AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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Batch 53

1. SUBJECT CLASSIFICATION
A. PRIMARY: TEMPORARY
B. SECONDARY:

2. TITLE AND SUBTITLE
Low cost methods of treating water and sewage in developing countries,summary report

3. AUTHOR(S)
Reid,G.W.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1974	27p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Okla.

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

(Engineering--Hydrology R&D)

This report describes procedures used to develop a system of matrices dealing with water and wastewater treatment processes and in-country resources in order to identify the most optional treatment processes in terms of a country's resources. To test the soundness of its conceptual approach, the project included a global study of 20 sites representative of appropriate treatment processes. The concern of the directors at the date of this report, having developed and tested the methodology, pointed to developing acceptance of the most appropriate treatment technology by the less developed countries. The uniqueness of the project -- bringing process and resource together -- interested numerous groups, notably the United Nations Environment Program, World Health Organization, and Club of Rome.

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAD-219	
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER: AID/CM/ta-C-73-13 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

SUMMARY REPORT

On

LOW COST METHODS OF TREATING WATER AND SEWAGE IN DEVELOPING COUNTRIES

Prepared for

AID RESEARCH ADVISORY COMMITTEE (RAC)

by

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Norman, Oklahoma

October 22, 1974

CONTENTS

ABSTRACT

The project, to date, has developed a methodology for comparing processes and research directed toward the most compatible country/process selection. Sites and contracts have been established in twenty global locations, totaling $67,500 and generating $89,000 contributory support.

These studies include validation of the model, technical and user wise. They also include state of the art documentation on transfer, modified transfer and innovative transfer.

Numerous national and international groups have become meaningful involved, and the residual effort will involve technical appraisal of the methodology, and development of user (consumer) acceptance.

Delays normal to such projects have been encountered, primarily those associated with individual communications and professional acceptance, and quite frankly, an underestimation of the importance of the "snowballing" effect of the project. For example, WHO estimates put the project requirements at 10-20 fold of present level.

Additional time of one year and support of $116,000 is being requested for a more realistic study period and for better emphasis on the transfer or global user acceptance.

OBJECTIVES

For many years developing countries have been using developed countries' technology without modification and sometimes to their detriment (water and waste water treatment devices or processes that simply have not been compatible with in-country manpower and natural resources). The basic rationale that led to initiation of this project was to see if it would be possible to forecast which of the many water and waste treatment processes could be looked at in the frame of reference of maximum compatibility of in-country resources. Each failure of an imported high technology wasted valuable local resources. Not only were public funds normally invested for such development, but the noneffective use of such funds in the particular country also deprived it of other public services, and in some instances, the failure resulted in the default on loans used to develop water resources and treat waste water. The primary objective (as stated in the contract) was to develop a system of matrices dealing with processes and in-country resources, that could be brought together in such a fashion as to identify processes that would be optimal in terms of in-country resources. These processes need not be low or high technology, but more specifically would be technology appropriate to the ability of a country to supply the resources to build, maintain and operate the process. The secondary objective, once the matrices are developed, is to conduct a global study of sites representative of appropriate water and sewage treatment processes to see if the conceptual approach is sound, and to gather data on the state of the art. Once the Methodology is (I) developed, and (II) tested in the field, the final order of business is to document it and determine what is necessary to bring it to the useful attention of those involved in this activity. Although the contractual objectives have not been modified, the scope and purpose of the project have grown; of particular consequence is the spin-off in fiscal terms at present of an estimated $89,000.

An indication of increased relevance that occurred after the project was awarded and research undertaken, was the interest of the United Nations Environment Program (UNEP). UNEP has stated that one of its major concerns is with low cost water and waste water

treatment technology for developing countries. After meeting with professionals of the WHO International Reference Center (IRC) and various faculty of many countries, and the presentation of the project at several international meetings, it became increasingly apparent that interest in the objectives of this project was worldwide. Few seemed to share the overall objectives (processes and system), however there appeared to be a greater interest in providing information on low cost technology (process model). On the other hand there are groups such as the Club of Rome, and World Health Organization (WHO) whose activities in systems dynamics and other modeling strongly show the increasing interest in models such as the project's resource model. The project remains unique in that it is attempting to put the two matrices (process and resource) together.

As part of the overall objective the question still arises as to the types of activities necessary to get LDC acceptance of the most appropriate technology. In other words, will they be willing to use older, tried and proven processes that are more in keeping with their resources? Can they be brought to understand that current Developed Country (DC) technology is normally not the answer for their current time frame? The older types of treatment historically were adequate for DC's and within their rising affluence, were quite satisfactory. The DC's have been able to use higher technology as their economy escalates. Because of this concern the project director suggested to both WHO and UNEP, since they, by charter, are interested in this particular area, that they publish and disseminate the project material once it is documented and verified by the global studies. WHO, through its IRC's, will publish it and UNEP will assist in the development of regional workshops to bring it to the attention of the appropriate recipients. To this extent then the objectives are modified. An additional enhancement of the scope of work is the development of the classification of tests that will insure the adequacy of any given process and a kit to go along with this. This is open ended, e.g., as more processes are included, so are additional tests. Another elaboration will be the identification of manpower requirements and, perhaps, educational remedies such as relevant short courses.

