

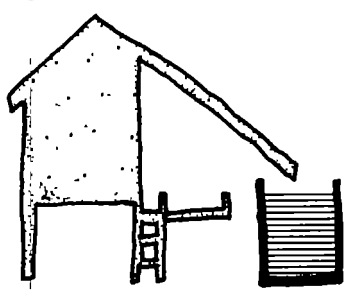
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# Collection and Storage of Roof Runoff for Drinking Purposes

A Project supported by  
International Development Research Centre

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Volume 4

**SOCIO-ECONOMIC STUDIES**

**IDRC**



CANADA

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**T H A I L A N D**

213.1-4128



FINAL REPORT

COLLECTION AND STORAGE OF ROOF RUNOFF FOR DRINKING PURPOSE :

SOCIO - ECONOMIC STUDIES

Submitted

to

THE INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC)

LIBRARY, INTERNATIONAL REFERENCE  
CENTRE FOR COMMUNITY WATER SUPPLY  
AND SANITATION (IRC)  
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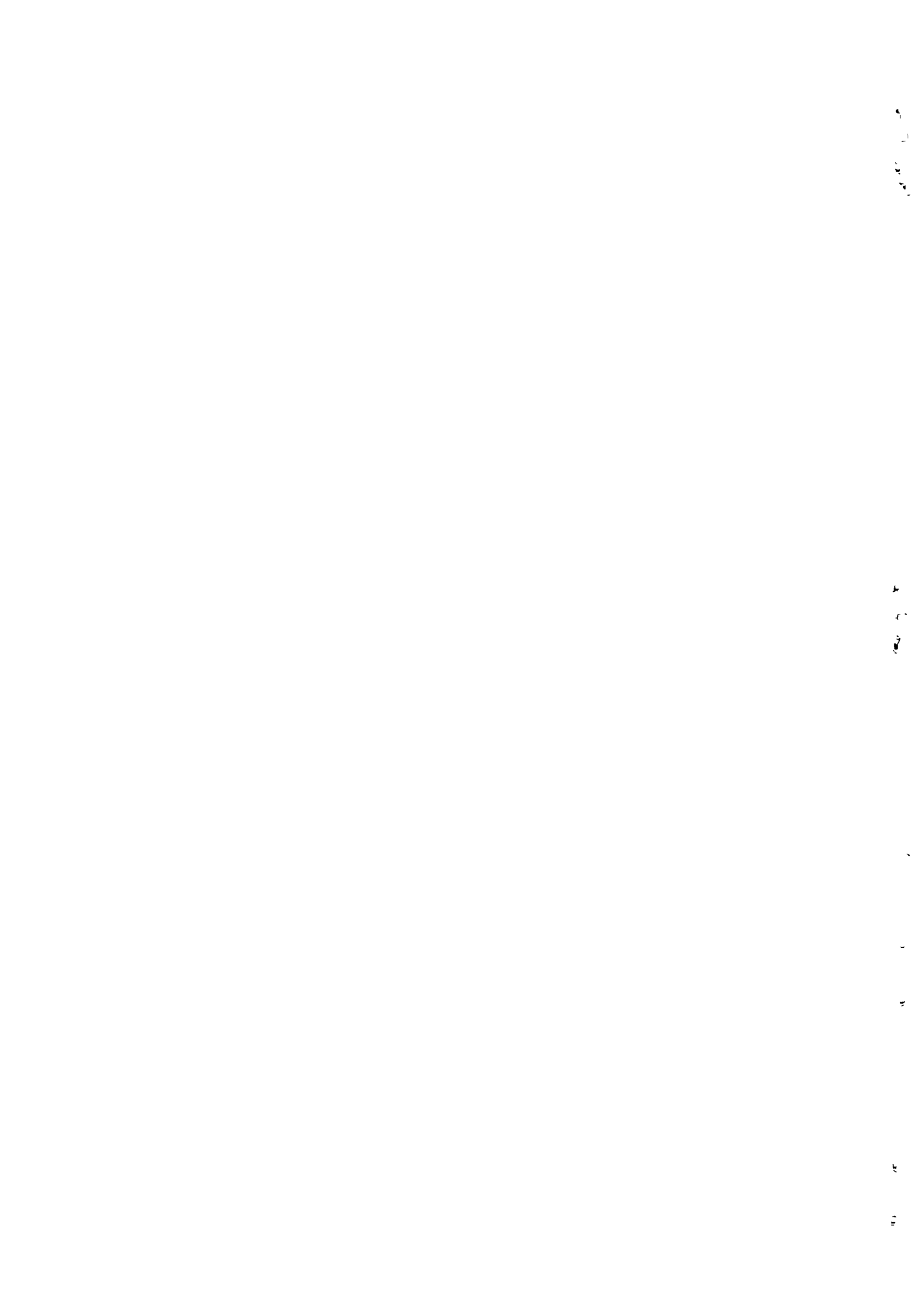
Khon Kaen University

August, 1984

*With Regards,*

*Chariya Sethaputra*

*May 28, 1985.*



## PREFACE

### Background

With a total population of about 14.7 million and an area of 170,226 square kilometres, Northeast Thailand constitutes about one third of the entire Kingdom both in terms of population and area. The annual population growth rate amounts to more than 3 percent. Almost all major indices used to reflect the quality of life in the Northeast indicate the Northeast to be poor, if not the poorest, in comparison with other regions. The majority of the region's population, which derives much of its livelihood from agriculturally related activities, is very much handicapped by erratic rainfall patterns and unfavourable soil conditions. Consequently the regional family income which is about 14,600 baht per annum (WHO 1976) ranks the lowest on the national income scale. Unemployment is also normally unacceptably high during the dry season. Disparities also exist in the area of public services such as health and infrastructure. For example, medical manpower statistics show that there is one doctor for every 50,000 people in the Northeast while the figures for the rest of the Kingdom and for metropolitan Bangkok read one doctor for 15,000; and one doctor for 1,000 respectively.

One of the most important factors determining health conditions of the Northeasterners is the lack of acceptable quality drinking water. This is relevant to the majority of the Northeast villagers who normally do not have access to piped water or other forms of a centrally distributed potable water supply. The villagers have to rely on rain water in the rainy season; and ground water, from deep or shallow wells, in the dry season. Water from deep wells in the Northeast usually contains high mineral concentrations and is unacceptable to the taste of most villagers. The quality of water from shallow wells for drinking purposes is questionable, as it is easily contaminated. At present, the technology involved in the improvement of ground water quality is outside the capability of the village .

For the villagers, rain water seems to be the most viable solution to provide an acceptable quality of drinking water. The rain water stored for this purpose has to be intercepted and collected before it reaches the ground in order to prevent undesirable contamination. The traditional approach is to use the household roof as a rain collector and the water is stored in jars, pots, or tanks. However, this traditional method has not changed or improved in the last generation. People still have inadequate rain water for drinking due to inadequate or unsuitable storage vessels. The full potential of rain water for drinking purposes in terms of quantity and quality is still untapped and probably unrecognized. To exploit this resource more effectively, there must be improvements in the existing practices. Village level technology is urgently needed to solve the problems related to the suitable type and size of storage tank which can be cheaply built and maintained.

#### Project Goal

The goal of this project is to provide the essential knowledge necessary for rural villages in the Northeast to have an adequate quality drinking water supply.

#### Project Objectives

If the rain water storage tank system is to live up to its potential as a means of solving rural drinking water supply problems for the Northeast, or other parts of Thailand, a comprehensive study on the subject must be performed and the result of the study must be readily available in a simple form for any interested villager. Therefore, the objectives of this research are:

- a) to develop knowledge about appropriate rural technology required for the design, construction, operation, and maintenance of a rain water collection and storage systems.
- b) to prepare a simplified manual for use by average villagers.

### Project Duration

The duration of the project was 3 years from July 1981 to August 1984.

### Project Organization

In order to develop the required knowledge, following four groups of research tasks were studied and presented in four report volumes.

#### Volume 1: HYDROLOGIC STUDIES

by Pradit Nopmongcol and Sanguan Patanajakul

Rainfall characteristics in terms of temporal and spatial patterns in the Northeast were investigated from the following aspects:

- a) the relationship of rainfall, roof area, tank size, and the household demand, from which the optimum tank size can be determined if other parameters are given, and
- b) the potential and availability of rain water supply in various localities, as well as its reliability during each month.

A computer simulation model was employed to study these aspects. Rainfall records from all 16 provinces in the Northeast, with record length of about 10 years, were analyzed with the aid of a microcomputer.

#### Volume 2: STUDIES OF RAINWATER QUALITY

by Vanasri Bunyaratpan and Suparek Sinsupan

Rainwater quality from the atmosphere, roofs, and new and old tanks in the aspects of physical, chemical, and biological parameters and compared with the standards.

Volume 3: CONSTRUCTION MATERIALS, TECHNIQUES AND OPERATIONAL STUDIES

by Chayatit Vadhanavikkit, Nipon Thiensiripipat and  
Suthipol Viwathanathepa

Design and construction procedures of bamboo reinforced concrete, ferrocement, brick and interlocking mortar block water tanks were presented. The comparisons of these water tanks with other conventional types of water storage vessels were made. Preliminary investigations into the use of non-cement based materials for water tank construction were presented. The operational aspects of water management, maintenance and repair were also discussed.

Volume 4: SOCIO-ECONOMIC STUDIES

by Chariya Sethaputra

Two socio-economic surveys were carried out for selected villages in Khon Kaen. A preconstruction survey was conducted in advance of the actual construction of tanks to identify socio-economic variables in the villages such as general living conditions, problems and conditions associated with drinking water, attitudes towards drinking water in terms of taste preferences, construction operation, and investment of storage tanks. A post construction survey conducted after the tanks were constructed, was assessed. The changes in the socio-economic variables were identified and discussed.

Epilogue

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Our behalf of all project members, I am happy to announce that the manual for tank construction has been produced, published, and is available for use throughout the rural villages in the northeast.

During our three year research project, through gratifying advances and disappointing setbacks, all project members have remained



steadfast in the pursuit of our goal. Therefore, we respectively submit this project, "Collection and Storage of Roof Runoff for Drinking Purposes", for your carefully study and consideration.

We trust that the information and data provided will assist all quality water to the rural regions of ~~Northeast Thailand~~.

