Project Management Unit
UP Rural Water Supply & Environmental Sanitation Project

The PMU Manual

Volume IV Technology Manual
(Part III) Feasibility Manual

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Section I
Introduction

1.1 Purpose

The Feasibility Manual is the third part of the Technology Manual (the first, second and fourth parts are the Community Level Technology Options, Prefeasibility and Detailed Design Manuals respectively) and describes the technical component of the Community Action Planning (CAP) process. It also enables the community and the Support Organisation(SO) to undergo the feasibility process and then go on to the Design phase. This manual is also the basis for the first technical training to SOs on the CAP feasibility process.

The purpose of a feasibility report is to develop a list of options, with active participation of the community, on a variety of issues including water supply , sanitation, catchment area protection and environment management. While considering the options, the community can compare and assess various implications, such as capital and operation & maintenance costs, level of service, time savings, health benefits and environment improvement. Finally, after weighing the pros and cons, the community will select the most appropriate option.

A blank feasibility form is at Annexure A (A-1:A-17)

1.2 Contents of this Manual

This manual is divided into nine sections

(i) Introduction

(ii) Baseline Survey

(iii) Needs Assessment

(iv) Women's Development Initiatives

(v) Water Supply Feasibility Study

(vi) Sanitation Feasibility Study

(vii) Drainage Feasibility Study

(viii) Catchment Area Protection Feasibility Study

(ix) Village Environmental Programme Feasibility Study.

The contents of the nine Sections are given in brief as follows:

(i) Introduction : This section explains the objectives of the Feasibility Manual and describes its contents.

(ii) Baseline Survey : This section discusses the process of preparation of the baseline community map. This involves collection of available maps (like shajra* sheets and Survey of India topo sheets), undertaking a reconnaissance survey and baseline survey on environmental parameters including land use, vegetation cover, economic use of the watershed, the number of springs and dry season flows, groundwater levels in the dry season and after the monsoon , ground water availability, initial water quality

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*Shajra map is the revenue map of a village and is available with the village level revenue functionary (Lekhpal/Patwari)

and follow up measurements, rainfall and stream flows originating from the concerned watershed. The baseline survey also includes information gathered through the Healthy Homes Survey and information from Primary Health Centres regarding diarrhoea, worm diseases, skin diseases, other diseases such as malaria and lack of basic sanitation.

(iii) Needs Assessment : This section describes the process of determining the needs of the community and includes description of various tools pertaining to community self investigation.

(iv) Women's Development Initiatives (WDI) : This section explains the objectives of WDI and focuses on the process of involvement of women in various feasibility studies.

(v) to (ix) The sections on feasibility studies for water supply, sanitation, drainage, catchment area protection and village environmental programmes focus on the following issues.

(a) Technology options

(b) Identifying at least three technology options

(c) Presenting the options to the community using community participation techniques

(d) Selecting the best option.

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Section II
Baseline Survey

2.1 Purpose and contents of baseline survey

The purpose of the baseline survey is to collect data and information about the present status of the community and its water and environmental sanitation conditions, for conducting feasibility studies. The decision on what information should be gathered, should be guided by relevance and priority of information vis a vis the problem to be solved. This survey will mainly have three components.

(i) Preparation of the Baseline Community Map: This map will be prepared by the community, assisted by SO staff, which will serve three purposes:

- basis for planning;
- serve as an information source for the community;
- help the community for monitoring the changes over time.

(ii) Baseline survey on Environmental Parameters: This survey will mainly provide information on the present landuse pattern in the village, vegetation cover in the village, present erosion condition, ground water availability and location and use of water sources in the village.

(iii) Baseline Health Survey : This survey should be conducted with the objective of providing a status report of health and sanitation conditions in the community. This will give information on various diseases prevalent in the area and the sanitation practices adopted by the community.

How to start

The process of collecting baseline data should be such that it involves the community in all stages and creates a sense of ownership in the community vis a vis the project. Initially, the SO staff should try to build up a rapport with the community and have general discussions on socio-economic issues, problems in general and then a specific discussion on the prevailing water supply and environmental sanitation situation. The broad objectives of the SWAJAL project should also be explained to the community. Some suggested steps to be taken by the SO staff during their initial visits to the community are listed below:

- walking around the village and starting informal conversations
- explaining to the community the intentions and interests of the SO
- listening to what villagers have to say, about whatever concerns them
- getting familiar with the layout of the village
- calling informal groups together and planning dates and times for future visits, convenient to the villagers' schedule
- using some creative techniques for building a rapport, like story telling, using unserialised posters and flexiflans

After the initial rapport building, an effort should be made to strengthen informal cluster groups. These groups can be informally organised as learning groups i.e. groups of residents in a neighbourhood who agree to help work in developing the Community Action Plan (CAP). If the neighbourhood is large, the SO should try to break it into manageable units which would

approximate future tapstand groups. Groups should be formed in a natural fashion based on proximity of homes and social relations. Women should play a key role in this effort.

2.2 Preparation of Baseline Community Map

This map will be prepared by the community with the facilitation of SO staff. The map will give a general view of the village, its physical features, various resources, ethnic groups and its social structure. An illustrative list of the subjects which should be included in the map are as follows:

- present population (with SC/ST breakup)
- number of households
- number of clusters
- households in each cluster
- schools
- roads
- community centre (Panchayat Ghar)
- temples
- power supply
- postal services
- present water supply sources and their locations
- hospitals
- agricultural land
- grazing land
- forest land
- % area under vegetation
- % area under wasteland
- ponds
- rivers
- streams
- garbage dumps

The detailed procedure for community mapping is described in Section 3.

2.2.1 Collection of available maps

The following two village maps should be collected for further refining the community map:

Shajra map:
This is the revenue map of the village which is to scale and is available with the Lekhpal / Patwari. It shows village boundaries, individual field boundaries, pathways, roads (*kachcha /pucca*), orchards, forests, rivers, streams and boundaries of inhabited areas.

Toposheets :
These are survey sheets prepared by the Survey of India, showing the location of the village and its surrounding area. These maps are available in 1: 50,000 scale as well as in 1: 25,000 scale. These can be obtained from the Map Record and Issue Office, Survey of India , Hathi Barakala,

Dehradun or its Regional Offices. These sheets also show perennial water sources, spot levels and contours which will help in planning.

2.2.2 How to use the Shajra map and toposheets

A copy of the shajra map is taken on a tracing paper. Village boundaries, individual field boundaries and forest area is marked on the community map by superimposing the copy of shajra map on the community map. Points of elevations and depressions and perennial sources should be marked on the community map with the help of toposheets.

2.2.3 Cross verification of community map through a reconnaissance survey

A reconnaissance survey of the village should be conducted by the community members and SO staff along with the map prepared by the community (updated by shajra map and toposheets) by taking a round of the village. A note of features like hamlets, buildings, water sources, roads, pathways, public utilities (like post office, health centre , school. panchayat bhawan, transmission line), agricultural land, grazing land, forests , tanks and reservoirs, general slopes etc., will be taken during this reconnaissance survey. This information should be used for cross checking and further refining the community map. A general idea of distances and directions from known points should also be marked on the community map.

This map, prepared in the manner explained above, will be the baseline community map. This map will be used for preparing the scheme layout plan by the villagers as well as serve as a source of information for monitoring future progress by the community.

2.3 Baseline survey of environmental parameters

Information on environmental parameters can be obtained from the community map. If required, separate maps can be prepared to display different environmental parameters.

2.3.1 Land use in watershed and visual estimate of present erosion

The community mapping technique , described above, should be used to collect information on land use pattern.Refer Annexure A-1. For this, a land use map can be prepared. The basic purpose of preparing a land use map is:

- to know land use pattern (agricultural land, waste land, forest land etc.)
- to know ownership of land
- to know the existence of different resources like streams, forests, minerals, tanks etc

The land use map should contain information on various types of land use and also a visual estimate of present erosion. A brief description of these subjects is as follows:

Types of land

(i) **Agricultural land** - The following two types of cultivable lands are categorised as agricultural land:

(a) Cultivated land
(b) Fallow land

(ii) **Waste land** - Common types of wasteland are as follows:

(a) Rocky
(b) Eroded
(c) Ravines
(d) Saline
(e) Water logged
(f) Snow covered

(iii) **Forest land** - This is classified into the following, depending on ownership and use:
(a) Reserve forest
(b) Protected forest
(c) Village wood lot (Gram Sabha forest).

(iv) **Grazing land** - This is also divided into two categories as mentioned below:
(a) Village Panchayat / community owned grazing land
(b) Individually owned grazing land.

Visual estimate of present erosion

Erosion mainly takes place due to unplanned cutting of trees and reduction of area under vegetation. It is important to know the existing status of the land resource and causes of erosion. Erosion reduces soil fertility and also causes floods.