PROCEDURE

The project is divided into resource and process data, methodology or models, and global field model verification and data development. The Kit and Predictive Methodology, including a user's manual, are complete. The basic methodology shown graphically in Figure 1, is complete. This computerized program, using socio-economic inputs as well as process cost, predicts costs for operation, maintenance, and construction at four socio-economic levels and four scale levels. The treatment process matrices cover at present and will shortly include those shown in Tables I & II. A typical printout is shown in Tables III & IV. The field work is just starting since it could not start until the technology to be tested in the field was developed. The sites selection matrices, which were developed initially to assure that all different types of innovative, adaptive and translative technology could be looked at, are included. Our literature search to date of published sources has uncovered many bits and pieces of data/information which fit into the whole. In addition we have also found unpublished information of significance to various facets of the project.

The basic data manipulation format has been established as the basis of a proposal made to the IRC to use the some 900 participants of the IRC to detect the innovative and unusual techniques that are being done around the world.

Documentation for the individual contracts with the global sites has been completed and instructions for the collection and codification of all kinds of relevant data have been undertaken. The basic field kit level I is complete, and is being tested by the Peace Corps in Kenya. The kit is also being expanded (see Table V).

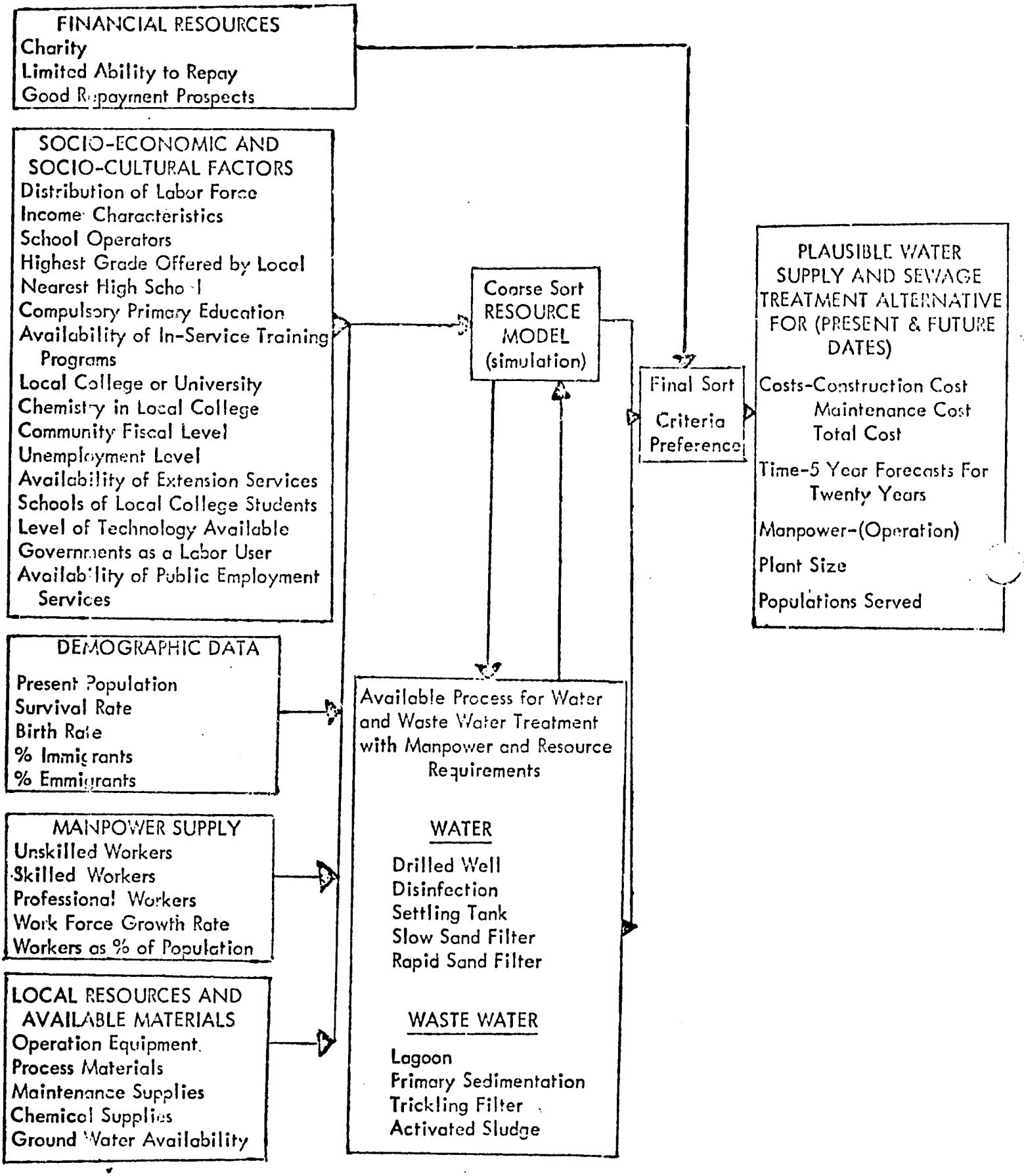

Figure 1. The Water and Sewage Treatment Method Planning Model Data Flow

TABLE I

WATER TREATMENT PROCESSES*

	Water Treatment Processes	Original	Expanded
PW1	Drilled Well	X	
PW2	Pre-Treatment		X
PW3	Slow Sand Filtration	X	
PW4	Rapid Sand Filter - Conv.	X	
PW5	Rapid Sand Filter - Adv.		X
PW6	Softening		X
PW7	Disinfection	X	
PW8	Taste-Odor - Fe, Mn		X
PW9	Desalting - Salt		X
PW10	Desalting - Brackish		X
PW11	Coagulation Pressure Filtration		X

* This includes all the processes in water treatment.