Project Leader : Chayatit Vadhanavikkit

Researchers : Pradit Nopmongcol

Sanguan Patamatankul

Vasari Banyaratpan

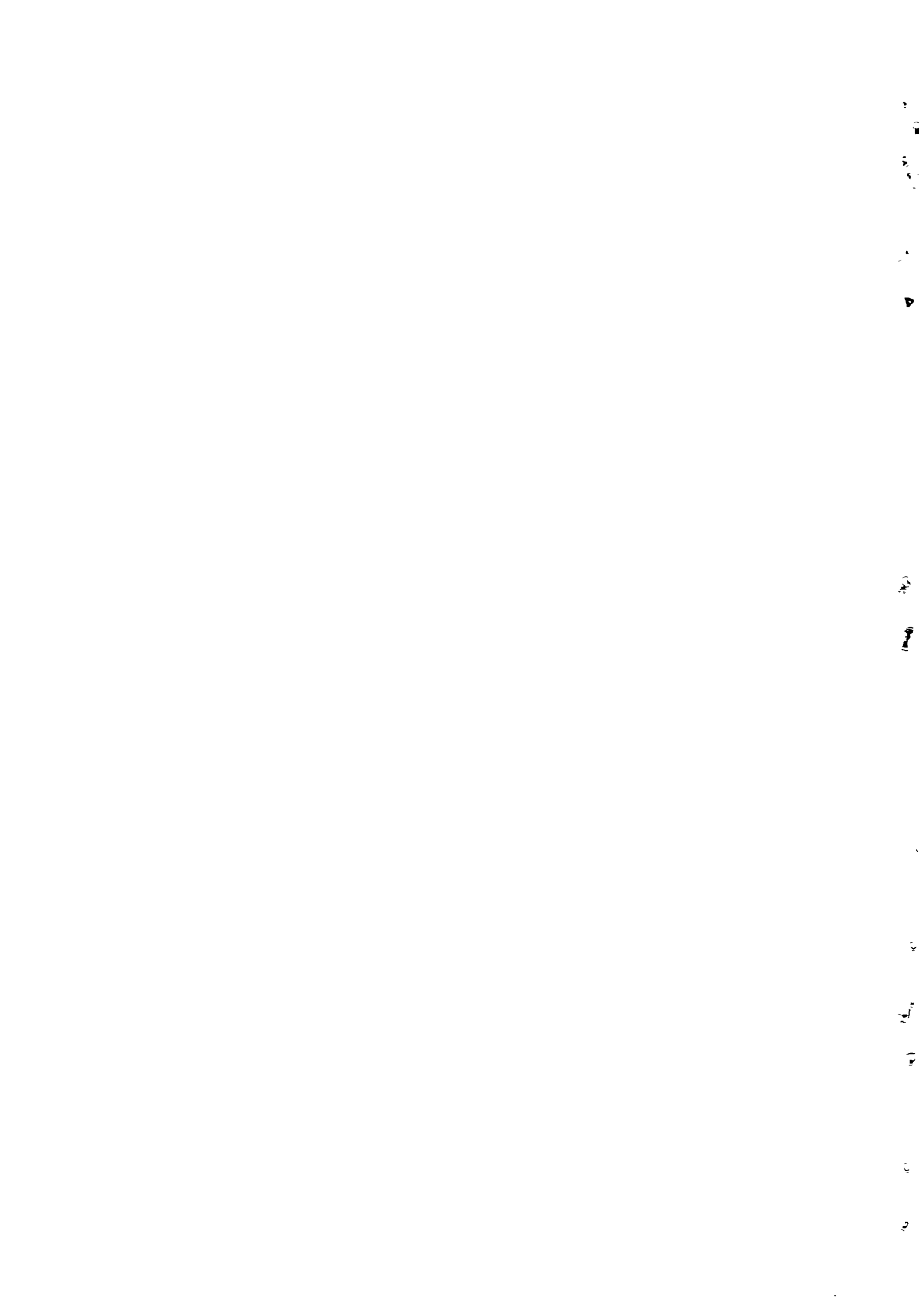
Saparak Sinsapan

Nipon Thensiripipat

Sethipol Vivethanathapa

Chariya Sethapetra

August, 1984



## ACKNOWLEDGEMENTS

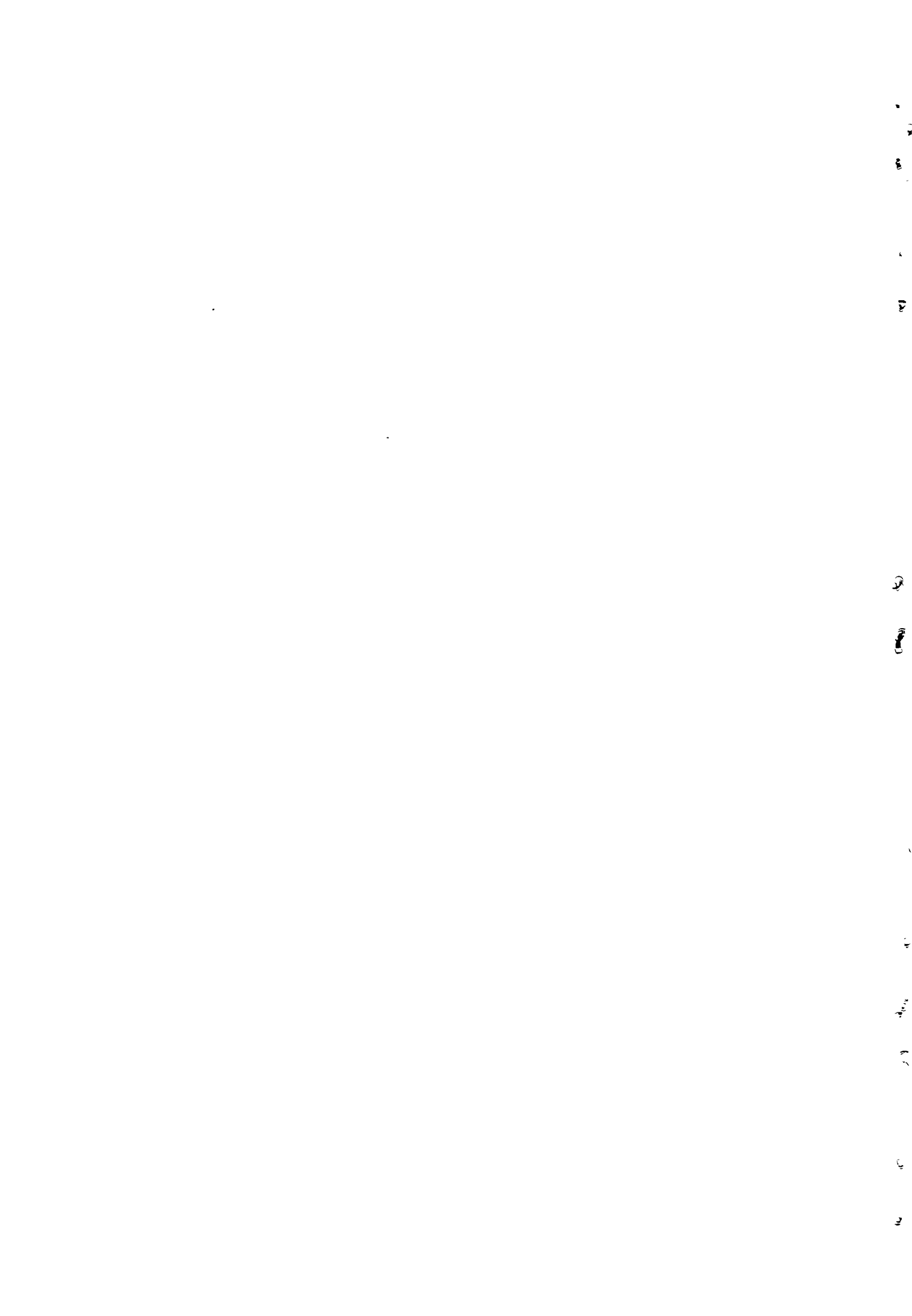
Grateful acknowledgements are made to the following :

1. The International Development Research Centre for their generous grant to support this study.
2. The Faculty of Engineering, KKU for providing counterpart support funds for field trips to villages and research sites.

The author would like to express her appreciation to the village chiefs and school headmasters of Ban Kradueng, Ban Nong Kung, Ban Non Muang, and Ban Savathi which were selected as research sites, these individuals provided outstanding assistance and close cooperation.

Special appreciation is given to Col. Henry S. Sachers from the Department of Foreign Languages, the Faculty of Humanities and Social Science for his assistance in editing this report.

Finally, sincere thanks to all the villagers for their kind hospitality and cooperation in answering the innumerable inquiries.



## SUMMARY

The present study was an intensive survey research conducted in order to investigate nontechnical aspects of the project for developing a supply of drinking water for rural regions. It provided information concerning the nontechnical aspects for engineer researchers in the preconstruction period of the water storage tanks. It provided a basis for a later comparison with a postconstruction survey. The preconstruction survey was carried out in advance of the actual construction of tanks so as to examine the socio-economic conditions, problems, and conditions associated with drinking water of the villages selected as research sites. It included attitudes of villagers towards the drinking water as well as their degree of acceptance of the new water storage tanks. The postconstruction survey conducted after the construction of both private and public tanks assessed the behavioural changes of tank owners and their degree of acceptance of the proposed terms of the project : to include ; supply of the drinking water, construction, operation and taste preferences of drinking water from the various types of storage tanks.

Data collections were accomplished by means of oral interviews utilizing special questionnaires developed for this project along with the critical observations of the researchers. It was found from this study that all four of the selected villages have per capita incomes below the average national value. Only two of the selected villages had per capita incomes above the regional

standard and thus were found qualified to implement the monthly installment plan for private tank construction. In the dry season which runs from November to May, there was a shortage of drinking water in each village therefore the villagers had to depend on shallow wells for drinking water. The villagers lacked knowledge and information about diseases, illnesses such as intestinal problems which are transmitted and caused by filthy drinking water. Thus the villagers have not yet recognized the need for high sanitary standards. Results concerning villagers' attitudes towards taste of drinking water showed that this factor was valued as the most important ; more so, than the quality in accepting the water for drinking. The majority of villagers recognized the problem of water shortage, and agreed with the idea of construction of storage tanks. Those who were well-off agreed with the monthly installment plan for private tanks while the poor suggested other alternatives including public or communal tanks. It was also found that time periods for acceptance of the drinking water from storage tanks varied depending on the types of tanks, the design of overflow pipes, and the water management system used in each household. Storage tanks produced more changes in water utilization habits and behaviour in children than in adults.

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## I. INTRODUCTION

### 1.1 Background

It has been widely recognized that water is one of the basic needs of people for daily living. Especially drinking water and this water for human consumption should be clean and without contaminants in order to guard against infectious and water-related diseases. Nevertheless, today's reality is that  $1\frac{1}{2}$  million people, particularly those who live in rural areas, are forced to drink filthy, contaminated water. As a result, approximately 30,000 people die each day because of water-related diseases (IRC, 1984). Since 1977, the United Nations Organization has recognized this problem. At the U.N. Water Conference held during that year the world's attention was focused on this urgent problem, and all nations were called upon to find viable solutions. The conference concluded that all people, whatever their stage of development, or their social and economic conditions, have the right to have access to safe drinking water in sufficient quantity to satisfy their basic needs. The conference also recommended that by 1990, national governments provide all people with water of safe quality and adequate quantity along with basic sanitary facilities. Priority was to be given to the poor in water scarce areas. As a result of this conference, the United Nations General Assembly declared the decade of 1980-1990 as "The International Drinking Water Supply and Sanitation Decade". The programme was formally launched in the year of 1979 (Sathianathan, 1981). Since then Thailand, as one of the member states of World Health Organization, adopted the declaration and has implemented the policy of the programme.

In Thailand, it was explicitly emphasized that the rural areas of the country containing 85 percent of the total population of the nation, have problems with drinking water and general sanitation conditions (Sanitation Division, 1981). Particularly, rural areas in the northeastern part of the country have problems both in the quality and quantity of drinking water. During the dry season, women and children have to walk intolerable distances and wait long periods at the wells in order to fetch drinking water for their families. Since 1964, the Thai government has recognized and pursued these problems. Under the National Economic and Social Development Board, a special project, "The Provision of Safe Quality Water for Rural Areas", was established in order to provide people in rural areas with water of safe quality and adequate quantity (ONESDB, 1981). Since 1966, the project has been implemented through the cooperation of 12 various government agencies : such as ; the Office of Accelerated Rural Development, Department of Health, Sanitation Division, Department of Mineral Resources, and others. In 1978, twelve years after the initiation of the project an evaluation study to determine effectiveness was conducted. Results from the evaluation study by Wesakul (1978) revealed that only 24.4 percent of the target population (eight million people) received benefits from the water resources provided by the project. Also only 9.3 percent of the group mentioned above (3.35 million people) benefited with water of a safe quality. It was evident from the study that the resolution of the government has not yet been attained, the goal of providing people in rural areas access to safe water in sufficient quantities had not been reached in real life situations. This points out the

need for more research and study in this area in order to identify viable solutions for this critical problem.

## 1.2 Need for the Study

This project, the socio-economic studies, provided background information concerning social aspects for engineers in the preconstruction period of water storage tanks and basis for later comparison with a postconstruction survey. In the past, rural development research dealing with water supply and sanitation did not pay much attention to the many socio-economic aspects of the projects. Most of the researchers were engineers and health experts primarily concerned with technologies and transferring the appropriate technologies to villagers (Simpson-Herbert, 1983). Often in the past after projects had been completed sometimes villagers would revert back to their former practices which they were used to : such as ; relying on shallow wells for drinking water in the dry season, or drinking directly unacceptable quality water without prior boiling or filtration (Kumkanab, 1971 ; Wesakul et.al, 1978). This illustrates the need for more attention in the area of social science in attaining the stated goals of the research projects. It was also evident from the study by Dechadilok (1978) that other significant factors, besides technologies, contributed to the success of research projects in water supply and sanitation. These included social factors : such as ; socio-economic conditions, attitudes of villagers towards resources of water provided, and their acceptance on these matters. Thus the goal of the present study was to help the engineer researchers who needed to have socio-cultural data for planning and demonstration of

construction of water storage tanks in villages selected as research sites. Additionally, this study served as a component in the evaluative studies of the system : the villagers' acceptance of the proposed drinking water supply programme.

### 1.3 Purposes of the Study

The purposes of the present study were focused on the following aspects :

1.3.1 Socio-economic conditions of the villages selected to be research sites in Khon Kaen Province. These included living conditions, occupations, average household incomes, and current levels of knowledge about disease transmission in each village.

1.3.2 Problems identified by villagers with drinking water and condition.

1.3.3 Local beliefs and attitudes regarding drinking water.

1.3.4 Traditional water use and storage.

1.3.5 Acceptance by villagers of the proposed terms of the project : to include ; supply of the drinking water, construction, operation, and costs of storage tanks as the proposed containers for the drinking water, and taste preferences of drinking water from the various types of storage tanks.

