

CONTENTS

	Page
Introduction	i.
I. Baseline Data	1
II. Methodology	2
III. Work to Date	3
IV. Evaluation	3
V. Repairing the Tanks	6
VI. Kinds of Tanks	7
VII. Recommendations	8
Appendix C - Ha'apai storage tanks and catchment requirements.	
Appendix I - Central Planning Department Eval.	
Appendix II - Field trip report of visit to Ha'apai Island group.	

INTRODUCTION

In 1979 Peace Corps, with support from the U.S. Agency for International Development, began a program to improve water supplies in Ha'apai, a group of coral atolls in the Kingdom of Tonga. The program met serious administrative difficulties and the Foundation for the Peoples of the South Pacific (FSP), at the request of the Tonga Government and Peace Corps, agreed to take it over. In February 1981 FSP negotiated a grant from USAID for the program.

From the outset the program has been a partnership operation between Peace Corps, the Government of Tonga and FSP with support provided by USAID.

Ha'apai has always been a problem area for water as the islands are flat coral islets, mostly only a few feet high, a mile or two long and a few hundred yards wide. Some of the islands have lens water (underground water that floats on top of the salt water) but this is brackish and sometimes salty. Hence the islands must rely almost entirely on freshwater catchments.

The traditional water problems were greatly aggravated in March 1982 by cyclone Isaac which destroyed up to 90% of the buildings in the Ha'apai group.

In the light of this FSP, Peace Corps and the Government of Tonga proposed an emergency water supply program to meet the pressing problem. This was submitted to USAID in November 1982 and a two year extension of the program was requested.

The new program planned to make use of the 700 cyclone relief houses being built to provide catchments for the water tanks. It was also decided to erect

metal tanks instead of the more traditional concrete tanks. The main reason for this decision was speed, it was believed that the metal tanks could be constructed much more rapidly. A second reason was health, the metal tanks have a tap to draw water, while the water is drawn from the concrete tanks with a bucket or other container. A major innovation of the program was that it was the first time the Government of Tonga had given approval for the construction of private water tanks. Prior to this all Government supported tanks had been public tanks.

I. BASELINE DATA

Prior to the present program all of the islands had one or more (depending on population) public tanks - some of them built as far back as 1910. These are, for the most part, rectangular concrete tanks holding 10,000 gallons sunk a couple of feet below ground and rising three feet above ground. The catchment is a church or school or other public building. Where no such is available a catchment has been built.

This was the pattern the program followed in 1979-81, although the design of the tank was modified. For much of 1982 the Peace Corps Volunteer in charge of the program was busy repairing tanks and catchment destroyed or damaged by the cyclone.

The public tanks have several drawbacks. Villagers often have to walk some distance to collect water. The water is drawn out by a bucket or other container which is often not very clean and is never sterilised. In a well controlled village the tank is locked except for a couple of hours in the morning. This improves cleanliness and reduces waste but means that water is unavailable for much of the day. Finally, there is insufficient water. In 1983, for example, water was carried in barges to the Ha'apai group.

Many village people are also convinced that the public tanks are a source of sickness. This view is shared by Health Department officials.

There are, of course, some private water tanks but these are not common. A survey by the Tongan Government (see Appendix "A") shows that the total tank capacity and catchment available is well below the minimum considered necessary.

II METHODOLOGY

The destruction of most of the houses in Ha'apai by Cyclone Isaac led to a major rebuilding program. The Government, with overseas assistance, builds houses for \$3,000. The householder must provide \$700 of this. The houses have iron roofs suitable for water catchments.

The Tonga Government set up the Tonga Water Committee to promote water supply programs in the Kingdom. The Committee brings together representatives from the various interested groups - the Department of Health, of Public Works, Central Planning and FSP.

Early in 1983 the Tonga Water Committee approved of a program to provide private water tanks to families which had a suitable catchment available. In most cases this is the roof of a new cyclone relief house.

The Committee also accepted the recommendation of the Ministry of Works (MOW) and FSP to erect metal tanks. The tank chosen is a zincalume coated tank built by Lysaghts of Australia. The tank has been thoroughly tested and has a life expectancy of fifteen years according to Lysaghts.

Most tanks in Tonga are of concrete. However the Government has become extremely conscious of the depletion of sand from the beaches because it is being used for construction and this decision was in accord with the Government conservation policies.

The Department of Health supported the decision because the water taps on the metal tanks will help keep the tanks clean and so improve health. Most important of all, it was expected that the tanks could be built much more quickly than the concrete tanks and an emergency situation existed in Ha'apai.

FSP, with USAID approval, agreed to provide funds for the program, Peace Corps provided the building supervisor, MOW provided the labor, UNICEF provided the funds for the guttering and the downpipes.

III. WORK TO DATE

Between March 1983 and January 1984 the program moved quickly. 260 metal tanks were constructed on twelve scattered islands in the Ha'apai group.

Initially PCV Tom Hicks was in charge of construction. He completed his tour in June 1983 and was replaced by PCV Dallas Bowen who is currently in charge of tank construction.

The PCV has a team of from four to six tradesmen supplied by the Ministry of Works. FSP/USAID pays the salary of these workers while MOW is responsible for their living expenses in the outer islands. The program was delayed for several weeks in July 1983 when MOW ran out of funds for the living expenses but the problem was eventually solved.

