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Mission report

Republic of Yemen / Kingdom of the Netherlands

Rada' Integrated Rural Development Project

Sanitation programme

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Republic of Yemen
Ministry of Agriculture
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Ministry of Foreign Affairs
Directorate General of
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RADA INTEGRATED RURAL DEVELOPMENT PROJECT

SANITATION PROGRAMME

Mission Report

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ANNEXES

ABBREVIATIONS AND TERMS

DGIS	Directorate General of International Cooperation (Netherlands Government)
ERP	Emergency Recovery Programme
feddan	0.42 hectare
GoN	Government of the Netherlands
GoY	Government of Yemen
hay	cluster of villages
HoS	Head of Section (RIRDP)
HWC	High Water Council (GoY)
LCCD	Local Council for Community Development (formerly, Local Development Association)
mahmoor	Governor's representative (for a muderiya)
mandub	Governor's representative (for a nahiya)
medana	town
MoAWR	Ministry of Agriculture & Water Resources
MoE&W	Ministry of Electricity & Water
MoUP&H	Ministry of Urban Planning & Housing
muderiya	district
nahiya	sub-district
NGO	Non-governmental organization
O & M	Operation & maintenance
PHC	Primary Health Care
PME	Planning, Monitoring & Evaluation (Unit of RIRDP)
RIRDP	Rada' Integrated Rural Development Project
RWES	Rural Women Extension Section (of RIRDP)
RWSD	Rural Water Supply Department (MoE&W)
RWSSP	Rada' Water Supply & Sanitation Project
sheikh	leader of group of villages or tribe
SNV	Netherlands Volunteers'Organization
SRWSD	Sopport Rural Water Supply Department (Project)
TAU	Technical Assistance Unit (for RIRDP)
wadi	stream (bed)
WID	Women in Development
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund

1 INTRODUCTION

1.1 Background

Since 1984, the RIRDP Project includes a Sanitation Programme for which there is a Sub-Section within the Engineering Section. Of close relation to the Sanitation Programme are the activities of the following other RIRDP Sections:

- Rural Women Extension Section (RWES);
- Water Supply Unit (WSU);
- Planning, Monitoring & Evaluation (PME).

Sanitation refers to measures for hygiene, health protection, and improvement of the environmental conditions at the village level. It includes household and other sanitary facilities, and safe disposal of wastewater and garbage. Health education also forms part of sanitation, particularly for raising awareness and understanding of the relationship between hygiene, health protection and disease prevention.

Sanitation surely is a basic need of the rural population in the RIRDP project area. It fully corresponds with the overall RIRDP project objective of improving the health and living conditions in Al Bayda Governorate. One sanitation scheme may prevent more disease than a doctor can cure in his lifetime !

A considerable number of diseases are directly and indirectly related to poor household hygiene, pollution in the village environment, unsanitary disposal of wastewater and garbage, and inadequate drainage. Many of these diseases, such as, diarrhoeas, hepatitis, amoebic dysentery, helminthic and protozoal worm infections, occur in the project area. They can be reduced -to a varying degree- by sanitation measures.

There is a close interlinkage between sanitation and water supply. On the one hand, continuous availability of safe water is -in many respects- a prerequisite for effective sanitation. On the other hand, adequate water supply alone cannot be expected to produce lasting effects of improved hygiene and health conditions. Sanitation and water supply thus are each other's necessary complement. It is, therefore, prudent to direct sanitation interventions primarily to villages that already have adequate water supply. Moreover, both water supply and sanitation require health education for effectiveness.

To date, nearly 80,000 people are supplied with drinking water from water supply schemes designed and constructed with supervision of RIRDP. These schemes serve some 90 villages communities in the project area. It is not unusual that provision of improved water supply raises the problem of sanitary disposal of increased amounts of wastewater. This is actually the case in many villages served by water supply schemes.

There are also many villages where disposal of garbage presents problems of unhygienic conditions and health hazards. Food tins, cans and other packaging materials, metalware and plastics, all are causing pollution and unsightliness.

Inadequate drainage is found in many villages built on rock hills. This results in wet spots or pools of standing polluted water that are a health hazard to all.

Generally, there is a considerable backlog of sanitation needs in the project area, and the urgency of a continued RIRDP Sanitation Programme is real and great.

1.2 Development of RIRDP Sanitation Programme

The development and progress of the RIRDP Project is under regular review and evaluation. A joint Yemeni/Netherlands team evaluated the Project from 23 August - 18 September 1987. The evaluation report was issued in October 1987.

On the RIRDP Sanitation Programme, specific recommendations were made for re-orientation, i.e.:

- scope of activity to narrow (i.e. mosque sanitary facilities and some household sanitation)
- Programme needs re-definition to have it focused better on the overall RIRDP project objective (which is improvement of the development potential and living conditions in Al Bayda Governorate)
- realistic programme planning is required in view of the limited resources (especially staff) available.

In February 1988, a re-orientation and work planning was made for the RIRDP Sanitation Programme. Its various components were, at the same time, specified for moderate levels of activity, as recommended by the Evaluation Mission.

Persistent efforts have, throughout 1988 and following years, been made to develop a consistent Sanitation Programme comprising of the following components:

- Hygiene education and sanitation extension;
- Implementing activities
  - . basic village sanitation improvement
  - . village schemes for garbage disposal
  - . sanitary improvement of shallow well water supply systems
  - . village schemes for wastewater collection/disposal
  - . sanitary facilities for mosques
  - . sanitary facilities for schools and PHC units
- Supporting activities
  - . water quality monitoring
  - . training and technology transfer
  - . demonstration of solar water heaters
  - . promotion of adequate disposal of waste oil
  - . promotion of re-use of wastewater for irrigation.

The goal of the RIRDP Sanitation Programme is to support village communities, that are interested in sanitation improvements and willing to make their own contribution, in the planning and design, and in implementation of sanitary facilities and schemes for improved health and living conditions. The RIRDP assistance includes:

- extension on sanitation and health protection
- site investigation and survey
- planning and design of sanitation schemes/facilities
- cost estimation
- assistance in arranging the village contribution
- providing the agreed RIRDP contribution
- contracting for works execution
- supervision of construction.

Sanitation extension and health education are provided in cooperation with the RIRDP Rural Women Extension Section, village extension agents, and PHC workers. The Sanitation Extensionist contributes to training courses for these staff.

All sanitation activities need to be based on agreement between the village and RIRDP. The supporting communications address issues that are not always easy. Problems for sanitation schemes - as for other RIRDP activities - may be caused by frictions and strife among families and groups within villages. These can greatly interfere with the work, for example, during extension sessions and when cleaning days for garbage disposal are organised.

Internal evaluations were made by PME on:

- garbage disposal schemes
- sanitary facilities for schools
- shallow well water supply improvement.

1.3 Results

The Sanitation Programme activities have produced encouraging results, in terms of real and active village interest, and actual participation of the beneficiary village communities. Although on a modest scale, the results have gradually become visible and the work approach and methods have definitely matured.

Table 1 Results RIRDP Sanitation Programme

Activity	Achievement				
	1988	1989	1990	1991	Total
- Basic village sanitation	-	-	-	1	1
- Garbage disposal village scheme	2	3	6	6	17
- School & PHC unit san. facilities	-	2	5	3	12
- Shallow well improvement	1	1	2	3	7
- Mosque sanitary facilities	13	3	6	13	35
- Village scheme for wastewater disposal	-	-	1	1	2
- Water quality tests	102	16	n/a	n/a	n/a
- Solar water heaters (demonstr.)	7	5	2	-	14

Table 2 RIRDP Sanitation Programme 1984-1991

No.	Year	Village	Region
Garbage disposal schemes			
1	1988	Al Qagarah	Qaifah
2	1989	As Suar	Al 'Arsh
3	1989	Al Qaharah Hubabah	Al 'Arsh
4	1990	Sarar Al Jism	Qaifah
5-10	1990	Menaseh & 5 other villages	Qaifah
11	1990	Ar Rubat (3 pits)	Dhi Na'im
12	1991	Al Khilaw	Qaifah
13	1991	Ar Rawq	Qaifah
14	1991	Az Zuab	Qaifah
15	1991	Hanakat Al Mas'ud	Qaifah
16	1991	Noghalah (Wadi Tha)	Qaifah
17	1991	Hayd Al Majil (Wadi Tha)	Qaifah
18	1991	As Sawm'ah	As Sawm'ah
		Al Awabal	Juban
		Junobah	Qaifah
		Ar Rubat (Wadi Matar)	Qaifah
		Juban	Juban

Village sewered wastewater disposal

1	1990	Al Khalagah	Al 'Arsh
2	1991	Al Qaharah	Qaifah
		Ar Rubat (Dhi Na'im)	Al Bayda
		As Sawm'ah	As Sawm'ah
		Ghaleb (Wadi 'Amad)	Qaifah

Shallow well improvement

1	1988	Sawman	Al 'Arsh
2	1989	Haryah (Wadi 'Amad)	Qaifah
3	1989	An Nuqub (Wadi 'Amad)	Qaifah
4	1990	Safiah (Wadi 'Amad)	Qaifah
5	1991	Zanabi' (Wadi 'Amad)	Qaifah
6	1991	Ghaleb (Wadi 'Amad)	Qaifah
7	1991	Al Waq'ah	Qaifah
		Ad Dra	Qaifah
		Wadi Sirhan	Qaifah
		Ad Darb (spring)	Al 'Arsh
		Hanakat Al Mas'ud (spring)	Qaifah

School sanitary facilities

1	1989	Al Qadry	Qaifah
2	1989	Suar	Al 'Arsh
3	1989	Quarn Al Asad	Al 'Arsh
4	1989	Rada' (girls' school)	Rada'
5	1990	Safiah (Wadi 'Amad)	Qaifah
6	1991	Sayanim	Qaifah
7	1991	'Amer 'Abd Al Wahab	Rada'
8	1991	Musallah (girls' school)	Rada'
9	1991	Kharbah Jiradah	Sabah
		Al Qawz (Wadi Mansur)	Qaifah
		Furkhan	Sabah

PHC units sanitary facilities

1	1989	Al Qaharah	Qaifah
2	1990	Draybah	Al 'Arsh
3	1990	Bayt As Suraymi	Ar Riashiah

Mosque sanitary facilities

1	1985	Jubayr	Sabah
2	1985	Al Khabar 1	Sabah
3	1985	Al Hajar	Sabah
4	1986	Al Khilaw	Qaifah
5	1986	As Sara	Qaifah
6	1986	Uteifa 1	Rada'
7	1986	Majlain	Sabah
8	1986	Uteifa 2	Rada'
9	1986	Bayt Al Majrab	Al 'Arsh
10	1987	Maswarah	Sabah
11	1987	Furkhan	Sabah

12	1987	Hawat	Sabah
13	1987	Al Qauz	Qaifah
14	1987	Al Lahbi	Qaifah
15	1987	Yahmum	Ar Riashiah
16	1987	Biut As Salama	Ar Riashiah
17	1987	Hanakat Al Mas'ud	Qaifah
18	1987	Mawr 1	Al 'Arsh
19	1987	Al Qabl	Sabah
20	1987	Al 'Asha	Qaifah
21	1987	Surm Ash Shadadi (Wadi Tha)	Al 'Arsh
22	1987	Augatah	Ar Riashiah
23	1987	'Azzan	Al 'Arsh
24	1987	Hawat 2	Sabah
25	1987	At Tahlah	Ar Riashiah
26	1987	Al Qadry	Qaifah
27	1988	Ash Sharaf	Sabah
28	1988	Al Gorayshiah	Qaifah
29	1988	Baqarat	Qaifah
30	1988	Mawr 2	Al 'Arsh
31	1988	Safi Al Ma	Rada'
32	1988	Mallah	Al 'Arsh
33	1988	Al Hamra (Wadi Tha)	Al 'Arsh
34	1988	Sarar Al Jism	Qaifah
35	1989	Al Khabar 2	Al 'Arsh
36	1989	Sudan	Al 'Arsh
37	1989	Hayd Al Majil	Qaifah
38	1989	Nughalah	Qaifah
39	1989	Habban	Qaifah
40	1989	Bayt Haddash	Ar Riashiah
41	1989	Qarn Qasad	Sabah
42	1989	Ad Dard	Ar Riashiah
43	1990	An Nubah (Wadi Matar)	Qaifah
44	1990	Safiah (Wadi 'Amad)	Qaifah
45	1990	Al Khalagah	Al 'Arsh
46	1990	Al Lijuw	Ar Riashiah
47	1990	Az Zuab	Qaifah
48	1990	Khobza	Qaifah
49	1991	Sarea' (Wadi Mansur)	Qaifah
50	1991	Al Wag'ah	Qaifah
51	1991	'Abbas	Qaifah
52	1991	Al Ghargah	Al 'Arsh
		Al Gorayshiah (Wadi Mansur)	Qaifah
		As Sawadiyah	As Sawadyah
		As Sharbah (Qa' Rada')	Rada'

1.4 **1989 evaluation**

The joint Yemeni/Netherlands mission which, in June 1989, evaluated the RIRDP Project, recommended continuation of the Sanitation Programme. The mission emphasized the need for health education to support implementation of sanitary schemes/facilities. The Programme's sanitation extension work was commended upon.