TABLE II

WASTEWATER TREATMENT PROCESS*

Wastewater Processes*		Original	Expanded
PS1	Primary - Conventional	X	
PS2	Primary - Stabilization Pond	X	
PS3	Sludge - Conventional		X
PS4	Sludge - Advanced		X
PS5	Sludge - Combined Imhoff		X
PS6	Secondary - Standard Filter	X	
PS7	Secondary - High Rate Filter		X
PS8	Secondary - Activated Sludge	X	
PS9	Secondary - Extended Aeration		X
PS10	Disinfection		X

This includes all processes in wastewater.

TABLE III

WATER TREATMENT COST TRANSFER CONSTRUCTION MATRIX LABOR AND MATERIAL FOR SELECTED TREATMENT PROCESSES TECHNOLOGY LEVEL - III

Treatment Processes	Labor As Percent Of LDC Construction Cost	Percent Unskilled Labor - LDC	Percent Skilled Labor - LDC	Hourly Wage Un-Skilled Labor - LDC	Hourly Wage Un-Skilled Labor - DC	Hourly Wage Skilled Labor - LDC	Hourly Wage Skilled Labor - DC	Material as Percent Of LDC Construction Cost	Percent On-Site Materials Manufac.	Percent Off-Site Materials Manufac.	Cost On-Site Materials Manufac. LDC/DC	Cost Off-Site Materials Manufac. LDC/DC	Total Construction Cost Per Capita DC - US $	Population Served DC - X 1000	Total Construction Cost LDC - US $
		X_{11}	X_{12}	X_{21}	X_{22}	X_{31}	X_{32}		X_{41}	X_{42}	X_{51}	X_{52}	C_1	P	C
Slow Sand Filter	60	40	20	1 1 1.5 1.5	3	8 8 7 7	6	40	20	20	1/2 1/1.5 1/1.5 1	1.5/1 1.5/1 1 1	67 6 4 2.7	0.5 25 50 100	
Rapid Sand Filter	60	20	40	1 1 1.5 1.5	3	8 8 7 7	6	40	10	30	1/2 1/1.5 1/1.5 1	1.5/1 1.5/1 1 1	88 24 19.5 15.5	0.5 25 50 100	
Sedimen-tation	60	30	30	1 1 1.5 1.5	3	8 8 7 7	6	40	30	10	1/2 1/1.5 1/1.5 1	1.5/1 1.5/1 1 1	137 40.5 33 26.5	0.5 25 50 100	
Chlor-ination	25	5	20	1 1 1.5 1.5	3	8 8 7 7	6	75	5	70	1/2 1/1.5 1/1.5 1	1.5/1 1.5/1 1 1	134 40 32 26	0.5 25 50 100	

$$C = (C_1)(X_{11} X_{21}/X_{22}) + (X_{12} * X_{31}/X_{32}) + (X_{41} * X_{51}) + (X_{42} * X_{52})$$

TABLE IV

WATER-OPERATION COST TRANSFER MATRIX TECHNOLOGY LEVEL - III

OPERATIONAL COSTS FOR SELECTED TREATMENT PROCESSES

Treatment Processes	Labor as Percent of LDC Operating Cost	Percent Unskilled Labor - LDC	Percent Skilled Labor - LDC	Hourly Wage Un-Skilled Labor - LDC	Hourly Wage Un-Skilled Labor - DC	Hourly Wage Skilled Labor - LDC	Hourly Wage Skilled Labor - DC	Materials as Percent LDC Operating Cost	Percent In-Country Materials	Percent Out-Country Materials	Cost In-Country Materials LDC/DC	Cost Out-of-Country Materials LDC/DC	Total Operation Cost Per Capita DC - Us $	Population Served
		X_{11}	X_{12}	X_{21}	X_{22}	X_{31}	X_{32}		X_{41}	X_{42}	X_{51}	X_{52}	C_1	P
Slow Sand Filter	.90	10	0	1 1 1.5 1.5	3	8 8 7 7	6	10	10	0	1/1.5	1.5/1	2 .5 .25 .2	.05 25 50 100
Rapid Sand Filter	80	10	10	1 1 1.5 1.5	3	8 8 7 7	6	20	15	5	1/1.5	1.5/1	4 2 1.75 1.5	.05 25 50 100
Sedimen-tation	90	5	5	1 1 1.5 1.5	3	8 8 7 7	6	10	5	0	1/1.5	1.5/1	6 3.5 2.75 2.5	.05 25 50 100
Chlor-ination	.40	10	30	1 1 1.5 1.5	3	8 8 7 7	6	60	40	20	1/1.5	1.5/1	5 2.3 1.75 1.5	.05 25 50 100