Erosion should be recorded from ridge to valley on the land use map. The eroded portion should be drawn on the map to estimate the quantity of erosion. The following should be marked on the map:

- the direction of flow of rain water
- submergence area at HFL.(High Flood Level) of river / nala
- approximate average slope of land i.e. > 30^0, 20-30^0 ,< 20^0
- structures like soil and water conservation bunds, tank, checkdams
- forest area, agricultural and other land, length and width wise by scale approx. (the height / depth should be written in the specific location to facilitate the estimation of erosion.)
- siltation in the tanks and other reservoirs should be noted along with their bund erosion.
- land slide zones and areas prone to soil erosion.
- in the hills, areas where snowfall occurs.

In this way, we can mark the present location and approximate length, width and height /depth of erosion. This record shall be kept safely and when the community would like to evaluate the effect of any protection/conservation measure implimented in the area, they can do so by comparing the two situations. This erosion record will also help them to make plans for reclamation of wasteland.

2.3.2 Vegetation cover

The vegetation cover mainly depends on climatic and geohydrological factors. Information on vegetation cover should be plotted on the land use map. The species available in that area and their percentage cover should be indicated on the map. The main local species should be categorised and listed region wise based on their characteristics to check erosion, water retaining behaviour etc.

(i) Bundelkhand region- This is a dry tropical climatic area where thorny and deciduous plants/ trees are found in majority . In higher altitudes of Bundelkhand, kardhai, tendu (*Diaspyros melanoxylon*), khair(*Acacia catechu*), rian, babool (*Acacia nilotica*) are found. Kardhai covers

majority of the area of quartz reef and granite hills having very little soil cover. It can survive in very hard and difficult atmospheric conditions like scanty soil moisture, thin soil cover and high temperature like 47- 50 ^{0} C and it has the property of coppicing. Similarly, tendu trees are also found in majority in the forests of Karvi-Banda. These have good capacity to check soil erosion and this tree also survives in very hard and difficult climatic conditions. In the middle and lower area of Bundelkhand, timber trees like teak(*Tectona grandis*), seesam (*Dalbergia sissoo*), chilbil are found. In the plains, mahua (*Madhuca indica*), jamun (*Sygizium cumunii*), ber, bargad (*Ficus benghalensis*), peepal(*Ficus religiosa*), babool and mango (*Mangifera indica*) tree are quite common.

Bushes like karil, karaundi, ber, *Lantana camara* and ipomea are found in rocky areas of Bundelkhand and these are more or less similar in the UP hills also . As far as grasses are concerned, mainly doob grass, parva grass, khas, kans are found. They grow after rains and generally recede in the month of December and January due to lack of moisture in the top layer of soil.

(ii) Hill region - UP hills can be broadly classified according to height from mean sea level. In the foothills where the climate is moist tropical, deciduous plants like mango, sal , seesam, eucalyptus, poplar are found, whereas in the lower Himalayas, deciduous trees like fir, deodar, chir, banjh (Oak), spruce and uttees are found. As far as bushes are concerned, ghighani, kilmoda, hisalu, rambans, kafal, lantana, ber and ipomea are commonly found. At higher altitudes, evergreen trees like bhojpatra, rhododendron, betul are found. The whole vegetation cover can be divided in the following manner for the baseline survey:

- fodder, fuelwood, timber, fruit and medicinal plants
- groundwater retaining plants
- erosion controlling plants
- plants providing raw material for rural and cottage industries .

2.3.3 Economic use of watershed-

In the baseline map, the economic use of watershed is to be recorded. The inhabitants of the watershed are human beings and animals and both are dependent on the products of the watershed. The basic dependency on the watershed is for fulfilment of the following needs:

- foodgrains
- fodder
- fuelwood
- water
  (a) drinking water
  (b) irrigation water
- building materials
  (a) timber
  (b) construction materials
- minerals, ores for industrial purposes
- medicinal plants and herbs

The above baseline information will be helpful to explore possibilities to enhance the productivity of the watershed.

In the planning and implementation of water supply schemes, management of land and the water resources within the watershed is of crucial importance. This approach will enhance conservation of soil moisture and groundwater, save the depletion of top soil and slow down siltation

of reservoirs, and also ensure that water reaching the major water courses is surplus to the needs of the upstream population. The emphasis of this strategy is to use appropriate technologies which help ecorestoration, utilise local and renewable resources and restoration of the natural hydrological balance of the watershed which is usually depleted over years by environmental degradation.

It is envisaged that the development of watershed will be done in two phases. In phase one, using the micro watershed as the unit, rapport will be developed with the villagers and a participatory baseline survey will be done. Detailed information will be documented on the following aspects of the micro watershed as a result of these exercises:

- rainfall and water discharge of springs, naulas and streams(including the silt) round the year,
- household and socio-economic data,
- hydrogeology,
- vegetative cover,
- land use pattern,

The data will be collected to prepare a comprehensive water budget for the area.

Thereafter, an action plan will be prepared in conjunction with the villagers for implementation in the second phase. The principal components of this plan, depending on local conditions and needs will be:-

1. Sustainable water harvesting and utilisation by employing appropriate technological means. These will include roof run-off tanks to harvest rain water, storage structures like irrigation tanks, infiltration wells to tap additional groundwater sources for drinking water, and repair/renovation of existing tanks, naulas and springs.
2. Increasing water availability by revegetation of the watershed; soil and water conservation by both biological and engineering means to reduce run off and increase recharging of groundwater.
3. Reducing pressure on existing forests for fuelwood by providing alternative and efficient energy sources like biogas plants and smokeless chulhas.

At the end of this phase an impact assessment will be carried out in the villages and households, where the baseline data was collected. This action plan will become a part of the village environmental action plan.

2.3.4. Number of springs and their dry season flow (in the month of May)

The community along with0 SO staff should identify all the water sources available within or in the visinity of the village and collect all the related information. Refer to Annexures A-2 to A-6. They will also measure the flow (in litres per sec) of water sources like naulas, springs, streams and gadheras in the dry season (lowest capacity period). This will help to assess water availability for design purposes. Some of the basic methods of measurement of spring flows are given below :

(a) **X-section velocity method -**

Find out section of stream flow by trapezoidal method
The area A= Z*[First offset + last offset + 2 * (sum of remaining offset)]

where d is the common distance between the offsets.

Velocity: Float a wooden piece for a known distance and measure time of flow with a stop watch. Calculate velocity of flow and multiply it by 0.80 to get the average velocity.
Now the discharge of stream Q= Area of section * Avg. Velocity
Repeat the same exercise three times and find out the average discharge of the stream. The limitation of this method is that it is only applicable where the reach of the stream is straight.

(b) **V-Notch method -**

In this method we divert the whole discharge of a stream with the help of a metal sheet guided over a V-notch fixed. It is placed at a suitable place in the bed of the stream. Generally we use a 90^0 notch. Place the notch vertically and ensure that all the stream flow is coming into the V - notch and there is no leakage. The depth of flow over the V-notch at a distance, not less than 0.6 meter up stream of the notch, should be measured. Read height of flow (H) in cms. with the help of scale and from the table given below calculate the discharge of the stream.

Sl.no.	Head over 90 deg. V-notch H in cm	Discharge, Q Ltr./sec.
1.	1.00	0.015
2.	2.00	0.08
3.	3.00	0.23
4.	4.00	0.47
5.	5.00	0.82
6.	6.00	1.30
7.	7.00	1.9
8.	8.00	2.66
9.	9.00	3.57
10.	10.00	4.65
11.	11.00	7.33
12.	12.00	10.78
13.	13.00	15.50
14.	14.00	20.20
15.	15.00	26.30

(c). **G.I. bucket method:-**

The most common and convenient method is by a bucket (20 ltr.) and a stop watch. This method is suitable for springs and small streams.

- Temporary arrangements are made with big leaves or a split bamboo spout to divert the entire flow of the source to a measuring bucket. A small drain pipe of tin or plastic is very helpful in leading water to the bucket.
- Readings of bucket filling should be taken a number of times after a gap of 5 to 10 minutes. The readings should be recorded as follows:

Sl. No.	Time of start	Time at end	Time taken in sec.	Discharge, Ltr. / sec.
1	2	3	4	5
1	t1	t2	t= t2-t1	Q1= 20 / t
2	t1	t2	t= t2-t1	Q2 =20 /t
3	t1	t2	t= t2-t1	Q3=20 /t
				Avg. discharge, Q Q=1/3(Q1+Q2+Q3).

2.3.5 Groundwater levels in May and after the monsoon in September / October

Baseline information on groundwater level can be obtained from the Groundwater Investigation Organisation . This department records the groundwater table of each *Nyaya Panchayat* and maintains it monthwise. They have their selected observatory wells and piezometers are installed in them for measurement purposes. If the geological conditions of a particular village are not matching with the representative observatory well, then another observatory well should be selected which will give more information about the groundwater table. This well can be selected as follows:

- The well should be at least 100 meters apart from other wells.
- This should be located in the average elevation of village to avoid slopes.
- Considering the geological formations, it should represent the average formation of the village.
- A permanent mark or nail should be fixed in the well for measuring the depth of the water table.
- The depth should be taken at a fixed time i.e. at 5.00 a.m.(before starting use).
- No pumping should be done in nearby wells 24 hours before recording measurement .
- A metallic tape should be used with a straightening weight at the end.