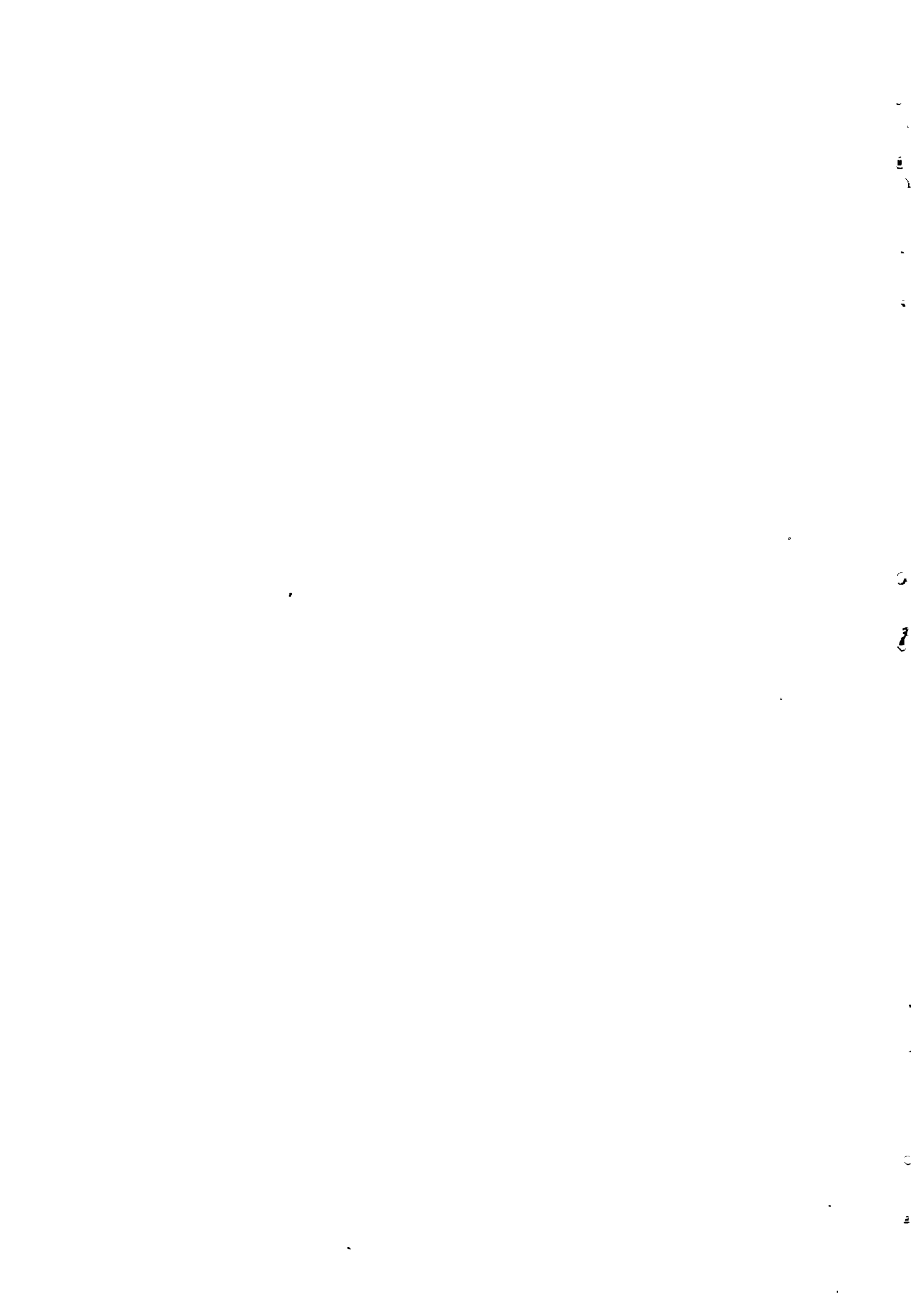
### 1.4 Scope of the Investigation

The research for this study was divided into two stages : a preconstruction and a postconstruction survey. The preconstruction survey was conducted in advance of the actual construction of storage

tanks in order to identify socio-economic variables and to provide socio-cultural data for engineer researchers in construction demonstrations. The postconstruction survey was conducted after the storage tanks had been constructed and in operation through a period of one dry season in order to assess changes in traditional water use, and the villagers' acceptance of the proposed drinking water supply programme.

Villages selected to be research sites resulted from a consensus of the researchers involved in the project. The preconstruction survey was conducted in four villages in Khon Kaen Province : Ban Kra-dueng, Ban Non Muang, Ban Nong Kung, and Ban Savathi. The postconstruction survey was limited to the first three villages mentioned as no construction was done in Ban Savathi.

With regard to data-gathering methods, because of a seasonal and time constraint for the life of the project, this was accomplished by means of oral interviews with a selected sample of key informants, heads of households, some members of the selected households, school teachers, and students. Special questionnaires were developed by the author to generally guide the interviews, and record observations. The contents of the questionnaires were composed of both socially and technically related inquiries which would yield significant information for engineer researchers in both the preconstruction and postconstruction periods.



## II. REVIEW OF THE LITERATURE

Research projects dealing with the provisions of water of safe quality for villagers in rural areas have been carried out by a number of governmental and non-governmental organizations since 1964 to the present. The various methodologies for obtaining safe quality water for the villagers use a number of construction techniques and containers : such as ; artesian wells, constructing of water jars, water storage tanks, and sanitary water filters, In implementing the projects, some organizations had conducted advanced sociological surveys on the target villages and others had not. However, in conducting evaluations of the projects, most organizations did pay some attention to sociological aspects in order to determine the effectiveness of the implemented programmes.

During 1977-1978 the Sanitation Division, Health Department (1981) introduced a new device, the sanitary water filter, to obtain safe drinking water for rural people in all parts of the country. The sanitary water filter was a modified model of water filters which were first developed for rural people in the North. It can reduce up to 90 percent of all the bacteria in the water, and the quality of the filtrated water is acceptable for consumption. Later it was revealed that this method of obtaining clean water, eventhough the cost is low, was accepted only by villagers in the northern part of the country especially those who live by rivers or natural water resources while it was ignored by villagers in other parts.

In 1981, the Office of Accelerated Rural Development launched the Concrete Jar Construction Project for farmers in Tayang District, Petchaburi Province, and Huayhin District, Prachuab Kirikhan Province. A training programme for concrete jar construction along with the construction materials were provided for the farmers. A project evaluation conducted by the Department of Research and Evaluation (1981) showed that after completing the training programme, each trainee's household received an average of three concrete jars. This meant that each household had more water storage vessels and consequently reduced the time spent by members of the family, especially women and children, in fetching water in the dry season. However, it was interesting to note that after completing the training programme, only 21-67 percent of the trainees disseminated their knowledge to the neighbours. Furthermore, it was later found that the concrete jar construction activities in both districts were terminated due to the lack of construction materials. Also the fact that villagers were not concerned with problems of water shortage in the dry season ; since, they could buy water at a low price from the water trucks commuting among the villages in those districts.

The project of the Provision of Water of Safe Quality for Drinking Purpose Project which has been widely recognized by villagers in the Northeast is the one at Khon Kaen Sanitation Centre, It was established in 1979 with the cooperation of the Sanitation Division, Health Department. Rain water storage tanks were first introduced to villagers in 1974 and four years later had expanded to nine provinces in the region with approximately 2,330 tanks. At present, villages in the suburbs of Khon Kaen city : such as ; Ban Ped and



Ban Kogphanpong have successfully reached the target of the project. Almost all of the households in these villages were equipped with rain water storage tanks. It was interesting to note, however, that implementation of the project differed from those mentioned previously. A preconstruction study concerning sociological aspects was conducted to identify needs and living conditions of villagers. As a consequence of the study, orientation programmes were provided for villagers in order to prepare them to take part in the proposed project.

It can be seen from the studies mentioned above that knowledge of the social aspects played a vital role in achieving the target of each project. Recent research dealing with the provisions of safe quality water for people in rural areas has pointed out the need for more research and investigations in the area of social science. As mentioned earlier, Dechadilok (1978) reported that the significant factors, (besides the appropriate technologies), in determining types of water resources that should be constructed in each village are : social factors which include socio-economic conditions ; needs, and attitudes of villagers towards resources of water provided; and costs of investment, and maintenance. It was also recommended in this study that socio-economic studies receive more attention for further research in this area. The findings of Wesakul et, al (1978) were found to be in accord with those of Dechadilok mentioned previously. It was evident from the evaluation study that the resources use in providing water of safe quality for drinking purpose for some villages were wasted. The villagers did not take advantage of the water resources provided as they were not concordant with their preferences and traditional practices.

On the basis of research results reviewed above, it is, then, possible to state that investigations dealing with both sociological and psychological aspects should be carried out and received more attentions in water supply and sanitation research projects. This does not mean only that researchers would get multidimensional viewpoints on the projects they are working on but the study would develop better understandings and closer working relationships with villagers as well. Once the villagers get to know: what is provided for them, what is expected from them, and when they are expecting to do it, it would have been impossible for researchers not to attain the set goals of the projects.

### III. RESEARCH METHODOLOGIES

The investigation for this study was divided into two stages : a preconstruction and a postconstruction stage. The preconstruction study was conducted in four selected villages in Khon Kaen Province : Ban Kraeueng, Ban Non Muang, Ban Nong Kung, and Ban Savathi. Results from the preconstruction study along with recommendations were then submitted to the research team as a component of background information for selection of construction demonstrations sites. After a series of discussions, it was decided to select three of the villages Ban Kraeueng, Ban Non Muang, and Ban Nong Kung, as construction demonstrations sites. The construction of water storage tanks both private and public, were carried out in the households and schools of the villages. The period of constructions began late in the dry season of 1983. Thus, during the rainy season of that same year, the owners of the water storage tanks were able to collect rain water for consumption in the dry season of the following year. After the termination of the 1984 dry season, the postconstruction study was carried out in order to determine utilization and effectiveness of the water storage tanks as vessels for drinking purpose. Details of research methodologies are listed as follows :

#### 3.1 Sample

In the preconstruction study, selection of a sample from each village was based on the cluster sampling technique (Blalock, 1979). The population was divided into groups of elements called clusters; then, a random selection was made from the clusters. A sampling unit from each of those selected clusters was taken to produce the study sample. In conducting the cluster sampling method - in this case a

single - stage cluster method - the author divided households in each village into blocks according to pathways which passed through the village. Among the blocks, random selection was made proportionate to the size of the village, and every household in the selected blocks was included in the sample. Finally, within each selected household, the family leader was chosen to be the interviewee. The sample sizes for Ban Kradueng, Ban Non Muang, Ban Nong Kung, and Ban Savathi were 28, 35, 45, and 57 respectively. Key individuals included in the interviews were : the village headman, the village school headmaster, members of the village committee, and some workers from the selected villages employed at Khon Kaen University. With regard to the postconstruction study, the subjects selected for the investigation were limited to those who owned water storage tanks. This included both private and public tanks.

### 3.2 Measuring Devices

Measuring devices utilized in data collections were questionnaires : the preconstruction and the postconstruction questionnaires were both developed by the author. The preconstruction questionnaire was divided into three parts. The first part consisted of general information questions on the village. The second part dealt with socio-economic variables such as: family's average per annum income, land rights, number of livestock, agricultural products, structures and conditions of households, and living conditions of villagers. The third part included a series of questions on conditions of drinking water in the village, traditional storage and use of water, attitudes and preferences toward drinking water, and opinions on the

construction of water storage tanks in terms of costs of investment, sites of construction, and management systems. Item types in the questionnaire included checklists, fill in the blanks, and open-ended responses.

In constructing the questionnaire, the author studied several sources of information as guidelines for writing content and item styles (e.g. Dobbert, 1981 ; Forcese & Richer, 1973 ; Phillips, 1969 ; Simon, 1978 ; Wesakul, 1978). The first draft of the questionnaire to determine the clarity of item contents and duration of time for conducting the interview was administered to villagers in Ban Non Muang and workers from Ban Savathi working at the Faculty of Education. After the pretest, the author revised the items which appeared to be ambiguous, and deleted those which did not yield the required information. The revised form of the questionnaire took 30-45 minutes for experienced interviewers to conduct each interview. This was considered an optimal duration of time for the oral interviews. A longer duration of time than this would have fatigued both the interviewer and interviewee resulting in unreliable data. Details of the preconstruction survey questionnaire are shown in Appendix A.

As for the postconstruction survey questionnaire, the research team convened and discussed topics of interests which arose from their studies to be included in the postconstruction interview such as : water quality, managements, and utilizations. This questionnaire was divided into three parts. Part I consisted of questions on general conditions in the selected villages where water storage tanks had been constructed including both private and public tanks. Part II

consisted of questions on conditions of drinking water in a house and a school in which a private and a public tank were provided respectively. The last part was a series of open-ended questions on the villagers' routine concerning water supply (see Appendix A).