IV. EVALUATION

The FSP Evaluator travelled to nine islands in the Ha'apai group and inspected about half of the 260 tanks so far erected. Appendix II is a report of this trip. The Evaluator was accompanied by the FSP Small Projects Officer Douglas Merz, and by two representatives from Central Planning, Dennis Wolff and "Ofa Afuha'amango. The team concentrated on the work of the last twelve months, as does this report. However a number of concrete tanks and catchments built prior to 1983 were inspected and these were generally in good order. They are all public tanks.

In most cases (perhaps 80%) the iron roof of the new cyclone relief house provides the catchment. Only one side is used, but this should be sufficient for a one thousand gallon tank. When the householder did not get a new house it was sometimes possible to use his old house or a new (FSP supported) disaster relief kitchen.

The Ministry of Health (MOH) inspected all catchments and decided which were suitable. Generally these were reasonably satisfactory but in a few cases the old roof was barely adequate or was so badly built that it was difficult to attach the guttering.

In formal and informal meetings the evaluation team spoke to about a hundred village people concerning the water tanks. The general reception of the program was very positive. For the first time they had water available only a few yards from their homes. Prior to this they had to walk some distance, often half a mile or so, to the public tank which was open only two hours a day. The women especially benefitted, since they do most of the water fetching.

The second benefit is that far more water is now available - an additional 260,000 gallons. Third, the family has the water under their own control. The taps on the tanks can be fitted with a lock and some were. When the tanks get low during a drought there is no doubt but that the family will exercise extreme care in their use of water.

There is every hope that the new tanks will lead to improvements in health.

The public tanks are, it is believed, often a source of infection and are at best difficult to keep clean. The metal tanks, with taps, are much easier to keep clean.

Also, hopefully, people will be more ready to wash when water is readily available.

The Evaluator gives strong support to the decision to provide tanks to the individual householder in lieu of building public tanks. An additional cost/benefit advantage is that special catchments do not have to be built.

There is a negative side. More than half the tanks inspected were leaking, or at least had been leaking and were repaired with cement. Generally the patching was fairly successful, but there was some weeping at times.

The tanks are pop riveted and almost all the leaks were along the seams.

When the tanks were purchased, Lysaghts, the Australian supplier, sent an expert from Fiji to train the local builders. He advised them to use three tubes of mastic to seal the seams. When it was found that leaks were developing the builders increased the mastic to five tubes and are hoping that this will solve the problem. On the last two islands visited by the Evaluator, Manga and Fonoifua, the tanks had had five tubes of mastic and very few were leaking. However these tanks had only a foot or so of water so it is too early to say if the problem has been solved yet.

There are other problems. In some cases, especially on the island of Fotuha'a, the roofs are very low so the tanks are sunk up to two feet below the surface of the ground. This means a hole has to be dug under the tap so a bucket can be put there. This is inconvenient. Also the Evaluator wonders if the sides of the hole will fill in so rubbish rests against the tank and reduces its life. Another problem is that many of the water taps leak.

Pigs are another problem. They love the leaks and root around the foundations of the tanks. In time they may undermine the foundations and cause serious damage. Very few of the tanks are fenced against the pigs. This should be done. There were also reports that the pigs were eating the mastic but the evaluation team found no direct evidence of this. However in one case the bottom of the tank had been sheltered with pandanus matting because the owner claimed the chickens were pecking off the mastic.

Also some tanks had a lean. However this was usually only slight and did not seem to be a problem.

V. REPAIRING THE TANKS

On February 1, 1984, the Evaluation team and the FSP Country Director met David Keith, the Director of Works, and Ekho Lim from whom the tanks were purchased to discuss the problem of the leaks. Meanwhile the FSP Evaluator recommended that the order for 160 new tanks should be cancelled, at least until the problem of the leaks is solved. This was done.

It was agreed at the meeting that Lysaghts be asked to make an on site inspection to determine the cause of the leaks and the way to repair them. This will be done during February, when an expert from Fiji will visit the site. If the fault is Lysaghts, they will be asked to make the repairs at their cost.

VI. KIND OF TANKS

The Evaluator recommended to the meeting that no more metal tanks should be purchased for the program. He was convinced that ferro-cement tanks are superior and will last longer.

The FSP Country Director advised the meeting that the present plan calls for the building of one hundred 1,000 gallon slab sided square ferro-cement tanks to a design built and tested by W.H.O. The slabs will be built in the FSP Workshop at Pangai, where quality control will be comparatively easy. From there they will be transported to the site and erected.

The FSP Evaluator asked that a test sample of twenty or so of these should first be built to make sure they do not leak. This was accepted.

The FSP Evaluator also suggested that the methodology of the program should be rethought so that the village people should be more heavily involved.

Two of the islands visited have concrete tanks built by the Niuola Women's Group from Fua'amotu, headed by Tami Vakasiuola. FSP has worked with this group and has great respect for them.

The Niuola tanks are ferro-cement, oval in shape, about four feet below ground and four feet above, using the ground as the form makes the construction cheap and simple. 8 or 9 bags of cement are used (about US \$80) and perhaps \$50 of steel mesh. The tanks hold 3,000 gallons. They have been built for three years and show no sign of cracking.

Using this tank would save some \$70. This could be used to put guttering on both sides of the shouse, instead of one side as at present. This would give twice the catchment and three times the capacity for about the same price as the present tanks.