The format for Groundwater Assessment is attached at Annexure A-7.

2.3.6 Groundwater availability

In Bundelkhand and Terai regions, groundwater is the major source for any water supply scheme. For designing a sustainable water supply project, groundwater estimates are required. For this purpose, the following baseline information should be collected:

- the quantity of recoverable groundwater storage within the watershed.
- the estimate of surface water component that provides periodical / occasional recharge to the groundwater body.

2.3.7 Site selection for drilling of handpumps/ tubewells

It is quite difficult to locate a feasible bore well point for drilling of tubewell / hand pump or construction of well / blast well in the Bundelkhand region because of its varying geological conditions. For this there are two service agencies adept at locating groundwater, which can be hired .

(1) Remote Sensing Application Centre
(2) Groundwater Investigation Organisation

Before boring / drilling or constructing well/ blast well any one of the above agencies should be contacted to judge a suitable point to get good water discharge. It is necessary to get such feasibility reports before starting any groundwater exploration work. This will help minimising risks of failure in drilling.

2.3.8 Initial water quality and follow up measurements

Baseline information on initial water quality of water sources should be recorded and follow up arrangements should be made to measure the water quality on an annual or bi-annual basis at the start of the monsoon. The following description will help in understanding the process of water pollution and the need for water quality testing.

(a) **Surface water quality -**

Quality of surface water depends on the topography, geology of area, rain fall pattern, vegetation and land use pattern of catchment. When rainfall occurs, it carries minerals, organic and microbial impurities on its way. It flows toward the slope and dissolves the natural and chemical fertilisers, pesticides and it also gets mixed with domestic and factory sullage and waste.

(b) **Groundwater quality-**

At the time of precipitation, clouds come in contact with atmospheric gases i.e. nitrogen, oxygen, carbon-di-oxide , sulphur-di-oxide etc. and these gases get dissolved in water. When this precipitation infiltrates the underground strata, it is further mixed with carbon-di-oxide present in the top layer of the soil produced by bacteria. For the same reason groundwater contains anaerobic products like methane, ammonia and hydrogen. Carbon-di-oxide gas is acidic in nature and when present in sufficient concentration, the water gets acidic properties. This acid content dissolves minerals present in water like iron, manganese, fluoride etc and, when it comes in contact with calcium or magnesium, it dissolves calcium and magnesium carbonates and becomes hard water. This is one way groundwater gets polluted. Hence it should be tested to record presence of soluble gases, carbonates, sulphates, minerals, toxic substance, pH value and hardness. It should also be checked for presence of pathogenic bacteria, odour, turbidity, and taste. These should be recorded in the baseline survey separately for each source that is to be later considered for the scheme.

2.3.9 Rainfall

Natural precipitation in any area is the rainfall of that area . This leads to

- surface run off
- groundwater infiltration
- evaporation

For designing water supply systems or drainage systems an assessment of these components is required. Data on these components is available in different regional meteorological centres and rainfall data is available tehsilwise, in each district headquarters. This data is collected daily from rain gauge metres located at the tehsil. For the Bundelkhand region, the data of evaporation rates is available at the Indian Grassland and Fodder Research Institute, Jhansi for the last ten years and it is continuously being recorded at this institute.

2.4 Baseline Health Survey

The baseline health survey is undertaken to develop an indepth understanding of some of the key health problems . There is a need to understand community attitudes, knowledge, beliefs, practices and values in relation to the problems identified during the survey. The objective of the health survey is to ascertain the extent to which a problem affects the people and the existing health status of the village. The baseline health survey provides records for impact assessment of the health programme, it also helps the community to get to know about their problems, analyse the situation and plan activities for health intervention and improvement.

The baseline survey helps us to gather information about:

- number of births in the past year
- number of infant deaths / still births
- probable causes of deaths
- most common communicable diseases
- water supply sources / quality /quantity
- water borne diseases and availability of water
- excreta disposal practices etc

2.4.1 Sources and means of collecting information:

The information needed for conducting the baseline health survey can be obtained from :

- records and reports available at the PHC (Primary Health Centre)
- Healthy Homes survey
- KAP (Knowledge, Attitude and Practices) study

2.4.2 Healthy Home Survey

The purpose of this activity, to be conducted with a group of women, is to decide attributes of a HEALTHY HOME. Features of a healthy home will be decided by the women's group. The attributes should be categorised into three main headings of PERSONAL, DOMESTIC and ENVIRONMENTAL . Literate members of the group can write the items on a chart or may use available local materials such as leaves, beans etc. The facilitator then introduces the cards with pictures of the attributes selected by other communities in the project area. For the personal attributes, a secret ballot can be used and for the domestic attributes, women inspect all the homes and decide the healthy and unhealthy attributes. These scores can be depicted on large wall charts so the community can see changes over time. The detailed process of the Healthy Home survey is explained in Section 3. For environmental attributes, participants walk around their community and observe. They rate the overall community and specific areas in the community as "healthy" or "unhealthy".

2.4.3 KAP study

In the Swajal project SOs are required to conduct a KAP and time use study in 30% of their villages. The study will establish baseline information on hygiene and sanitation to assess changes in per capita consumption, time saving and changes in practices related to health and hygiene. This study will help to highlight the knowledge, attitude and practices of the villagers in the beginning of project and changes brought about after SOs have worked with the community. In

the planning phase, after completion of community mapping, SOs will undertake this study. The format of the study is given at Annexure A-8.

The KAP study will be undertaken by the Community Worker. He/She should be aware about common health problems, their causes and symptoms. Some of the prevalent health problems are mentioned below:

I. Typhoid fever:

Typhoid is an infection of the gut that affects the whole body. It is spread from faeces to mouth by contaminated water and food. Germs and worms or their eggs are passed in thousands in the stools or faeces of the infected person.

Symptoms are:

- It begins like a cold or flu.
- headache and sore throat
- body weakness and chills
- sometimes there is vomiting, diarrhoea, or constipation with abdominal pain.
- high fever, pulse relatively slow
- weakness, weight loss, dehydration.

II. Cholera:

This is a very infectious and dangerous disease and often comes as an epidemic. It is spread through contamination of drinking water by the faeces of an infected person or through contamination of uncovered food by flies.

Symptoms are:

- The person suddenly passes large amounts of watery stool continuously without feeling any pain in the abdomen. This is usually followed by vomiting and grey stools.
- At the start of the diarrhoea, the person will complain of thirst, body weakness, quick heart beats, wrinkling of skin and drowsiness.

III. Diarrhoea and dehydration :

When a person has three or more watery stools in a day it can be classified as diarrhoea. During diarrhoea the body loses water and salts and becomes dehydrated.

Symptoms are:

- thirst
- sunken eyes
- dry tongue and lips
- no tears
- reduced skin elasticity
- no urination for 6 hours
- breathlessness and fainting

IV. Malaria :

Malaria is an infection of the blood by a parasite. This parasite is transferred from one person to another by the bite of a mosquito. The mosquito sucks up the malarial parasites from the blood of an infected person and injects them into the next person it bites.

Symptoms are:

- the typical attack strikes every 2 or 3 days and lasts several hours
- it begins with chills and often headache. The person shivers or shakes for 15 minutes to an hour

- chills are followed by fever. The fever lasts for several hours
- finally the person begins to sweat and his temperature goes down. After an attack, the person feels weak, but may feel more or less OK
- the liver may be large and painful and there may be jaundice
- the spleen is also enlarged and painful.

V. Hepatitis / jaundice :

Hepatitis is a viral infection that affects the liver. Hepatitis often causes little or no rise in temperature. The disease is usually mild in small children and more serious in older persons. Symptoms are:

- person does not want to eat or drink.
- sometimes there is pain on the right side near the liver
- may have fever
- after few days , the eyes turn yellow
- sight or smell of food may cause vomiting
- the urine turns dark yellow or brown and stools become whitish

VI. Worms and other intestinal parasites

There are many types of worms and other tiny animals(parasites) that live in people's intestines and cause disease. Those which are larger are sometimes seen in the stools (faeces).

i) Roundworm (ascaris):

These worms are about 20 to 30 mm long and pink or white in colour. They spread from faeces to mouth. The roundworm eggs pass from one person's stool to another person. Many roundworms in the intestines may causes discomfort, indigestion and weakness, children with round worm often have very large, swollen bellies

ii) Threadworm :

These worms are about 1 cm long, white in colour, very thin and are like threads. These worms lay eggs in thousands just outside the anus. This causes itching especially at night. When a child scratches, the eggs stick under his nails, and are carried to food and other objects. In this way they enter the mouth causing infection.

iii) Tapeworm :

In the intestine, tapeworms grow several metres long. But the small, flat, white pieces (segments) found in the faeces are usually about 1 cm long. Occasionally a segment may crawl out itself and be found in the underclothing.