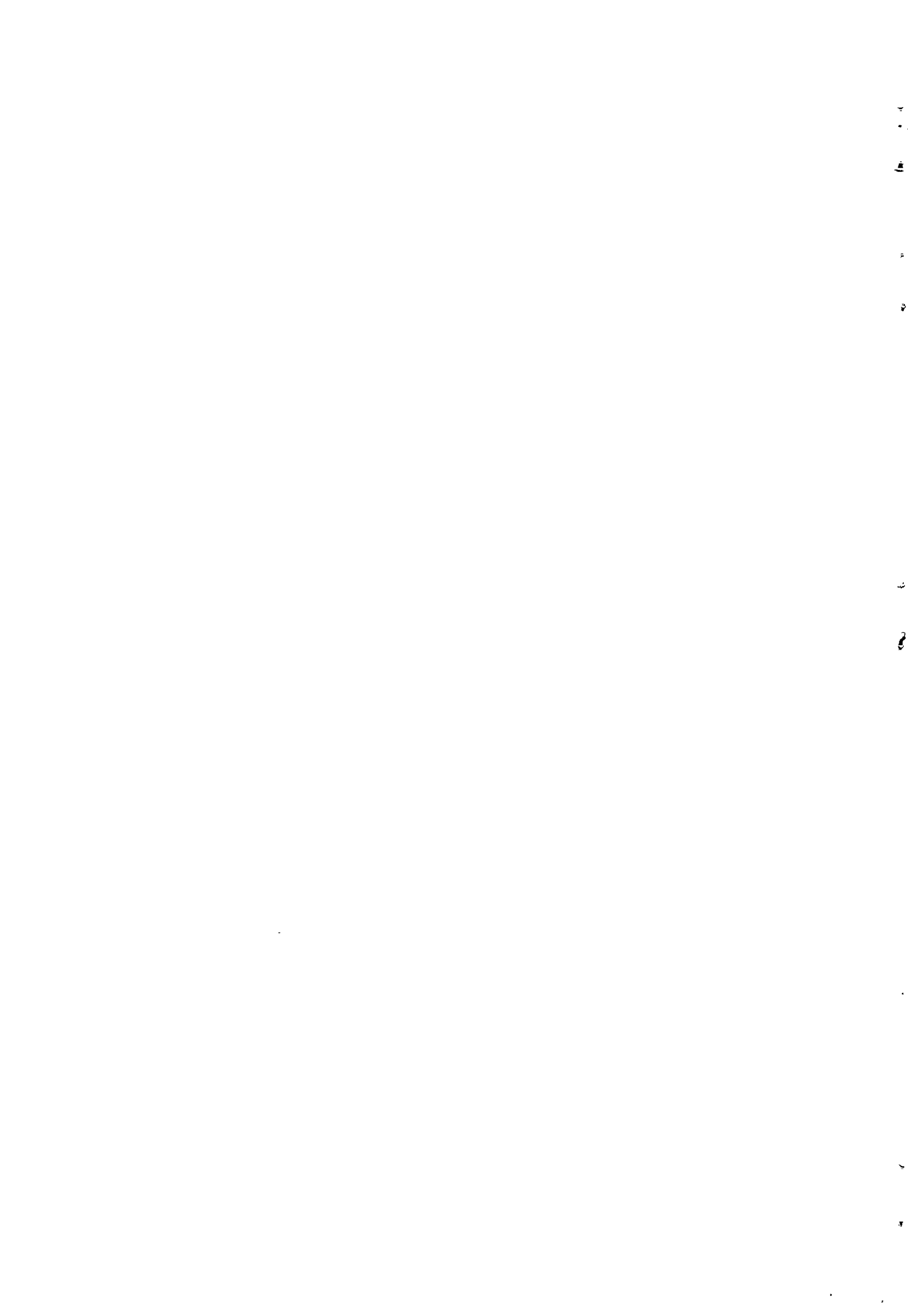
### 3.3 Procedure

The field work team for the preconstruction period comprised the author plus six research assistants. Four of the research assistants were graduate students in the area of Educational Research and Evaluation they worked as interviewers. The remaining two were undergraduate students from the Faculty of Engineering who collected data on household conditions and water resources which would provide necessary information for the engineer researchers in the construction stage. Selection of the interviewers were based on the following criteria : having successfully completed courses in Research Methodologies, Psychometric Methods, and Attitude Scale Construction; and speaking abilities in the Isan dialect. Trainings for these interviewers were conducted in advance of the visits to the research sites.

Data collections were accomplished by means of oral interviews and general observations. In the preconstruction study, it was assumed that family leaders were decision makers in household matters : thus, in order to follow this basic assumption, after a sample unit had been selected a head for each household was chosen as the respondent. Analysis of data was separately done for each village. Descriptive statistical analyses were carried out in order to report significant characteristics of the villages and variables which were

of interest for the research team.

As regards the postconstruction survey, it was designed to be an intensive oral interview with tank owners and some members of their families, the village school personnel, and school children. The author and the assistant researchers took turns visiting the owners of the tanks. Results of the investigation were then compared to those obtained from the preconstruction survey in order to determine changes associated with drinking water problems for villagers.





#### IV. RESULTS AND DISCUSSTIONS

This chapter describes results of the investigation in two consecutive parts. The first part, the results of the preconstruction study, was primarily intended to present the research team with information for decision makings in the construction stage. The second part, the results of the postconstruction study, provided information on the changes in traditional water utilization, practices, and acceptance of the rainwater storage tanks by the owners. Details were reported as follows:

##### 4.1 Results and Discussions of the Preconstruction Study

The results of the preconstruction study were classified into five sections : general information on the villages, socio-economic conditions, drinking water (conditions, storage, traditional use). attitudes towards drinking water, and opinions on the construction of water storage tanks in the villages.

4.1.1 General information on the villages Four villages, Ban Kradueng, Ban Non Muang, Ban Nong Kung, and Ban Savathi, in Khon Kaen Province were selected as research sites for the preconstruction study. A brief description on each village follows :

Site 1 : Ban Kradueng Ban Kradueng is a small village located in Pa Manoa subdistrict west of Khon Kaen city. The village is situated on a high plain. Since it is surrounded by other villages, it has a rather limited amount of land for agriculture. There is a canal passing through the village which is used for agriculture and other general activities. As for other water resources, there are ponds, artesian wells, shallow wells, and a small weir. However, during the dry season, there is not enough water for agriculture and

other use. The village population is approximately 570, and the number of households is 95.

The village is connected to the district centre by a laterite road which intersects the Khon Kaen - Loi highway ; the distances from the village to the highway and to the district centre are 12 and 19 kilometres, respectively. During the dry and cold seasons, transportation is no problem. Many minibuses operate daily to and from the district centre. However in the rainy season, from late May to October, communication is difficult though not impossible. Villagers have to walk to other nearby villages to get a bus to the district centre. Electricity is not available in this village since the village is relatively poor compared to other villages. The villagers mentioned that they can not afford the cost of electricity and the electrical units.

Site 2 : Ban Non Muang, Ban Non Muang is composed of subvillages nos. 3 and 12. It is located in Sila Subdistrict about eight kilometres to the north of Khon Kaen City. This village is considered as a somewhat developed area, since villagers have access to electricity. Communications to Khon Kaen city is convenient and quite a few village children have the chance to continue their higher education at Khon Kaen University.

Most houses and households are situated along the main village road with the rice and paddy fields around the village. There is a laterite road connecting the village with the mainroad to the city. Children from the village can commute daily to schools in town for their higher education after finishing compulsory education (grade six level) at the village school. The population is about 2,030 and the number of households is 385.

As for water resources, most of the households have private shallow wells for general use. There is a public pond at the entrance and a small weir at the exit of the village for agricultural use. Artesian wells and public shallow wells are also available for villagers in the dry season.

Site 3 : Ban Nong Kung Ban Nong Kung is situated along the highway between Khon Kaen and Udonrthani Provinces which is in the north of Khon Kaen city. There is no problem in transportation and communication, villagers frequent the town market by public buses at the cost of three bahts for a single journey. The road from the village to the highway is well maintained. There is a village school provided for students up to grade six. However, some of the children in the village go to better schools in town since transportation is quite convenient. Electricity is available in

this village , but some of the villagers can not afford the cost of an electrical outlet. The population of Ban Nong Kung is approximately 1,462 and the number of households is 239.

The main water resources for villagers include two man-made ponds in the village temple, one natural pond at the exit of the village, artesian wells, and shallow wells. Water for household use is obtained from the man-made ponds, artesian, and shallow wells. While water for agricultural use is obtained from a natural pond. Water storage vessels in households are better than those in households in the other villages in terms of both quantity and conditions. There are five private concrete tanks, and a number of large and medium sizes water jars which are in good condition. Nevertheless, during the dry season, water shortage is a major problem for this village as in the other three selected villages.

Site 4 : Ban Savathi Ban Savathi is a large village with a total population of approximately 2,868 and 427 households. The name of this village is also the name of the subdistrict as well. It is situated 22 kilometres to the northwest of Khon Kaen city. Travel to the village is fairly easy, as there is a laterite road which connects to the mainroad with buses in operation daily. The cost of transportation from the village to Khon Kaen city

is 10 bahts. There are two schools in the village : a primary school up to grade six and a secondary school up to grade nine.

There is a public pond in the village which is for household use. There are also a number of artesian, and shallow wells scattered around the village. It was reported by the villagers that water from some artesian wells was not usable, particularly the one in the primary school because of salinity and odors. Water storage vessels for each household are in fair condition. Also medium-size water jars are widely used among the villagers. It should be noted that there are a few large-size water jars, but no private storage tanks in this village ; eventhough, some of the villagers are well-off. (See Appendix B for more details on the four villages).

Table 4.1 Total Population and Number of Households in the Four Selected Villages

Village	Subdistrict	District	Population	Household
Ban Kradueng	Pa Manoa	Ban Phang	448	95
Ban Non Muang	Sila	Muang	2,030	384
Ban Nong Kung	Sila	Muang	1,462	239
Ban Savathi	Savathi	Muang	2,868	427

4.1.2 Socio-economic Conditions Agriculture

constitutes the main occupation for the majority of the population in each village. Most villagers are rice farmers growing rice mainly during the rainy season. During the dry season, most take up non-farm jobs. According to interviews with villagers, it was found that the per capita incomes of Ban Non Muang and Ban Nong Kung were well above regional standard. However all four villager were found to have per capita incomes below the reported notional value established in 1980 by the Office of National Economic and Social Development Board (1982). The per capita incomes of the four selected villages are shown in Table 4.2 together with the regional and national figures.

Table 4.2 Comparison of Per Capita Incomes in the Four Selected Villages

Source	Per Capita Income (in Baht)
Ban Kradueng	2,267
Ban Non Muang	5,849
Ban Nong Kung	5,208
Ban Savathi	4,750
Northeastern Region (1980)	5,086
National (1980)	14,475

Ban Kradueng, as compared with the other three villages, is relatively poor. Similar to these three villages, Ban Kradueng is primarily oriented toward agriculture. In spite of the fact that rice cultivation is the main occupation of the villagers, their substantial income does not come from rice farming. Rice production is mainly for individual household consumption. Only after household demand is met, then any remainder is sold to traders in the district town. However, there are some families which do not have sufficient rice for the whole year. The main source of income for these villagers is derived by working for wages as labourers in the Central Plain. During the dry season, the younger generation, both men and women, will migrate to Kanchanaburi Province to work as temporary labourers in sugarcane fields. These people will return home before Songkran festival

(Thai New Year Ceremony) which is in the middle of April, and prepare themselves to grow rice during the coming rainy season which starts in May. As for land for rice cultivation, not all households own agriculture land. However, villagers who own no land are able to rent land for growing rice. For those who own agricultural land, the average land holding is between 9-19 rai (one rai is equal to 1,600 square metres).

As regards Ban Non Muang economically, this village is the most prosperous among the villages selected for this study. Rice, the main staple, is grown during the rainy season. Most villagers work on their own land, some have additional land for other cash crops. In addition to rice, villagers also grow cassava, fruit crops, and vegetables : such as; onions, shallots, beans, and others. The average villager owns about 19 rai of rice land and approximately nine rai for other cash crops. To earn extra cash income, some villagers with construction skills seek additional jobs as construction workers during the dry season. Others are involved in trade within the village, e.g., setting up small village shops selling household items and food. There are three small rice mills in the village. Milling is free provided that the husks and bran are left to the mill owner. If the villagers want to take the bran back, they have to pay two bahts for one tang of rice (one tang is equal to 20 litres). Cattle are also raised both for agricultural work and commercial purposes. Whereas, poultry is raised only for home consumption. Some of the villagers have permanent job as workers with the support staff in Khon Kaen University.



Similar to the foregoing villages, most villagers in Ban Nong Kung are engaged in agriculture mainly growing rice. However, it should be noted that this village is better than Ban Kradueng and Ban Savathi. Since communication and transportation links to Khon Kaen city are readily available, most farmers are able to take up side-line jobs to earn extra cash. These are more than those in the other selected villages. Some of the younger generation have gotten permanent jobs as government officers in governmental organizations in the city. Some work as permanent workers and support staff in Khon Kaen University. As for the location of this village, since it is situated in the suburb of the city, those who own land along the main road have gained substantial income by selling their land to merchants or real estate agencies from town. In this village, there are five small rice mills offering services to villagers at the rate of two bahts a tang. Cattle are raised for agricultural purposes, while pigs are raised for commercial purposes. There are about five village stores selling food and household necessities which are owned by the villagers. The average amount of land owned by villagers is between 7-17 rai ; however there are some who have more than 30 rai. As for the poor, they must cultivate on rented lands.

As for Ban Savathi, most of the population in this village are engaged in agriculture growing ; rice, jute, cassava, and vegetables. The average land owned by villagers is between 10-30 rai. To earn extra cash, some of them become labourers in the town district; however, quite a few of them gain a relatively high income by working as semi-skilled labourers in the Middle East countries.