$$C = (C_1)\,(X_{11} * X_{21}/X_{22}) + (X_{12} * X_{31}/X_{32}) + (X_{41} * X_{51}) + (X_{42} * X_{52})$$

PROCESSES \ TESTS		BOD	COD	NH_3	NO_2	PO_4	pH	D.C.	Organic Nitrogen	Turbidity	Color	Odor	Alkalinity	Temperature	Total Solids	Volatile Solids	Suspended Solids	Hardness	Chlorides	Algae	Fe	Mn	Coliform	Taste	Grease & Oil	CO_2	JAR	Salinity		Chlorine
	WATER TREATMENT																													
PW1	Drilled Well						K1																K1							K
PW2	Pre-Treatment						K1			K1													K1							K
PW3	Slow Sand Filteration						K1			K1													K1							K
PW4	Rapid Sand Filter-Conventional						K2			K2	K2	K2	K2	K2	K2								K2	K2		K2				K
PW5	Rapid Sand Filter-Advanced						K3			K3	K3	K3	K3	K3	K3	K3	K3						K3	K3		K3	K3			K
PW6	Softening						K3			K3	K3	K3	K3	K3	K3	K3	K3	K3	K3		K3	K3	K3	K3		K3	K3	K3		K
PW7	Disinfection						K3			K3	K3	K2	K2			K3	K3		K3				K3	K3		K2				K
PW8	Taste-Odor Fe, Mn						K3			K3	K3	K3	K3			K3	K3		K3		K3	K3	K3	K3						K
PW9	Desalting - Salt						K3			K3	K3	K3	K3	K3	K3	K3	K3		K3		K3	K3				K3		K3		K
PW10	Desalting - Brackish						K3			K3	K3	K3	K3	K3	K3	K3	K3		K3		K3	K3				K3		K3		K
PW11	Coagulation Pressure Filteration						K3			K3	K3	K3	K3	K3	K3	K3	K3	K3	K3		K3	K3		K3		K3				K
	WASTEWATER TREATMENT																													
PS1	Primary-Conventional	K1						K1						K1									K1							
PS2	Primary-Stabilization Pond	K1						K1						K1									K1							
PS3	Sludge-Conventional	K2			K2	K2		K2			K2			K2									K2		K2	K2				
PS4	Sludge-Advanced	K3	K3		K3	K3	K3	K3			K3			K3						K3			K3		K3	K3				
PS5	Sludge-Combined Innoff	K3	K3		K3	K3	K3	K3			K3	K3		K3						K3			K3		K3	K3				
PS6	Secondary - Standard Filter	K3	K3	K3	K3	K3	K3	K3			K3	K3		K3	K3	K3	K3			K3			K3		K3	K3				
PS7	Secondary - High Rate Filter	K3	K3	K3	K3	K3	K3	K3			K3	K3		K3	K3	K2	K3			K3			K3		K3	K3				
PS8	Secondary - Activated Sludge	K3	K3	K3	K3	K3	K3	K3			K3	K3		K3	K3	K3	K3			K3			K3		K3	K3				
PS9	Secondary - Extended Aeration	K3	K3	K3	K3	K3	K3	K3			K3	K3		K3	K3	K3	K3			K3			K3		K3	K3				
PS10	Disinfection	K3	K3	K3			K3							K3						K3			K3			K3				

NOTE: K1: Tests run by Kit I for level I processe
K2: Tests run by Kit II for level II proces
K3: Tests run by Kit III for level III proce

As of October, 1974 the detailed site matrices are complete and operational; the resources model is complete, computerized and operational; the process matrices that go with it are complete; the data formatting is complete and has been communicated to the International Reference Center for incorporation into the activities of locating innovative and unpublished or undiscovered published information. In addition we have attempted to develop information on the needs of water and waste disposal in terms of the demographic and socio-economic parameters of LDC's. The problems of data availability are beginning to resolve themselves in sampling and data processing: new techniques have been developed in the management of the model; and the research findings have revealed that the present methods we are using should be adequate. We do not envision at the present time any new approaches, but of course, this will rest entirely on the verification in the field of the modeling processes.

As was stated earlier, the research has been undertaken in two broad divisions. One is on the overall literature search, documentation and the various matrices, conducted mostly on-campus and, the other is the testing of these matrices under actual global conditions. It was envisioned initially in the proposal, that only three global sites be selected: one in Latin America, one in Africa, and one in Asia. This approach has been modified since it has become apparent that we need several sites in Latin America (coordinated through CEPIS) and perhaps two smaller ones in the Caribbean. It also became apparent that we needed a site in the Middle East as well as in Africa. The division there has been between the dry arid and sea contiguous or fringe Middle Eastern Arabic countries and those that are basically in the East and West African domain.

All of the sites (or potential ones) have been visited, and most of them are under or will be shortly under contract. This network is shown graphically in Figure 2 and tabulated in Table VI. Each project in this table is described in the Appendix. We plan to select three or four experts and have them visit the sites in addition to taking the information for collating and evaluating into our data bank on all the different treatment processes and developing a State of the Art on each treatment process. These statements will then

