecnico Industrial for the purpose of producing well screens. Four PVC samples were broached (hand powered) for test purposes. The problem of poorly dimensioned tubing was again encountered, making it necessary to reduce the outside diameter in order to load the tubing into the broaching equipment.

The four samples were enough to allow some trial runs on the slotting operation. I left the plant satisfied that the well screens can be produced there to meet the requirements of the strainer/check valve assemblies.

The check valves will, of course, be injection molded. Diseno Mecanico y Construccion quoted a price of RD$3,000 for the mold. Other tool and die makers have still to be contacted for further estimates.

2.4 Suppliers of Plastic Water Containers

On the third trip to the Dominican Republic in February it was necessary to look for a supplier for the 20-gallon household water container and a tool and die manufacturer to make the required molds. After visiting two companies in the plastic blow molding business, it was obvious that a plastic container of a 20-gallon capacity could not be found in the Dominican Republic.

We met with Mr. Francisco Velez of Polyplas Dominicana. He showed us an excellent five-gallon container which would be perfect for carrying water from the pump to the household, but had nothing suitable for a household container.

The next visit was to Duralon where we met with Mr. Manuel Lebron. He gave us a sample of a very sturdy plastic trash container (14-1/2 gallons). This container would be very suitable for storing water. However, the lid would have to be modified in order to reduce the possibility of contamination. This would require the services of a tool and die maker to manufacture a mold for injection molding a new sealed lid. The cost of the 14-1/2 gallon trash can at that time was RD$7.50.

Later, we visited a recommended tool and die shop, Diseno Mecanico y Construcciones and met with Mr. Julio Cesar Perez Garcia. After showing him the plastic faucets and explaining the needed modifications of the plastic container he assured us there would be no difficulties in meeting these needs. He suggested that we leave samples with him and said that he would have a quotation for the necessary molds within two days.

In our continuing search for a 20-gallon container we visited Multiform, S.A. and talked with vice-president Carlos Fernadez A. This company specialized in fibre glass products. Mr. Fernandez said he could supply a 20-gallon container in any desired shape for about RD$20. This price should be studied before a decision is made.

Chapter 3

CONCLUSIONS AND RECOMMENDATIONS

The handpump program in the Dominican Republic shows all the signs of being successful. There appears to be great interest and enthusiasm among those in USAID and SESPAS. This can be a desirable combination provided the enthusiasm does not run too far ahead of the interest. That is to say, the installation should not overshadow the follow-up support program, including maintenance, availability of spare parts, and the training of personnel to carry out minor repairs and maintenance operations.

An example of precipitous installation is the improperly installed pumps in the Azua region. The problem stemmed from an error in the preparation of the concrete slab. The drawing calls for a one-inch protrusion of the well casing or in the case of a dug well installation, one-inch pipe of a suitable dimension above the level of the slab. This prevents contaminated water on the surface of the slab from draining into the well and, at the same time, does not interfere with the pump base. As it is in Azua with one and one-half to two inches of pipe protruding above the concrete, the pump is resting on the pipe and not on the concrete.

It is not suggested that the installation crew be instructed to slow down, but rather that they return to correct the faulty installations at the earliest opportunity. In addition, every effort should be made to stimulate the support-services.

It would appear that all major problems in the manufacturing of the pump have been overcome and that the quality of the pump in its present state is good.

From observations in the field, the most frequent defects were found to be in threaded parts, some of which were stripped completely, while others had worked loose over time. The stripped threads are most likely the result of a common manufacturing practice -- make the thread loose and it will not require re-cutting. This is effective in some cases, but where loads, such as those applied to a pump rod in a deep well are so great, this is inadequate and quality control is the answer. The threads inspected at Equipo Tecnico, the current pump manufacturer, were of good quality.

The problem of loosening parts is quite different. This is most common with the pump plunger parts. In this instance, machined and threaded metal parts are tightened against the leather cups. There is no metal-to-metal contact. Under such conditions it is difficult to arrive at a correct tightening torque. It is possible to tighten the parts until the leather cups are seriously damaged.

Another point to consider is the expansion and contraction of the leather, particularly in a shallow-well where there is a great likelihood of cyclical wetting and drying. This will certainly create a loss of friction between the leather and metal parts, resulting in the loosening of the threads and the eventual result that all the plunger parts, save for the cage may fall to the bottom of the cylinder. At least four such cases have been encountered during an inspection of fewer than 25 pumps.