Other cash income is derived from repairing fishing nets which were brought to the village by traders from town. This kind of job was taken up mostly by women and children. There is a small rice mill in the village offering milling services at 1-2 baht a tang. Bran and broken rice are left for the mill owner who utilized them for raising pigs. Cattle are raised mainly for use on farms while pigs are raised for sale. Poultry is raised by most households for both consumption and for sale whenever there is a demand. There are village shops offering household items and fresh food from Khon Kaen city.

In the four selected villages, with respect to housing conditions such as : interior walls, floor, roofs, gutters, and areas around houses; these were assessed to be fair to good with Ban Nong Kung at the top and Ban KraDueng at the bottom of the ranking list. Structures of most of the households in Ban Nong Kung are in fair to good condition. Number of houses with roofs and gutters which are in good condition were approximately 72 per cent of the total. As for Ban KraDueng, about 35 per cent of the households are made of temporary construction materials, e.g., bamboo for interior walls, and palm and lalang leaves for roofs. Households with roofs and gutters in good condition were approximately 31 per cent of the whole village. Results of this investigation are shown in Tables 4.5 and 4.6 in Appendix C.

Results from oral interviews concerning living conditions revealed that the majority of villagers in each village utilize soap :

shampoo, detergent, tooth paste including cosmetics such as talcum powder and hair cream in their routine activities. Some of them possess luxury items such as television sets, radios, refrigerators, motorcycles, and pick-up trucks. As regards questions concerning improvements of households if extra money were available, villagers responded as their first choice that they would like to have a water tank for use during water shortages.

4.1.3 Drinking Water Conditions and Traditional Water Use and Storage In the northeast region of the country, the dry season starts in November and ends in the month of May. It was found in this study that there was plenty of drinking water for each village in the rainy season. This runs from late May to October. However, the supply was rapidly used up during the two months of November and December. After that most villagers must depend on shallow well water for consumption. The severest water shortage is during the months of February through May. During this four month period, even shallow well water is not enough for these villagers. Members of families, particularly women and children, had to spend time travelling to and waiting to shallow wells in order to fetch drinking water for their families. There were approximately two drinking water wells in each village. Distances from households to wells ranged from 0.5 to 2.25 kilometres. Water was carried to households by several means : such as ; carrying it in buckets hung from both ends of a pole placed on shoulders, using pushcarts and carts. Water from these wells was ordinarily utilized in the following manner : drinking, cooking, and brushing teeth. It should be noted that water from artesian wells was available for consumption

in all villages. However except for Ban Savathi as mentioned earlier, the villagers did not accept this type of water for drinking purposes. In regard to sanitation practices related to drinking water, it is noteworthy to note that only approximately one per cent of the villagers boiled the shallow well water before consumption.

As for drinking water storage in the rainy season, rainwater catchment was accomplished by placing storage vessels under gutters and sheets of corrugated metal to collect the runoff from the edge of the roof. Separate storage vessels were utilized for drinking water to distinguish from those used for general water. The most widely used storage vessels were pottery jars, cement jars (sometimes referred to as red jars), ceramic jars decorated with figures of dragons or flowers, and concrete tanks. Some households did not directly drink rainwater stored in cement or ceramic jars. They first would transfer water from these containers into pottery jars and then used it for drinking. This storage technique was also practiced in the dry season ; that is shallow well water would first be stored in cement or ceramic jars and then transferred into the pottery jars. For the final stage of drinking water, usually metal bowls, plastic bowls, or glasses were used to take water from the jars for consumption.

4.1.4 Attitudes Towards Drinking Water Results dealing with villagers' attitude towards drinking water showed that rainwater and water from shallow wells were the only two acceptable drinking water sources. Water from other sources such as : natural ponds and

artesian wells were not acceptable for drinking purposes. It must be noted that villagers in the selected villages valued drinking water higher than other usages of the water. The containers utilized for storing the drinking water as well as the locations in and around the houses were kepted seperately from those used for storing non-drinking water. Drinking water storage vessels were placed in areas which were clean and out of reach of children ; e.g., pottery jars were usually placed on wooden planks supported by poles and covered with sheets of corrugated metal. This practice was also extended to the sources of drinking water. Wells for drinking water were seperated from other wells. Shallow wells within the villages were acceptable for general water usage. Those wells which were drinking water sources were located in open spaces outside each village, mostly in the rice fields. Washing and bathing were not allowed at the drinking water wells.

Results from oral interviews questioning villagers' criteria for selecting drinking water revealed that taste was ranked as the first criterion; while quality, colour, and scent of water were ranked as the second, third, and fourth criteria respectively. According to views of the villagers, they stated that drinking water must have a good taste, rainwater has the best taste compared with water from other sources. Shallow well water is tasty in spite of it's turbidity. As for artesian well water, it was not acceptable as drinking water by villagers in the four selected villages since it was said to be saline in Ban Savathi; and insipid in the other three villages.

#### 4.1.5 Opinions on Construction of Water Storage Tanks

Regarding drinking water problems as perceived by villagers, it was found that all interviewees in each village acknowledged the problem of water shortage during the dry season. They accepted the fact that it is one of the most serious problems they encounter in the dry season and also expressed their needs for help on the matter. The majority of respondents, about 95 per cent in each village, agreed with the idea of constructing tanks for collecting rainwater for drinking purpose. It was suggested that there should be both private and public tanks. The fact that the poor can not afford private tanks in their households resulted in suggestions for constructing public tanks in which drinking water would be distributed without restrictions to everyone. As for those who are well-off, they preferred constructing private tanks. The reason for this was that it would be more convenient in utilizing, managing, and distributing water within each family ; rather than, among groups of households, or throughout the whole village. In the construction of public tanks respondents replied differently as to sites for construction. Those in Ban Kradueng and Ban Non Muang ranked the village temples as their first choice ; where as, those in Ban Nong Kung and Ban Savathı gave priority to the centre of the village. As regards water management systems; all respondents expressed similar opinions in this area. This included the suggestions that there should be a person or a working group of villagers to act as a water management body, and also that drinking water should be distributed to everyone free of charge. Respondents in Ban Kradueng suggested the chief of the sub-district, and the village chief ; whereas, those in the other

three villages suggested a village committee as the water management body. As for private tank construction, when the idea of an installment scheme was introduced more than fifty per cent of the respondents in each of the selected villages agreed with this idea. Results are shown in Table 4.3. Monthly payments which villagers can afford were found to range from 70 to 250 bahts.

Table 4.3 Results of Questionnaire on Private Tank Constructions  
Financed by Means of an Installment Scheme with Affordable Monthly Payments

Village	opinion			Decision on Monthly Payments (Bahts)
	Agreed (Percent of Village Population)	Undecided	Disagreed	
Ban Kra-dueng	52	-	48	70
Ban Non Muang	55	12	33	144
Ban Nong Kung	88	-	12	250
Ban Savath <sub>1</sub>	77	-	23	232

4.1.6 Discussions Results from this preconstruction study were provided the research team. It included data necessary for decision making and in the construction stage. In prioritizing sites for constructions the following important factors concerning conditions in each village were carefully considered : general information of the village, socio-economic conditions, quality and quantity of drinking water in the dry season, attitudes of villagers on tank constructions, types of tanks to be constructed, i.e., private and public tanks. As for the public tanks, it was learned in the preconstruction study that agreement among the villagers as to the site of construction, and the water management system were inconclusive. Thus the research team turned their attention to two other important organizations in the village : the village temple, and the school. After a series of visits by the construction team to the four villages, it was decided to select village schools as the sites for demonstrating the construction of public tanks. A major factor in this decision was the fact that school children faced severe problems with the shortage of drinking water during the months of November to March - (the school term ends in the middle of March and begins in the middle of May). Most students have to carry drinking water from home to school. Shallow well water was also provided for those who did not have containers for carrying drinking water, but very often it was inadequate.

It can be seen from the results of the preconstruction study mentioned in the preceding sections that all the selected villages experienced problems with shortage of drinking water in



the dry season. Among these Ban Kradueng, the poorest and least privileged was chosen as the first construction site. Ban Nong Kung, the village with the second highest per capita income and a high percentage of people who favoured the idea of tank constructions, was recognized as a good potential site for construction demonstrations. Also the monthly installment plan appeared feasible. It was thus selected as the second construction demonstration site. As for the third construction site, Ban Non Muang was chosen instead of Ban Savathi because of the ideal construction conditions for building a public tank at the village school. Due to limited funds for constructing tanks, only one public tank was allowed for construction demonstration in each school. Likewise, the village schools in Ban Savathi, both primary and secondary school, were much larger than those in the other villages, and in the village of Ban Non Muang, the primary school was about the same size as those in Ban Kradueng and Ban Nong Kung, it was selected to be the other construction site. As a result of decisions made by the research team, construction demonstrations were performed in three villages : Ban Kradueng, Ban Nong Kung, and Ban Non Muang. Each of these was provided with private tanks for selected villagers' households and a public tank in the village school.

#### 4.2 Results and Discussions of the Postconstruction Study

The investigation for the postconstruction study was limited to those who had access to drinking water from storage tanks in Ban Kradueng, Ban Nong Kung, and Ban Non Muang. Results of the investigation were divided into two parts: results from the private tank

construction and results from public tank construction. Changes in the attitudes and habits of the tank owners were discussed ; as well as, changes in the condition of drinking water.

4.2.1 Results and discussions of the private tank construction Seven private tanks, one in Ban Kradueng and three each in Ban Nong Kung and Ban Non Muang, were constructed for demonstrations. Details are shown in Table 4.4.

Table 4.4 Types of Water Storage Tanks Constructed in the Three Selected Villages

Village	Types of Tanks					
	Private			Public		
	F	B	I	F	B	I
Ban Kradueng	1	-	-	-	1	-
Ban Nong Kung	1	1	1	-	1	-
Ban Non Muang	1	-	2	1	-	-
Total	3	1	3	1	2	-

F = Ferrocement Tanks

B = Brick Tanks

I = Interlocking Mortar Block Tanks

It was found that tank owners cleaned their tanks at least once before collecting rainwater for utilization. In the rainy season, since rainwater was abundant, collected rainwater was utilized for multipurposes such as : washing, bathing, gardening, cooking, and drinking. When attention was directed to consumption of rainwater from storage tanks during the rainy season, it was found that tanks were not the major sources of drinking water for most respondents. They preferred drinking rainwater from their traditional usual containers. These respondents stated that rainwater from newly constructed tanks had a hard taste with a concrete odor. As for the period of time required for the villagers to accept rainwater from the newly constructed tanks as drinking water, it was found that this varied from one week to two months. This period was measured starting from the last cleaning date until the first date of consumption. The longest periods of acceptance were of ferrocement tank owners in Ban Kradueng and Ban Nong Kung. The ferrocement tank owner in Ban Nong Kung reported that for the first week after the last cleaning, rainwater from the tank could be used only as general usage water because of the bad taste and concrete odor. The family had tried to utilize this rainwater for cooking rice, but it was found that sticky rice soaked with the rainwater turned green while the inside of the aluminum cooking containers turned a black colour. However, after the third week or so they found that the quality of the water - in terms of flavour and scent - was better. Around the end of the second month the members of this family started utilizing the rainwater from the tank as a part of their drinking water sources in the household. The shortest period of acceptance occurred in the

same village with the owner of an interlocking mortar block tank. In this case it was found that members of the household started drinking and utilizing rainwater for cooking within the first week after the second cleaning of the tank. However, it is interesting to note that they did not directly take rainwater from the tank for consumptions as in the former case. Instead they transferred the water from the tank into pottery jars, their usual drinking water containers. Despite their acceptance of drinking water in the very short period, there were no comments from the respondents concerning water flavour or concrete odor. This led to a series of discussions between the author and the engineer researcher involved in constructing the tank. As for the construction aspect, it was explained that mortar blocks were soaked in water for at least two weeks before utilized for tank constructions and further the design of the overflow pipe for this tank was different from the others. Generally, there are two types of overflow pipes employed in tank constructions as shown diagrammatically in Figure 4.1. In Figure 4.1 a, it can be seen that the top layer of the collected rainwater overflows while in Figure 4.1 b the bottom layer of collected rainwater, normally having concrete odor, overflows. Everytime the bottom layer of the collected rainwater overflows it automatically helps in cleaning the tank. As regards the construction demonstration of this tank, the engineer researcher had employed the design shown in Figure 4.1 b while for the other tanks the design in Figure 4.1 a was chosen. This might help reduce the concrete odor and hard taste of water due to the cement. As for the remaining interlocking mortar block tank owners, it was found that the period

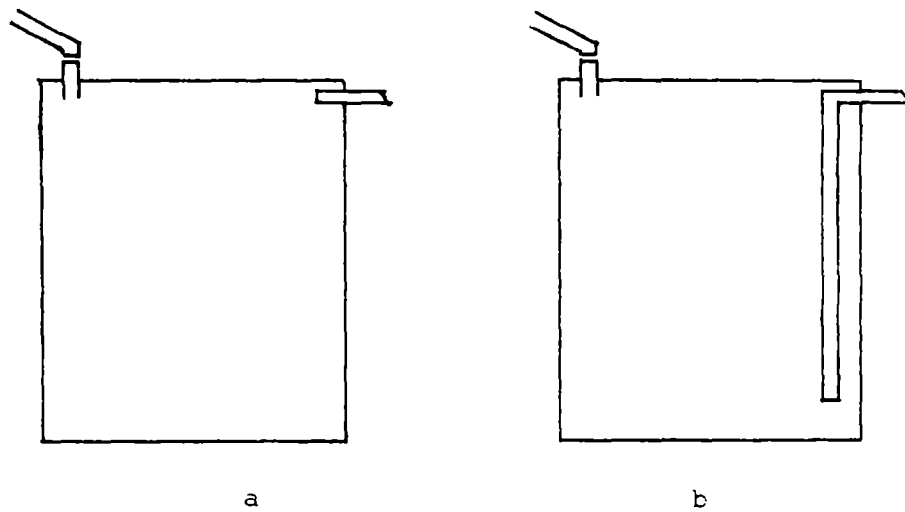


Figure 4.1 Design of Overflow Pipes for Tank Constructions.

of acceptance started after the third week. Results concerning the brick tank construction revealed many interesting points. It was found that the tank was cleaned only once before starting to collect rainwater. Problems with water flavour and concrete odor were also reported but not as strongly as those from ferrocement tanks. The respondents utilized rainwater from the tank for household uses about five weeks before accepting it as drinking water. In spite of this somewhat lengthy period before acceptance by the respondents on drinking water from the tank, it was evident that the tank became one of the major sources of drinking water for this household in the rainy season.