The local people were very definite about preferring the Niuola tanks to the metal tanks. They also claim they are easy to build. Both men and women work on the building teams. A team of five or six can build a tank in one day.

The Evaluator is not convinced that the metal tanks are quicker to construct. The present building team is made up of five. If each of these works with a local team of five, it should be possible to build as many as five ferro-cement tanks in a day. This is more than the three which the team can build when erecting the metal tanks.

David Keith of MOW brought up another problem. The Department of Health have the ultimate responsibility for the program and must approve of any change. They have reservations about the ferro-cement tanks because the water is drawn from the tank by bucket, and this is unhygienic.

There is some truth to this. However it should be easier to keep a private ferro-cement tank clean than a public one, and at worst infection will be confined to one family and not spread through the community. Further, for a small sum it would be possible to attach a hand pump to the ferro-cement tanks.

The recommendations of the Evaluator, and especially the question of the kind of tanks to be built for the second half of the program, will be discussed at the next meeting of the Tonga Water Committee.

VII. RECOMMENDATIONS

1. Cancel the order for new metal tanks.
2. Find the cause of the leaks and repair them
3. Encourage those who have received tanks to fence them against the pigs
4. Build only a small number of W.H.O. type tanks as a test run
5. Purchase and erect no more metal tanks. In place of these, build ferro-cement tanks. The village people should be organized to build the tanks.

APPENDIX "C"

HA'APAI STORAGE TANK CAPACITY AND CATCHMENT AREA REQUIREMENT
RAINWATER CATCHMENT SCHEME

Village	Popu- lation	STORAGE TANK CAPACITY (GAL)				CATCHMENT AREA (SQ. M)			
		Total Reqmt. Pop. x 330	Exist. Public.	Exist. Private.	Net Reqmt. Total-Exist.	Total Reqmt. Pop. x 7.50	Exist. Public.	Exist. Private.	Net Reqmt. Total-Exist.
1. Ha'ano	326	107,580	46,200	41,200	20,180	2445	348	691	1406
2. Pukotala	218	71,940	20,000	21,200	30,740	1635	50	342	1243
3. Pakakabai	352	116,160	41,000	33,000	42,160	2640	100	650	1890
4. Nuihoa	173	57,090	27,900	20,900	8,290	1297	99	297	901
5. Ha'afakahenga	88	29,040	-	-	29,040	660	-	-	660
6. Lofanga	426	140,580	32,900	62,600	45,080	3195	263	680	2252
7. Tofua	107	35,310	10,100	-	25,210	802	152	-	650
8. Kounga'ono	234	77,220	23,800	44,200	9,220	1755	230	400	1125
9. Ha'afava	560	184,800	20,000	64,000	100,800	4200	490	1000	2710
0. Tungua	357	117,810	36,000	27,000	54,810	2678	217	383	2078
1. 'O'ua	280	92,400	48,400	73,000	-	2100	365	766	969
2. Matuku	125	41,250	23,200	4,800	13,250	938	90	120	728
3. Kotu	233	76,890	14,400	20,000	42,490	1747	185	180	1382
4. Potuha'a	212	69,960	20,900	6,000	43,060	1590	290	135	1165
5. Nomaka	942	310,860	73,700	172,300	64,860	7065	862	2310	3893
6. Poneifua	154	50,820	19,700	14,300	16,820	1155	91	385	679
7. Maro	86	28,380	14,700	11,300	2,380	645	123	222	300

NOTE - The First Five Villages on this list are being provided assistance by FSP/USAID under its current one year water supply program in Ha'apai.

- Ha'afakahenga Village is situated beside Paleloa Village at FOM Is and currently getting its water supply from Fa water reticulation system. Data on its existing private tanks and catchment areas are not available.

- 11 -

AN EVALUATION OF THE FSP HA'APAI WATER SUPPLY PROJECT
- prepared by the Central Planning Department

INTRODUCTION

Mr. Bernard Hosie, FSP Evaluator, was in Tonga from 17 January - 6 February for the annual evaluation of all FSP programmes. At the invitation of FSP Tonga, the Central Planning Department participated in this evaluation, both by contributing input to Mr. Hosie's evaluation and by providing this separate report. Although a number of different programmes were evaluated, this report focuses solely on the Ha'apai Water Supply Project, as it is funded separately from the other programmes, under a two-year extension (November 1, 1982 - October 31, 1984) to USAID Operational Program Grant 879-0251-G-00-10005-00.

It should be noted that the methodology of the two-year extension differs somewhat from that of the original project (for which a final evaluation has already been submitted). This report will concern the previous project only where necessary. Additional information concerning both of the projects can be found in the final evaluation and/or relevant progress reports.

CONTEXT OF PROJECT

The goal of this project is to provide additional reserves of fresh (rain) water to the people of the Ha'apai Group. The islands of the Ha'apai Group are both small and scattered, and are one of the most rural areas of Tonga. The water supply on these islands is, under the best conditions, barely adequate, and frequently not even this good. The islands are, in general, low-lying coral islands; the result is that many have no water lens at all and are entirely dependent on rain catchment. Those islands which do have a water lens generally have a limited number of poorly developed open dug wells. The salinity of

11

12

this well-water varies greatly and is often high. In addition, these wells are often contaminated in some manner.