People get tapeworms from eating meat or fish that is not well cooked.

VII. Skin infection:

Scabies :

Scabies is especially common in children. Scabies is caused by little animals-similar to tiny ticks-which make tunnels under the skin. It is spread by touching the affected skins or by clothes and bedding. Scratching can cause infection, producing sores with pus. It occurs in people not bathing / cleaning themselves regularly. It is a result of poor personal and domestic hygiene. It causes very itchy little bumps that can appear all over the body but are most common between fingers, on the wrists, on the genitals, small itchy sores on the penis and scrotum of the young.

VIII. Eye infection :

Trachoma :
Symptoms:
Trachoma can be recognised by

- red watery eyes for 1-2 months.
- itching and feeling sand particles under the eyelids
- scarring on whites of the eyes

This infection is spread through towels, handkerchiefs, flies or any other objects which come into contact with the eye discharge. If not treated, this can last for months or years and can lead to blindness.

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Section III
Needs Assessment

The objective of needs assessment is to understand peoples' perceived needs and the ranking of water and sanitation within the framework of priority needs. The process of needs assessment should be a user-friendly one; innovative enough to arouse curiosity; one that evokes participation and makes it pleasurable and useful; dissolves hierarchical barriers between SO and local people, opening up free communication among all actors. Since women are the major stakeholders in the Swajal project, the need assessment should begin with a simple issue such as how they perceive their priority problems. If water is a perceived problem, the women can analyse what sources they use, how many trips they make to the water source, what else they could do with their time, what role they play vis a vis men at the level of family, the farm or the community, and how they feel about different technology options. Similarly, both men and women can be involved in gender diagnosis through activities that focus on division of labour, sources of household income, relative control over resources, and roles played in decision making at different levels, from personal to community level.

The following participatory techniques (SARAR tools) can be used for needs assessment :
1. Community mapping
2. Flexi-flans
3. Unserialised posters
4. Pocket chart - water use
5. Pocket chart - latrine use
6. Healthy home survey
7. Control and access to resources by gender
8. Task analysis by gender
9. Women's lives : a needs assessment

The application of these tools requires a lot of skill in the SO staff involved in the process. There can never be a "cookbook" which lays down a straightforward process to understand the sequence and appropriate time and atmosphere for using a particular tool. However, the broad approach would be to build rapport with the community through informal meetings and formation of informal small cluster/habitation groups which could be involved in community self investigation, problems analysis, giving information and community planning

Description of the above techniques is as follows :-

3.1 Community Mapping

PURPOSE:
To gather information about a community by enabling community members, including children, to represent their community and its issues through drawings or three dimensional models.

BACKGROUND:
Map making can be used to identify different kinds of information, including:
locating the major resources of a community and its physical features (rivers, ponds, markets, roads, health posts, schools, etc.); identifying existing community and private water and sanitation facilities, those which are used by men and those by women; focusing on health hazards and resources that promote health; providing a visual picture of the community social

structure (ward and kinship groups and boundaries, rich and poor, male and female local leaders, etc.). Maps can be of any size. They can be drawn on paper and super-imposed on one another to show change or to add new features; they can also be made on the floor or on walls, in schools, people's homes, at the community centre or the village Panchayat Ghar. Maps drawn in public places are an extremely effective community monitoring device.

MATERIALS NEEDED:

Maps can be drawn on the ground with a stick, or, if the group wants to produce maps which can be used in future discussions, large sheets of paper with felt pens or other drawing materials.

Three-dimensional maps can also be built using wood or scrap material. String and ribbons can be used to show connections between activities, geographic areas or socio-economic groups. Twigs, leaves, seeds, stones, wire, clay, shells, or other objects can be used to symbolise groups or facilities with a community.

HOW TO CONDUCT THE EXERCISE:

1. Begin by determining whether the mapping will be carried out within one group or several, if the group is large.
2. Participants may want to divide themselves into smaller subgroups to depict different parts of the village which can then be joined together into a larger map.
   In most contexts, it is important to have men and women map separately because there are usually strong gender differences in perceptions about the community. It is also important to be aware that different people have different perceptions. Whenever mapping activities are conducted, sufficient time should be allowed to resolve differences and reach a consensus. People whose perceptions differ dramatically should make separate maps. These differences will reveal important information through discussion.
3. Provide participants with mapping materials and ask the group to use them to describe their community by making a map of it. Remind them that they are the experts in describing their own community life. Reassure them that they are free to plan and produce the map in any way they wish.
4. After introducing the activity in this way, the community facilitator conducting the session should "let go", letting the participants take over the process.
5. Ask some members of the group to use the map to take the other participants on a tour of the community, including the topography, demographics, aspects of the lives of the people, and all those things that people see as problems.
6. Based on the map and how people have described their community, initiate discussion on any of a range of issues : water supply and sanitation needs; particular concerns of women; community history (what the community was like in the past; how it has changed; what made it change); community aspirations for the future (in what ways can the community be improved; what aspects of life need to be changed; how can that be done?).

3.2 **Flexi-flans**

PURPOSE:
To stimulate and increase the creative participation of community members through the use of open-ended materials.

MATERIALS NEEDED:
A variety of flexi-flans of people, animals, tools, and possessions, and a flannel board on which to arrange them. If there is no flannel board, then the ground can be used to arrange them. Flexi-flans made of stiff paper or light cardboard, are cutouts of human figures that have moveable arms, legs and torsos. However, they are not puppets and should not be manipulated as such. Rather, they are a form of "picture writing" and can be arranged on a flannel board to tell a story, identify a problem, analyse possible solutions, and so forth. Flexis should be used as a way of eliciting ideas and stimulating discussion, not as a tool to teach messages to community members. Human figures should be broadly representative of the local community or society, and of different ages, both male and female. Figures should be both in full face and left and right profile so that they can be arranged to show people working, talking and engaged in conversation. The set should also include a number of props-houses, trees, animals, possessions, tools, utensils-associated with rural life.

HOW TO CONDUCT THE EXERCISE :
1. Begin by spreading out the flexi-flans on a table or flannel-covered board.
2. Hold up the flexi-flans to show how they can be used to illustrate different actions. Show how they can be combined to express ideas, relationships and incidents.
3. Propose a simple task such as suggesting that the participants use the flexis to share something about their community or an event that they recall with pride or amusement. In setting up the task, make the instructions as brief and clear as possible.
4. Encourage the participants to use the materials to illustrate whatever they want to say. Impress upon the group that their creativity is what matters.
5. Have the participants share their experience with the larger group.

3.3 **Unserialized posters**

PURPOSE:
To encourage creativity and stimulate discussion on important family and community issues through the use of open-ended and flexible visual aids.

MATERIALS NEEDED:
A set of eight or more pictures of dramatic human situations. These scenes are open to varying interpretations and can be arranged in different sequences. The pictures should focus on human interaction, rather than activities such as harvesting crops or pumping water that can be easily described without having to think about what they might mean.

HOW TO CONDUCT THE EXERCISE
1. Divide the participants into small groups. Give each a full set of pictures.
2. Ask each group to choose any four pictures and weave them together into a story, giving names to the characters and to the community where the story takes place. Encourage them to develop a story with a plot that has a beginning, middle and end. Allow 15 to 20 minutes for this task.

3. Invite the groups in plenary to tell stories, using the pictures they chose. Groups may choose similar pictures but compose very different stories from them: or they may choose different pictures but compose similar stories. The reasoning behind the differences and similarities in the stories should be thoroughly discussed by the group.
4. Allow time for the groups to tell stories as they want. Let one member of each group record the themes, issues and notable points raised in the stories.

3.4 **Pocket chart-water use**

PURPOSE:
To help community members learn a new way to assess and analyse their situation.

MATERIALS NEEDED:
A pocket chart consists of rows of paper or cloth pockets, usually four to six horizontally and six to ten vertically. A set of pictures is attached above the top row of pockets. These pictures represent areas in which data are needed, such as different sources of domestic water supply. In the Swajal project, there are nine types of water sources- handpump, naula, gadhera, spring, stream, river, tapstand, well and pond. Each of these pictures is placed at the head of a vertical column. Similarly, pictures will be attached down the left-hand side to indicate other variables, such as how the different water sources are put to use by community members.
Materials required to carry out this exercise include:

- picture cards of different water sources and water use;
- a pocket chart (either as described above, using cans or pots set on the ground beneath the pictures; or drawing a matrix on the ground);
- paper slips, leaves or seeds for voting.