With respect to utilization of water during the dry season, since the investigation was carried out in the period in which

respondents had just experienced for the first time a dry season with water storage tanks ; results were different from household to household. However, it can generally be stated that rainwater collected in the constructed storage tanks was utilized for only three functions : drinking, cooking, and brushing teeth. It should be noted that most Thai villagers have bathrooms outside their houses, and water for bathing was stored in containers within the bathroom while water for brushing teeth which was drinking water was stored in a different place. When attention was focused on water consumption procedures of the respondents during the past dry season, results showed that members of the respondents' families in Ban Nong Kung and Ban Non Muang, especially those of the young relied mainly on rainwater from water storage tanks : while most of the elder ones returned to use of shallow well water. It was also found that the behaviour of those who had access to the ferrocement tank in Ban Kra-dueng were not much different from the older ones in the two previously mentioned villages : that is they depended on shallow well water as a part of their drinking water when they had used up rainwater stored in the usual containers. At this point, oral interviews were extended to other private tank owners who were not involved in this project, i.e., those who owned bamboo reinforced tanks provided by the Sanitation Division in the selected villages. This was done in order to determine the drinking water sources during the dry season. Results revealed that there was a relationship between the age of the tanks and changes of behaviour of people who had access to drinking water from those tanks. These people tended

to depend more on drinking water from the storage tanks as the age of the tanks increased. For those who has owned tanks for more than two years, in the dry season they depended completely on rainwater from the storage tanks as their drinking water. This group of respondents indicated that the flavour of rainwater from the storage tanks improved with time. This indication was in accord with that of the respondents involved in this project.

In terms of water management, the respondents indicated that owning private tanks have many advantages. They did not have problems with water distribution, tank maintenance, and cleaning. It was suggested that if communal tanks were to be constructed, they should be constructed for use among families which are relatives in order to avoid conflicts in water management. However, it was found from this study that all the tank owners had given some amount of rainwater from storage tanks for consumption by their neighbours during the dry season. Normally, heads of the households or housewives played a major role in management of rainwater from tanks. Methods of utilizing rainwater from tanks of seven households were classified into two major groups : a group utilizing rainwater directly, and a group utilizing rainwater indirectly from the tanks. The former group used plastic hoses attached to the water taps and then drew the rainwater directly from the tanks for household uses and other consumption. While the latter group first transferred rainwater from the tanks into other containers, and then utilized this water for their specific purpose later. Tank cleaning was reported to be a

problem for the families which did not have grown-up-sons or sons-in-law. It was difficult to climb down and clean the inner sides of the tanks. Heads of the households and other adult males in the families were responsible for this duty.

Results from measurements of attitude by the method of paired comparisons on taste preferences of rainwater from different containers revealed that rainwater from pottery jars received the highest rating value. While those from other containers such as : ceramic jars, storage tanks, and cement jars were ranked as second, third and fourth in terms of scale values. The respondents indicated that rainwater from pottery jars was more tasty and cooler than that stored in other types of containers. It was evident that within the category of rainwater which was considered to be safe quality water, taste preferences still played a major role in selecting rainwater from different types of containers for consumption.

As for current levels of knowledge on disease transmissions, the respondents for this section which included tank owners, teachers, headmasters of the village schools, and the villages' chiefs, acknowledged problems with unhygienic latrines and traditional defecation habits of villagers as the most important factor which caused disease transmissions. When asked about the factors that they believed caused diarrhea ; unhygienic food was mentioned more frequently than filthy drinking water as the reason for diarrhea.



Generally speaking, it can be seen from the results the survey of private tank construction, that owners were satisfied with the construction of the water storage tanks. Most of them view the storage tanks as a new type of furniture for their house, and selected sites for tank constructions at the most noticeable place in front of their houses. It was reported that these storage tanks had received much attention from their neighbours and nearby villagers passing by the houses. As for the tank owners, it was found that they were pleased to share their experiences with those who were interested in constructing tanks of their own for storing drinking water. Sometimes they would give rainwater from their tanks to those villagers interested in tank construction.

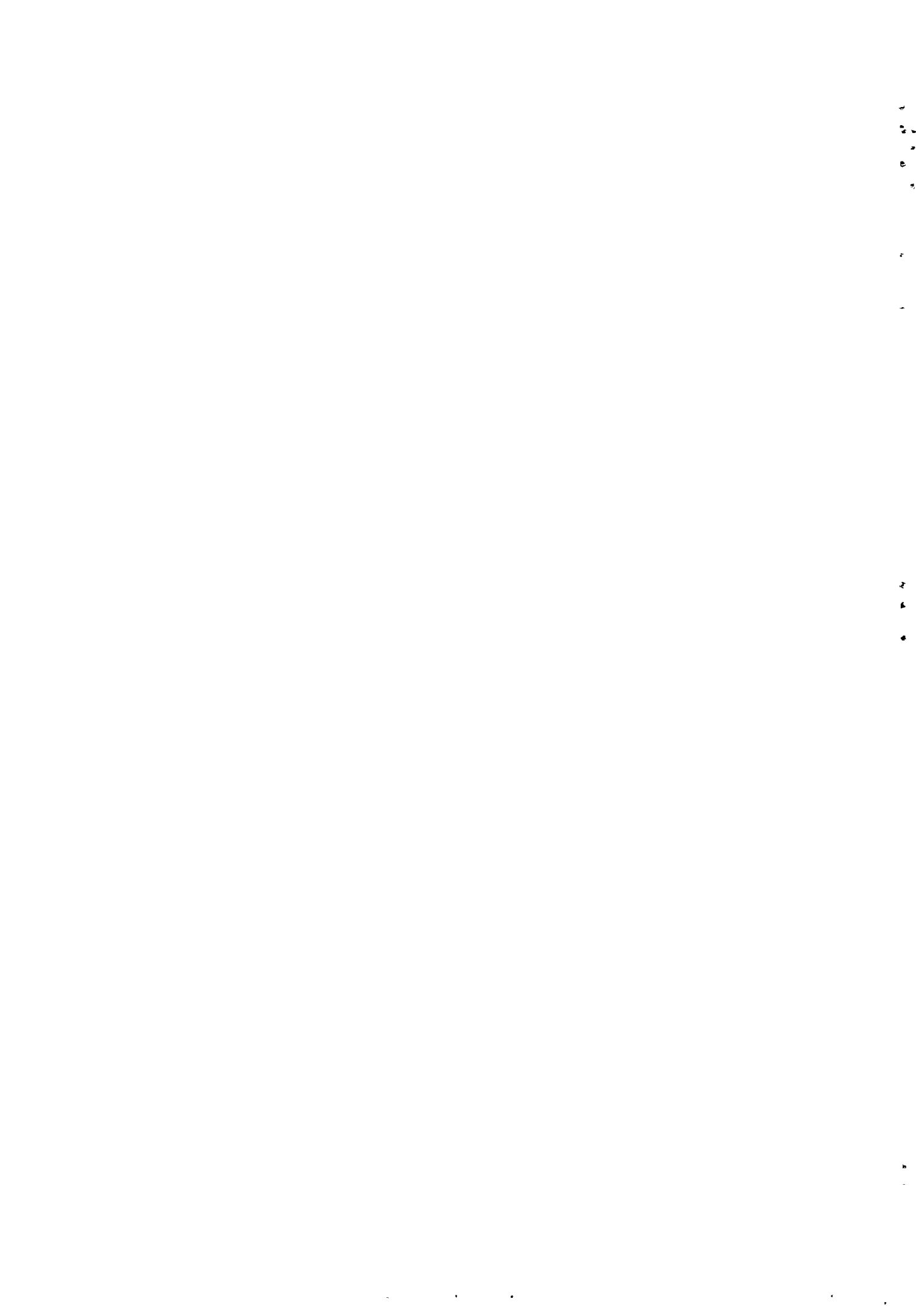
4.2.2 Results and discussions of construction of public tanks For the construction of public tanks ; two types of tanks, brick and ferrocement, were selected for construction demonstrations in the three village schools in Ban Krađueng, Ban Nong Kung, and Ban Non Muang. Details are shown in Table 4.4. Tank constructions were done in cooperation with teachers, janitors, and villagers. Additionally, schools donated money for buying materials for fixing gutters for the storage tanks. Each of the newly constructed tanks was cleaned twice before collecting rainwater for drinking. In terms of students' acceptance of rainwater from the storage tanks, it was interesting to note that it was different from that of the private tank owners which was discussed earlier. It was found that the students in each school accepted rainwater from the newly

constructed tanks as their drinking water as soon as it was available for drinking after the two cleanings. Further the changes in habits of the students in each school were reported to be similar to each other. The students left classes for a water recess at the newly constructed tanks more frequently than usual. Psychologically, the reasons for this could be explained : first, these tanks were the new water storage containers which reduced the necessity for carrying drinking water to schools ; second ; it was the largest source of drinking water in each school (they could rely on the tank while other containers were much smaller and had problems with seepage) ; lastly, it was normal for children to explore new things.

As regards management and utilization, interviews revealed that rainwater was utilized for drinking and brushing teeth for students after lunch. Water was occasionally given to villagers from nearby villages who travelled passed the schools but not for those within the village. Traditionally, those of live in the village do not take water which had been stored in schools or temples for students and monks. The janitor in each school was responsible for maintaining and cleaning the tank. Sometimes he was also in charge of distribution of the water. Headmasters of the village schools in Ban Nong Kung and Ban Non Muang did not live in the village where they worked ; thus water management including the keys to the water taps was the responsibility of the school janitor. However the headmaster of the village school in Ban Kradueng lived in the village and thus took charge of managing the drinking water.

Students were allowed to use personal glasses to take water directly from the tanks for drinking ; but for brushing teeth they were required to use water which had been transferred into cement jars. This was in order to avoid wastage and problems with overused of water taps.

It was evident from oral interviews with school personnel and students that the storage tanks had provided them with adequate drinking water during the past dry season. School children showed no concern as to taste preferences for drinking water. They easily accepted rainwater from both brick and ferrocement storage tanks. They also indicated a preference for drinking water from the new tanks over the usual containers.



## V. CONCLUSIONS AND RECOMMENDATIONS

This study was primarily concerned with the non-technical aspects in the project for developing a supply of drinking water for rural areas, "The Collection and Storage of Roof Runoff for Drinking Purposes". The investigation was limited to the essential scope and definite methodologies to serve the specific needs of the engineering technical group to accomplish the project. Readers should be aware that because of the limited sites for this study and the limited samples selected in both the preconstruction and postconstruction phases ; the findings are not generalizable beyond those stated in the research report. Also because of the limited duration of time for the follow up phase in the postconstruction stage ; experiences of the tank owners who participated in this project, cover only one dry season. Thus the results for the follow up phase of the study applied only to this limited period.

### 5.1 Conclusions

Results of this study support the following conclusions :

5.1.1 The villages in which the per capita incomes were above the stated regional standard were found to be capable of implementing the monthly installment plan for construction of private tanks. As for those which was poorer and less privilege, public or communal tanks were more appropriate.

5.1.2 In selecting and accepting drinking water, villagers relied more on personal preferences than potable characteristics of the water. For example, in the selection of drinking water taste preferences played a more important role when compared to the quality of the water.

5.1.3 Villagers lack knowledge on the transmission of diseases by filthy drinking water. Thus they do not yet recognize the necessity for high sanitary standards. Consequently, this was reflected in the traditional practices of water utilization.

5.1.4 The positive attitude of villagers towards tank constructions with agreements on monthly payments in an installment plan indicated their recognition of the problem of water shortages and their willingness to invest in improvements for the supply of drinking water.