Sanitation interventions should be based on affordable (low-cost) and small-scale technologies. Targets for basic village sanitation, sanitary facilities for schools and PHC units, village garbage disposal schemes, and shallow well improvement, were reviewed and the recommended levels of these activities given. In view of the prevailing constraints, some reduction in programme targets was advised. Overall, the mission considered the achievements of the Sanitation Programme as quite encouraging. Village interest and response to RIRDP assistance and the number of village requests for various sanitation improvements, were appreciated.

The Mission was particularly positive on the comprehensive study of alternative solutions for village wastewater disposal in the project area. In this study the social aspects, technical options, and financial/economic feasibility of village wastewater disposal were fully covered. The study results were considered to give a solid basis for the planning and design of future village wastewater disposal schemes. Special reference was made to the sewerage scheme designed for Al Khalagah.

For mosque sanitary facilities, a maximum number of 8 units per year was recommended, with a village contribution that should be raised to 40%, and ultimately to 100%. It was noted that in the current Programme many more than the ceiling number of mosque facilities were being constructed with only 20% village contribution. While accepting that the activity of mosque sanitation had greatly contributed to the Sanitation Programme of RIRDP gaining visibility and strength, the Mission questioned its relevance in terms of development cooperation.

Regarding sanitary facilities for schools and PHC units, the Mission called for emphasis on health education. Attention should be given to the need for separate sanitary facilities for women and men. Thus, the standard designs for these facilities and their costs should be reviewed. Old facilities cause health hazards and smell nuisance, and should therefore be demolished.

The Mission was pleased with the results of the first few garbage disposal schemes (at that time, June 1989). The cost sharing was considered appropriate whereby the village provides the land for the disposal site and RIRDP provides funds for pit excavation, fencing and garbage bins. To support adequate disposal of garbage, more emphasis on health education was asked for. Verification of design criteria and sizing of the disposal pits was recommended.

The Mission agreed with the importance of sanitary improvement of shallow wells for securing safe supply of water to villages. Water supply from improved wells is particularly suited to small villages (i.e. less than 200 people), many of which are poor. Hundreds of such villages can potentially benefit from this form of sanitation. Full community participation is essential in view of the multiple claims on these shallow wells and special arrangements are needed because they are generally under private ownership. The need to provide for sanitary drainage at the water delivery points, and a washing slab was emphasized.

The importance of water quality monitoring was stressed, as several water supply schemes appeared to supply water with fluoride and/or nitrate levels in excess of permissible standards for drinking water. Similarly, water quality testing should be done for water sources under consideration for new water supply schemes.

The installation of solar water heaters should only be continued where it really is for demonstration and can be integrated with other RIRDP activities. The training course for village health workers at the PHC clinic in Rada' was considered very relevant, in order to emphasize the importance of sanitation and to support cooperation at the village level.

In summary, the main recommendations of the 1989 Evaluation Mission concerning the RIRDP Sanitation Programme were:

- To implement the proposed Programme, with emphasis on health education; covering village garbage disposal, low-cost solutions to wastewater collection and disposal, and sanitary improvement of shallow wells;
- Initially (up to mid 1991), the Programme should be confined to Rada' District only;
- A ceiling should be applied to the activity of providing sanitary facilities for mosques, at the level of 8 per year; while striving to increase the village contribution to 100% so that the RIRDP assistance would be limited to technical support only;
- An integrated approach to water supply, sanitation and health education should be promoted at the village level;
- To strictly implement the adopted policy for village contributions for the various activities;
- To design and implement procedures for the systematic and regular monitoring of all activities in the Programme;
- To give more attention to water quality aspects of design, construction and operation of drinking water supply systems;
- To determine long-term staff requirements for the Programme, and to draft a training programme.

2 REVIEW OF RIRDP SANITATION PROGRAMME

2.1 Health education and sanitation extension

Health education must be an integral part of every sanitation programme. Its aim is to support the user groups in the adoption of hygienic practices of excreta disposal, household cleanliness, disposal of garbage, and collection and disposal of wastewater; all of this linked to using safe water for drinking and domestic needs, and for household tasks (i.e. cleaning, food preparation, water storage).

Health education and sanitation extension are processes of communication and explanation towards effective use of sanitary facilities, maintenance of hygiene, health care and prevention of diseases. These activities of the Sanitation Programme are closely interlinked with the health education activities as carried out by the Rural Women Extension Section of RIRDP.

Supporting information and guidance for this work is available in the Manual " Elementary Hygiene and Sanitation" prepared by Mrs. Marion Derkx for the Non-Formal Education Centre for Women, Rada'; the PHC Clinic, Rada'; and RIRDP. Further guidance is provided in Annex B of the April 1989 Mission Report on Sanitation Programme Review and Planning.

The work of the RIRDP Sanitation Extensionist is perceptive and finely tuned to the intricate aspects of communicating with village communities on the not-so-easy subjects of sanitation, hygiene, and environmental cleanliness in the village. The communication process on village sanitation may be further streamlined into a structured (step-by-step) series of consultations with the village representatives and members.

Well-designed and attractive posters and display materials have been developed for use in the RIRDP Sanitation Programme; these should be utilized wherever possible. Further guidance is available in UNICEF's excellent booklet "Sanitation: A Way of Life" (Annex C). The purpose of these and other materials is to support the communication with graphics that present well-defined and tested messages on sanitation, hygiene and health protection. Video clips may be used as supporting means for the same purpose. Some further health and hygiene materials will be obtainable from the Ministry of Public Health which has been receiving expert assistance from WHO and UNICEF in this field.

Cooperation with the PHC Project/Clinic in Rada' is particularly appropriate. The teaching contribution by RIRDP sanitation staff in the course for village health workers is regularly given and much appreciated. Field cooperation between RIRDP and PHC Project at the village level will also be very beneficial. It should be focused on:

- securing appropriate design and construction of sanitary facilities at the PHC units (building programme of PHC Project);
- exchange of medical statistics on incidence of water- en hygiene related diseases in order to programme sanitation assistance for the most needy villages.

2.2 Sanitation implementing activities

The following sanitation implementing activities form part of the RIRDP Sanitation Programme.

2.2.1 Basic village sanitation improvement

Many villages of the project area have site-specific sanitation problems, such as, wet spots with polluted soil or -worse- stagnant pools of wastewater (particularly at shaded places behind the houses); garbage dumping sites near or between houses, which attract flies and are an immediate and serious health hazard; depressions where pools of water remain after rains due to lack of drainage; and, sometimes, places that are used for indiscriminate defaecation.

A standard form may be used for survey and inventory of these village sanitation problems (Annex D).

Technically, basic sanitation improvement involves measures to solve or mitigate the above-mentioned problems. These measures include:

- construction of collector pits and soakaways for disposal of wastewater; if necessary, with soakage trenches or sub-surface drains;
- gulleys or pipes to carry the wastewater to sites where infiltration is better or -at least- evaporation more effective;
- drainage by stone-filled trenches, with pipe sections for road crossings; to allow wastewater or excess run-off to run to places where the health hazard is less, infiltration better, or -at least- evaporation more effective;
- soakage pits at the bottom of depressions; pits filled with large-size rock segments.

2.2.2 Village schemes for garbage disposal

Most villages in the project area have no provisions for sanitary disposal of garbage. Indisriminate dumping is practiced which leads to situations that are unhygienic and hazardous to human health. Often, it is common practice to just throw the garbage out at sites behind the house or on the hillslopes. Especially metal cans, tins, packaging materials, and all sorts of plastics, are a very visible sanitation problem.

Organic wastes are less prominent, as goats and other livestock scavenge on the heaps of garbage. Serious health hazards arise particularly from flies breeding on open waste where they easily multiply and may cause infestation. Flies can pick up disease-causing germs (i.e. bacteria, viruses) from open waste or uncovered excreta, and may transmit them to food or water; direct infection by stinging insects may also take place. Children when playing or wandering around disposal sites of garbage, can contract infection through direct contact with infested waste. Animals scavenging on garbage heaps are subject to the same hazard.

Garbage is also blocking drainage channels in villages and so causes formation of stagnant pools of polluted water that are ideal breeding places for flies and other insects. These are a serious health hazard to all.

RIRDP project staff have, since 1988, worked hard to raise awareness in the villages of the need for proper disposal of garbage. Experience with the work approach and methods has been gained, and nearly 20 village schemes for garbage disposal have been implemented successfully.

Technically, village garbage disposal schemes involve:

- site selection and agreement by the village to provide the land needed for the disposal pit;
- sizing, design and layout of the pit;
- contracting for pit excavation (often by drill hammer);
- arrangements for waste collection and transport (provision of garbage bins forms part of the schemes).

The garbage disposal pit must be at sufficient distance from the nearest houses of the village, in order to eliminate health hazards and smell nuisance. The breeding of insects and their action radius are an important consideration (Annex ..). Siting and design criteria for garbage disposal pits have been established, and are being verified in actual practice.
In Annex E an example of garbage pit design is presented.
Initially, transport of full garbage bins from the houses to the disposal pit proved to be the main constraint. However, since RIRDP started providing wheelbarrows this problem appears to be solved. It is perhaps regrettable that some of the garbage bins provided by the project, are being used for other purposes (e.g. fodder, water storage) but this seems to be unavoilable.

2.2.3 Sanitary improvement of shallow wells

Many village communities in the project area depend for their water supply on shallow wells. These wells draw water from sub-surface storage in valley floor sediments and wadi alluvium. Often, the condition of shallow wells is poor and improvements are required for sanitary withdrawal of water, i.e.:

- Repair or replacement of well lining to secure the stability of the well; sealing cover as appropriate;
- Strengthening of superstructure and pump support;
- Construction of headwall and cleaning of the well surrounds to protect the well water against pollution; (i.e. removal of donkey manure and mud)
- Installation of suitable pump for drawing the water;
- Construction of small storage reservoir or repair of existing reservoir (i.e. watertight inside lining)
- Overhead tapstand for filling of water containers
- Water use facilities (i.e. washing slab for laundry, cattle trough)
- Provisions for drainage of spilled water.

Because of the differences in size, yield and condition of shallow wells, their site and ownerhip, the requirements for sanitary improvement vary considerably. The actual improvements to be made are highly specific, and must be determined in close consultation with the village(s) concerned. A working list of shallow wells in the project area that should be considered for improvement, has been drawn up by project staff based on field survey data.

It should be noted that sanitary improvement of shallow wells is an inexpensive means of securing the supply of safe water. With a modest investment, a considerable improvement of health and living conditions of the village can be achieved. Typical designs used for shallow well improvement are shown in Annex C.3 of the April 1989 Mission Report "Sanitation Programme Review and Planning".

Securing proper maintenance of improved shallow well water supply systems requires explicit arrangements, as the wells are usually under private ownership.