HOW TO CONDUCT THE EXERCISE

1. Begin by creating a pocket chart as follows:
   - Across the top of the chart, place three of the cards depicting water sources (a river, a well, a pump, and so forth).
   - Down the left-hand side of the chart, place three or more cards showing different water uses (cooking, washing, drinking, and so forth). The number of cards used is based on the detail and level of complexity desired.
   - Place a small cloth or paper pockets or other containers along each of the rows you have created.
2. Place the pocket chart in a location that is accessible, but also where voting can be done confidentially.
3. Explain to the group that the pocket chart can be used to determine how different sources of water are used by the community.
4. Illustrate how the balloting is performed by placing a slip of paper into a pocket or container to indicate a choice or preference. Remove the slip after the demonstration.
5. Ask for six volunteers to perform the voting. Give them enough ballots so that they can vote on how they use each source of water. Have the participants vote one at a time. If the entire group wants to vote, organise the voting accordingly.
6. When the voting is complete, ask another group of volunteers to remove the voting forms and tabulate the results.
7. Discuss the patterns of use that emerge and record the findings. Engage the group in a discussion about the meaning of these findings. For example, "Why do so many (or so few)

people prefer one source of water for washing over another? Is this sample representative of most people in the village? Do preferences have any effect on health and well- being? Are there seasonal differences?

8. Once the activity is understood, it should be taken over by the community and used to assess and analyse information about other issues they face.

3.5 **Pocket chart-latrine use**

PURPOSE:
To help community members learn a new way to assess and analyse their situation.

MATERIAL NEEDED:
A pocket chart for latrine use is prepared in the manner described for the pocket chart-water use. The only difference will be that pictures of various defecation practices are made instead of pictures of water sources. Similarly, picture of men, women and children using these practices are prepared instead of cards showing different water uses.

HOW TO CONDUCT THE EXERCISE:
Similar steps as described in pocket chart-water use are followed to determine how different defecation practices are used by the men, women and children in the community.

3.6 **Healthy Home survey**

PURPOSE:
The purpose of this activity is for a group of community women to decide among themselves the ten or more attributes of a healthy home and then survey the homes in the community and rate each according to the criteria they have chosen.

HOW TO CONDUCT THE EXERCISE:

1. A group of women first brainstorm on the features they consider to be important in a healthy home. This might include a roof in good repair, good ventilation, food properly kept in a covered jar, and so on. it is important that the facilitator be non directive and let the women list whatever attributes they want. After they have discussed the issue, they make a list of the ten or so features of a healthy home. The attributes should be categorised into three main headings of 'personal', 'domestic' and 'environmental'. A literate member of the group can write the items on a flip chart or they may use available materials (like sticks, beans, leaves) as symbols.
2. The facilitator then introduces the cards with pictures of the attributes selected by other communities in the project. The next activity is just to familiarise the participants with the cards. They are asked to discuss each one and see if they consider it very important, important or not so important. They can then compare the list with the one they did earlier.
3. The participants are then given three tasks:
   For the Personal Attributes:
   They use a secret voting system to indicate how often they personally wash their hands with soap each day, how often they bathe, and so on. The totals are tallied and divided by the member of women to find the average for the group. This can be done with hidden pocket charts or some other "secret" ballot so that the group does not know how each woman answered.

For the Domestic Attributes:
They inspect all the homes and decide whether each home is healthy or unhealthy for that attribute. These scores are depicted on large wall charts so that the community can see changes over time.
For the Environmental Attributes:
Participants are asked to walk around their community and observe. They should rate the overall community and specific areas in the community as "healthy" or "unhealthy" for that attribute.

4. The summary information should be made available to those SO staff who are planning the hygiene education program for the community so that they can learn the most frequent unsanitary situations and target those for educational programs. SO staff will want to keep the individual home surveys to use when they do the follow-up after the system is installed.

The survey should also be repeated six months to one year after the water system has been installed. In that case, women should review their original criteria and see if they still like their original list. They may wish to add some attributes, but for evaluation purposes, they must inspect them for original attributes again.

A sample format for compiling information collected through the Healthy Homes survey is given in the Feasibility Form (Annexure A-9)

3.7 **Control and access to resources**

PURPOSE :
To collect information, raise awareness, and enable the community to understand how access to and control of domestic and community resources varies according to gender.

BACKGROUND:
Gender analysis concepts tend to be abstract and controversial since they affect everyone. Visual tools have been found to be very effective in getting people, both men and women, to focus on gender issues without being threatened. In most countries where these tools have been used, they have been so successful in stimulating discussion that the process could go on for hours if the facilitator did not end it.

MATERIALS NEEDED:
Large drawings of a man, a woman, and a couple.
At least fifteen cards depicting different resources and possessions owned by local community members, such as cattle, chickens, bicycle, currency, trees, vegetables, furniture, plants, fruit, pipe, jewellery, bags of maize, donkeys, horse/cart, radio, sheep.
Blank cards and writing implements.

HOW TO CONDUCT THE EXERCISE:
1. Place the three large drawings on a table or on the ground in a row. Underneath these drawings, scatter the smaller cards at random. Include some blank cards.

2. Ask the participants to sort the cards by categorising them under the three large drawings in columns, depending on who owns or controls the resources. If important resources or possessions are missing from the cards, ask participants to draw them.
3. Facilitate the discussion among the participants about why they made the choices they did. Make sure women are included in the discussion, or organise the exercise into two separate activities, one for men and one for women, and let them share the results of their activities.
4. Next, ask participants to focus on women's access to resources, even if they are controlled by men. Give people coloured stickers to mark the resources that men own, but women can use. Focus the discussion around the use of the resources.
5. Ask participants to discuss what happens to women's access and control over resources in cases of divorce or separation. Ask participants to move the cards or introduce another colour sticker to mark the resources that move out of women's control due to divorce or separation.

3.8 **Task analysis**

PURPOSE:
To raise awareness within the community of how domestic and community tasks are distributed according to gender; and to help the facilitator understand the degree to which role flexibility by gender is associated with different tasks.

BACKGROUND:
Like the previous activity, a visually conducted task analysis is very effective in raising gender awareness and getting information on gender specific tasks in a particular cultural environment. Combined with resource analysis, it usually highlights the imbalance between women's access to resources and their workloads.

MATERIALS NEEDED:
Three large drawings of a man, a woman and a couple.
At least a dozen cards depicting daily household and community tasks being performed (such as growing crops, basket weaving, looking after a child). The pictures can be drawn using either male or female figures, regardless of whether it is a man or a woman who usually performs the task in question. Blank cards should also be provided so that participants can draw tasks not already included in the set.

HOW TO CONDUCT THE EXERCISE:
1. Place the three large drawings on the ground, in a row. Underneath these drawings, scatter the smaller cards at random.
2. Ask the participants to sort the cards by categorising them under the three large drawings in columns, according to whether the task is generally performed by a man, a woman or both.
3. Let the participants take over the exercise and conduct the discussion themselves.
4. When some degree of consensus is reached, initiate a discussion among the participants about why they made the choices they did. Be particularly sensitive to including women in the discussion.
5. Ask the group to analyse the workloads- both the relative amount of work involved in each task and the division of labour between men and women. Ask which are the most burdensome tasks. Discuss how much flexibility there is in changing the workload of particular tasks. Link the tasks and workload to tasks and activities required to be undertaken in a project; focus discussion on the participation of women.

3.9 **Women's lives: a needs assessment**

PURPOSE:
To collect information, raise awareness, and understand the priority needs of women based on their different tasks and responsibilities.

MATERIALS NEEDED:
At least ten cards depicting women performing various daily tasks, such as: feeding a child, leading a meeting, relaxing, working in a field, visiting health centre, sweeping, harvesting, carrying water, bathing, cooking, sewing, hoeing, carrying firewood. Blank cards should also be provided for drawing additional tasks.

HOW TO CONDUCT THE EXERCISE:
1. Place the cards on the ground in full view of the participants.
2. Explain that the cards show women performing different tasks.
3. Ask the participants to discuss the tasks, and then categorise them into three groups: most difficult to perform; easiest; most problematic. If consensus is not achieved, note the minority opinions.
4. Allow the participants to take over the discussion as much as possible. For example, the picture of a woman and her child at the health clinic can lead to a discussion of the distance from the village to the clinic, problems in transporting pregnant women in a safe and timely manner to the clinic, and so forth.
5. Ask participants to consider which problems they can solve using resources available in the community.

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Section IV
Women's Development Initiative

The project aims at involving villagers, especially women, through self help in achieving increased water availability while emphasising social aspects like rural health, cleanliness, sanitation and overall social welfare. If women in communities are to take the initiative and responsibility for their own development, they must be actively involved in decision making. The emphasis should shift from a centrally managed supply driven approaches to a decentralised demand driven, community partnership approach, not forgetting that women are the integral part of the community. Since women are the major beneficiaries of the project, involving them would ensure that they will commit their time, resources and abilities towards selecting, paying for, installing, using and maintaining water supply and sanitation facilities in the long run.