The remoteness of most of the islands of the Ha'apai Group and the related transport difficulties have retarded or altogether prevented the development of water supplies in the past. This factor, plus a steadily increasing population, has put increasing pressure on the existing inadequate supply of fresh water. This in turn has had a negative effect on the health and sanitation of these areas. It was clear that additional water supply facilities were urgently needed. FSP's response was the initial Ha'apai Water Supply Project, which although it did run into difficulties, nonetheless helped to alleviate part of the problem.

Then disaster struck. On March 3, 1982, Cyclone Isaac devastated the Kingdom of Tonga. Ha'apai was the worst-hit area, as the cyclone's path went directly through this group of islands. The cyclonic winds destroyed many rain catchments and tanks, and salt spray and tidal surges put an additional strain on the salinity of the water lenses, and following this disaster, a prolonged drought hit, one of the worst in Tonga's history. The situation became desperate. Additional supplies of fresh water and storage capacity became a major issue. A revision of the first Ha'apai Water Supply Project permitted renovation and repair of damaged tanks and catchments. This was recognized as being a temporary measure at best, as additional water storage/catchment facilities were still urgently needed. It was out of this need that the two-year extension arose.

PROJECT METHODOLOGY

The first project focused primarily on large 5,000 gallon ferrocement tanks with free-standing catchment structures. Although effective, there were certain problem areas. The large tanks/

12

catchments were prone to cyclone destruction which resulted in the loss of a large portion of a village's water supply. A secondary problem was a frequent lack of care and maintenance. They were in public tanks, which in Tonga is perceived as synonymous with government tanks. The responsibility for maintenance was therefore unclear to many people, and so these large structures did not receive the proper care necessary to ensure a good supply of fresh water from clean surroundings. Finally, the degree of difficulty of construction was also considered.

The recognition of these problem areas resulted in a change of policy on the part of the Tongan Government which permitted a change in methodology in the project extension which would hopefully not only overcome the difficulties mentioned, but also provide greater storage capacity which would be more convenient as well. The change was to smaller 1,000 gallon tanks, complete with guttering, which would be attached to existing public or private buildings/homes. The plan was to provide every house in the outer islands of the Ha'apai Group with a water tank. This entailed either renovation of an old tank, or provision of a new tank. By making use of existing roof-catchment area (and it should be noted that the input of hurricane relief housing to Ha'apai vastly increased this area), the costs would also be reduced permitting a greater number of tanks and therefore more storage capacity. By providing tanks to individual houses, it was hoped to create a feeling of ownership which would inspire a desire to keep the tanks clean and repaired; it would also provide a more convenient water supply than would a public tank. And it was considered that a large number of small tanks would result in less loss of water during a natural disaster. Just as one doesn't put all your eggs in one basket, nor should one put all your water in one tank.

PROJECT HISTORY

Ferrocement tanks were initially planned. This was consistent with other existing water tanks and available technology. Water tanks in Tonga had generally been constructed out of cement blocks or by the ferrocement method. Both have advantages and disadvantages concerning cost, method of construction, ease of construction, on-site vs. off-site construction, difficulty of transport of materials, strength of tanks, expected life-span, local labour involvement and a number of other factors. However the ferrocement method was initially selected because it was compatible with the existing project infra-structure, utilizing a Ministry of Works crew and a Peace Corps Volunteer Project Manager.

Two additional factors also had a high priority in choosing ferrocement tanks: speed of construction and quality-control. Regarding quality-control, it has been a fact of life in Tonga that cement water tanks leak; by having a specially trained crew construct all tanks, it was hoped to eliminate many of the leaks which may have been the result of poor quality construction due to untrained unskilled labour. In addition, the speed of construction would be higher by having a trained work crew. Due to the shortage of water caused by the cyclone and the drought, this was perceived as vital. So vital, in fact, that the Water Committee decided to minimize the involvement of the local people, sacrificing this involvement in favour of speed.

An experimental 1,000 gallon ferrocement water tank design was selected to used. This tank consisted of ferrocement panels which would be constructed at the Workshop in Pangai (capital of the Ha'apai Group) and then transported to the islands and assembled there. This

presented some difficulties with transport due to weight, bulkiness and breakability of the ferrocement panels, and the difficulty of access to some of the islands, but it was believed that this was preferable to on-site construction.

It was at this point that a local businessman let it be known that low cost, durable metal tanks were available.

A thorough study of these tanks was done comparing cost, durability, and ease of construction/transport. The first two factors were comparable with the ferrocement tanks, and the last factor was even more favourable. The metal tanks are constructed of curved segments of special galvanised corrugated sheet metal. The segments are riveted together with a mastic applied to prevent leakage. These tanks could be transported to the islands in pieces, and rapidly assembled on site. After due consideration, it was decided that the metal tanks could be provided more quickly and easily than the ferrocement tanks. The project began with the metal tanks, and scheduled the ferrocement tanks to be used at a later, less pressing date on islands allowing easy access. The company that makes the tanks sent over a trainer who demonstrated the method of construction to the local work crew. Following this training, and having completed the necessary surveys and studies, the project began.

THE EVALUATION VISIT

The FSP/CPD evaluation team was in the Ha'apai Group for 5 1/2 days, during which time a very strenuous schedule was followed. Some of the results of the initial Ha'apai Water Supply Project were seen. As they

have already been reported on and evaluated, it is sufficient to say that everything is still in place and functioning.