2.2.4 Village schemes for wastewater disposal

There are villages in the project area where the configuration of the village and the conditions (i.e. density and distribution of housing in the core area, topography, hardrock or other resilient ground) do not allow digging of pits for soakaways or septic tanks for individual households. However, the wastewater problems are as severe in these villages as in others, with stagnant pools of sewage at shadowed places behind the houses, swampy low-lying areas where wastewater collects, and situations where wastewater from houses located uphill runs down to lower-lying houses. Under these circumstances, village schemes for sewered collection and disposal of wastewater have to be considered as the only practical option.

This was, for example, the case for the village of Khalagah which requested RIRDP assistance in solving its wastewater problems. On-site investigations and topographical surveys carried out by project staff provided the basis for a preliminary design of sewered wastewater disposal system, with the corresponding cost estimation.

The envisaged small-bore sewerage system proved to be technically feasible and the cost estimates showed it could be constructed at relatively low cost. The village was prepared to contribute a major part of the scheme cost. The detailed design of the sewerage system was then made, and it was constructed under RIRDP supervision.

Technically, a village scheme for sewered collection and disposal of wastewater involves:

- Construction of small-bore sewer system for direct collection of wastewater from house collector pits;
- Conveyance of the sewage to septic tanks for primary treatment;
- Soakage pits or trenches for safe disposal of the septic tank effluent.

It should be noted that trenching from the house sewage collector box to the sewer sometimes is difficult in hardrock or other resilient ground. House owners may stop trench digging when hard formations are encountered, e.g. at 20 cm depth. Where the ground really is difficult to excavate (even with the pneumatic hammer), above-ground house connections to the sewer may have to be considered. In extreme cases, even the sewers themselves may partially or entirely have to be laid above-ground. It is then necessary to protect both the house connections and the sewers by stone blocks and heaped up backfill soil.

A similar matter are soakage pits when these must be dug in hard (rock) formations. The project uses pits of standard design, with a width of 2m and a length of 2m, 3m or 4m depending on the sewage (equivalent) loading of the pit and the soil's specific infiltration rate. Experience shows that with pneumatic hammer digging all excavations are made larger and wider than as per design. Inside the excavation, the pit is built from blocks placed with 3cm slots. In hard rock, one or more of the block walls may be omitted. The cover slab will then rest on the edge of the excavated rock and the remaining walls. However, no reduction of pit size should be attempted because the annular space is needed for a fill of coarse material which promotes infiltration and thus the proper functioning of the pit. Coverage of the annular space by soil is required to prevent smell nuisance.

2.2.5 **School sanitary facilities**

This activity is a well-established part of the RIRDP Sanitation Programme. Standard designs, tested in practice, are available (April 1989 Mission Report, Annex C.1).

Technically, sanitary facilities for schools involve: toilets/latrines connected to collector vaults that discharge into soakaway pits or septic tanks with soakage trenches for effluent disposal. Aqua privies could be selected for this application as well, but they require completely watertight construction which is difficult to ensure.

2.2.6 Sanitary facilities for PHC units

Provision of sanitary facilities for PHC units/health centres is well-established in the RIRDP Sanitation Programme. Standard designs are available (April 1989 Mission Report, Annex C.2).

Technically, these sanitary facilities involve construction of toilets connected to septic tanks or soakaway pits for effluent disposal. A special feature of the PHC units/centres is that provision of hot water is particularly desirable. For this, solar water heaters may be installed.

2.2.7 Mosque sanitary facilities

This activity of the RIRDP Sanitation Programme was, until 1989, the most prominent. At its peak, in 1987, as many as 17 mosque sanitation schemes were completed in a single year. Islamitic law prescribes personal hygiene of worshippers when entering the mosque and in general during prayers. Washing and sanitary facilities thus are required, and awareness of the need for hygiene and cleanliness is strongly promoted. Since the start of this activity, in 1985, nearly 60 village communities have requested and obtained RIRDP assistance in the improvement of sanitary facilities in their mosques.

Technically, sanitation improvement for mosques involves construction of washing facilities in the hardtop court area, toilet construction, and wastewater disposal using collector vaults connected to a soakaway pit or septic tank with drain trenches for effluent disposal. In some cases, it has been possible to connect the wastewater outlet of the mosque to a sewer. Standard designs for mosque sanitary facilities are available (April 1989 Mission Report, Annex C.3).

2.3 Supporting activities

Several supporting activities are incorporated into the RIRDP Sanitation Programme:

2.3.1 Water quality monitoring

Water samples are selectively taken from water sources and water supply schemes (i.e. those designed and constructed under RIRDP supervision). Since 1988, the samples are analysed in the project laboratory at Al Khabar on key quality parameters. In a complete chemical analysis, the water is tested on some 10 constituents.

For newly proposed water supply schemes, advice is given on the basis of quality analysis of samples to determine the suitability of the water source for drinking water supply.

The water quality parameters receiving special attention (based on the project's experience with water sources in the area) are:

- nitrate and nitrite
- fluoride
- electric conductivity (as a measure of TDS, and taste)
- iron and manganese (in some cases)
- sulphate (in some cases).

Bacteriological analysis for determination of coliform and E. Coli numbers is not generally carried out. Apart from the laboratory equipment, field kits for water quality analysis are also available.

Forms used by the project laboratory for recording of water quality test data and for interpretation of the test results, are shown in Annex F.

The laboratory technician received training in water analysis in a 3-month course in Egypt.

2.3.2 **Training**

Training and knowledge transfer are supporting activities of the RIRDP Sanitation Programme. It is particularly required for the Yemeni extensionists and village health workers who are either directly or indirectly concerned with sanitation extension (as well as with water supply improvement).

Training is also needed for village representatives and persons who, on behalf of the village leaders, take up the role of contact person for sanitation improvement activities in the village.

Relevant sanitation technology for project staff has been presented in the April 1989 Mission Report (Annex ...).

A course for primary health care personnel and village health workers has been developed at the PHC Clinic in Rada'. This course is also of great benefit to field staff of the RWES Section of RIRDP, as well as the project's agricultural extension agents.

A course for RIRDP project staff involved directly and indirectly in the Sanitation Programme should be held once or twice a year; the estimated number of participants is 15-20. The course programme would be as follows:

- Basics of health care, hygiene, and disease prevention;
- Sanitation extension;
- Basic village sanitation;
- Village schemes for garbage disposal
- Sanitary improvement of shallow wells
- Village schemes for wastewater disposal
- Sanitary facilities for schools & PHC units/centres
- Sanitary facilities for mosques
- Water quality analysis & monitoring
- Planning & cost estimation
- Contracting & construction supervision
- Arrangements for operation & maintenance.

Details of the proposed course programme are presented in Annex G.

2.3.3 Demonstration of solar water heaters

A suitable model of solar water heater has been developed by RIRDP and is now being manufactured by several workshops in Rada'. These solar heaters are of simple design, yet effective, and inexpensive.

Demonstration of solar water heaters can be supported by RIRDP in a selective manner, i.e. at PHC units/health centres, extension centres, and schools. Through such demonstration, the Project can extend the benefit of hot water supply for personal hygiene and health care. Further interest and application of solar water heaters can thus be stimulated.

2.3.4 Disposal of waste oil

A test model of a special incinerator for disposal of waste oil has been developed by RIRDP. The incinerator produces hot water, and appears to be suitable for use at the village level.

2.3.5 Promotion of re-use of wastewater

This involves showing the potential of re-using wastewater in applications , such as, small-plot irrigation, vegetable garden watering, etc. The limitations in terms of health hazards should be explained, i.e. no watering with untreated wastewater or primary effluent of crops (e.g. vegetables, qat) that are consumed raw or uncooked.

3 KEY ISSUES

3.1 General

The principal goal of the RIRDP Sanitation Programme is to contribute to creating awareness and understanding in the project villages, of the relationships between hygiene, sanitation, and health protection. Through health education and sanitation extension, interest is to be generated for village participation in sanitation schemes and facilities.

Health education and sanitation extension thus have a "spearhead" function in the Sanitation Programme for implementing activities through which various types of sanitary schemes and facilities are installed. This basically has the purpose of showing that "it can be done" and that "it works". Health education and implementing activities are supported by supplementary activities, such as, water quality monitoring, training, promotion of waste oil disposal, and demonstration of solar water heaters.

Sanitation extension and implementation of village sanitation improvements are also closely linked to the extension work of the Rural Women Extension Section of RIRDP.

3.2 Geographical coverage

In the RIRDP Plan of Operation 1990-1992, the geographical coverage for the Sanitation Programme is clearly specified as exclusively within Rada' District until about July 1991. The objective of this has been to allow the Programme to gain experience and strength in an area at relatively small distance from project headquarters. This had the advantage of intensive liaison with the project villages and relatively frequent working visits by project staff. An exception was made for the activity of mosque sanitation improvement which was allowed early -be it limited- expansion into Al Bayda District.

The planning of the future RIRDP Sanitation Programme should take account of the envisaged re-directing and focusing of project activities, after 1992, in Al Bayda District and some (parts of) southern governorates.

3.3 Technical issues

In view of the close relationship of sanitation with water availability, it is of great relevance that there is a general scarcity of water in most of the RIRDP project area, and particularly in Al Bayda District. Traditionally, water usage in the rural villages has been very limited, not more than 35-40 l/c/d, even in the villages having water supply schemes constructed with RIRDP assistance and supervision. It is illustrative that the Yemeni Government's Rural Water Supply Department has been applying 40 l/c/d as design standard.

The sanitation facilities and schemes provided with RIRDP assistance, should be low-cost and require limited water use. The used sanitation technologies include:

- Pour-flush (water sealed) toilets or latrines connected to septic tanks, with effluent disposal in soakaway pits or drain trenches;
- Pour-flush latrines connected to collector pits that discharge directly into (double vault) soakaway pits;
- Aqua privies connected to soakaway pits or drain trenches (with the explicit requirement that the privy tank is constructed completely watertight);
- House collector pits connected to (small-bore) sewer systems discharging into septic tanks, with soakaway pit or drain trenches for effluent disposal.

These low-cost sanitary facilities can give all the hygiene benefits and health protection required of them, and also an acceptable standard of convenience. They are designed for very limited water usage (e.g. some 2 litres of water per use of a pour-flush latrine/toilet). Clearly, this is particularly appropriate for the RIRDP project area with its prevailing general scarcity of water.

Communal sanitary facilities (e.g. multiple-latrine sanitation blocks) are excluded from consideration, because experience in all parts of the world shows that these are nearly always poorly used and maintained. Sanitary facilities for institutions, such as schools and PHC units/centres, are a different category since the user group is homogeneous.
Communal facilities are no real substitute for household sanitation, certainly not in the Yemeni socio-cultural conditions of the project area. Household units are the preferred option with facilities either for individual household disposal of wastewater (i.e. soakaway pits, septic tanks) or with village schemes (i.e. garbage disposal, sewer systems for wastewater collection and disposal).

Sewered collection of wastewater (sewage and sullage) is hard to economically justify for the majority of small and medium-size villages in the project area. The cost of sewerage systems would be prohibitive, because of topography, number and location of the houses, and difficult trench and pit excavation (e.g. rock at or near the surface). Moreover, sewer systems are not likely to function properly at the low sewage loading and limited effective flows in small and medium-size villages. Retention times in the sewer system would be unduly long, and putrefaction of the sewage is likely to occur. The cases where village sewer schemes for wastewater disposal are both technically feasible and economically justifiable, are very few.

For the towns of the project area (i.e. Al Bayda, Juban, Sawmah) sewerage schemes and low-cost sewage treatment for safe disposal of effluent are both viable and urgent in view of the major problems of wastewater in these towns. These town sewerage schemes will require proper planning and design.

It will have great merit to marshall the technical capacity of the (re-focused) RIRDP Project to these much needed town sewerage schemes. Proper functioning district centres are essential for rural development and will benefit directly and indirectly project activities for the villages in the districts. Inclusion of selected town sewerage schemes in the future Sanitation Programme should be considered.

For surface drainage (and also for sewer system design), it is of relevance that most villages in the project area are located on rock hills or mountain slopes, above the surrounding areas where the cultivated fields are. Drainage of surface runoff often can be provided by simple measures.