FIGURE 2

ENVIRONMENTAL HEALTH NETWORK

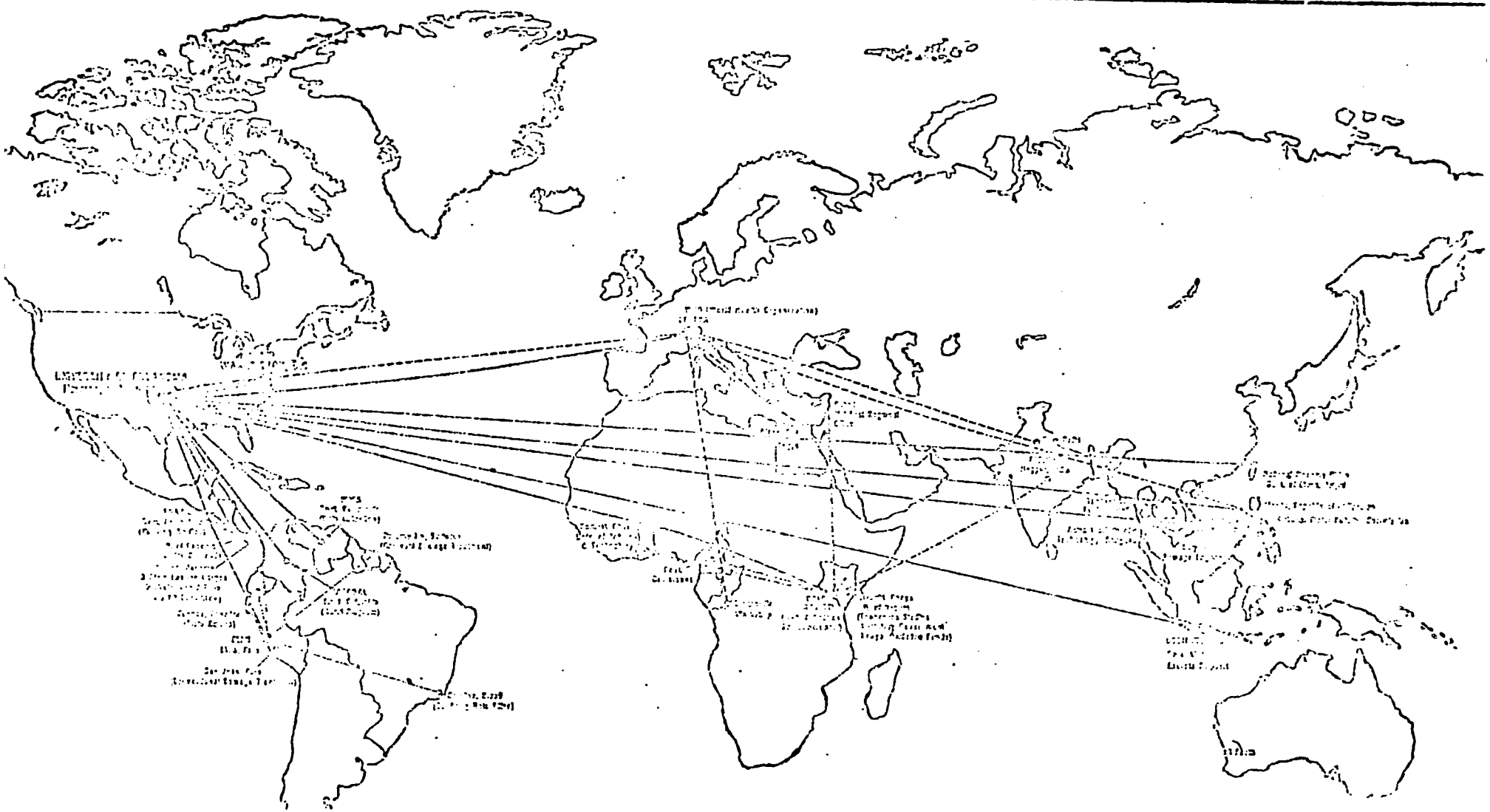

TABLE VI

CONTRACTS AND SPINOFF

No.	Project	Budget	Start	Duration	Additional Funds	Visits
1	CEPIS/PAHO/Lima-Water treatment Witt/Sperandio - Technology	25,000 (30,000*)	6/74	2 Years	10,000	10/74 Reid 10/75 Consultar
2	EMPIS/AID-Columbia - Model test Kearney	No Cost (3,000)	10/74	6 Mo's.	NONE	10/74 Reid
3	IRC/NL/Delft-Historic Methods-Sewage Prof. Knoppert	1,500	9/74	8 Mo's.	NONE	
4	IRC/NL/-- Inventory, Survey, Village Emergency Methods Van Damme	2,000 (2,000)	10/74	6 Mo's.	2,000	
5	IRC/NL--Sand Filters-Water Van Damme (Kenya, Ghana, Brazil)	No Cost (7,000)	8/74	2 Years	NONE	
6	IRC/Zurich - Historic, Colonial Methods-Water Warmer	2,000 (2,500)	10/74	2 Mo's.	NONE	
7	Tunisia/Oswald/AID - Lagoons-Opt. Oswald	No Cost (2,500)	8/74	2 Years	NONE	12/74 Reid 12/75 Reid
8	AUB -- Sand disposal, abestos filter Ayoub/Acra	7,500	11/74	2 Years	10,000 (2nd yr.)	11/74 Reid 12/75 Reid

TABLE VI (Continued)

CONTRACTS AND SPINOFF

No.	Project	Budget	Start	Duration	Additional Funds	Visits
9	Turkey--UF.GR. Lagoon-Aerator Ulug/Arceivala	5,000 2,500	10/74	2 Years	4,000 (2nd yr.)	1/74 Reid
10	Kenya/P.C. -- Lagoons Govaerts	(5,000) No Cost 1,000 kit	8/74	1 1/2 Yrs.	1,000	12/74 Reid
11	Kenya/ Demand Study Muga	2,000	6/74	2 Years	2,000	12/74 Reid
12	Manila -- Water Sterilization Lesaca/Philipine Govt.	5,000	11/74	2 Years	5,000	4/75 Reid 4/75 Consultan
13	Manila -- Model Studies CDM/Lesaca	No Cost (1,500)	9/74	3-4 Mos.	NONE	
14	Taipei -- Night-Soil, Sludge, Algae, etc. Liu/NSC	5,000	11/74	1 Year	5,000	4/75 Reid
15	Indonesia--Model Studies CDM/Reyes	No Cost (1,500)	11/74	3-4 Mos.	NONE	
16	Indonesia--Lagoon-fish-Bandung UNV/Reyes	4,000	11/74	2 Years	6,000	4/75 Reid
17	Jakarta/ Dutch Ditch Webb	2,000	10/74	2 Years	3,000	

TABLE VI (Continued)