The team visited the islands of Lofanga, Fotuha'a, Kotu, Tungua, 'O'ua, Nomuka, Fonoifua, and Mango. All of these are involved in the extension of the Ha'apai Water Supply Project. The number of metal tanks varies from island to island but can be commented on as a whole, since the tanks are the same. In a few cases, tanks of different designs were also present, and these will be commented on where relevant.

The metal tanks leak. Leakage problems had been reported to FSP, but this was the first instance of eye-witness verification. Approximately 50% of the tanks seen had patches (usually cement) on them, indicating previous leakage (and in some cases they still were leaking). An additional 25% (approximately) were leaking but not patched. The final 25% (approximately) showed no signs of leakage, but in many cases these tanks did not have a great deal of water in them, because of lack of rainfall and/or heavy use of water and/or recent construction of tank. Whether these will develop leaks as the water level rises remains to be seen. Finally, the above-mentioned leaks were leaks through the seams of the tank. In addition to these leaks, perhaps 75% of all metal tanks also suffered from leaky, dripping faucets.

To lighten such a gloomy picture, one must consider that even a leaky tank is far better than no tank at all, and that the people of Ha'apai are nonetheless thankful for the tanks. Their appreciation and concern are indicated by their crude efforts to patch the tanks, and their good efforts in fencing the tanks to keep animals away, thereby increasing standards of health and sanitation. Already more care is being given to these tanks than was given to the large public tanks, so

16

this is a step in the right direction.

As mentioned, the primary areas of leakage are the faucets and seams, with the seams being the more worrisome and severe area. The vertical seams and the seam where the bottom of the tank joins the sides are the worst offenders. The reason is as yet uncertain, but involves the mastic used as a seam sealer. The manufacturer indicated that 2-3 tubes of mastic, placed between the overlaps of the segments, would be sufficient. In actuality, it is taking twice as many tubes of mastic, placed not only between the overlaps, but also on the outside and inside of the seams! And, due to the recent construction of tanks using this method, it's uncertain if even this will solve the problem. The local agent has contacted the manufacturer about this problem, and investigatory steps are being taken: a sample of the mastic has been sent for analysis, and a technical expert is scheduled to arrive during the month of February for an inspection/evaluation of the problem. The two most likely explanation for the problem are either that the mastic itself is no good (some mention was made of the mastic possibly being past its expiry date, although no such date is stamped on the tubes); or that the training provided to the local work crew by the demonstrator from the company was inadequate. An interesting note is that when the original training took place, 3 tanks were made; one entirely by the demonstrator, and two with his assisting/supervising the local crew. The location of one of the tanks (exactly which one is uncertain) is at the house of an FSP employee in Pangai. This tank also leaks at the seams, although not severely.

It is hoped that the arrival of the technical expert will solve the problem of the seams leaking. Plans are being made to fix the leaks as soon as the remedy is known. The problem of dripping faucets is another

11

matter altogether, and may be due to poor quality of equipment used. It is hoped that this problem also will be solved. Until time as the leakage problem has been solved, additional orders of metal tanks have been cancelled. The parts in stock will be used, but no more ordered at this time.

It should be noted that in some cases leakage through seams, and especially the bottom seam, is due to damage from animals. Unfenced tanks are subject to animal damage. Some villagers report that ducks and chickens eat the mastic, and that pigs chew on the tanks, compressing the mastic, breaking the seal, and causing leaks. The veracity of these reports is uncertain. Nonetheless, the advantages of a fence around each tank is obvious in terms of improved health and sanitation by keeping animals away from the drinking water, and all of the people were encouraged to fence in their tanks.

This break from metal tanks in no way hinders the program, as construction of the ferrocement tanks has already begun (as scheduled) and at worst, a slight change in the order of islands to work on might be necessary. As regards the ferrocement panel tanks, the evaluation team did not inspect any of these as their construction has only just begun, and none have been finished and distributed as yet. One therefore cannot objectively comment on them. However, on a cautionary note, the experimental nature of these tanks must be kept in mind. The individual panels will be wired together and the interior seams sealed with additional cement. These tanks have been tested under controlled, but not field, conditions. They should be kept under close examination as a safeguard against leaks. Any leakage would then be detected at an early stage and adjustments could be made.

18

Two types of non-FSP tanks were also viewed during the evaluation. The predominant type was constructed out of cement blocks and plastered inside and out. The largest of these were usually government-constructed public water tanks, dating back to 1909-1911. These are still in good shape although like many cement tanks, some leakage occurs. (An interesting point is that small leaks in cement tanks tend to eventually be self-sealing due to build-up of calcium deposits) some of these large tanks were renovated by FSP following the cyclone. There are, however, many smaller tanks (of the same cement block design) that are sitting idle. It would seem that many were private home tanks, but the house used as catchment no longer exists. Indeed, these tanks can be found in odd isolated places as well as in the middle of villages. Roofless, unused and uncared for, they are collectors of garbage and mosquitos, and are a health hazard. It would be a worthwhile project to clean and renovate these tanks. By placing a small cover/catchments on these tanks, additional reserves of water could be collected. Admittedly as the catchment area would be small, it would take some time for these tanks to accumulate water. This would present no problem if they were kept locked and used only as an emergency water supply to be used after other supplies are exhausted. Such a project would not only create additional water reserves, but eliminate a health hazard.