3.3 Village contribution

The types of sanitation facilities/schemes provided with RIRDP assistance and supervision, and the required village(/LCCD) contribution for each type of scheme or facility, are summarized in Table 3.1.

Table 3.1 Types of sanitation facility/scheme and required village(/LCCD) contribution

Sanitation Programme Component		Number/year	Contribution village/(LCCD)
1	**Sanitation extension & Hygiene education**	n/a	n/a
2	**Sanitation implementing activities**		
2.1	Basic village sanitation (removing main health hazards)	---	30%
2.2	Village schemes for garbage disposal (a)	---	30% (incl. land)
2.3	Shallow well improvement (b)	---	25% (well & pump)
2.4	School sanitary facilities	4	20%
2.5	PHC unit/centre san. fac.	4	0%
2.6	Mosque sanitary facility	6(8)	YR 20,000
2.7	Village scheme for wastewater disposal (c)	2	30%

3	**Supporting activities**		
3.1	Water quality monitoring tests	---	n/a
3.2	Training & knowledge transfer (incl. support PHC courses)	---	n/a
3.3	Demonstration of solar heaters	---	---
3.4	Disposal of oil waste	---	n/a

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* Notes n/a = not applicable
(a) Excavation pit, provision bins & wheelbarrows
(b) Well superstructure, small reservoir, taps, washing slab, cattle trough, drainage
(c) House collector pits, sewer system, etc. (Technical Note No. 25)

Security of village commitment

Firm arrangements for the village contribution to sanitary facilities/schemes must be made to secure the agreed input by the village (excavation work, payment, etc). Sometimes, however, these arrangements are made exclusively with the village representative or leader, and without full participation of the other family households. The village population then will not be really informed on the required work and/or payment; the difficulty of trenching or other digging work may well be underestimated.

In such cases, the agreed work or payments is not likely to be provided readily. It is necessary that each individual family should fully understand and agree to its part of the total village commitment. This should be verified at an early stage, prior to the actual commencement of works.

Length of time required for all procedures

To indicate the length of time required for completion of all steps in the procedure for a village wastewater disposal scheme (which is the most complex type of scheme under the RIRDP Sanitation Programme), the example of Al Qaharah village is given. This is a village with some 500 inhabitants, in nearly 70 houses (built on a small sandstone hill); it is located 15 km northeast of Rada'. There are a primary school and PHC unit (with RIRDP improved toilets and solar water heater). The village's water supply was constructed in 1979, and a garbage disposal scheme was implemented in 1989.

In May 1990, after extensive consultations with the village and survey work, a proposal for a village scheme of sewered wastewater was presented; the scheme consists of small-bore sewers connected to masonry checkpoints, with septic tanks for primary treatment and soakaway pits for effluent disposal.

The total cost of the scheme was estimated to be YR 954,700 out of which excavation by the villagers themselves of household collector pits and connecting pipe trenches was valued at YR 164,900 (or 17%). The remaining cost of YR 789,800 would be far in excess of the maximum amount that RIRDP could contribute, i.e. YR 300,000. It was then agreed that, in order to raise the village contribution, all excavation of soakaway pits and septic tanks (requiring the use of heavy pneumatic equipment) would also be for the charge of the village.

Excavation of house collector pits and connecting line trenches was mainly by hand, but some families had their sections done by pneumatic equipment. This was stopped when the rental of the pneumatic equipment was raised from YR 200 to YR 300 per hour.

Meanwhile, by May 1991, a contractor had been engaged for all concrete work, under an agreement between the village and RIRDP. This work was then started within two weeks. However, the excavation work by the houseowners slowed down and often came to a halt, particularly where pit and trench digging encountered hard rock. It was then agreed to engage a contractor using pneumatic equipment. The contract was signed on 4 January 1992 between the village, RIRDP and the contractor.

The collector pits to receive the sewage from the individual houses, and the trenches for the connecting lines, now are to be made urgently, since the sewer system with the septic tanks and soakaway pits is almost ready. This sewer system will be of no use unless the houseowners complete their pits and connecting lines. It is hoped that the scheme can be completed by May 1992, exactly two years after the initial agreement between the village and RIRDP, and approval of the corresponding proposal.

4 PLANNING BASIS

4.1 Strategy and approach

The RIRDP Sanitation Programme uses an approach which attempts to integrate water supply, sanitation and health education as much as possible. The reasoning for this is that improved water supply or sanitation alone, without matching health education, cannot be expected to produce lasting impact on health and living conditions. Similarly, health education in isolation, without follow-up by sanitation improvement and availability of water supply, will have little (if any) tangible results.

It has to be said that the integrated approach is extremely difficult to implement under the conditions of the RIRDP Project. Many factors affect the preparation and implementation of schemes and facilities. In fact, it appears that sanitation improvements are best accepted and utilized when installed some time after the commissioning of the water supply scheme for a village. Whereas the interlinkage between water supply, sanitation and health education, is strong and close, this does not mean that it is always perceived as such by villagers. The time required for awareness of health hazards and for sanitation improvement to become a felt need, is often years rather than months.

In view of the limited resources and staff capacity of RIRDP, the project can also not be expected to ensure that every village having a water supply scheme will automatically qualify for basic village sanitation, a garbage disposal scheme, amd a wastewater disposal scheme. One reason is that construction of water supply schemes by RIRDP started much earlier (1978) than the Sanitation Programme did (1988). By the end of 1991, there were some 90 water supply schemes implemented by RIRDP against nearly 20 garbage disposal schemes and only 2 schemes for sewered wastewater disposal. Moreover, it should be noted that implementation of basic sewerage requires more extensive topographical surveying and planning because of the greater technical complexity of these systems when compared with water supply schemes.

Thus, in spite of the great merit of the integrated approach in itself, it will for practical reasons be necessary to continue with sequential development in which garbage disposal schemes and wastewater disposal systems follow on, sometimes with an interval of several years, the construction of water supply schemes.

Another strategy would be to concentrate RIRDP assistance almost exclusively on "pilot villages" and thus limit it basically to demonstration only, without any attempt towards coverage of the project area. This was, some time ago, recommended for the Sanitation Programme. Two villages (Al Hagar and Hanakat Al Mas'ud) were tentatively selected.

Al Hagar (which had its water supply scheme commissioned in 1984) unfortunately had to be omitted as a potential "pilot village" for integrated water supply and sanitation development, when a comprehensive study in 1989 showed that a wastewater disposal scheme would be neither technically feasible nor economically justifiable. It further appeared that the village was not prepared to make land available for a garbage disposal pit.

The other pre-selected village, Hanakat Al Masu'd (which has an existing water supply scheme) indeed received a garbage disposal scheme by 1991, some 15 years after the commissioning of its water supply system. The village has submitted, by late 1991, a request for RIRDP assistance for a wastewater disposal scheme and this is presently under study by the project.

Thus, experience shows that total integration of water supply and sanitation cannot really be achieved, even in "pilot villages", let alone in villages where the extent and timing of RIRDP assistance is less concentrated. The priority of the villages remains squarely on water supply which leads and generates the interest and actual demand for sanitation development. The general RIRDP policy of providing assistance on request only, means that the project has to refrain from addressing "missing" needs as the integrated approach would demand. This applies equally to sanitary improvement of shallow wells, garbage disposal, and wastewater disposal schemes. Otherwise, the project could well run the risk of providing facilities which the villages never asked for and which thus are unlikely to give real benefits.

As an exception, a more active approach of the project may be appropriate in the case of shallow well improvement. If poorly functioning wells are identified by project staff or otherwise brought to their notice, it would probably be a good thing if field visits to such wells are allowed even if there is not (yet) a formal request submitted to RIRDP.

4.2 Constraints

Planning of the RIRDP Sanitation Programme was incorporated in the approved Plan of Operations 1990-1992, presented in December 1989; basically, it was according to the recommendations of the April 1989 Mission Report "Sanitation Programme Review and Planning". This planning proved to be too optimistic because of several constraints, such as,:

- All activities are undertaken on request only; thus, preparation and implementation follows on submittal and approval of requests, with all the time delays involved;
- Required village contributions are often not forthcoming as readily as hoped for; economic conditions in the project area have become unfavourable and the making of any payments by villages more difficult; participation in the form of excavation work often proves more difficult than expected;

- It is frequently difficult and costly to make land available for garbage disposal pits;
- Construction supervision needs to be more intensive and frequent than envisaged.

Water supply remains the villages' main concern. It is often difficult to obtain active interest and participation in sanitation improvements.

Sanitation extension is frequently hampered by social strife and disputes between families within villages. It has happened that village members stayed away from extension sessions for this reason. The Sanitation Sub-Section of RIRDP does not have a female extensionist for communication with the women on planned sanitation activities; the female extensionist of RWES is only for one day a week available for this work.

Specific point regarding the various sanitation activities are:

- **Garbage disposal schemes:** the village contribution basically is the land for the disposal pit; securing land often requires extensive consultations and invariably takes a considerable amount of time; it even may prove to be impossible and then the whole garbage disposal scheme has to be cancelled (e.g. Al Hajar); or the village may be forced to pay an excessive amount for the land to the owner (i.e. Hayd Al Majil);
- **Shallow well improvement:** the village contribution (i.e. the well and pump) remains private property; this has some advantages for maintenance, but basically the well owner can only be requested to assure water availability for drinking water supply as long as the well provides enough water over and above his own needs for irrigation; the project requires an undertaking form the well owner in this respect, but it is possible that the well is pumped dry.
- **Village wastewater disposal schemes:** The village contribution mainly consist of excavation for house collector pits and trenches for connecting lines; sometimes also excavation work for soakaway pits and septic tanks; this is important since it promotes full participation, responsibility, and feeling that it is "their" scheme; however, there may be a lack a motivation to actually carry out the excavation work especially when it is difficult in hard and resilient ground;
- **School and PHC unit sanitary facilities:** These require more emphasis on health education and actual utilization and proper maintenance; which is more time-consuming than expected;
- **Mosque sanitary facilities:** Sofar, this activity has continued on the basis of 20% village contribution; villages often paid the required amount out of remittances from migrants working overseas, but these payments have reduced sharply since the Gulf Crisis; under the circumstances, it is extremely difficult to implement the recommended rise of village contribution to 40% and ultimately 100%.

- **Water quality monitoring:** This work depends on project staff of several RIRDP sections and sub-sections taking samples which often is haphazard; the laboratory technician does not have his own transport; doing water quality tests has also been severely hampered by lack of distilled water.

4.3 Sustainability

4.3.1 Organisational provisions

The maintenance requirements of completed sanitation facilities and schemes has to receive more and persistent attention, if their sustainability is to be secured. This requires, probably in the first place, organisational arrangements and a clear distribution of responsibilities. Generally, this appears to be even more important than availability of funds.

It is noted that maintenance of mosque sanitary facilities presents less problems, precisely because of the relatively clear organisational arrangements. The personnel responsible for the maintenance of the mosque as such, is required to look after the sanitary facilities as well.

In the improved shallow well water supply schemes, it is not so that the well owner has any automatic responsibility for maintenance of the reservoir, water dispensing taps, washing slab and cattle trough. It is, thus, necessary to specifically assign responsibility for maintenance of these facilities to one or more persons. The users, mainly women, then can turn to these persons in cases of breakdown or malfunctioning.

4.3.2 Economic feasibility

The economic feasibility of village sewer schemes for wastewater collection and disposal needs to be carefully checked. It is rarely the case, probably only for larger villages which have favourable topography and other conditions.

For example, a tentative design for a small-bore sewer system was made for the village of Al Hagar comprising 1500-1800 people in some 200 households. The design provided for 200 interceptor pits receiving the domestic wastewater; these were to be connected to sewers discharging in the main sewer that would carry the sewage to a low-lying field under the village; at this site a stabilization pond was projected for treatment of the wastewater. The total cost of the scheme was estimated at YR 2,000,000. Assuming a 50/50 cost division between the village and RIRDP, this would mean that both RIRDP and the village would have to contribute YR 1 000 000. It appeared that neither RIRDP could cover such an amount for a single village scheme, nor could it be realistically expected that each household would be prepared to contribute YR 5,000.