CONTRACTS AND SPINOFF

No.	Project	Budget	Start	Duration	Additional Funds	Visits
18	Bangkok/Filters Praphorn/Thai Govt. Coordinated with AUB/Taipei/IRC, Frankel, et al	3,000	11/74	2 Years	3,000	4/75 Reid
19	OU/AID Sewerless Alternatives Swisher/Reid	No Cost (6,000)	12/74	2 Years		
20	Libya -- Model Test WHC/Europe	No Cost	11/74	1 Year	NONE	11/74 Reid
	TOTALS	$ 67,500 (61,000)			$ 51,000 (20,000)	

*Those shown inside the parentheses are matching funds.

be used in the global conferences and workshops, one at a technical level, and the other at a decision level. At this time some of these experts have been identified: Dr. Pasveer, of Delft (Waste Treatment); Dr. Ives, with the University of London (Water Treatment); Dr. Cleasby from Iowa State University (Water Treatment); Dr. Meadows, from Dartmouth (Systems Dynamics, Resources and Population Projections), and Prof. Don, Institute of Tropical Medicine and Hygiene, London, (on Elementry Systems). The global technical workshop and conference will be sponsored by several international agencies.

The global workshop (Technical Global Workship on Low Cost Method Treatment Water and Waste Treatment in Developing Countries) is to bring technical experts together, to review and evaluate the technical programs. The global workshop will also be used to structure the conferences. The global conferences are for the purpose of presenting the technological scheme to the users. The workshop is set for IRC/NL in May 1974. The conferences are scheduled the following year at UNEP-NAIROBI, CEPIS-LIMA, etc.

The project staff has distributed considerable information as the study has progressed. A brochure describing the program was developed and given to most of the possible project participants and was presented at the Bilthoven Conference (1973) of the International Reference Center and collaborating institutions. "Lower Cost Methods of Water and Waste Treatment in Less Developed Countries," by the Principal Investigator, and Dr. Albert Talboys and Mr. Dale Swisher was presented at the International Meeting of the International Water Resources Association in Chicago, in October, 1973. Another paper entitled "The Importance of Low Cost Technologies in Water and Waste Water Treatment in Developing Countries," authored by the Principal Investigator, was presented at the Conference for Environmental Health in Arab Cities in Baghdad, April 20, 1974. A paper, similar to that at Baghdad, was given by Mr. Swisher at the AIDIS conference in Mexico City the first week of August, 1974, entitled "On Compatible Country Capabilities and Water and Waste Water Treatment Process Selection." Another paper by Talboys and Reid was given by Talboys at the June 17, 1974 meeting of the Association Fronterize Mexicana, Estadocinidense de Salabridad, "Lower Cost Water and Waste Treatment--A Global Research Project." This was presented in Monterrey, Mexico. Finally, Reid gave a similar paper on September 20, 1974, at the ASCE meeting in El Paso. All of these papers were met with considerable interest.

There have been delays, but it appears that we are on the road. Part of the delay was the fact that many others have worked on various facets of the project as we envisioned it. Some of these individuals and organizations have made some progress whereas others have made little or no progress. All initially were quite jealous of their territorial prerogatives; the barrier has been resolved. Finally we feel that we have made some headway in answering the important question of in-country acceptance by working with WHO, UNEP, and the Peace Corps. They have all shown strong interest in helping us develop an in-country acceptance. The actual contractual arrangements being developed are varied but they are more in the nature of catalyzing efforts, in the sense that the monetary amounts are rather small with the funds paying for graduate assistants at the universities as well as providing special materials. Of real importance to the recipients is that of being involved with the global effort and having access to a wide array of expertise. "Selling" this concept has caused delays, or has separated those interested in money first and the project second. The projects, including negotiated subcontracts, are shown in Table VI. If this schedule can be maintained, it will require an extension in time of approximately one and a half years to give each contractor approximately two years, and the University of Oklahoma staff six months, to wind up the final report. Several short term model tests, data documentation, state of the art brochures, etc., as well as project visits will occupy the staff until completion of the larger projects.

The monetary sums for each project (except CEPIS, which is for two years) is so low, that a two year contract is almost necessary to insure their involvement. The subcontract negotiations with PAHO (CEPIS) have been a major source of delay in establishing the overseas testing and evaluation part of the overall project. Although a contractual document signed by the University of Oklahoma was sent to PAHO in February 1974 for PAHO signature, a formal contractual agreement has not been consummated to date (October 21, 1974). Both PAHO and AID had objections to the original (February) document. The objections were resolved and a new agreement, apparently satisfactory to all parties, was finally submitted to PAHO for formal acceptance on their part in June 1974.

In early September 1974 the University was finally informed by PAHO that there was another objection that apparently had been overlooked during the months of deliberation on the part of PAHO. Neither the latter nor the previous objections had anything to do with the University's requirements. They have all been against contractual restrictions imposed upon the University by the original AID/OU contract (AID/CM-ta-73-13).

On October 4, 1974, AID gave verbal approval that again apparently resolved the last objection. A letter addendum to the PAHO subcontractual document was sent to PAHO (according to PAHO directions) on October 7, 1974. As of October 21, no formal agreement between PAHO and the University has been signed by both parties. All that lacks for such an agreement is an authorized PAHO signature.

The delays in consummating the other overseas subcontracts have been primarily due to long distance communications and to principal parties being out of the country for varying lengths of time. Almost all of the delays have been overcome and we expect final signed agreements to all subcontracts within the next two months.