There are two possible remedies. One is to change the plunger so that there is a metal-to-metal interface where a definite tightening torque can be established. The other is to lock the threads with either a recognized mechanical device, or use a commercially available compound such as "loc-tite" which is brushed on the threads at assembly.

Some of the concrete slabs seen in Azua region, although well designed, were of doubtful quality. There appeared to be too much sand in the mix, and they probably cured too fast in the hot sun. While fully aware of the acute shortage of potable water, it is nevertheless suggested that the slabs be covered by some material, such as burlap or polyethylene sheeting, and soaked from time to time with river water during the curing period.

Another problem is that of the hold-down bolts turning in the concrete. This can create a great problem when the pump has to be removed. A partial solution would be to tamp the fresh concrete around the area of the bolt heads with a thin tamping rod. This would tend to fill any voids in the concrete in the proximity of the hexagon heads. Hexagon head bolts, however, are not the recommended things to use for this purpose. There is such a thing as a "J" bolt, so named because of its shape. The advantages of a bolt of this shape can readily be seen when embedded in concrete. It will not turn, and it cannot easily be pulled out.

The above mentioned problems should not be considered a serious threat to the success of the program. The solutions are simple and, if acted upon expeditiously, the dividends will be rewarding and long lasting.

Chapter 4

ADVANTAGES AND COST SAVINGS OF MODIFIED AID HANDPUMP

Some of the advantages of the proposed design changes will be found in the ease of installation and maintenance of the handpump. It will no longer be necessary to place the drop-pipe, cylinder, pump rod, and plunger as a complete assembly in the well before installing the pump body. The simple requirement will be to place a desired length of PVC drop-pipe, part of which will be the cylinder, into the well and then attach it to the pump base. The pump rod and plunger assembly can be installed by feeding it down through the pump body until the plunger is in the desired position below the water table. The normal pump rod cutting and threading and a pump cap assembly will then be required. (For clarification, refer to Figure 1.)

Maintenance of the down-well components is simplified, as removal of the pump cap is all that is necessary in order to be able to withdraw the pump rod and plunger. Changing leather cups will be done in a fraction of the normal time and with much less trouble.

Other advantages that can be seen are the reduced material costs and the fact that the complete handpump will be almost exclusively manufactured in the country.

The cost of the deep well cylinder can now be eliminated. The G.I. drop-pipe which is imported at a cost of $0.92 per foot will now be replaced by locally manufactured PVC pipe at a cost of $0.59 per foot. The imported check valve and strainer assembly costing US$40 will be replaced by a locally manufactured plastic unit costing something in the region of US$5 to $10.

One possible disadvantage in the modified pump will be the reduced water output per plunger stroke as the former 3 inch plunger will be replaced with a 2 inch plunger. This may be offset, particularly in deeper wells, with ease of pumping.

The lack of information available on the tensile strength of solvent welded PVC pipe joints gave cause for concern as the plan was to use this easy method for the drop-pipe connections. To fasten the pipe to the pump base, a standard PVC adaptor is used. The male end is threaded into the cast iron base, then the pipe is solvent-welded into the socket end of the adaptor. This is a critical point of the assembly as it has to support the weight of the entire drop-pipe plus possibly a column of water. Therefore, it was considered prudent to conduct a number of tests. A variety of specimens were fabricated and tested. Some of the results can be seen in Figure 2. One and one-quarter inch pipe and fittings were used in this series of tests. The surfaces to be solvent-welded were not all prepared the same way.