For the village of Musallah with an estimated population of 500 people (85 households), a tentative design was made for a basic wastewater collection scheme. It would particularly address the severe problem of ponds of polluted water forming at a lower area near the village where it could not drain off.
The tentative design provided for a collector main which would discharge the sewage into a soakaway with drain trenches.

The total cost of this scheme was estimated at YR 600,000. Assuming a 50/50 division of costs, it required that each household in the village would have to contribute an amount of YR 3,500 and the RIRDP contribution would be YR 300,000. It appeared that such expenditure would be far beyond what could be realistically planned for.

5 STAFFING

5.1 Staff situation

In the 1990-1992 Plan of Operations of RIRDP, the staffing of the Sanitation Programme is presented as follows:

Table 5.1 Staffing of RIRDP Sanitation Programme

Position/function	Staff time allocation (person.year) 1989	1990	1991	1992
Head, Engineering Section	m/s	m/s	m/s	m/s
Adviser, Engg. Section (TAU)	a/g	a/g	a/g	a/g
Head, Sanitation Sub-Section	1	1	1	1
Sanitation Engineer (TAU)	1	1	1	1
Sanitation Engineer	-	1	1	1
Sanitation Extensionist (TAU)	1	1	1	1
Construction Supervisor	1	2	2	2
Draughtsman	-	1	1	1
Laboratory Technician	1	1	1	1

The above-listed staffing is the absolute minimum for the RIRDP Sanitation Programme at the level of activity included in the 1990-1992 Plan of Operations.

5.2 Future staffing

The present Yemeni staffing of the Sanitation Sub-Section would be absolutely insufficient to continue the RIRDP Sanitation Programme at its present level of activity, if (phased) withdrawal of TAU staff would take place.

An urgent requirement is the appointment of an additional Yemeni engineer in the Sanitation Sub-Section. It is proposed to make a urgent request for recruitment of a suitably qualified person to the authorities concerned. The engineer is particularly required as counterpart for the TAU Sanitation Engineer in the technical work for implementation of sanitation schemes and facilities (i.e. planning of surveing work, design, cost estimation, in-work design modifications). The Head of Sub-Section is increasingly occupied with the time-consuming handling of village contribution matters and tender procedures.

The TAU Sanitation Extensionist is particularly well-versed and experienced in the intricate communication with villages for preparation of sanitation schemes and facilities, and during their implementation. Over the years, he has developed work methods and a treasure of experience which are truly essential for the RIRDP Sanitation Programme and which must be preserved. There is now an urgent need to appoint a Yemeni sanitation extensionist to work as his counterpart and gain the needed expertise and experience, prior to any withdrawal of TAU staff.

At present, a time allocation of only one day a week is available from RWES female health extension staff for the RIRDP Sanitation Programme. This is insufficient for the requirements, and an increased time allocation for female RWES staff input should be made.

Presently, there are two construction supervisors working in the Sanitation Sub-Section. They have an on-going work load in surveying work and construction supervision (several of the Sanitation Programme activities require particularly intensive supervision). Both supervisors are experienced and have had on-the-job training in special aspects of sanitation schemes and facilities.

The laboratory technician is currently receiving training in water quality analysis and monitoring.

The Head of Engineering Section and the Adviser of Engineering Section (TAU) provide management and technical support to the Sanitation Sub-Section and the Sanitation Programme generally.

Extensive consultations with the villages are required on technical (i.e. layout of schemes, dessign), financial (i.e. cost estimation, village contribution), and socio-cultural matters, before any actual construction work can start.

The staff available for the Sanitation Programme is quite limited and some problems have continued which need not be detailed here. Limited staff availability and transport have remained constraints to the number and frequency of visits to the villages for preparation and implementation of sanitation schemes.

It has to be said that some of the work procedures which apply to the Sanitation Programme -as well as to other RIRDP project activities- are extremely cumbersome and time-consuming. For example, the tendering of approved project works to contractors often takes many months to complete; it involves preparation of tender documents, announcement of tender, time allotted to contractors to prepare their bids, evaluation of bids, final selection and award of contract. Requests to fill vacant posts in the project organisation, or to recruit new staff, often remain pending for a very long period of time, sometimes years.

Clearly, RIRDP must comply with the relevant government regulations. But it will be difficult to secure satisfactory progress in the implementation of the Sanitation Programme -as in other RIRDP activities- under these circumstances.

6 INDICATIVE PLANNING OF SANITATION PROGRAMME

6.1 General

Reference is made to various reports and documents listed under "References"

In particular, the framework and perspectives set out in the RIRDP Plan of Operations 1990-1992 have been used as a basis for the indicative planning of the Sanitation Programme.

Generally, the various implementing activities under the Sanitation Programme have been programmed at the level which corresponds with the number of villages that have put forward requests for RIRDP assistance for the different types of sanitary schemes and facilities. Due account has been taken of the limited capacity of the Programme, in terms of available staff and because of other constraints.

The numbers of villages for each type of implementing activity have been estimated on the basis of survey data and assessment of needs, and the estimated time spending of project staff on each of these activities. The slightly expanded number of villages programmed for sanitary improvement of shallow wells, reflect the fact that this activity is very cost-effective; for relatively small investments a significant improvement of sanitary protection of safe water supply can be provided.

6.2 Indicative planning

Indicative planning of the RIRDP Sanitation Programme for the period 1993-1995 is as follows:

Table 6.1 Indicative Planning: Sanitation Programme

Activity	Achievement 1988	1989	1990	1991	Target 1992	Planning 1993-1995
1 Sanitation extension & health education	- as planned-			n/a		-cont'd-
2 San. implementing activities						
2.1 Basic village san'tion	-	-	1	1	2	**6**
2.2 Village garbage disposal scheme	2	3	5	7	4	**12**
2.3 Shallow well sanitary improvement	1	1	2	3	4	**12**

2.4	School san. facilities	-	2	1	1	2	6
2.5	PHC unit san. fac'ties	2	2	2	2	2	6
2.6	Mosque san. facilities	13	3	6	13	6	18
2.7	Village wastewater sewerage & disposal	-	-	1	1	2	6
2.8	Town sewerage scheme	-	-	-	-	1	3
3.	**_Supporting activities**						
3.1	Water quality testing	102	16	n/a	n/a	n/a	600
3.2	Training & knowledge transfer	-as planned-					cont'd
3.3	Demonstration of solar water heaters	4	4	3	3	3	9
3.4	Disposal of waste oil (test units)	-	-	-	n/a	2	6

The planning 1993-1995 corresponds with the following list of requests for RIRDP assistance:

	Village	Region	Date of request
Village garbage disposal			
1	As Sawm'ah	As Sawm'ah	
2	Surm As Shadadi	Qaifah	
3	Al Junobah	Qaifah	
4	Ar Rubat (Wadi Matar)	Qaifah	
5	An Nubah (Wadi Matar)	Qaifah	
6	Qarn Al Asad	Al 'Arsh	
7	Dar Al Najd	Qaifah	
8	Nubat 'Issa	Qaifah	
9	Ghawl Al Azraq	Al Bayda	
10	Furkhan	Sabah	
11	Juban	Juban	
12	Malah	Al 'Arsh	
13	Draybah	Al 'Arsh	
14	Al Hajar	Sabah	
15	Al Hattab	Al Bayda	
16	Dhi Na'im	Dhi Na'im	
17	Al Khuf	Al Bayda	
18	Feraze'	Al 'Arsh	

Shallow well improvement

1	Al Kharabah (Wadi Sirhan)	Qaifah	14-09-91
2	Ad Dhra' (Al Waq'ah)	Qaifah	13-10-91
3	Jabar (Wadi Mansur)	Qaifah	02-11-91
4	Nati'	Nati'	14-11-91
5	'Abas (Al Ghunayn)	Qaifah	23-11-91
6	Haryah (Wadi 'Amid)	Qaifah	12-01-92
7	Hakar (Razqiah)	Qaifah	19-01-92

School sanitary facilities

1	Al Waq'ah	Qaifah	15-10-91
2	Al Qawz (Wadi Mansur)	Qaifah	05-09-91
3	Maswarah	Sabah	03-11-91

PHC health units

-as per PHC health unit building programme; PHC project-

Mosque sanitary facilities

1	Al Hattab (Al Jawf)	Qaifah	20-10-90
2	Humaydah	Qaifah	05-12-90
3	Al Gorayshiyah (W. Mansur)	Qaifah	22-04-91
4	Zanabi'	Qaifah	01-07-91
5	Hamat Sarar	Qaifah	10-07-91
6	As Sharbah	Qa' Rada'	14-08-91
7	Sare' (Wadi Mansur)	Qaifah	24-09-91
8	Mokayraden	Qaifah	25-09-91
9	Kharba Jirada	Sabah	19-11-91
10	Ad Dhra' (Wadi Mansur)	Qaifah	20-11-91
11	Al Hajfah	Qaifah	23-11-91
12	'Abas (Al Ghunayn)	Qaifah	23-11-91
13	Al Qaharah	Qaifah	10-12-91
14	Hakar (Ar Razqiah)	Qaifah	19-01-92

Village wastewater disposal scheme

1	Ar Rubat	Dhi Na'im	03-01-90
2	Chaleb (Wadi 'Amid)	Qaifah	02-06-91
3	Az Zuab	Qaifah	19-07-91
4	Hanakat Al Mas'ud	Qaifah	12-11-91
5	Noghalah	Qaifah	12-11-91
6	Hayd Al Majil	Qaifah	12-11-91

ANNEXES

ANNEX A

Rada Integrated Rural Development Project

TERMS OF REFERENCE

Short-Term Mission: Sr. Sanitation Expert

January 1992

- To review the progress made in the implementation and other activities of the RIRDP Sanitation Programme during the years 1990-1991;

- To analyze, in cooperation with the staff of the Sub-Section Sanitation, the Head of Engineering Section and the Engineering Adviser, the impact of implementation, extension and training activities on the personal and environmental hygiene of the rural population;

- To analyze the village contribution to implementation activities and the relation between contribution, interest, potential and needs for improved sanitation in rural areas;

- To review the 1992 programme of sanitation activities, taking into account the results of the above-mentioned analyses, and the experience gained sofar with the various activities;

- To prepare a preliminary planning for the RIRDP Sanitation Programme for the period after 1992;

- To discuss the findings, conclusions and recommendations with the RIRDP project management;

- To prepare a draft mission report before leaving.

ANNEX B

Rada Integrated Rural Development Project

Short-Term Mission : Sr. Sanitation Expert

Work Programme: January 1992

Thu 9	Arrival Sana'a (from Amman) 3.00 a.m. Onward travel to Rada' Introduction to Teamleader and Advisers TAU
Fri 10	Study of reports and documents General briefing on project status
Sat 11	Ambassador's working visit to RIRDP project Introduction and general meeting with: Ambassador, Embassy staff, General Manager RIRDP, all Heads of Section, TAU Teamleader and Advisers Field trip: Hanakat Al Mas'ud (garbage disposal) Hayd Al Majil " " Noghalah (Wadi Tha) " "
Sun 12	Working session with staff of Sanitation Sub-Section Field trip: Al Qaharah (garbage disposal) " (wastewater scheme)
Mon 13	Working session with staff of Sanitation Sub-Section Meeting with Adviser, Rural Women Extension Section Study of reports and documents
Tue 14	Field trip: Wadi Yunis (cistern & sanitary facilities) Wadi 'Amid (shallow well improvement)
Wed 15	Study of reports and documents Preparation of working notes Meeting with PHC Project Manager, Rada'
Thu 16	TAU coordination meeting Visit to SRWS Project, Dhamar Preparation of working notes
Fri 17	Draft report preparation
Sat 18	Working session with staff Sanitation Sub-Section Discussion with Teamleader TAU and Engineering Adviser Work on preliminary planning after 1992
Sun 19	Field trip: Ar Rubat (wastewater scheme: planned) " (garbage disposal : existing)
Mon 20	Working session with staff Sanitation Sub-Section Preparation draft mission report Finalisation of data and material for report

Tue 21	Meeting with General Manager, Head of Section, Teamleader TAU, Engineering Adviser, staff Sanitation Sub-Section Presentation of review results and findings Preparation draft mission report
Wed 22	Debriefing meeting on mission General Manager RIRDP, Head of Sections, TAU Teamleader, Engineering Advisers, Advisers Preliminary planning after 1992, general recommendations Final meeting with staff Sanitation Sub-Section Departure for Sana'a
Thu 23	Departure (03.40 a.m.) for Frankfurt & Amsterdam

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SANITATION : A WAY OF LIFE

SANITATION: A WAY OF LIFE

A sanitation handbook
for
Community Organisers

WHY SANITATION?