5.1.5 Types of tanks constructed, (ferrocement, brick, and interlocking mortar block), along with design of overflow pipes, and the water management system of the tank owners yielded different duration of time for the villagers in accepting rainwater from the storage tanks as drinking water. The interlocking mortar block tank with the design of the overflow pipe which permitted the bottom layer of the storage water to overflow while transferring the rainwater into usual containers helped to raise the drinking water to an acceptable quality. This was true - in terms of taste preferences. Thus for owners of this type tank it provided a shorter acceptance period than the others.

5.1.6 Concern for convenience was a more factor than concern for health in the villagers' acceptance and utilization of rain water from the new storage tanks.

5.1.7 Comparing age groups of respondents for use of rainwater from both private and public tanks, it was found that the younger respondents tended to accept this new source of drinking water easier than the older respondents. Construction of public tanks have brought about more behavioural changes in water utilization for school children than the research team had expected.

## 5.2 Recommendations

Recommendations for researchers in implementing water supply projects for rural areas are as follows :

5.2.1 For engineer researchers, prior to the decision making process, careful considerations should be given to the benefits from the drinking water supply programmes from users' point of view with their suggestions.

5.2.2 An orientation programme with social activities to prepare the tank owners for the introduction of storage tanks should be carried out prior to the demonstrations and construction. Knowledge of water management along with the basic mechanical know-how to properly look after, maintain, and repair the tanks should be provided.

5.2.3 Two categories of tanks for villagers in different levels of incomes should be provided : private and communal - the communal tanks are for those who can not afford private tanks and this category should receive more attentions. There is a need for

further research and more investigation in terms of both technical and non-technical aspects in this area.

5.2.4 A longitudinal study on habit and behavioural changes of tank owners on water consumption should be conducted. A study of this type could determine whether a relationship between the age of the tank and changes of behaviour in the tank owner exist.

5.2.5 For social science researchers, water supply projects for rural areas often require information on several aspects of village life. Rural villagers have their own traditional practices, beliefs, and values which are different from those of town people. In order to acquire more information for these projects, interviewers, in addition to the selected respondent, the household head, should expand their interviews to others directly involved in a specific activity. In Thai rural society, women and children are water-carriers and responsible for household activities such as : household cleansing, cooking, and washing. Thus this group could provide more accurate information on water utilization than others. A knowledge of the Isan dialect or Loatian is another important factor for interviewers in developing a better understanding with the villagers. Finally, interviewers should be prepared to be good listeners, since villagers will not limit their discussions to topics of pure research interests. They will provide information on other interesting topics as well.



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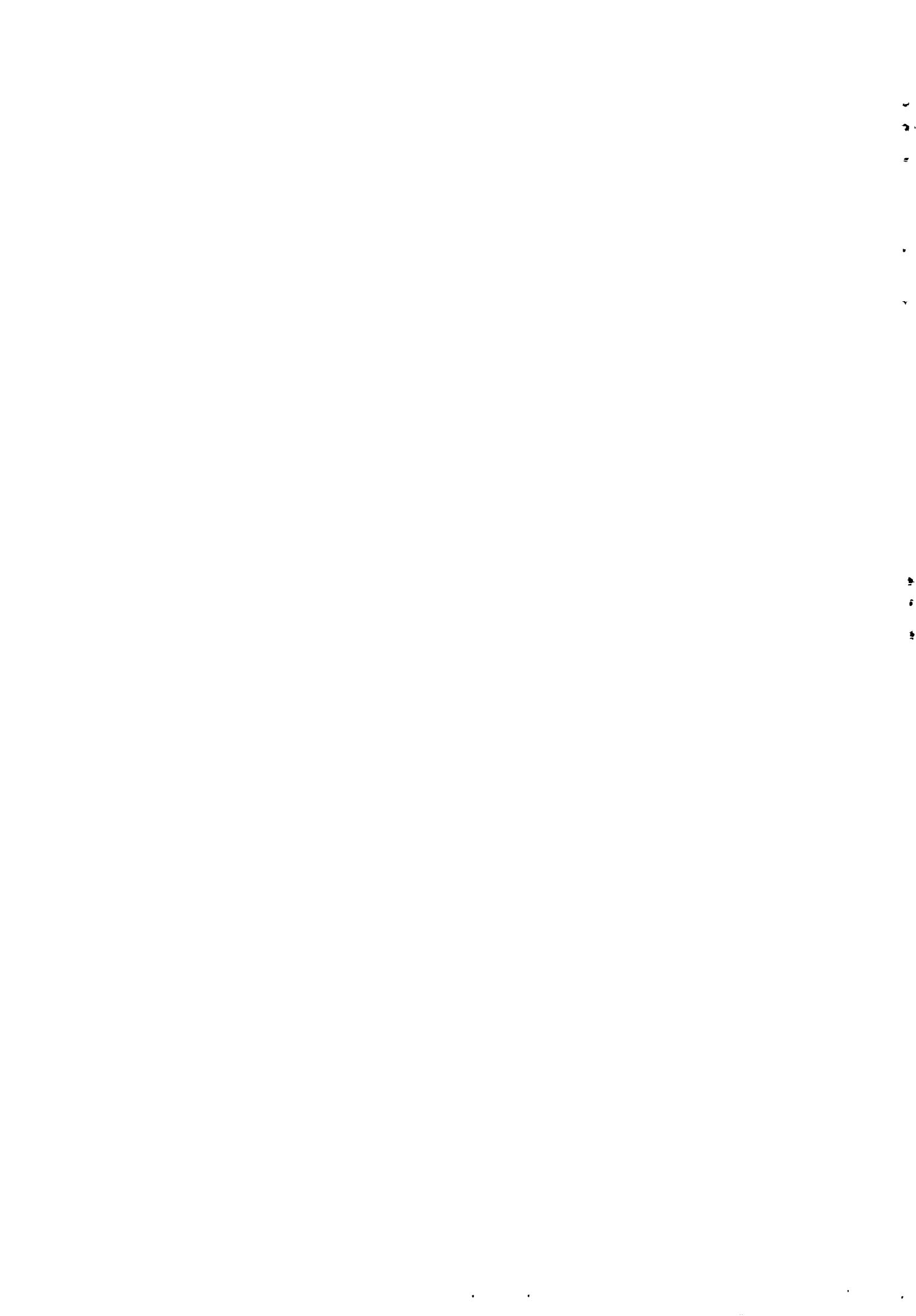
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APPENDIX A



A Preconstruction Questionnaire :

A Questionnaire on the socio - economic conditions and conditions of drinking water in villages

Directions : This questionnaire is divided into three parts. Part I Consists of questions on general information on a village. Part II is about the socio - economic conditions of the village community. Part III deals with condition of drinking water in the village, and traditional water use and storage.

Part I : General Conditions of the village

1. Name of village : \_\_\_\_\_ Village no. : \_\_\_\_\_  
Sub - district : \_\_\_\_\_ District: \_\_\_\_\_ Province: \_\_\_\_\_
2. Name of village headman : \_\_\_\_\_
3. No. of population : \_\_\_\_\_ No. of households : \_\_\_\_\_
4. No. of ricemills: \_\_\_\_\_
5. No. of toilets: \_\_\_\_\_
6. No. of village schools : \_\_\_\_\_
7. Is there a public health office in the village ? \_\_\_\_\_
8. Distance from village to main road : \_\_\_\_\_ km.
9. Distance from village to district : \_\_\_\_\_ km.
10. Types of roads leading into village : \_\_\_\_\_ (asphalt, laterite)
11. Is electricity available in the village?
12. No. of storage tanks for storing rain water : \_\_\_\_\_
13. Do the villagers own any private concrete water tanks? \_\_\_\_\_
14. Approximate no. of large-size water jars : \_\_\_\_\_
15. No. of water storage containers: \_\_\_\_\_

- 15.1 Medium-size jars     many     average     a few  
15.2 Pottery jars         many     average     a few

Part II: Socio-economic Conditions

1. Name of householder : \_\_\_\_\_ House no.: \_\_\_\_\_
2. No. of people in the household : \_\_\_\_\_ and no. of those with jobs and incomes: \_\_\_\_\_
3. Occupation of people in the household (more than one answer in possible)
- 3.1 Working in civil service
  - 3.2 Working in state - owned enterprises
  - 3.3 Merchandizing
  - 3.4 Raising animals
  - 3.5 Working in paddy fields
  - 3.6 Working on plantations
  - 3.7 Working as labourers
  - 3.8 Other (please specify e.g. domestic handicrafts) \_\_\_\_\_
4. Family's average per annum income from occupation : \_\_\_\_\_ baht
- 4.1 Below 3,000 baht
  - 4.2 Between 3,001 - 5,000 baht
  - 4.3 Between 5,001 - 7,000 baht
  - 4.4 Between 7,001 - 9,000 baht
  - 4.5 Between 9,001 - 10,000 baht
  - 4.6 Between 10,001 - 15,000 baht
  - 4.7 More than 15,000 baht
5. What rights do you have over your paddy fields ?
- 5.1 Own land
  - 5.2 Rented
  - 5.3 Other (please specify, e.g. letting your land to other farmers)

6. Area of your paddy fields (more than one answer is possible)

6.1 Own land \_\_\_\_\_rai

6.2 Rented \_\_\_\_\_rai

6.3 Other (please specify) \_\_\_\_\_rai

7. What rights do you have over your plantation fields ?

7.1 Own land \_\_\_\_\_

7.2 Rented \_\_\_\_\_

7.3 Other (please specify) \_\_\_\_\_

8. Area of your plantation fields (more than one answer is possible)

8.1 Own land \_\_\_\_\_rai

8.2 Rented \_\_\_\_\_rai

8.3 Other (please specify) \_\_\_\_\_

9. No. of domestic animals (more than one answer is possible)

9.1 Buffalo (s) : \_\_\_\_\_

9.2 Oxen/cow (s) : \_\_\_\_\_

9.3 Horse (s) : \_\_\_\_\_

9.4 Pig (s) : \_\_\_\_\_

9.5 Duck (s) : \_\_\_\_\_

9.6 Chicken (s) : \_\_\_\_\_

10. Total amount of land under your ownership : \_\_\_\_\_rai

11. The roof of the house is made of : \_\_\_\_\_.

The roof is in good condition \_\_\_\_\_ fair condition

\_\_\_\_\_ bad condition \_\_\_\_\_

12. Size of the roof in square metres : \_\_\_\_\_ sqm.

13. Sketch of the roof and position where a cement water tank can be placed.

Is there any gutters ?

14. Approximate area of the house : \_\_\_\_\_ sq.wah, or \_\_\_\_\_ rai, or \_\_\_\_\_ sqm.

15. Structure of the house

15.1 Interior wall             zind  
                                  wooden planks  
                                  bamboo  
                                  brick or cement  
                                  other (please specify) \_\_\_\_\_

15.2 Floor                     wooden planks  
                                  bamboo  
                                  earth  
                                  cement  
                                  other (please specify) \_\_\_\_\_

16. No. of rooms : \_\_\_\_\_

17. The kitchen is             in a separate room in the house  
                                  in an open plan area in the house  
                                  outside the house

18. Lighting                  oil lamps  
                                  electricity  
                                  candles  
                                  other (please specify) \_\_\_\_\_

19. Cooking fuel              firewood  
                                  charcoal  
                                  kerosine  
                                  gas

20. Bathroom                 in the house  
                                  outside  
                                  none  
                                  other (please specify) \_\_\_\_\_



21. Toilet  earth and board squat toilet (open latrine)  
 squat toilet with fixture  
 none  
 other (please specify) \_\_\_\_\_.
22. Livestock enclosure  underneath the house  
 separate enclosure in the compound  
 none  
 other (please specify) \_\_\_\_\_.
23. Routine activities : Do you  Bathe with soap ?  
 wash hair with soap or shampoo ?  
 wash clothes with detergent or soap ?  
 use toothbrush and/or toothpaste ?  
 use talcum powder and comb ?  
 sleep under a mosquito net ?  
 use cosmetics such as perfume, hair cream etc.?  
 wash dishes with soap or detergent ?  
 wear shoes when going out of the house ?  
 boil water before drinking ?  
 eat with spoons ?
24. Commodities and other possessions. Check the box if you have a \_\_\_\_\_
- |   |  |   |
|---|--|---|
| <input type="checkbox"/> radio          | <input type="checkbox"/> television        | <input type="checkbox"/> large-size water jar               |
| <input type="checkbox"/> sewing machine | <input type="checkbox"/> wardrobe          | <input type="checkbox"/> watch                              |
| <input type="checkbox"/> bicycle        | <input type="checkbox"/> bed               | <input type="checkbox"/> lantern                            |
| <input type="checkbox"/> motorcycle     | <input type="checkbox"/> mattress          | <input type="checkbox"/> suite of easy chairs<br>for guests |
| <input type="checkbox"/> car            | <input type="checkbox"/> water-pump        | <input type="checkbox"/> clothing accessory                 |
| <input type="checkbox"/> gas ring       | <input type="checkbox"/> cement water tank |   |