Oklahoma Input (Manpower and Financial)

The Oklahoma manpower and fiscal input has been fairly well described in terms of output to date. The Project Director has carried the major load, developing the theoretical models, making the contacts, etc. In this he has been assisted by Drs. Discenza, Law, Lowsley and Govearts as well as various research assistants. The Director has also been accompanied and assisted on the various field trips by Mr. Swisher (AID), Mr. Martin (OU), and Dr. Talboys (DHEW).

The expenditure rate has been slower than anticipated, primarily because of a reluctance to undertake the field studies without adequate preparation. All of the initial field visitations are now complete, and the lag or waiting was warranted in view of the accomplishments. One facet of the expenditure rate has been the subcontracts, most of which have been agreed upon in principle although consummation has been delayed because of the

problems mentioned earlier. In most instances, AID, WHO, the particular country and the particular university all are being kept informed, if not actually involved. The complexities in doing this are inherently delaying, but hopefully it will provide greater support in the long run. For example, the Turkey contract will be with the University in Ankara, but it is expected to be coordinated through AID/Turkey and the Turkish National Science Council, etc. Now there is some question of aid to Turkey at all, and maybe we will use the overloaded lagoons in Kenya. There have been no significant changes in management, except that we have found a surprising number of devoted people around the globe who are interested in being involved with us.

A detailed budget, Table VII, explains the staff support, and projected efforts, as well as suggested extension of the project. The first important step will be the consumation of the various global sites studies in Middle East, Africa and the Far East. This is underway. Each of these major studies will require site visits. The site visits are indicated: Latin America in October, 1974, the AUB and Turkish contracts in November, 1974, the African contracts in December, 1974, and those of the Far East in April, 1975. These visits are exhausting, but absolutely necessary.

The purpose of these site visits in addition to assisting in the research, is to form a group of consultants for the preparation of State of the Art Papers on Water and Sewage. Once the State of the Art Documents have been developed, they will be published by WHO for use in the global workshops. The completed global contracts will be summarized as well. The experts, project director and consultants will test, at the global workshop the completed field kit, the resource model, and the global cost and demand studies. Following the workshop with its suggested modifications and the assimilation of the State of the Art papers, the literature surveys, the direct mailings, the cost demand studies, and the historic practices studies, the on-site global studies will be put together and documented and presented in three global conferences. The report of the global conferences will constitute the project's final report. The global conferences address themselves to the important aspects on the problems associated with obtaining acceptance of recommended technology by the LDC's.

TABLE VII BUDGET SUMMARY

	PRESENT (Oct. 74 to Dec. 75)	FUTURE * (Jan. 75-Jan. 77)
CONTRACTS	$ 67,500 (61,000) (Contributed)	$ 51,000* (20,000)**
GLOBAL	WORKSHOP	CONFERENCE
Stipends & Staff (Contributed)	(WHO ($5,000+) (PAHO ($5,000+) (BANKS ($8,000) (IRC ($2,000)	(WHO, UNEP, etc.) $ (20,000)**
		Staff $ 6,000 Travel $ 5,000 Pub., etc.
CONSULTING		
State of Art, etc.	$ 15,000 WHO (5,000) Publ IRC (3,000) Staff	$ 3,000
OU OPERATIONS	$ 15,000 (Reid)) $ 3,000 (Martin)) Direction $ 18,500 (other-Engr. Sec. Report) $ 8,500 (Travel)	$ 31,000
DIRECT TOTAL	$127,500	$ 96,000
Fringe Benefits and Overhead	$ 50,000	$ 20,000
SUB TOTAL	$177,500	$116,000
Spent to Date	91,500	
GRAND TOTAL	$269,000	$116,000
Contributed	($ 89,000)	($ 40,000)**

*Calculation, start additional program for January, 1975 through August, 1976. This provides one more year for completion of all field studies Dec. to Dec., 1974-75. Four weeks for three global non-technical conferences, the final document, and the three summer months.

** Estimated contributions.

there are no marked departures from the procedures and activities underway at the present time. One slight departure from the original proposal, rather than assigning an expert at any particular site for a long tour, is to assign him for a shorter tour, to have him function in the development of the State of the Art Papers and to act as a member of the professional or consultation group which will bring together all aspects of the total program. The global contracts will function under AID contractual requirements and with definitive instructions as to the work to be performed as well as a uniform approach to use of personnel and data arrangements. Because low cost methods are not necessarily low technology, the process matrices will be further developed to include all relevant treatments of water and waste (see Tables I and II). Because of the credibility of acceptance, we plan to study the problems that must be coped with in getting LDC's to use more suitable or appropriate technology.

The factors that perhaps significantly promote or accelerate the accomplishments are really associated with the concepts of momentum. There is a broad interest around the world in this kind of activity, albeit it is in pieces here and there. The project itself is having a catalytic action, and if this continues there will be an exponential effect. There are two things that might impede the rate of accomplishment. One is reluctance on the part of the Director to proceed faster than we feel we are capable of doing. On the contrary, in some ways, the project director has been deemed "brash" and in a "hurry". This has been evidenced in that we refused to visit foreign installations until we were sure we knew with whom we were to visit and why. The second thing that might impede these activities to some extent is establishing the insititutional arrangements and reducing inertia associated with any global program. At present, it appears that we are accepted, and many are anxious to proceed.

APPENDIX

This appendix discusses briefly each of the nineteen contracts collated with Table VI in the body of the report:

1. CEPIS - This project is the largest in scope and support. It will encompass two years. PAHO (CEPIS) will contribute effort and funds equal to or greater than that of the subcontract under the direction of Dr. Sperandio, assisted by Drs. Arboleda and Bartone, and will select three or four water treatment processes technology in Central and South America. These will be of different size and different socio-economic relationships and include such things as valveless filters, multi-deck, multi-media sedimentation and filtration, and the employment of polyelectrolytes.