1

If people had proper nutrition and safe drinking water, kept themselves and their surroundings clean, and got their children immunised, there would be very little illness. Improved hygienic practices and sanitation can prevent many water and filth related diseases According to the World Health Organisation, 80 per cent of all the sickness and disease is due to the lack of safe drinking water and proper sanitation

1.1 Survival and Development of children depends on proper sanitation

Children, especially the malnourished ones, are very vulnerable to the effect of contaminated drinking water and an insanitary environment. Every year, 15 lakh pre-school children (aged under five) die of diarrhoea due to dehydration (loss of water and salt in the human body). An even larger number suffer from frequent illnesses due to repeated attacks of diarrhoea.

Diarrhoeal deaths caused by dehydration can be prevented by replacing the water and salt that the body has lost. However, frequent attacks of diarrhoea worsen the condition of poorly noursihed infants and children They will not grow and develop healthily Improved sanitation, which can help prevent the spread and repeated attacks of diarrhoea, is therefore vital for child survival and development

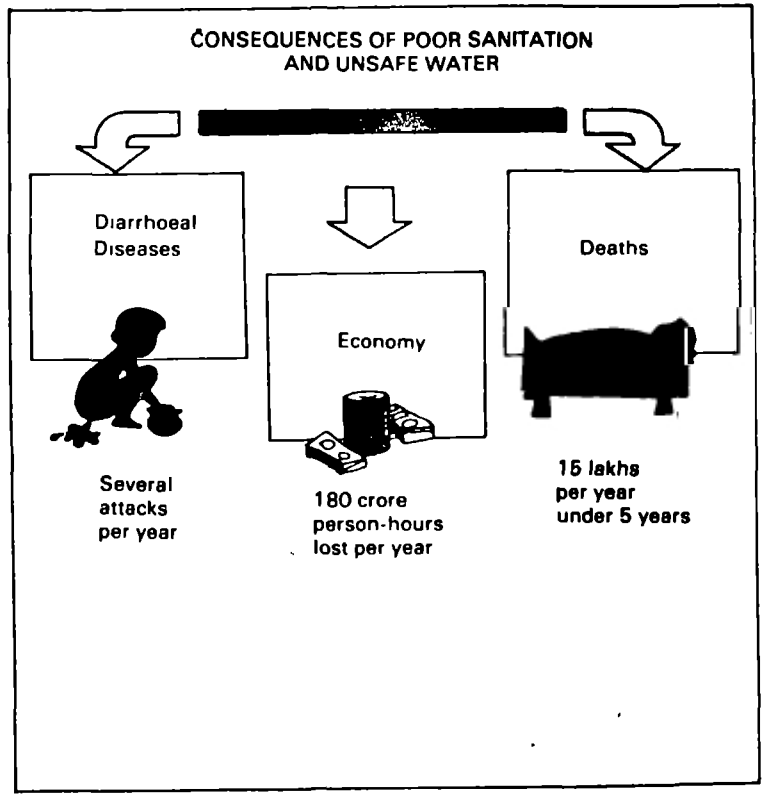

Fig 1 1 Consequences of poor sanitation and unsafe water

1.2 How are the family and the nation affected ?

A person who is frequently ill may not be able to provide all the needs of the family He is enmeshed in the "Circle of poverty" as illustrated He has less energy and hence produces less work In turn, he may produce less food, or earn less money to buy food If the family does not have enough to eat, they will be more likely to fall ill This circle can be broken if the spread of disease is controlled

The country also suffers economically because of diseases related to water and sanitation It has been calculated that India loses 180 crores person-hours each year due to these diseases

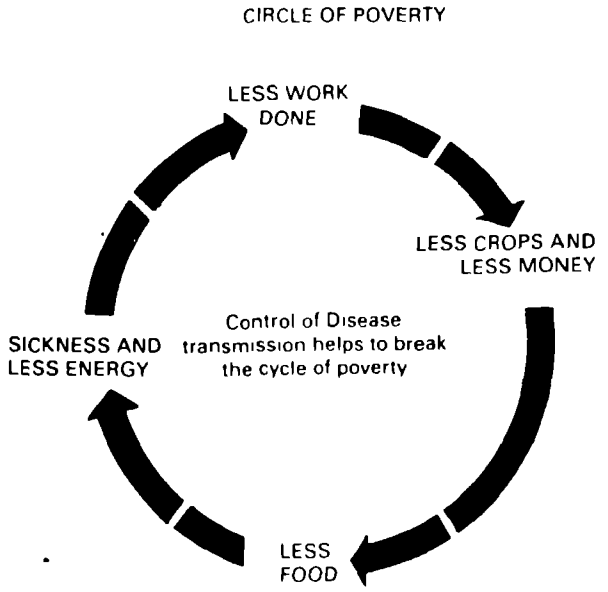

Fig 1 2 Circle of poverty

1.3 What is sanitation ?

Many people think that sanitation means only a sanitary latrine This is not correct. No doubt, exposed human excreta is one of the major sources of diseases like diarrhoea However, even when latrines are used, this does not always eliminate the diseases of bad sanitation. Good sanitation depends mainly on practices and attitudes of the people The word "sanitation" is therefore used to define a package of health-related measures It covers all aspects of environmental and household cleanliness as well as personal cleanliness or hygiene.

Fig 1 3 Sanitation–A health related package

ROLE OF COMMUNITY ORGANISERS

2

The community organisers should work jointly with the community to increase their awareness and help them take action to prevent the spread of diseases. The people themselves can greatly improve the environment they are living in.

2.1 what should the community organisers do ?

* understand why sanitation and hygiene are neccessary
* improve their own hygiene and sanitation practices
* understand the problem and needs of the community
* begin with the knowledge and skills that the people already have
* help people understand the link between better sanitation and health
* suggest changes that are in keeping with the community's resources
* motivate the community to take action to improve their sanitation and provide technical help if necessary

2.2 How can all these be done ?

The community organisers should meet community leaders and discuss the type of activities that the community members themselves can do to improve sanitation. Group meetings with the community members can be arranged to identify these activites and discuss how they can be carried out

2.3 Respect people

It is important to gain the confidence of the people. For instance, do not start telling mothers that their children get sick because of their own dirty habits Instead, try asking mothers what sicknesses their children get, what they think is the reason, and what they do to deal with these sickness Show them how human excreta sticks to the feet when one walks over it, and how one's feet carry it everywhere one goes Ask them what would happen if a fly walks over excreta Would it be transferred to food and drink that the fly later stands on? Let people work things out for themselves

2.4 Identify good traditions

There is both good and bad in old practices Build on the good Help people identify the useful practices in the community For example, many religious traditions emphasize the importance of washing hands In many areas the traditional food for children suffering from diarrhoea is rice water Studies have now shown that some traditional practices including the use of rice water have a scientific basis. Washing hands with soap helps control the spread of diarrhoea.

2.5 Sanitation is forever

Sanitation is a community responsibility Do not take action for them Instead motivate the people to take action for themselves. Remember, that sanitation is not achieved if people wash their hands once, or use a latrine once Staying clean, and keeping the surroundings clean is a continuous process Otherwise, the disease cycle will start again.

ANNEX
INVENTORY AND SURVEY SHEET

Name of village: District:
Number of houses: Population:
Men: % Women: % Children: %
Health centre: Yes/No School: Yes/No
Other institutions: Yes/No If yes, specify: .....

WATER SUPPLY Source: Wells .... No.
Boreholes .... No.
Other .... No.
Condition: Good - Acceptable - Poor
Estimated supply rate: .... m^3/day .....l/c/d

SANITATION	Excreta disposal:	Condition:	Estimated number of users
	Baladi vault	.....	.....
	Pour-flush toilet & collector pit	.....	.....
	Other facility	.....	.....
	Sullage disposal	**Condition**	**Estimated number of households**
	Extended pipe	.....	.....
	Soakaway	.....	.....
	Other	.....	.....
	Environmental hygiene	**Stagnant pools & wet spots**	
	Around houses	.....	
	Community area	.....	
	Overall condition	good/acceptable/poor	

WASTE DISPOSAL Any provisions Yes/No
If yes, specify:
.....

HEALTH EDUCATION Awareness existing Yes/No
If yes, specify: ....

Prepared by: Date:

ANNEX E

EXAMPLE DESIGN OF VILLAGE GARBAGE PIT

Assumptions:

- Daily waste disposal per capita = 0.25 kg

- Village waste composition by weight:

(a)	Organic matter (food remains, manure, ashes)	25 %
(b)	Clothes, plastics, paper	60 %
(c)	Bones, dead animals, etc	2 %
(d)	Metals, tins, etc	10 %
(e)	Dust, stones & miscellaneous	3 %

- Component (a) <u>not</u> disposed off in garbage pit, because:

  . Food remains used for livestock feeding
  . Manure is used for fuel
  . Ashes used as fertilizer and for Baladi toilet.

- Garbage disposed off in pit is periodically burnt; especially when there is a dead animal, to avoid fly breeding and foul odours in the pit.

- Original weight by volume (density) of dumped garbage is:

. Clothes, plastics, paper	0 9 kg/litre
. Metals, metallic components	3.0
. Dust, stones, bones	2.6

- For a village population of 750 people the total garbage output is:

  . 750 x 365 x 0.25 kg = 69 tons/year
  . 5 years x 69 tons = 345 tons
  . divided in:
    - 86 tons organic matter
    - 207 tons clothes, plastics, paper
    - 7 tons dead animals
    - 35 tons metals, tins, etc.
    - 10 tons dust, etc.

- By burning, the combustible components could be reduced to 10% of their original weight; however, combustion will be imperfect and a reduction to 40% is assumed:

  . deposited material in pit: 345 - 86 = 259 tons
  . combustible material : 207 + 3 = 210 tons
    (assuming out of 7 tons dead animals, some 4 tons of bones and about 3 tons of body tissue and water)
  . 40% of 210 tons (burned to ashes) = 84 tons.

- Density of ashes assumed to be: 0.5 gram/litre

- Volume of materials remaining in pit:

. combustible material:	84 : 0.5 =	168	cu m.
. dust & bones:	14 : 2.6 =	6	
(dust 10, bones 4 tons)			
. metals	35 : 3.0 =	12	
Total		186	cu m.

- Volume of proposed garbage pit:

. 12 x 4 x 4 =	192	cu m.

- Thus, the proposed pit will accomodate all net remaining volume of garbage for 5 years.