25. If you had money, how would you improve your house ?
- 25.1 Build a kitchen
  - 25.2 Build a toilet
  - 25.3 Build a water tank for use during water shortages
  - 25.4 Build a bathroom
  - 25.5 Build a balcony
  - 25.6 Build a living room
  - 25.7 Build a fence
  - 25.8 Other (please specify) \_\_\_\_\_
26. During which months do you get income from selling your products ? \_\_\_\_\_
27. During which months does your family not have any income ? \_\_\_\_\_
28. Is the income you get from selling rice enough to pay for your expenses ?  
\_\_\_\_\_
29. Is the income you get from selling products of the plantation enough to cover your expenses ? \_\_\_\_\_
30. Do you have to buy rice for family consumption ? \_\_\_\_\_

Part III : Condition of drinking water in the village and traditional water use and storage

1. Main sources of drinking water. (please put them in order from most used to rarely used)

	Normally	In the dry season
1.1 Rainwater	_____	_____
1.2 Wells	_____	_____
1.3 Canals	_____	_____
1.4 Swamps	_____	_____
1.5 Streams	_____	_____
1.6 Rivers	_____	_____
1.7 Reservoirs	_____	_____
1.8 Natural creeks	_____	_____
1.9 Underground water	_____	_____

2. Water from sources far from your house is carried to your house by \_\_\_\_\_
  - 2.1 carrying it in containers hung from both ends of a pole placed on the shoulders
  - 2.2 a pushcart
  - 2.3 a cart
  - 2.4 a truck
3. The nearest source of water is \_\_\_\_\_ km. from your house, and the furthest source is \_\_\_\_\_ km. away.
4. How available is drinking water in the village ?
  - 4.1 Water is available all year
  - 4.2 Water is available in large amounts at times but there is a severe shortage in the dry season
  - 4.3 There is always a shortage of water due to \_\_\_\_\_
5. During which months is there the severest water shortage ?  
From the month of \_\_\_\_\_ to the month of \_\_\_\_\_
6. How do you store drinking water ? (More than one answer is possible)
  - 6.1 In a water jar
  - 6.2 In an iron tank
  - 6.3 In a cement tank
  - 6.4 Other (please specify) \_\_\_\_\_
7. From the various sources given in item 1 from which source do you prefer to get your water ? Please rank in order of preference
  - 7.1 \_\_\_\_\_
  - 7.2 \_\_\_\_\_
  - 7.3 \_\_\_\_\_
  - 7.4 \_\_\_\_\_
  - 7.5 \_\_\_\_\_
8. In choosing drinking water, what do you consider as important ?
  - \_\_\_ Cleanliness
  - \_\_\_ Flavor
  - \_\_\_ Smell

- \_\_\_ Color
- \_\_\_ Convenience and distance
- \_\_\_ Price

9. Do you think that the condition of the drinking water at present is a problem which needs to be solved ? \_\_\_\_\_ why? \_\_\_\_\_.
10. Do you agree with building a water shorage unit for year-round consumption ?
- 10.1 Agree because \_\_\_\_\_
  - 10.2 Disagree because \_\_\_\_\_
11. If a water storage unit were to be built, what form should it take ?
- 11.1 A private storage unit for each house hold, because \_\_\_\_\_
  - 11.2 A public storage unit because \_\_\_\_\_
12. If a public water storage unit were to be built, where should it be ?
- 12.1 In a temple
  - 12.2 In a school
  - 12.3 At a health station
  - 12.4 At the house of the kamnan or the village headman
  - 12.5 Anywhere that is accessible to everybody
  - 12.6 At a densely populated area
  - 12.7 Other (please specify)
13. If a water storage unit were to be built for year round consumption, what type should it be ?
- 13.1 A cement well
  - 13.2 An iron tank
  - 13.3 A cement tank
14. What kind of water should be stored for year-round consumption ?
- Please rank them in order according to your opinion.
- \_\_\_ Well water
  - \_\_\_ Canal water
  - \_\_\_ Underground water
  - \_\_\_ Rain water
  - \_\_\_ Water from streams or rivers

Why ? \_\_\_\_\_

15. If there were a public water storage unit, how should it be managed ?
  - 15.1 There's no need for a committee to look after it.. Anybody can use it at will.
  - 15.2 There's supervision or water usage, but the villagers are able to consume the water free of charge.
  - 15.3 There's supervision on water usage and the villagers pay for the water consumed.
  - 15.4 Other (please specify) \_\_\_\_\_
16. If there were to be a supervisor for this water storage unit, who do you think would be the most suitable ?
  - 16.1 The abbot or a monk in the temple
  - 16.2 The headmaster or a teacher at the school
  - 16.3 The sub-district headman or the village headman
  - 16.4 The village committee
  - 16.5 Other : (please specify) \_\_\_\_\_
17. Your house is near to which of the following. Rank them from nearest to farthest.
  - 17.1 The temple \_\_\_\_\_
  - 17.2 The school \_\_\_\_\_
  - 17.3 The health centre \_\_\_\_\_
  - 17.4 A densely populated area \_\_\_\_\_
  - 17.5 The house of the village headman or the sub-district headman \_\_\_\_\_
18. If the researcher advanced the money in building a private cement water tank, and you paid back by instalments with no interest, would you accept the proposal ? \_\_\_\_\_

How much money can you pay back per month ? \_\_\_\_\_ Baht.

Name of interviewer \_\_\_\_\_

Date \_\_\_\_\_

A Postconstruction Questionnaire :

A questionnaire on the conditions of drinking water in villages where storage tanks have been built to store rain water.

Directions : This questionnaire is divided into three parts. Part I consists of questions on general conditions in the village. Part II deals with condition of drinking water in a house or a school where storage tanks have been built Part III is a series of open - ended questions on the villagers routine concerning water supply.

Part 1 : General conditions of the village where cement tanks have been built

1. Name of village : Village no.:

Sub-district : District :

Khon Kaen Province

2. Natural water sources in the village

Kind and name of sources	Drink	Usage	Is it available in the dry season
Shallow well	_____	_____	_____
_____	_____	_____	_____
Pond	_____	_____	_____
Artesian well	_____	_____	_____

3. No. of cement tanks in the village :

Private tanks : \_\_\_\_\_

Communal tanks : \_\_\_\_\_

Communal tanks in the temple : \_\_\_\_\_

Communal tanks in the school : \_\_\_\_\_

Part 2 : Condition of drinking water in a house or school where cement tanks have been built

1. Site of cement tank construction \_\_\_ house \_\_\_ school
2. Name of householder with cement tank construction : \_\_\_\_\_  
House no : \_\_\_\_\_  
Name of headmaster : \_\_\_\_\_  
Name of school : \_\_\_\_\_
3. No. of members in the household : \_\_\_\_\_  
No. of pupils in school : \_\_\_\_\_
4. The roof is made of : \_\_\_\_\_
5. Size of the roof in square metres : \_\_\_\_\_
6. Type of cement water tank \_\_\_ ferro - cement \_\_\_ brick  
\_\_\_ interlocking mortar block
7. When did the construction start ? \_\_\_\_\_
8. The tank can store \_\_\_  $7m^3$  \_\_\_  $9m^3$  \_\_\_  $12m^3$  or \_\_\_  $14.5m^3$   
At the time of the interview, there were \_\_\_\_\_  $m^3$  of water in storage.
9. Since the construction, the tank has been cleaned \_\_\_\_\_
10. The family's drinking water is taken from which sources ?  
\_\_\_ rain water from water jars  
\_\_\_ rain water from cement tanks  
\_\_\_ water from shallow well (s)  
\_\_\_ water from artcsian well (s)  
\_\_\_ others (please specify) \_\_\_\_\_
11. Give the first two sources of the water which you drink \_\_\_\_\_
12. In general, is there enough drinking water for members of the family ?
13. In the dry season, between November - May, is there enough drinking water ?  
Please give details \_\_\_\_\_
14. The amount of drinking water per person per day is approxintely \_\_\_\_\_  
bottles ( 1 bottle equals 750 cc.)  
In the summer between March - May, the amount of drinking water per head per  
day is \_\_\_\_\_ bottles or \_\_\_\_\_ litres In the winter, November to  
February, the amount of drinking water per person per day is \_\_\_\_\_



15. From which source do you take the water which you use for cooking ?

The daily amount of water used for cooking is \_\_\_\_\_ bottles or \_\_\_\_\_ litres.

The daily amount of rainwater used for cooking is \_\_\_\_\_ bottles or \_\_\_\_\_ litres.

16. Where does the water which you use to brush your teeth with come from ?

\_\_\_\_\_

17. For what activities do you use the water in the storage tanks ?

18. Do you drink the rainwater stored in the storage tanks ? \_\_\_\_\_

If so, when did you begin drinking it ? \_\_\_\_\_

18.1 If you drink it, do you like its flavour ? \_\_\_\_\_

18.2 If you don't drink it, why not ? \_\_\_\_\_

Because of 1. flavour \_\_\_\_\_

2. cleanliness \_\_\_\_\_

3. other (please specify) \_\_\_\_\_

19. Is the amount of rain water stored in the storage tank enough for everybody in the family to drink during the dry season ?

20. During the past dry season, did you drink water from shallow wells ? \_\_\_\_\_

21. Do you think that the water tanks should be built for communal use or built in individual houses for private use ? \_\_\_\_\_

22. Do you think that it is convenient to have a water tank built in each house ?

\_\_\_\_\_

Do you have any problems sharing the stored water with those who don't have a water storage tank ? \_\_\_\_\_

23. How do you look after the water storage tank ? \_\_\_\_\_

Which person in the family is responsible for their maintenance ?

Which person regulates usage of the water ?

24. Have people without a water storage tank ever asked for drinking water from you ?  
How many people ? \_\_\_\_\_
25. Have you ever given drinking water from your tank to people who don't have a tank ?  
If not, why not ?  
If so, what is the motive ? (ex. Because you want to show the quality of drinking water from the tank, etc.) \_\_\_\_\_
26. In your opinion, what is the quality of drinking water from a cement tank ?  
Characteristics : \_\_\_\_\_  
Flavour: \_\_\_\_\_
27. In your opinion how much interest do people in your village have in storage tanks for storing rain water ? \_\_\_\_\_
28. Have your neighbours ever asked you about the tanks ? \_\_\_\_\_  
How ? \_\_\_\_\_
29. How do you feel about having to explain about the tanks and water storage to other people ?
30. Do you buy water to drink ? \_\_\_\_\_  
Where does this water come from ? \_\_\_\_\_
31. Have you ever drunk water from shallow wells since the water tank was built ?
32. Do you have to donate water from the cement tank during a merit - making or a festival ?
33. Does having a water tank lessen problems concerning drinking water ? \_\_\_\_\_  
What problem (s) does it cause ?
34. How far is the nearest source of drinking water ? \_\_\_\_\_  
And the farthest source ? \_\_\_\_\_
35. How long do you have to wait for water from shallow wells ? \_\_\_\_\_  
Why do you have to wait ? \_\_\_\_\_ no water \_\_\_\_\_ a long queue
36. How much time do you spend in transporting water per trip ? \_\_\_\_\_  
How many trips a day ? \_\_\_\_\_

37. Which person in the family is responsible for providing drinking water ? \_\_\_\_\_
38. Do you like the idea of storing drinking water in a storage tank ? \_\_\_\_\_  
If you had the money, would you build more ? \_\_\_\_\_
39. Would you recommend your neighbours to have a cement tank for water storage ?
40. Apart from the water tanks, what other containers do you store drinking water in ?
41. Is the flavour of the water from a cement tank that has just been cleaned different from that of the the water from the same tank later on ? \_\_\_\_\_  
when the tank has just been cleaned, the flavour is \_\_\_\_\_  
Later on, the flavour, is \_\_\_\_\_
42. Do you purify the drinking water from the tank ? \_\_\_\_\_
43. What do you think is the cause of people having a stomachache or diseases of the digestive tract ? \_\_\_\_\_
44. From the following pairs of sources, which would you choose to drink water from first ?
- a. Rainwater from a cement tank or
  - b. Rainwater from a cement jar
- a. Rainwater from a cement tank or
- b. Rainwater from a pottery jar
- a. Rainwater from a cement tank or
- b. Water from a shallow well
- because \_\_\_\_\_
- a. Rainwater from a cement jar
- b. Water from a shallow well
- because \_\_\_\_\_
- a. Rainwater from a cement tank or
- b. Rainwater from a pottery jar
- because \_\_\_\_\_

General Information on Ban Non Muang

1. Name of village : Ban Non Muang Village no. : 3, 12 Sub - district :  
Sila District : Muang Province : Khon Kaen
2. Name of village headman : Mr. Tuang Pewdum .
3. No. of population : 2,030 No. of households : 384
4. No. of small rice mills : 3
5. No. of village school (s) : 1
6. No. of public health office (s) : 1
7. Distance from village to main road : 2 km.
8. Distance from village to district : 8 km.
9. Types of roads leading into village : laterite road.
10. Availability of electricity in village : yes
11. No. of water storage tanks : 10
12. No. of private water storage tanks : 3