The second type of non-FSP tank viewed was made by the Niuala group (a group which has received FSP support in the past). These are (approximately) 3,500 gallon tanks constructed in a ferrocement fashion. They were constructed on-site by a Niuala team working with the local people. The cost is reportedly comparable with the FSP tanks. The thickness of the concrete and resulting durability of these tanks is uncertain. Speed of construction is acceptable, but quality control is variable. The one important point to these tanks is that of local

involvement. The local people participate in construction and

and in this way learn how to build their own tanks. This allows them to build additional tanks in the future if they desire. This is an area that is lacking in the current project, due to the decision to emphasize speedy construction and quality control. This decision was entirely understandable considering the context of the situation and the urgency of the problem, but it would be desirable to increase local involvement/training if at all possible.

Two final problem areas were identified in the evaluation. The first was that some of the structures which were designated as suitable for tanks were eminently unsuitable. And other perfectly suitable structures were ignored. The reasons for these errors in the original survey (which was, by the way, not done by FSP) are less important than the results. If at all possible, a tank was set up; if not possible, a nearby structure was used; and houses with suitable catchment space that had not been designated were given a tank anyway. FSP is commended for working its way out of a potentially sticky problem.

The second problem area is that, in general, the amount of catchment area per tank was small. It was normal for only one side of a roof to be used. The people must be encouraged to purchase the small amount of guttering and piping needed to use all possible roof space and maximize the benefits of having a water tank.

SUMMARY AND RECOMMENDATIONS

The Ha'apai Water Supply Project is filling a very definite need. The leakage problems are unfortunate, but should not detract greatly from the benefits generated by the project. All problem areas have been clearly recognized and identified, so the remainder of the work to be done should proceed relatively smoothly.

Based on the evaluation, we make the following recommendations:

- that the project continue its good work
- that no additional metal tanks be purchased until all leakage problems have been solved
- that the remaining (20 or 50) unassembled metal tanks be used experimentally to discover a leak-proof method of assembly
- that the findings of the technical expert from Lisat be followed up on immediately
- that all leaking metal tanks be fixed if possible, and all the potentially corrosive cement patches be removed from the tanks
- that methods of fixing the dripping faucets be investigated
- that the people be encouraged to fence their tanks
- that the people be encouraged to mosquito-proof their tanks
- that the people be encouraged and/or assisted in making full use of all roof catchment areas
- that the experimental ferrocement panel tanks be kept under careful supervision for any signs of leaking
- that methods of increasing local involvement be investigated
- that the possibility of training local villagers in simple methods of ferrocement construction (as in Hiuola method) be considered
- that renovation and provision of cover/catchment to all unused water tanks be considered
- that the possibility of extending this programme to other areas of Tonga be considered
- that the current investigation of low-cost methods of capping and developing small wells and providing a low-cost hand pump be continued

- that the minor damage to the Fonoifua community water tank be repaired
- that all metal tanks be kept under close supervision until all are judged leak-proof.. This applies especially to those tanks which, due to recent construction, haven't been adequately tested yet.

APPENDIX II

Field Trip to Ha'apai

Jan. 1984

by Bernard P. Hosie

Tonga

The Evaluation team was scheduled to fly from Neiafu (Vava'u) to Pangai (Ha'apai) on January 25, 1984 on the 10:30 a.m. plane. A breakdown of one of the SPIA flights meant the schedule time was changed to 6:00 a.m. The plane was an hour or so behind schedule so the team arrived in Pangai at 7:45 a.m.

The place was crowded because of the Land Commission of Baron Vaea and an ICA seminar at St. Josephs school. however we found a place at the Guest House. Peace Corps Director Geoff Schon was just leaving for Vava'u from Ha'apai.

Doug Metz (FSP Small Projects Officer) and Dallas Bowen P.C.V. in charge of the water supply project, showed the team the FSP workshop and store shed near the wharf. This former customs shed belongs to the Ministry of Works (MOW) which has lent it, rent free, to FSP for the project. It is well equipped and well stocked, and now connected to the town electrical supply. When this fails, a not infrequent occurrence, it has its own generator so work can continue.

The team examined:

1. A 5,000 gallon ferro-cement tank which was being built when the Evaluator was in Pangai in 1983. It is in good order, with a few minor cracks which have self sealed. This usually happens with the ferro-cement tanks.
2. An assembled metal tank, and the materials for about two dozen metal tanks in storage. Bowen explained how the tanks are pop riveted, the use of mastic (sealant), and discussed the problem of tank leaks.
3. A slab of the kind to be used in the square W.H.O. tanks the team is about to start building.
4. The materials for these, and the method of making them.

The slabs have three sets of stretched wires for reinforcing, and the cement-sand mix has fine steel pieces. With the quality control possible in the workshop, the slabs should be very strong. The wires stretch beyond the slab and will be used to attach the slabs to each other.

The team building the tanks consists of four NOW tradesmen whose salaries are being paid by PSP while their per diem is being paid by NOW. Bowen hopes to get additional NOW workers and to split them into three teams. One will continue to

build the metal tanks, the second will make the slabs, the third will assemble the slabs on site. Teams will alternate so that all have some time in Pangai.

The Evaluation team then hired a truck and visited the reticulated system built at Fangale'ounga in 1982. This has a Southern Cross diesel which pumps the water from a well to a tank about 25 feet high from which it is reticulated to the houses nearby. Apart from one minor breakdown quickly fixed it has operated very well (says Bowen).