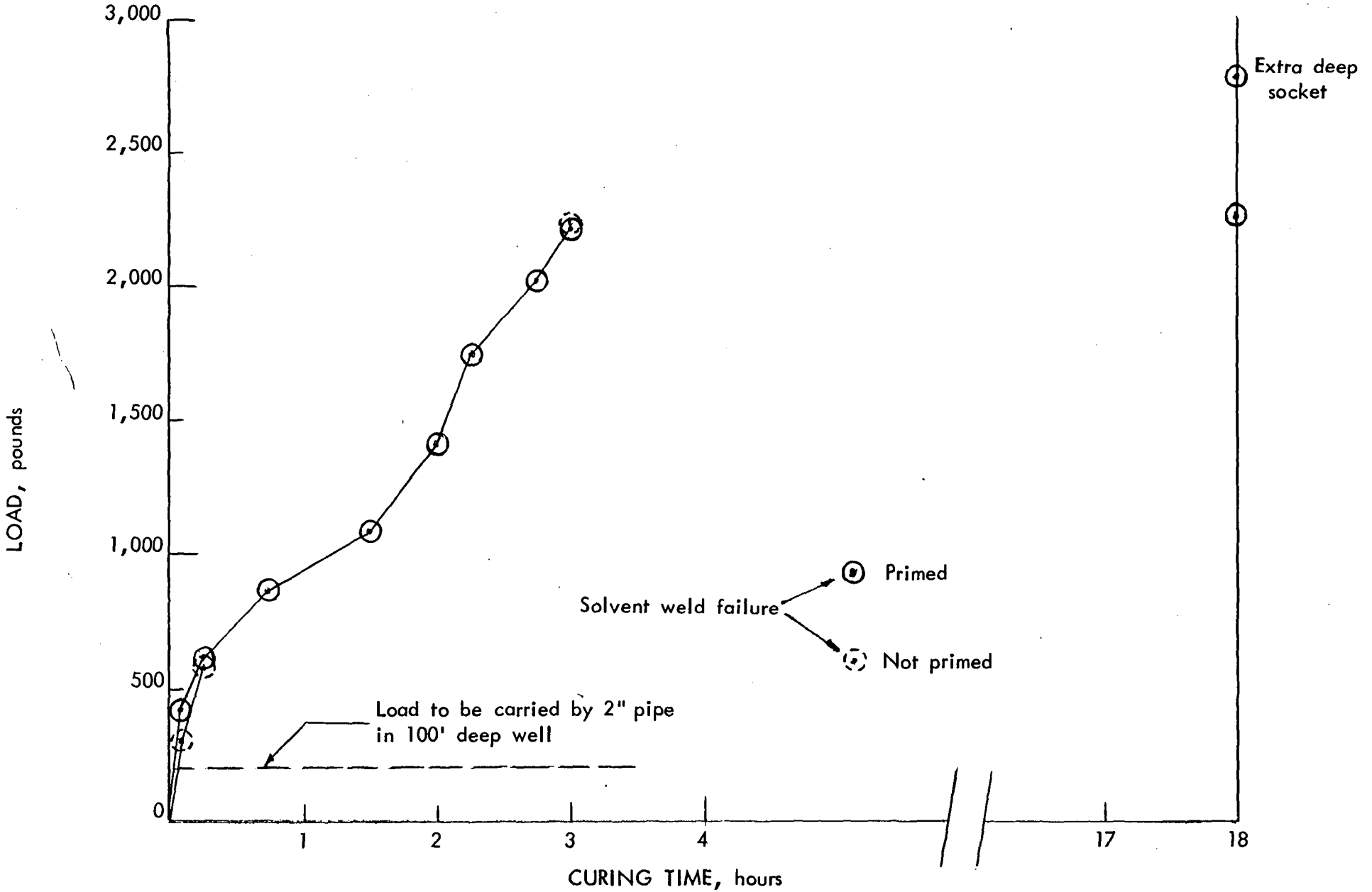

Figure 2

Load Tests on Solvent Welded PVC Pipes and Adaptors

Some were cleaned and primed before the cement was applied. Some were cemented without preparation. Referring to Figure 2, it appears that priming the joint surfaces is most critical during the first few minutes. At the three-hour mark, the points on the curve for the primed and the not-primed almost coincide. Only four unprimed specimens were tested for comparative results and two of them failed very quickly. It is intended that all joints be properly prepared during field installations.

APPENDIX A

WATER AND SANITATION FOR HEALTH PROJECT

ORDER OF TECHNICAL DIRECTION NUMBER 1 SEP 2 3 1980

TO: WASH Contract Project Director, Mr. James Arbuthnot, P.E.

FM. AID WASH Project Managers
Mr. Manoj K. Batavia, P.E.
Mr. Victor W. R. Wehman Jr., P.E., R.S.

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Dominican Republic

References: A) Santo Domingo 3974
B) Santo Domingo 5208
C) Santo Domingo 7438

1. WASH Contractor requested to provide technical assistance to USAID/Santo Domingo as per ref A scope of work (augmented).