The feasibility activities have to be designed in such a manner that they maximises participation of women and instil confidence in them through increased interaction around the community and increased access to productive activities. This would also increase access of women and children to improved, adequate and safe water and sanitation facilities so as to have a positive and direct effect on health and productivity.

Women's development initiative aims to provide support to

1) help women develop skills required to realise the benefits of improved water supplies
2) improve their access to the formal credit system
3) promote women's role in planning and implementing water supply and sanitation schemes including environmental resource enhancement initiatives, and
4) encourage participation in resource mobilisation activities such as collection of user fee charges and monitoring and evaluation.

SO staff should ensure that during the formation of Community Action Plans, focus of community development activities of the water supply and environmental sanitation schemes should be on the women. Specifically, in the following areas, the role of women will be emphasised:

- women will be guaranteed representation in VWSCs , which must have atleast 30% women members. Women participation will be ensured as they will be active members of the VWSC and will actively participate in the decision making process. All the activities including planning, implementation, operation , monitoring and evaluation will be carried out with the help of women;

- hygiene and environmental sanitation awareness(HESA) and non formal education (NFE) activities will focus on women. Mother and child tapstand groups should be formed for planning and implementing HESA activities. As far as possible, Healthy Homes Survey should be conducted by women. Similarly, respondents for KAP study should be women. Wherever required, small groups will be identified for conducting NFE activities with the help of local women teachers and using existing teaching material available through various adult education government programmes like Total Literacy Campaign;

  Women will be encouraged to take advantage of the women's development initiative programme, which would provide specific skill and management training to increase the scope of income generating activities and would help women to gain access to formal credit systems.

By providing drinking water near their houses, women will save a large amount of time presently spent in fetching water. This time saved can be utilised in income generation activities. Some of the income generating activities prevalent in the rural areas for women are: sewing, printing, knitting, weaving, carpet making, spices preparation, doll making, pickle making, dalia making, charkha, cane work, potato chips, mats preparation, basket making, candle making, incense stick (agarbatti) making, dairy activities, goat rearing, terracota work, black pottery, poultry, zari work, embroidery, mushroom cultivation, silk farming, chalk making, disposable delivery kit preparation (most preferred at present), bari-papad making, making wall hangings, thread lamp shades preparation, seesal (rambans) handicrafts, silk farming. These activities can be taken up depending upon the locally available material and the market so that the activity is economically viable;

- women will be encouraged to form female tapstand groups to collect monthly operation and maintenance fees to maintain tapstand/handpump.

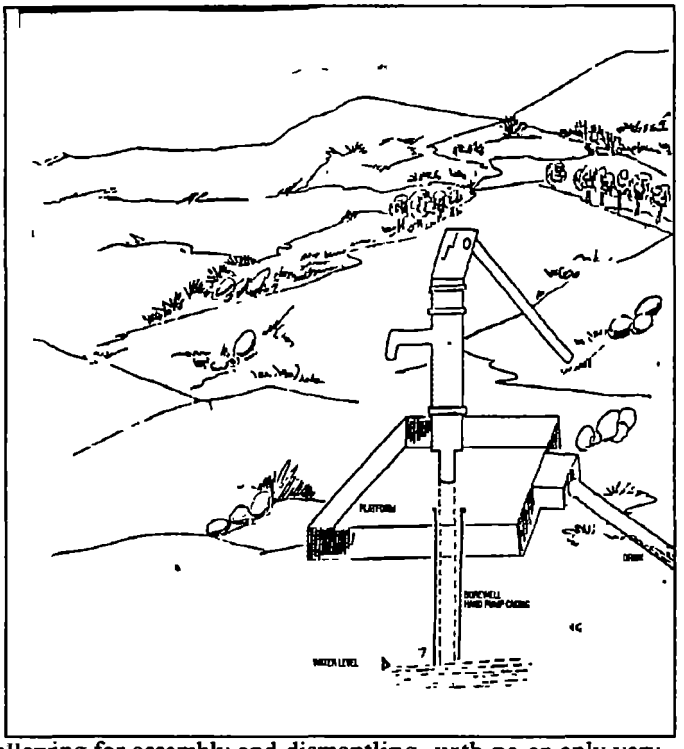
- the selection of female scheme maintenance workers will be encouraged. Women will be trained in operation and maintenance, including collection of user fees, monitoring, and reporting.

In brief, during the feasibility period, women should be involved in investigating, analysing, choosing options and planning of the system.

Deep Borewell Handpump W/S System

1. Brief description of technology

In a deep well piston handpump, the piston is placed in a cylinder below the water level which is usually in the range of 30 to 60 m below the ground The pumping motion by the user at the pump stand is transferred to the piston by means of a series of connected pumping rods inside the rising main. On the up-stroke, the plunger lifts water into the rising main and replacement water is drawn into the cylinder through the footvalve. On the down-stroke, the footvalve closes, and water passes the plunger to be lifted on the next up-stroke. The pumping height is limited only by the effort needed to lift water to the surface Now a days most cylinders have an open top which allows the piston and footvalve to be removed through the rising main for servicing and repairs while the rising main and cylinder can stay in place.



The pump rods have special connectors allowing for assembly and dismantling with no or only very simple tools. The joints incorporate pump rod centralizers that prevent water of the rising main To a large extent improved models can be maintained at village level. Such type of hand pumps are India Mark III hand pumps.

To tap underground water in alluvial soils boring is done by Palm and Pressure method or by Casing (Boggie) method .Casing method is costlier as it requires more tools and plants and higher level of skill. This method, however, is technically superior and gives better results. The boring in hard soils is done using machines The casing pipe is lowered in drilled bore. Water is tapped from the second strata. The first strata is sealed with Bentonite slurry to check the transmission of contamination from first strata to second strata. The hand pump machine is installed above pipe, on the ground. The platform around the handpump and a drain to carry away the surplus water, are constructed.

Initial cost The complete cost of installation of India Mark III HP in alluvial soil is about Rs. 19105/-

Range of depth 30 to 60 m

Yield 13 lpm.

Useful life 10 to 12 years

Area of use Rural areas where ground water tables are within 45 m from the surface.

2. Description of O & M activities

Operation

Operation of the pump is done by moving a handle up and down. This can be done by men, women and even children. Handle forces are usually kept within acceptable limits (depending on brand and lifting heights). Pump and site must be kept clean.

Maintenance

Preventive maintenance usually consists of checking pump functioning and cleaning pump and site daily, greasing weekly, checking all parts of the pump stand monthly and taking the whole pump apart for a check, cleaning the parts with clean water and painting the pump stand annually. Pump rods that show bad corrosion must be replaced. Under normal conditions, a galvanised steel pump rod needs replacement every five to six years Rising mains consisting of galvanised iron have to be removed and checked and pipes with badly corroded threads must be replaced. Small repairs and the replacement of bearings, cupseals and washers, straightening bent pumping rods etc. Major repairs may involve the replacement of the plunger, footvalve, cylinder, pump rods, rising main, pump handle, fulcrum etc. With open top cylinder pumps all preventive maintenance activities can normally be executed by a village pump caretaker. For major repairs and problems external support may be needed. Closed top cylinder pumps (India Mark II hand pumps) often need special lifting equipment to pull up the rising main and cylinder for maintenance of parts down in the hole
The platform and drain are kept clean The water should not be allowed to collect around the platform, to avoid pondage.

3. O & M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean pump and site	daily	local		broom, brush
grease bearings	weekly	local	grease of oil	lubricator
check pump stand parts	monthly	local		spanner
replace pump stand parts	occasionally	local	nuts and bolts, bearings, pump handle	spanners, screwdriver
replace cupseals	annually or less	local or area	cupseals	spanners, wrench, knife, screwdriver etc.
redo threads in pump rod or main	occasionally	local or areas	oil	pipe threader, tackle
replace footvalve, plunger or cylinder	occasionally	area	footvalve, plunger or cylinder	spanners, wrench
replace pump rod or GI pipe	occasionally	area	pump rods or GI pipe	spanners, wrench, pipe threader
repair platform and drain	annually	local	gravel, sand, cement	bucket, trowel

4 Actors implied and skills required in O & M

actor	role	skills
user	pump water keep site clean warn in case of malfunctioning	no special skills
caretaker	keep site clean regularly check pump do small repairs	basic maintenance
water committee	supervise caretaker collect fees	organising skills
area mechanic	perform more major repairs	some special skills depending on brand
external support	check water quality stimulate and guide local organisation	microbial analysis extension work

Organisational aspects

Most deep well pumps are too expensive for family use and will have to be used at community level. The price of these pumps also means extra importance of fund raising. Communities have to organise

themselves in order to maintain the pump in good working condition Often a caretaker is appointed and a pump committee co-ordinates activities.

5. Recurrent costs

The costs for preventive maintenance may range between Rs. 250-300 per pump per year for spare parts and materials. The labour will be provided by the community. In case larger repairs are needed, mechanics or other skilled people will need to be added.