A 5,000 gallon concrete tank at Fotua has some minor leaks which need patching. The catchment could be used as a small hall but no attempt has been made to do so. The tank has not been fenced. This was typical of the other tanks visited, at Holepeka and Koula, but all were in working order. At Koulo one of the double tanks was locked, the tap on the other was broken and a man was climbing a coconut log leaning against the tank. At the top he dipped the bucket (clean?) into the tank to get water, then carried it some distance to his home. The operation typified the problems associated with public tanks, and the reason that FSP decided, wisely, to change from large public tanks to small private ones.

After the trip to see the tanks the FSP Evaluator visited Brother Chrintopher, the new principal of St. Josephs to discuss the problems of the Ha'apai women's project.

Christopher (a New Zealand Marist Brother) has been heavily involved with Fualu and played an important part in the rescue of FATC in 1981, and the setting up of a curriculum in 1982. He believes FATC is of very great importance and assured the Evaluator: "If necessary I would take over FATC myself rather than see it fail." He is also introducing agriculture into the senior forms of the Catholic schools of Tonga so students going to FATC will have a better background than those now going. FATC is already the outstanding Farm School in Tonga, and is building a reputation far beyond Tonga. This year ILO are sending two students there from the Solomons. FATC is now so successful that it is beginning to appear that it might have regional significance.

Christopher agreed that the VWD is a program of great value. He also agreed that FSP support for the program is absolutely vital. There is not even the remotest possibility that the church can afford to support it if FSP withdraws. He suggested that the Evaluator see the Parish Priest, Father Sione Falemaka, to discuss what can be done about the Ha'apai VWD.

This the Evaluator did on the following Monday. Fr. Falemaka agreed that the program has gone downhill since Sister Petila was withdrawn. He proposes to ask the Sisters of Nazareth (who are at Ha'apai) for a sister who can take charge of the program.

Christopher also pointed out that Peter Tonga has been asked by the Bishop to start men's groups after the model of the women's groups. This was of great interest to the Evaluator. In later discussions with Sister Patricia Leamy she said that she felt it was a good move, and hoped it was not too late. The VWD has resulted in a tremendous output on the part of the women, and some jealousy from the men, who feel they are being left out.

The Evaluator interviewed Peter Tonga later in Nuku'alofa. About ten years ago FSP sent Peter Tonga for training in Fiji to the Bergengren Institute and then helped him set up the Credit Union Movement in Fiji but he is right out of this now. Peter explained that his work is strictly development and not pastoral. He is at present setting up groups in Tongatapu and getting a good response. He is beginning with a survey of the food the families eat and have available. He hopes to improve family food where necessary. Longer term he hopes to promote food gardens which will supply local markets and even export markets.

At this stage the Evaluator does not recommend including support for this in the new OPG. However, FSP should be aware of the program and be ready to nurture it as we did the VWD back in 1976 - perhaps negotiating a small grant from an organization such as Christian Aid. If the program is success-

ful is could be included in a future OPG. It has great potential.

Outer Islands Visit

At 8:30 a.m. the Evaluation team left Pangai in a 28 foot fishing boat with a diesel engine. The weather was fine and the sea calm - unfortunately this was not always the case.

Lofanga was the first island. The village is surrounded by a solar powered pig fence funded by FSP and built by the New Zealand Rotary. It is in perfect order, very well maintained and highly respected by the pigs. The pigs are kept inside the village and the bush apis beyond the fence are used for the vegetable gardens.

One result of the fence is that the gardens are now grown right to the fence. Formerly there was a wide strip of bush before the gardens started. Another important result, the Town Officer told us, is that there are now far fewer squabbles. A major cause of argument before the fence was built was the fact that "your pig ate my vegetables".

23 metal tanks have been built and the team inspected about twenty of these. About half had been fenced against the pigs. All except five had leaks, but in most cases these had

been patched with cement and the patches were fairly effective.

A meeting was held with the women, about 26 were present. The Town Officers and other leaders also attended. There are four women's groups, one a group of young people. In all the groups each member has a (personal) bank book, and the target is a kitchen for every group member.

Fotu'ha'a

A rough landing. A local boat came out through the rocks and picked us up. A steep climb up a cliff. Hot and dusty.

There are seventeen tanks and seventeen kitchens on the island. The kitchens were of good quality, all had been completed or very nearly.

The tanks almost all leak. Many tanks have been dug down a foot or two below ground because the roofs are so low; this makes it difficult to get at the taps. The Evaluator was also concerned lest the holes fill up with rubbish and cause the tanks to rust. A number of the taps leaked.

None of the tanks are properly fenced, and they pigs root around them. This could lead to problems with the foundations. In one case the bottom of the tank was wrapped

with a pandanus mat; the household told us the chickens had been pecking at the mastic and causing leaks.

The Nuiloa group, led by Tami Vakasiuola had a team on the island in 1981. They trained the local people to build concrete tanks and six were built. These are 3,000 gallon tanks, about 4 feet below ground and 4 feet above ground. None leak.

The team brought in only the cement (9 or 10 bags per tank at \$10 a bag) and the wire, so the cost was about \$150. The water is drawn out through a hole in the top.