RADA INTEGRATED RURAL DEVELOPMENT PROJECT
ENGINEERING SECTION / SUBSECTION SANITATION / LABORATORY

Village:	Village: .....
Source type:	Source type: .....
Sampling date:	Sampling date: .....
Analysis date:	Analysis date: .....
Remarks:	Remarks: .....
Conductivity .... _____ uS/cm	Conductivity .... _____ uS/cm
pH ..... _____	pH ..... _____
Alkalinity (P) .. _____ mg/l $CaCO_3$	Alkalinity (P) .. _____ mg/l $CaCO_3$
Alkalinity (T) .. _____ mg/l $CaCO_3$	Alkalinity (T) .. _____ mg/l $CaCO_3$
Total hardness .. _____ mg/l $CaCO_3$	Total hardness .. _____ mg/l $CaCO_3$
Calcium ..... _____ mg/l Ca^{++}	Calcium ..... _____ mg/l Ca^{++}
Chloride ..... _____ mg/l Cl^-	Chloride ..... _____ mg/l Cl^-
Manganese ..... _____ mg/l Mn^{++}	Manganese ..... _____ mg/l Mn^{++}
Iron (Total) .... _____ mg/l Fe^{+++}	Iron (Total) .... _____ mg/l Fe^{+++}
Potassium ..... _____ mg/l K^+	Potassium ..... _____ mg/l K^+
Nitrates ..... _____ mg/l N	Nitrates ..... _____ mg/l N
Phosphates ..... _____ mg/l PO_4^{---}	Phosphates ..... _____ mg/l PO_4^{---}
Sulphates ..... _____ mg/l SO_4^{--}	Sulphates ..... _____ mg/l SO_4^{--}
Fluoride ..... _____ mg/l F^-	Fluoride ..... _____ mg/l F^-

ANNEX
PROPOSED TRAINING COURSE

Day 1

- human excreta as source of enteric diseases
- sanitation for health protection
- existing unsanitary conditions
- field visit
  - . existing sanitary facilities
  - . typical sites presenting health hazard
- Group discussion

Day 2

- basics of sanitary facilities
  - . excreta collector chambers
  - . urine and sullage disposal
  - . soakage pits
  - . underground drains
- field visit
  - . existing facilities
  - . improved facilties (demonstration)
- Group discussion

Day 3

- basics of processes of composting
- aerobic and anaerobic processes in wastewater
  - . elements of design
  - . criteria for effluent disposal
- drainage provisions
- fied visit
  - . soakaway/retention tank
  - . septic tank
  - . aquaprivy
- group discussion

Day 4

- health hazards of solid wastes
- collection of solid wastes
- disposal of solid wastes
- fly breeding and role of flies in disease transmission
- site visit
  - . existing situation
  - . disposal site facility
- group discussion

Day 5

- cooperation of village communities and RIRDP project
- construction requirments and supervision
- arrangements for operation and maintenance
- role of hygiene education and sanitation extension
- closing session and awarding certificates of attendance.

SANITATION TECHNOLOGY

1. INTRODUCTION

1.1 The need for sanitation

Sanitary disposal of human excreta is a basic need because these excreta contain infectious agents which can transmit diseases. Disease-causing (pathogenic) agents may cause infection directly by bodily contact or indirectly through contaminated water or food. If food is prepared with unwashed hands, traces of excreta remaining on soiled hands may be passed on to the food and infections can so be transmitted to all members of the family.

Most of the diseases related to poor sanitation and lack of hygiene, are transmitted by contaminated water, food, or by insects. Some of these diseases rank among the chief causes of sickness and death in developing countries. It has been estimated that some 1,000 million people in those countries suffer from roundworm, some 800 million from hookworm, and about 500 million from whipworm. Other diseases associated with lack of sanitation and hygiene, are: cholera, typhoid and paratyphoid fevers, bacillary and amoebic dysentery, ascariasis, and similar intestinal infections and parasitic infestations. Particularly, diarrhoeal diseases are mainly caused by poor sanitation; together with malnutrition and respiratory diseases, they are the principal cause of death among small children and infants. Cholera is also closely related to inadequate sanitation; it causes numerous deaths in all age groups but again the number of fatalities is greatest for infants and children.

Bacterial infections are the cause of typhoid, cholera, bacillary dysentery, and several diarrhoeal diseases; viral infections are responsible for infectious hepatitis and a variety of diarrhoeal diseases; melminths (worms) cause roundworm, hookworm, and schistosomiasis.

There are many factors that influence response to infection. Particularly important are acquired immunity, the general health condition and level of resistance; these are different for individuals and people of different age groups. Long-lasting immunity can be acquired for some bacterial and viral infections, whereas for most helminthic parasites no immunity can be developed. Acquired immunity tends to reduce the possible immediate health benefits obtainable from moderate improvements in sanitation. This may be the reason why many sanitation programmes have produced rather limited reductions in occurrence of disease, especially in the short term.

Sanitary disposal of excreta of children and infants is particularly important. It is a common misbelief that children's excreta are not harmful because of the small amounts involved. However, the digestive tract of small children is not yet fully developed and much less effective than an adult's stomach and digestive tract in destroying infectious agents.

A classification of diseases related to deficiencies in sanitation (and conjunctive water supply) is given in Table 1.1.

Table 1.1 Classification of diseases related to deficiencies in sanitation and water supply

Water-borne

(diseases for which water can act as a vehicle of transmission)

- Cholera
- Typhoid
- Leptospirosis (Jaundice and Weill's disease)
- Infectious hepatitis
- Amoebiasis (dysentery)
- Shigellosis (dysentery)
- Giardiasis

Water-based

(diseases for which water is necessary to some part of the infecting agent's life-cycle)

- Schistosomiasis (Bilharzia)
- Dracunculosis (Guinea worm)
- Chlonorchiasis (liver fluke)
- Paragonimiasis (lung fluke)

Water-washed

(diseases which can be aggrevated by lack of sufficient water supply)

- Scabies
- Leprosy
- Trachoma
- Lice
- Typhus
- Conjunctivitis
- Salmonellosis
- Ascariasis (roundworm)
- Trichuriasis (whipworm)
- Enterovirus
- Paratyphoid fever
- Skin sepsis

Water-related

(diseases that are transmitted by insects which live in or near water)

- Malaria
- Yellow fever
- Dengue
- Bancroftian filariasis
- Onchoceriasis (River blindness)
- Sleeping sickness
- Arbovirus encephalitis

After: Feachem, 1978

Control of water-related diseases requires ample quantities of safe water, sanitary disposal of excreta and wastes, and proper hygiene, all in combination with each other. Alone, neither of these basic amenities can be expected to give any lasting health benefits. Hygiene and health education is necessary to supplement the effects of improved water supply and sanitation, and to promote awareness of the need for effective utilization. This is especially the case in tropical areas where conditions are favourable to the rapid multiplication of pathogenic micro-organisms.

1.2 Sanitation and water supply in conjunction

The need for adequate water supply generally is accepted by rural population and most communities without water are anxious to get water. Sanitary disposal of excreta is equally important but the need may not be so apparent.

Sanitation and water supply are closely related. It is not unusual that improvement of water supply raises the problem of disposal of increased amounts of waste water, particularly where impervious ground makes drainage and infiltration difficult. This will lead to stagnant pools of waste water which are a health hazard to all. The general relationship between feasible sanitation options and levels of water supply, is indicated in Table 1.

Table 1: Relationship between sanitation options and levels of water supply

Water supply service	Typical water consumption (l/c/d)	Options for excreta disposal	Options for sullage disposal
Standpipes	20-40	Pit latrines Pour-flush toilets Vault toilets	Soakage pits
Yard taps	50-80	Pit latrines Pour-flush toilets Septic tanks	Soakage pits Septic tanks Sewer system

Attempts to force acceptance of both water supply and sanitation by programmes stipulating that "it is either both or neither", will at best meet with grudging compliance but this is no proper basis for lasting effects and benefits. This matter should not be rigorously insisted upon in every instance. Where there is lack of actual support for sanitation, it may be prudent to first proceed with water supply improvement and to accept that it takes time for sanitation to become a felt need. With improved water supply installed and having its effects, the interest in sanitation can grow until a companion programme for proper disposal of excreta and wastewater meets with acceptance by the beneficiaries. It is, in many instances, good to first start with providing sanitary facilities at schools, health centres, and other community buildings.

Communal sanitation facilities are not considered, because experience in all parts of the world shows that public facilities are rarely, if ever, used and maintained properly; they are no real substitute for individual household sanitary facilities.

1.3 Low-cost sanitation

Water-borne disposal of excreta and wastewater (i.e. piped sewerage) is no realistic option for low-income rural village communities. The cost of such systems will be prohibitive. Moreover, in rural villages sewerage is generally not technically feasible because such systems cannot function properly at the very limited sewage flows generated from low per-capita water usage.

Fortunately, there are technical options for sanitation available (both on-site and off-site) for low-income communities, and which can give all the health benefits and convenience of use expected from them.

Table 2: General cost level of sanitation options

Sanitation option	Indication of capital cost (US $)
Low cost	
- Pit latrine	70
- Bucket latrine with cartage	100
- Pour-flush toilet	125
Medium cost	
- Vault toilet	400
- Aqua privy	800
High cost	
- Septic tank (double compartment) with seepage drain or pit	1200

Source: Kalbermatten et al, 1981

Pit latrines can only be used in areas of low density of population. Bucket latrines are not favoured because of unhygienic conditions in excreta cartage; in some countries where they are acceptable, they may nevertheless be considered. Septic tanks with sub-surface effluent drainage are seldom affordable for low-income communities.

1.4 Staged sanitation improvement

Higher levels of water supply service require that sanitation facilities are also upgraded, if a real impact on the incidence of water and excreta related diseases is to be made.

Examples of sanitation upgrading are:

- conversion of dry pit latrines to pour-flush toilets;
- extending single pit toilets to double-vault toilets;
- introduction of septic tanks with effluent disposal in soakage pits or drains;
- connection of septic tanks to small-bore sewer systems.

A pit latrine or pour-flush toilet with adequate effluent disposal can provide a satisfactory standard of sanitation. As population density increases, the simpler facilities such as pit latrines become less suitable and facilities providing a higher level of hygiene and convenience are then needed. For example, a dry pit latrine may be converted to a pour-flush latrine by connecting it to a soakage pit. The squatting plate can be replaced by a water-seal bowl; the soakage pit may be lined to function as a tank for connection to a small-bore sewer system. Because sanitation programmes often cover hundreds, thousands, or even tens of thousands of small communities, there invariably will be a shortage of funds and other resources. Upgrading of sanitation facilities will probably be spread over years, possibly decades. However, none of these sanitation upgradings leads to conventional sewer systems. Once low-cost sanitary facilities have been installed, it obviously does not make sense to replace them by a costly conventional sewer system.

2. SANITATION TECHNOLOGY

2.1 Selection process

The selection process aims at identifying that sanitation option which is most appropriate to the needs and resources of the communities covered by a sanitation programme. Essentially, the technology to be selected shall be socially acceptable, financially affordable, and technically feasible, under the local conditions.

A general classification of sanitation options for rural programmes based on the criteria of on-site/off-site and dry/wet is presented in Figure 3.1. An overview of the characteristics of the various sanitation systems is given in Table 3.1.

Many factors enter into the selection process. These include: social patterns of living, habits of cleansing and washing, segregation of sexes or age groups for defaecation, the acceptability of handling excreta and wastes, and the value attached to manure as fertilizer. Where certain types of sanitation exist and are accepted, this will influence the feasibility of any alternative sanitation. If users are accustomed to using bulky materials, such as straw, for anal cleansing, then pour-flush latrines with a water seal are likely to become blocked and such latrines can not function properly. Availability of water always is an important consideration in selecting the most suitable sanitation system.

Terrain and ground characteristics also are important for the choice of sanitation technology. Flat or sloping ground, and how steep or gentle the slope is, the depth of the groundwater table, the permeability of the soil, and whether digging is easy or difficult, influence the choice of sanitation.

Once a tentative selection of sanitation technology is made, it is important to check the choice carefully by using the following test questions:

- Is the selected sanitation system socially acceptable ? And compatible with cultural values, customs and beliefs ?

- Can it be maintained ? Can households reasonably assume their part of the responsibility for maintenance ? Are any support services from the authorities required, and are these likely to be made available ?

- Is the selected sanitation system culturally acceptable ? Are the beneficiaries willing and able to contribute to the costs of the proposed sanitation facilities ?

- What is the potential for upgrading of the selected sanitation system ? In what time frame ? Are the envisaged sanitation technologies for later upgrading really affordable ?

2.2 Excreta

Indicative amounts of excreta that require hygienic disposal in sanitation facilities, are listed in Table 2.1.

Type	Specific volume (litre/person/day)	Specific dry weight (gram/person/day
Faeces	0.135 - 0.270	35 - 70
Urine	1.0 - 1.3	50 - 70
Total	1.135 - 1.570	85 - 140

Source: Gotass, 1976

The principal health hazard of excreta is the presence of pathogenic micro-organisms and viruses. The chemical composition of excreta is also of relevance, especially if the use of digested excreta for fertilizer is planned.