2. WASH contractor/sub-contractor/consultants authorized to expend up to forty (40) person days effort over a three (3) month period to accomplish this technical assistance effort.

3. Contractor to provide draft final report to mission before leaving mission upon acceptance of first full manufacturers run of AID handpumps in the Dominican Republic. Final report due DS/HEA and mission within 30 days of acceptance of handpumps.

4. Contractor to coordinate directly with USAID/Santo Domingo, probably with Program Officer or mission engineer. Check with Mr. Charles Mathews, Chief Engineer for LAC for names and numbers of persons in the mission. Make sure Mr. Mathews and Ms. Sandoval (LAC/DR/HN) receive info copies of this order.

5. WASH Project Managers recommend that WASH contractor use technical assistance personnel for this effort that are already familiar with local manufacturing of the AID Handpump. Spanish language capability is highly desirable. Georgia Tech (tel no. 404-894-3851) have copies of the working drawings and latest designs for use in local manufacture and pattern development. Contractor authorized to pay for local patterns or models necessary for bringing about local manufacture of the handpump with the manufacturer that the mission has chosen. This should not exceed $1500.00 for the patterns and molds development.

6. WASH contractor authorized to allow consultant to make up to 4 trips in and out of Dominican Republic to his/her home base as appropriate during the technical assistance effort. Not necessary for consultant to come to Washington for briefing. Handle coordination by phone.

7. Mission should be contacted immediately and technical assistance initiated as soon as possible and convenient to USAID/Santo Domingo.

8. Appreciate your prompt attention to this matter. Good Luck.

APPENDIX B

Itinerary

Visit Number 1: October 6-11, 1980

While in the Dominican Republic, visits were made to the district of La Vega (which included sites in Guaco, Santo Cerro, Sabaneta) and the Azua region (including Los Tramojos, Palmarejo, El Cerro, Clavellina and Las Lomas).

Visit Number 2: November 17-22, 1980

A visit was made to the Azua region including San Jose de Ocoa.

Visit Number 3: Feburary 1-8, 1981

Visits were made to the district of La Vega (including sites at Guaco and Sabaneta) and to Azua region (including sites at El Barro, El Medio, Iguarto, Los Tramojos, Guaco, Santo Cerro, Canca La Reina, Canca Reparaciones, Ceiba de Madera, San Franciso Arriba, and Palmarejo).

Visit Number 4: April 19 - May 2, 1981

Visits were made to Los Tramojos and Palmarejo in Azua region.

APPENDIX C

Officials Interviewed

Visit Number 1: October 6-11, 1980

Dr. Oscar Rivera Rivera, M.D.
Office of Health and Nutrition
USAID Mission, Santo Domingo

John H. Thomas
Office of Health and Nutrition
USAID Mission, Santo Domingo

Elpidio Caba, Engineer
Office of Health and Nutrition
USAID Mission, Santo Domingo

Mr. Tobias and Freddie Fernandez
Equipo Tecnico Industrial, C. por A.
Santo Domingo

Visit Number 2: November 17-22, 1980

Dr. Oscar Rivera Rivera, M.D.
USAID Mission

Lic. Dulce Jimenez
Office of Health and Nutrition
USAID Mission, Santo Domingo

Elpidio Caba, Engineer
USAID Mission

Orlando Pannocchia, Vice-President
Tuberias y Materiales Plasticos, C. por A.
Santo Domingo

Visit Number 3: February 1-14, 1981

Dr. Oscar Rivera Rivera, M.D.
USAID Mission

Mr. Freddie Fernandez
Equipo Tecnico Industrial, C. por A.
Santo Domingo

Mr. Orlando Pannocchia, Vice-president
Tuberias y Materiales Plasticos, C. por A.
Santo Domingo

Mr. Francisco Velez
Polypas Dominicana
Santo Domingo

Mr. Manuel Lebron
Duralon
Santo Domingo

Mr. Julio Cesar Perez Garcia
Diseno Mecanico y Construcciones
Santo Domingo

Carlos Fernandez A., Vice-President
Muliform, S.A.
Santo Domingo

Visit Number 4: April 19 - May 2, 1981

Dr. Oscar Rivera Rivera, M.D.
USAID Mission

Paul Howard
Robert Struba
Charles Llewellyn
Members of AID/W.A.S.H. Health Impact Evaluation Team