Kotu Island

Arrived at 7 p.m. after a tricky trip through the reefs - went around once. Met by the Village Officers and (men) leaders. Spent the night on the island. The toilets were mesorable.

The (PEP funded) fence across the island is very solidly built and in excellent order. The vegetable gardens grow right up to the fence, with the pigs kept on the village side.

The team carried out their inspection next morning, saw about twenty-five kitchen and tanks.

The tanks are in fair condition. Many have one or two leaks, mostly patched. About half of the taps leak, some at the join but mostly the tap itself.

The kitchens are all finished except for quite minor items in some cases. When FSP Officer Doug Metz visited Kotu and the other Ma'apai Islands in November most were not finished so excellent progress has been made. Metz made it clear that future help was unlikely unless the kitchens were finished.

At 9 a.m. a feast, meeting, speeches. The women spoke with great feeling of their appreciation for the help they have received and what it has meant to their lives. The island is one of the poorest we saw.

Tungua Island

Arrived at 11 a.m. Inspected the FSP/USAID freezer. This was working but had only 50 pounds or so of fish and lobster.

There are fifty people in five groups started by Sister Petilla. 24 kitchens have been built and all are complete. The team saw about 20 of these.

In addition to the 24 Western kitchens, all 26 other members

have completed "Tongan" kitchens - made out of local materials entirely. Some of these have a coconut timber frame and so require only roofing iron and cement.

There are about 10 wells on the island; we saw none that are capped and more have a hand pump. This would make an excellent little project - here and in the other islands.

O'ua Island

Arrived at 2 p.m. and met by the Town Officer. There are fourteen in the women's group started by Sister Petila. Other groups, modelled after the WMD, have been started by the Government Extension Officer (from the Home Economics section of the Department of Agriculture). The leader of one such group approached the Evaluator to ask if they could join the FSP WMD.

There are twenty tanks, about half are leaking but otherwise are in fair order. Repairs have been made with concrete patches and these seem to be working. Most of the tanks are full.

There are 8 concrete tanks built by the Niuaola group on the island and the people prefer these. The people build these themselves for about \$150. A team between 5 and 10 build a

tank in one day. They get the sand from the beach - no gravel is used.

The kitchens in O'ua were of poor quality. About one-third had made no attempt to complete them by adding the cooking section, although they had promised to do so after the PSP inspection in November. The standard of cleanliness was only fair in the kitchens, the toilets, and the village in general.

The tanks were in similar condition. None had been fenced to protect them from the pigs. Some tanks already had a lean indicating that the foundation had not been well laid. Many taps dripped. But most of the tanks were full.

At Longomapu and other villages in Vava'u the team had been impressed by the general cleanliness and tidiness of the villages. This was not the case in O'ua. The constant care, instruction and pressure of the sisters was sadly lacking.

Fono'ifua Island

This is an isolated island and hard to supervise. The crossing from Nomuka was very rough.

The seventeen tanks on the island had just been completed. Most had only a foot or so of water in them as there had been

little rain since their completion. The builders used six tubes of mastic per tank and are hoping this will solve, or at least reduce, the problem of leaks.

The people were deeply grateful for the tanks. Formerly there was only one large public tank for the whole island and people had to walk long distances to fetch water. Some of the tanks had a lean - they had not been properly levelled.

The FSP/USAID funded ice maker on the island was out of order, having broken down a month earlier. Parts were on order.

There were nine kitchens, built with hurricane relief money. Some had not been well built. Too much cement was used in the footings and not enough was left to complete the floor. In other cases the coconut uprights were too short and the roof was low.

A meeting was held with the women, 9 attended. The FSP Evaluator urged them to complete their kitchen and continue their group work. The Chairperson, in tears, thanked FSP for its support. The women have set toilets as their next group target.

Mango Island 1/28/84

Nineteen tanks have been built on Mango. The tank builders had left only a few days before. They ran out of mastic and will return to complete their work. Several tanks had leaks but the general standard was quite good.

Fourteen kitchens had been built by the groups - there are two groups of seven, started by Sister Petila, and more women want to join. First aim is to complete their kitchens, then to build showers and toilets.

As on Fono'itua the standard of the kitchens was only fair. Again too much cement was used for the footings leaving insufficient for the floor. Several had not been completed, although all seemed to be working towards completion. Few have shutters so are hot. Some used masonite for the sidings but have not painted it and masonite is warping. About ten women and the Town Officers attended the meeting with the Evaluation team.

Nomuka Island

About ninety tanks and kitchens have been built on this islands. The team inspected about fifteen of each. The tanks are quite well built but over half had some minor

leaks. One tank was not on blocks - this will be investigated.

Prior to the building of the tanks the fresh water lake provided water for many households. This was filthy, with pigs wallowing in the mud at the edge of the lake. Even after boiling the Evaluator would be reluctant to drink it.

The kitchens had all been completed. Most are being used as kitchens, although several are also "home" for people who could not afford \$700 for a hurricane relief house.

There are about 80 women in ten groups on Nosuka. The leaders said they miss the visits of the sisters, these encouraged the groups and also served as important training tools. The groups are now working to complete the kitchens (furnishings, utensils, etc.) Their next target is showers and toilets.

It was 7 p.m. when the team finished - a long day. At that stage they got a message from the Nosuka police advising them that they could not return to Ha'apai next day because it was against the law to travel on Sunday. The problem was finally sorted out.