Table 2.2 General composition of excreta

Substance	Faeces	Urine
Moisture	66 - 80%	93 - 96%
Dry matter	20 - 34%	4 - 7%
Analysis of dry matter		
Organic matter	88 - 97%	65 - 85%
Carbon (as C)	40 - 55%	11 - 17%
Nitrogen (as N)	5 - 7%	15 - 19%
Phosphorus (as P)	1.3 - 2.4%	1.1 - 2.2%
Potassium (as K)	0.8 - 2.1%	2.5 - 3.7%
Calcium (as Ca)	2.9 - 3.6%	3.2 - 4.3%

Source: Pópel, 1980

Excreta also contain many malodourous volatile compounds. The amounts and strength of these stench-producing substances increase when the organic matter is degraded by bacterial action.

2.3 Waste water

The amounts of waste water are essentially determined by the level of water supply service.

The basic requirement for drinking is 2-3 litres per person daily. The minimum water usage is some 6-8 litres/person/day. Including water used for cooking, washing, laundry, and personal hygiene, total water consumption rises to 20-25 litres per person per day. Where handpump or standpost water supplies are provided, water consumption levels are commonly some 30-40 litres per person per day.

It is helpful to differentiate the total wastewater volume in two parts:

- waste water used for excreta disposal
- waste water from the kitchen, landry and washing (sullage water).

Sullage is far less hazardous than waste water carrying excreta. In rural communities, sullage often is simple spread around the house so as to drain into the ground; however, it is better to use soakage pits for safe disposal of sullage. Any serious pollution of the groundwater is not likely, as sullage contains little microbiological pollution and its content of nutrients (e.g. nitrates) is low, much lower than in sewage. In urban areas, disposal of sullage by tipping it in the street drains is no good practice since it leads to stagnant pools which promote the breeding of mosquitos and insects.

2.4 Pour-flush latrines

The pour-flush water seal latrine consists of a squatting pan with a steep bottom (25-30 degrees to the horizontal) and a water seal (20 mm) trap, set in a cement concrete floor. After use, the squatting pan is flushed by hand using a small container holding about 2 litres of water. The excreta are flushed through a pipe or drain into one of two leach pits; these are used alternately. The liquid in the pit percolates into the sub-soil and any gases are absorbed by the soil, leaving the solids behind.

Each pit is designed to last for about three years before it gets filled; when one is filled, it is taken out of use and excreta are then directed to the other pit. The filled pit is left for about two years, after which its contents have turned into a rich organic humus which is safe for handling. It may be emptied and the contents can be used as manure. The emptied pit is then ready to be put back into use when the other pit is filled up.

The pour-flush water seal latrine is a satisfactory and hygienic sanitation system; it can be located inside the house, since the water seal prevents odour and insect nuisance.

Squatting pan

The squatting pan should have a length of at least 425 mm. It can be of ceramic, glass-fibre reinforced plastic, polyvinylchloride, high-density ethyleen, mosaic or cement concrete. Ceramic or GRP pans have many advantages; they are smooth and thus require less water for flushing clean; and they are more aesthetic.

The glass-fibre reinforced pan is cheaper, lighter and easier to transport than the ceramic pan. Concrete pans are heavy, difficult to transport, and they get roughened and unattractive after use (due to the effect of uric acid).

Trap

The trap should be 70 mm diameter with a 20 mm water seal. Ceramic, glass-fibre polyester, high-density polyethyleen or polyvinylchloride traps are smooth and need less water for flushing than concrete traps. Although the initial cost is somewhat higher, traps of other material than concrete are to be recommended.

Connecting pipe or drain

The trap is connected to the pits either by a pipe or covered drain. If a pipe is used, a junction box (of minimum size 250 mm x 250 mm internal should be provided at the junction point. Non-pressure AC pipe should be used, with a size not less than 75 mm. If a drain is used, it can be made of bricks or stones with a minimum size of 75 mm x 75 mm with semi-circular bottom. The slope of the drain should be 1 in 5 to 1 in 15. Dends and curves in the drain are to be avoided. The inlet pipe or drain should project into the pits a minimum of 100 mm.

Leach pits

The size of the leach pits depends on a number of factors, such as,: number of users, cleaning interval, soil permeability and other properties, depth of water table, and the quantity of water used for flushing. Studies on sludge accumulation rates have shown that an effective capacity of 0.045 - 0.050 m3 per capita has to be provided under dry conditions; under wet conditions, i.e. where the groundwater is above the pit bottom at any time during the year, the pit capacity has to be increased.

Table 1 Effective pit volume for three years' service (= volume of pit below invert level of pipe or drain)

Number of users	Effective volume (in cubic metres)	
	Pit under dry condition	Pit under wet condition
5	0.68	1.0
6	0.81	1.2
10	1.36	2.0
15	2.04	3.0

It has been observed that all pathogens will die off in a period of about two years. Thereafter, the cleaning operations can be carried out depending upon the weather conditions and demand for humus.

A minimum storage capacity of three years is recommended for the leach pits, to facilitate cleaning operations. Each of the twin pits is designed for the required number of users.

The pit shape can be rectangular or circular. Wherever circular pits are feasible, these should be constructed as they are more stable and cost less. Where circular pits of standard sizes cannot be dug due to space constraints, deeper and smaller diameter pits may be adopted. More than one latrine seat can be connected to a pair of pits, provided the total number of users is not more than that assumed in determining the required capacity of the pits. The most economical pit sizes at any particular place depend upon the local rates of labour and materials.

The pits should not be located in depressions where waste water or rain water is likely to collect round and over the pits. Any depressions should be completely filled. If pits are to be constructed in water-logged areas, the pit tops should be raised to 0.6 - 0.8 m above ground level, and earth fill placed up to a distance of 1.5 m completely to the top. The raising of a pit top may necessitate raising a latrine floor also.

The pit should be lined with honeycomb brickwork or stone in cement or lime mortar, or random stone masonry without any mortar. Alternatively, the pit can be lined with burnt clay rings or concrete rings.

2.5 Small-bore sewer systems

Small-bore sewer systems can be effective for collection of limited flows of waste water. The systems consist of small-size (about 100 mm dia.) pipes laid at very flat gradients to form the wastewater collection network. They are particularly appropriate for unplanned urban slums with a high population density and a flat geography, where access is limited and and where on-site disposal systems (e.g. pit latrines, pour-flush toilets) cannot be used. Small-bore sewer systems can also be used in planned housing settlements and sites-and-services schemes.

These sewer systems collect all household waste water, i.e. flushed excreta, toilet water, and sullage. They carry the waste water to a treatment facility (e.g. stabilization pond) or discharge it into a receiving surface water body. The pipes of small-bore sewer systems are laid as far as possible in the backyards of houses, and in shallow trenches. Thus, the house connection pipes are kept short as the toilet, bathroom and kitchen normally are at the rear of the houses.

The characteristic feature of small-bore sewer systems is that they are flushed by the successive waves of wastewater produced in the houses. In conventional sewer design flow velocities are such that deposits **cannot** form, in small-bore sewers the temporary formation of deposits is allowed for.

If solids settle out in the sewer pipe, waste water collects behind the deposits until the pressure becomes great enough to remove the deposit. The solids are thus moved forward in a sequence of deposition, transport, deposition, transport, and so on. For this manner of sewer functioning, it is essential that most (and preferably all) households in the sewered area are actually connected. This is especially important in the upstream sections, more downstream the sewer system is likely to carry continuous flow. To provide access for rodding and cleaning out, simple inspection boxes on the backyard sewers are provided, rather tahn expensive manholes.

For areas of sufficiently high population density, small-bore sewer systems are cheaper than on-site wastewater disposal systems. They offer a satisfactory level of hygiene and convenience, at half or one-third of the cost of conventional sewer systems. In conventional sewer systems, gradients are needed that are steep enough to ensure that peak flows will flush out any solids deposited during periods of low flow. However, in low-income areas water usage is limited and the flows of waste water generally are not large enough in house connections and branches to ensure flushing of deposits. Where flow are intermittent, blockage of pipes in conventional sewer systems is a frequent problem.

By using small-size pipes, of 100 mm dia. rather than 200 mm as usual minimum size in conventional design for house connections and branch sewers, the capacity to transport solids is improved. The sequential waves of wastewater collect behind any deposits formed, until enough pressure is built up to shift the solids along the pipe invert. There is no need to apply a minimum gradient of 1 in 70, as in conventional sewer design. In some small-bore sewers, gradients as flat as 1 in 167 have been used successfully for systems serving up to 60 households. Field investigations in the United Kingdom have confirmed that there is no correlation between the occurrence of blockages and the gradients used in small-bore sewer systems.

Small-bore sewers are most effective in areas of high population density; they cannot function properly if wastewater is collected from only a few houses with long connection pipes. Successfull applications of these system include low-cost squatter settlements in Brazil having an average population density of 350 people per hectare, with water supply mainly from yard taps and pour-flush toilets for sanitation. Shallow small-bore sewer systems have now been installed in dozens of urban upgrading projects, and sites-and-services schemes. In Pakistan, these systems were introduced in a demonstration project in a low-income community on the outskirts of Karachi. There, the population desnsity was 200 people/hectare; water supply is by public standposts at a rate of 27 litres/capita/day only. The small-bore sewer system receives wastewater from water-flushed latrines and toilets, as well as **all** household sullage. Despite the low water consumption, and thus limited sewage flows in the sewer system, the system has worked perfectly well since its construction and no major blockages have occurred. Capital cost was as low as US$ 45 per household.

ANNEX H.2

FLY BREEDING

The fly is one of the most prolific pests of man. It can carry disease-causing agents inflicting typhoid, cholera, gastro-enteritis, diarrhoea, dysentery, eye diseases, hepatitis, tuberculosis, as well as intestinal worms.

Regarding transmission of these disease-causing agents, it is important to know that the fly can only swallow liquid food. In order to take up solid foodstuff, the fly uses saliva and regurgitated fluid from already digested food, to dissolve the solid into a kind of broth which it then sucks up through its proboscis.

During breeding the insect goes through four stages: egg - larvae - pupa - adult fly. For the deposit of the eggs, certain conditions are required; i.e. moist fermenting or decomposing vegetable or organic matter. The female seeks a suitable breeding site by sense of smell, and deposits her eggs into the mass of breeding material. This burying is done to protect the eggs against the heat of the sun, or from being dried out. The batches of eggs number up to 150, and an adult female fly will lay several batches during her short life.

The full life cycle - egg to adult - depends on weather and temperature. Under ideal conditions, it can be less than seven days. In tropical countries, the fly can live for about one month.

The deposited eggs guickly incubate and produce a small maggot or larvae which burrows into the decomposing organic matter or food to avoid light and to feed on the material. During this stage, the larvae remains below the surface. Eventually, it will move to just below the surface and it may migrate some distance horizontally. In this position a pupa is formed; this is a small bean-shaped object of up to 7 mm long. If infested soil around a refuse dump is excavated, it will reveal at a depth of about 5 cm considerable numbers of larvae and pupa; this can be as much as ten thousand per square metre, and even more.

In due course the adult fly emerges from the pupa and makes its way to the surface. Here it walks about the surface for some time until its wings fully expand and its air sacks are filled. Then it commences to fly. The adult fly can travel many kilometres from its breeding site.

Eeven when inoculated material is buried and covered with clean soil, the larvae which hatch out can eventually move upwards and outwards from the breeding site, to pupate just below the ground surface. In due course, the adult fly will emerge at the surface and fly out.

If larvae are present in waste material that is buried, pupation will take place in that material. The live fly is able to penetrate upwards through very thick layers of covering soil, even when it is compacted. Such emergence of flies has been found at sites of 45 cm of hard compacted soil. It is clear that the covering with clean soil as practiced at landfills, can do little to prevent emergence of flies from waste which has previously been infested with eggs or larvae. Heat generated in fermenting waste will destroy eggs and larvae in considerable numbers, but even so many adult flies will escape.