6. Problems, limitations and Remarks

Replacement of plunger seals is the most common repair needed. Connections of pump rods tend to break more often than conventional connections. Rods (if not made of stainless steel), the rising main (if GI) also regularly gets disconnected or bends spontaneously sometimes.

Especially where ground water is corrosive, corrosion has been reported to affect the pump rods if not made of stainless steel, the rising main (if GI) the cylinder, and the pump head bearing housing and other pump stand parts. Broken or shaky handles, mainly due to worn out or otherwise affected bearings. The number of problems usually increase with increasing ground water depth

7. Limitations

The maximum lift differs per brand, varying between 30 m - 100m. The forces required to turn the handle of the pump may be high in certain cases, depending on the brand and on the depth of the well.

8. Remarks

The quality of the material used for the riser pipe should be as high as possible to reduce the number of repairs needed on this part Rigorous quality control is needed.

The sealing of first strata of water is necessary to check the transmission of contamination from first strata to second strata.

Example for calculating cost of Deep Tube Well Hand Pump Water Supply System

Assumptions

Design population = 100
Discharge of well = 10 lpm
Depth of well = 50 m

Item wise costs

S No.	Components	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1	India Mark III Hand Pump m/c		1 no	5000	5000
2.	PVC pipe	(i) 110mm - 6kg/cm2 (ii) 65 mm - 6 kg/cm2	24m 22m	100 80	2400 1760
3.	PVC reducer	(110X 65)	1no	120	120
4.	PVC strainer	50mm - 4m length	1no	500	500
5.	GI riser pipe	50mm med.	24m	100	2400
6.	T & P & cartage costs	5 Casing method		LS	700
7.	Boring cost	0 - 15 15 - 30m 30 - 50m	15m 15m 20m	60 75 90	900 1125 1800
8.	Lowering cost	0 - 15 15 - 30m 30 - 50m	15m 15m 20m	3 3 3	45 45 60
9.	Extraction of 150mm MS casing pipe		50m	5	250
10.	Installation of hand pump			LS	200
11	Cost of platform			LS	1500
12.	Cost of drain		3 m	100	300
				Total capital cost =	Rs. 19105

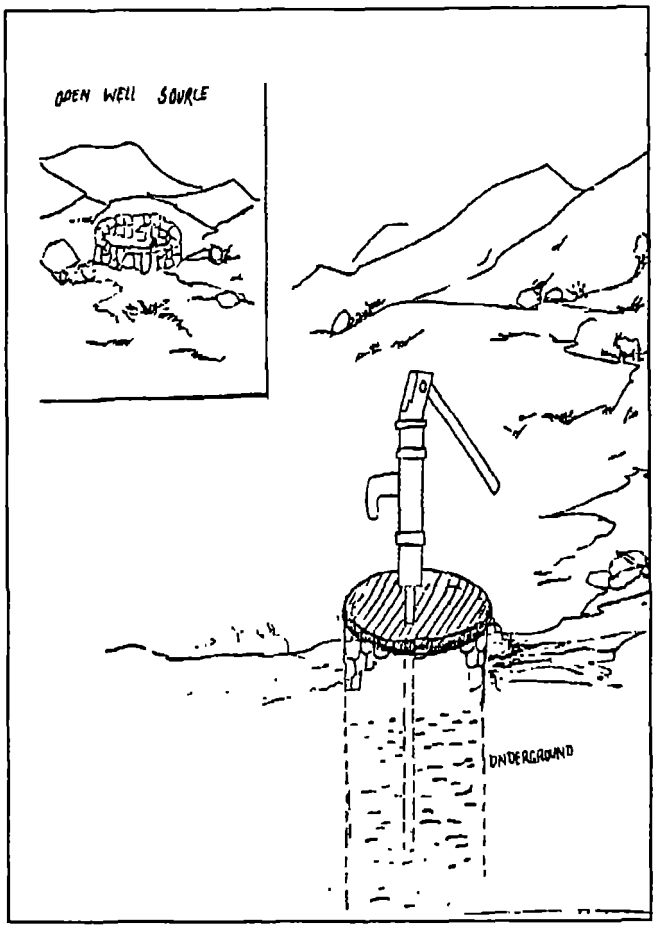
O & M costs @ 1.5 % of capital cost = Rs 270/- per annum

Note Above costs are applicable for casing method in alluvial soil These costs will vary with the soil conditions encountered, the type of method used for boring and the depth of the water table

Openwell Handpump System

1. Brief description of technology

An open dug well gives access to groundwater from an aquifer and facilitates its abstraction. The term 'dug' refers to those wells which can be entered by a person to clean or deepen. These wells are dug by hand or by machinery, consisting of three main parts



- A stone, brick or concrete apron with the above ground part of the well lining (the headwall) raised to a height above ground which is convenient for the method used to collect water from the well. The apron prevents polluted water seeping back down the sides of the well, provides a hard standing for users and directs water away from the well to a drainage channel. The headwall prevents spilt water, rainfall, runoff, debris, people and animals from entering or falling inside and keeps sunlight out.

- The lining between ground and water level, made of masonry with bricks or stone and concrete blocks or concrete rings etc , preventing the well from collapsing In consolidated formations lining may not be necessary In such cases at least the top few meters of the well should be lined to prevent any contaminated surface water from draining into the well

- The lining under the water level, prevents the well from collapsing and facilitates groundwater entering the well. Therefore the living material in this part is usually perforated with small holes or given a slightly different composition (eg permeable concrete or masonry joints left open) as compared to the lining above groundwater level.

Other components of the system are a drain to guide water further away from the well, usually towards a soakpit, filled with large stones where the water can infiltrate back into the ground or evaporate from the stone surfaces at a safe distance from the well, and a fence with a gate, surrounding the well The expected life of a modern dug well is at least 50 years

The water from openwell is proposed to be drawn with the help of an India Mark II HP or a local HP. Handpump m/c is installed at the top RCC slab on the well A proper drainage arrangement is also provided for carrying away the surplus water A man hole will be provided in the roof slab for inspection of well Normally the existing well will be used in this system If required, new wells can also be constructed

Capital cost The capital cost of this system is about Rs. 10,500

Range of depth From a 10 m to over 30 m

Yield About 8 cu m per day can be considered as a good yield

Area of use In areas where safe and sufficient quality and quantity of groundwater can be abstracted throughout the year from an aquifer within about 30m from the surface (sometimes even deeper) and where other water systems are less suitable

2. Description of O&M activities

Operation

Operation includes handling of handpump i e water is drawn-out from well by moving a handle up and down. HP can easily be operated by men, women and children

Maintenance

Usually little maintenance is required. Maintenance activities may consists of
For preventive maintenance of handpump refer the factsheet of deep borewell handpump water supply system

Clean the top slab and concrete apron Check the fence and drainage and clean and repair if required

At the end of the dry season, drain the well by taking as much water out as possible, repair where necessary and then disinfect. If the well has fallen dry or does not yield enough water, it has to be extended and lined further downwards

Check concrete apron and the part of the well lining above groundwater level for cracks or other ruptures and repair, if necessary

Check for undermining of the apron by erosion or settlement of filled in material Ensure that no latrines or other contamination sources are constructed within 30m from the well.

Maintenance can normally be executed by the users of the system or by a caretaker or watchman, whereas larger repairs may require higher skilled labour which can usually be provided by local craftsmen.

3. O & M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean well site	daily	local	water	bucket, broom
disinfect well	occasionally	local	chlorine	bucket
clean well	annually	local	rope, ladder, trolley, bucket, spade, broom	brush, bucket, ropes
repair apron, headwall and drain	annually	local	cement, sand, gravel, bricks	trowel, bucket, wheel barrow, spade
repair lining	occasionally	local	cement, sand, gravel, bricks etc	trowel, bucket, wheel barrow, spade
deepen well and extend lining further downwards	occasionally	local or area	cement, sand, gravel, bricks, concrete rings etc.	pump, bucket, ropes, ladder, spade
repair fence	occasionally	area	wood, nails, wire, mesh	axe, saw, machete, hammer, pliers etc
clean drain	occasionally	local		hoe, spade, bucket, wheel, barrow

O&M requirement for handpump part is the same as in Naula/ Spring Handpump w/s system

4. Actors implied and skills required in O & M

actor	role	skills
water user	use water, keep site clean, assist with major maintenance tasks	no special skills
caretaker	monitor water use, keep site clean	basic skills for cleaning and disinfection
VWSC	supervise caretaker, organize major maintenance, collect fees	organizational skills
mason	repair lining, headwall and apron	masonry
specialized well builder	deepen well	under water excavation skill
external support	check water quality, stimulate and guide users' organisation	microbial analysis, extension work

For the handpump part actors implied and skills required are the same as in Naula /Spring Handpump w/s system.