2. EMPIS - This is a no cost project in which we have an opportunity to test our model out in the selection of small town sewage treatment processes in Columbia. This will be the first real life use of the Users' Manual.

3. IRC Netherlands - This will be part of our "Historic Methods of Treating Sewage" study. There is evidence that the Colonial or earlier North European or North American processes would be ideal for less developed countries at the present time. There are probably some of the earlier processes that have been overlooked because of more developed technology. We plan to study historically how Northern Europe and England and the United States handled water and sewage at the mid 19th Century, or even in earlier times. This is a small contract of eight months that will have a professor and students look into the historic sewage processing methods used in the Netherlands and other European Countries. This is a complimentary project with Number six.

4. A Data Information Collection Inventory Study will be performed jointly with the IRC/NL. We have developed a data format which they are

reviewing. The formatting will be used on all of our test field programs. Reference Center personnel will use this format to accumulate everything they can on innovative and unique technology adaption to the needs of less developed countries. IRC will donate two or three man-months to the project. We will provide funds for students' assistance.

5. The Netherlands (Van Damme) have fielded a sand filter study in Kenya, Ghana and Brazil, as a direct result of the Bilthoven Conferences. They will use our data formats and furnish us the information/data needed.

6. Number six is similar to Number three in that the Zurich IRC group (In conjunction with the Swiss Federal Water Board - EAWAG) will look at the colonial and even pre-Roman times on water treatment. Actually, water had a lot earlier attention than sewage. The only costs to our project will be some travel. This should be a short term project of two months.

7. Dr. Oswald through Public Law 480 is developing quite an elaborate lagoon study in Tunisia and has invited us to assist. He will use our data format. The project director, Professor Reid, will probably visit the Tunisia study at their expense to assist them.

8. AUB Lebanon - This will be sea disposal of sewage possibilities using some of precipitation with sea water and natural occuring dolomites. The separated solids will be diluted with sea water for disposal without an outfall. In other words the outfall becomes a trade-off against the circulation of sea water. AUB will also conduct a study using asbestos/pine needles for filtration. The results will be collated with the studies at Thailand. This is a two year contract with the American University of Beirut although they actually suggested seven and eight programs that they would like to see undertaken. However the subcontract is for the development of the two discussed above. AUB will contribute in-kind services.

9. Turkey, in a two year program, will use lagoons and aerators to form oxidation ponds. This would be under Drs. Ulug and Arceivala. They tried to build their own aerator without success. We will furnish one in an attempt to upgrade the lagoon. Professor Reid has also agreed to provide some lectures.

10. Kenya will conduct a study of lagoon operation. We will furnish the data format and a test kit. This is a cooperative study with the Peace Corps. Dr. Govaerts, who was on this project at the University of Oklahoma, is now the Director there and will supervise it. Govaerts will also coordinate the sand filter study as indicated in Number 5.

11. In Kenya also is a water demand study. It is a small, socio-economic study which can be accomplished in one year and will be directed by Dr. Muga at the University of Nairobi.

12. Manila - Their primary interest is in the maintenance problems in processing, especially the use of chlorine. We will attempt through a two year project under the supervision of Dr. Lesaca to find alternatives to chlorination such as metallic salts, lime, chlorides, etc. This project is concerned with middle and smaller level cities and towns.

13. Manila and Indonesia - There will be two projects in which Camp, Dresser and McKee, a Boston consulting firm (AID contracts to build treatment plants) will collect information (Philipines and Indonesia) that is needed for our model studies. The model will generate for their consideration the optimal process to be used in the development of several treatment plants in each of these countries by this consulting firm. Our only cost will be to run the model.

14. Taipei - Because of wide use of night soil and the problem of disposing of it, we have two studies: one on its sterilization and another on its ultimate disposal by aerobic digestion using both algae and photosynthetic bacteria and finally gravel separation. This will be a two year study under Professor Liu and the National Science Council in Taiwan.

15. Indonesia - See Number 13.

16. Indonesia - This is a two-year study involving seven or eight lagoons using graduate students of the Bandung Technical Institute under the supervision of Professor Reyes to study the ultimate disposal of lagoon effluents as nutrients for fish production (milk fish). The primary motivation here is the fish production. Hopefully additional studies will be made on the possible health implications of eating fish.

17. Jakarta - Mr. Webb of the WHO will direct a monitoring study lasting two years of a Dutch Ditch.

18. Bangkok - This is a correlated study with a previous contract of AID with SEATEC and through the government of Thailand to study slow and rapid sand filters and the coconut hull, chared-rice filters. This is a two-year study in which we will pay for some labor.

19. This project will take a look at "Sewerless" alternatives. This will be of no cost to the project but has great implications in the project. It will be conducted by a WAE graduate doctoral student to look at some fifty different ways that sewage could be disposed of rather than sewering the cities and then developing a sewage plant. Most Far East cities are 6 or 7% sewered. Therefore before U.S. technology can be used there is a necessity of developing the sewers. In terms of U.S. technology, direct sewerage cost to a city runs somewhere between $12,000 and $15,000 per house. Consequently, it is almost impossible at this time to estimate a realistic cost of sewering cities such as Taipei and Bangkok.

20. WHO/Europe has indicated that they would like to use the model to test their sewage treatment program in Libya.