Organisational aspects

An organisation like VWSC will deal with issues such as the control/ supervision of the water use, prevention of water contamination, execution of O&M and monitoring of water quality Although (or may be because) the number of O&M activities required is limited and usually its costs are very little Maintenance of well should be given ample attention, as large number of well have been abandoned because, they were contaminated and collapsed for lack of maintenance and proper care. Well maintenance should be monitored by VWSC Proper management may also contribute to preventing social conflict over such and other issues

5. Recurrent costs

Recurrent material costs are usually small The recurrent personnel costs, in cash or kind (for caretakers, , labourers and craftsmen), will need to be added but usually will be low as well

6. Problems

Frequent problems

Collapse of the well where a lining is not properly maintained, old, or non-existent Wells running dry or yielding less than before because dry season water levels were not taken into account, water abstraction is higher than natural recharge rates, inflow of groundwater is reduced due to clogging of lining The groundwater may get contaminated through the well or by pollutants seeping to the aquifer through the soil

7. Limitations

Well construction depends on geohydrological conditions like presence, depth and yield of aquifers, Wells constructed at locations which are too far from the users' households or which are too difficult to reach, will not or insufficiently be used and / or maintained

Wells should not be sunk near places with latrines or where cattle gathers and vice versa; usually the distance should be 30m, although this is no guarantee that contamination will not occur. The investment, in labour, cash and / or kind, needed for the construction of a well may be beyond the capacity of communities

8 . Remarks

Use of well and HP could be enhanced by proper apron design, adding clothes washing and bathing facilities, diverting wastewater to irrigate vegetable plots etc

Some advantages of dug wells over most drilled wells are

- they can often be constructed with only locally available tools, materials and skills
- in case the water lifting system (HP) breaks down and is not or cannot be repaired, they can continue to be used with rope and bucket through man hole.
- they can be further deepened if the groundwater table drops,
- they have a great storage capacity;
- they can be repaired and desilted by the community; they can be constructed in formations where hand or even mechanical drilling is difficult or impossible

Sample for calculating cost of Openwell Handpump W/S System

Assumptions

Design population = 100
Diameter of existing well = 3m
Depth of water level from top = 5m

Itemwise Costs

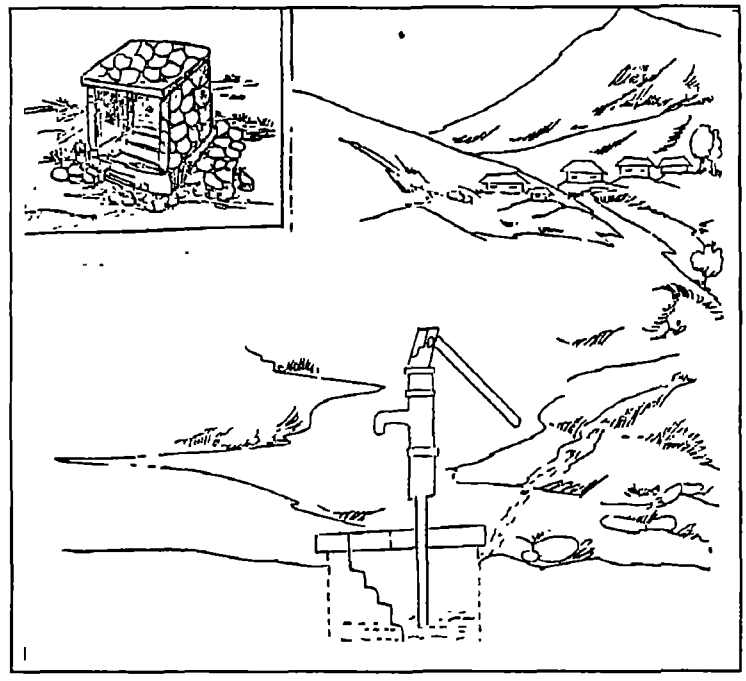
S No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Renovation of existing well	–	–	LS	3000
2	India Mark II Handpump m/c	–	1no	4500	4500.00
3	GI Riser pipe	32 mm dia	10m	80	800.00
4	Installation of handpump m/c riser pipe	–	1 no	LS	200 00
5	RCC roof slab	3m dia x 0 15m thick/ 0 9 cu.m	1no	1800/ per cu m	1620.00
6	Drain		3m	100	300 00
		Total capital cost =		RS	10420/- say Rs. 10,5000

Note All above costs are indicative and may vary with location & site conditions

Naula Handpump W/S System

1. Brief description of technology

In hills, naula is a traditional stepped shallow well into which subsurface water oozes out and gets collected Generally naula is surrounded by a structure and covered at top In the proposed system, naula is converted into a closed chamber and covered by R.C C roof. An India Mark II or local HP m/c with riser pipe is installed over roof of chamber and drainage is constructed to carry away the surplus water from the well



Capital cost

The cost of this system is about Rs 9120/-

Yield

Dependent on catchment area, precipitation etc

Area of use

In Hills where naula is available.

2. Description of O & M activity

Operation

Operation includes handling of handpump ie water is drawn from well by moving a handle up and down Handpump can be easily operated by men, women and children.

Maintenance

Usually little maintenance is required
For preventive maintenance of handpump refer to the factsheet of deep borewell handpump water supply system
Regular cleaning of Naula, platform, drains and apron, should be ensured and any damage should be repaired
Greasing, repair of rising main and minor repair of handpump are executed by the users of the system or by a caretaker, whereas larger repairs may require higher skilled labour

3. O & M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean pump and site	daily	community		broom
check performance	daily	—do—		
check whole pump	annually	—do—		spanners, screwdriver
replace cupseals and washers	occasionally	—do—	pump rod pump handle	spanners, wrench
replace pump rod and/or pump handle	occasionally	—do—	pump rods or GI pipe	spanners, wrench, pipe threader
replace cylinder and /or plunger and /or foot valve	occasionally	—do—	cylinder, plunger, foot valve	spanners, wrench, screwdriver
repair rising mains	occasionally	—do—	PVC tubing, PVC solvent and sandpaper or GI pipe	saw and file and pipe wrenches
repair pump platform and naula chamber	annually	—do—	cement, gravel, sand,	bucket, trowel

4. Actors implied and skills required in O & M

actor	role	skills
user	pump water keep site clean warn in case of malfunctioning	no special skills
caretaker	keep site clean regularly check pump naula chamber do small repairs	basic maintenance
water committee	supervise caretaker collect fees	organising skills
area mechanic	perform more major repairs	some special skills depending on brand
external support	check water quality stimulate and guide local organisation	microbial analysis and extension work

Organisational aspects

O & M can be very well organised at community level As maintenance is simple, a good organisation will result in a reliable service. Proper management may also contribute to preventing social and religious conflict over naula and other issues

5. Recurrent cost

Recurrent material costs are usually small The recurrent personnel costs in cash or kind will need to be added but usually will be low as well.

6. Problems

Worn washers, plungers and foot valve parts Abrasion of the seal on the cylinder and between the pump rod and rising main (nitrile rubber seals are better). Broken and damaged handles Connections of pump rods tend to break more often. Rods also reportedly get disconnected or bend spontaneously sometimes Damaged drain

7. Limitations

High demand of water quantity and quality may not be met by this system.

actor	role	skills
user	pump water keep site clean warn in case of malfunctioning	no special skills
caretaker	keep site clean regularly check pump naula chamber do small repairs	basic maintenance
water committee	supervise caretaker collect fees	organising skills
area mechanic	perform more major repairs	some special skills depending on brand
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7. Limitations

High demand of water quantity and quality may not be met by this system

Sample for calculating cost of Naula Handpump w/s System

Assumptions

Design population = 100
Size of Naula at ground level = (2 X 2)m

Item wise Costs:

Sl. No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Renovation of existing Naula Chamber	–	–	LS	3000
2	India Mark II Handpump m/c	–	1 no	4500	4500
3.	GI Riser pipe	32 mm dia	5m	80	400
4	Installation of handpump m/c and riser pipe	–	1 no	LS	200
5	RCC roof slab	(2x2x0 10)m/0.4 cum	1no	1800	720
6.	Drain		3m	100	300
			Total capital cost	Rs	9120

O & M costs @ 1.5% of capital cost = Rs 135/- per annum

Note All above costs are indicative and will vary with location & site conditions

Openwell(Dug) piped pumping W/S System

1. Brief description of technology

The basic part of openwell pumping system is electrically driven water lifting pump with suction and delivery pipes and foot valve /check valve at suction end Openwell is used as a water source From economic point of view, the existing well, with necessary repairs, should be preferred It should be covered with RCC-roof with a manhole to have access into the well Water is pumped into a overhead tank or some times direct pumping in the distribution pipes can be done. The water is distributed through tapstands & house connections

Range of depth

5 to 25 m

yield of well

More than 15 lpm

area of use

Rural areas of Bundelkhand and foot hills where openwells exist

Capital Cost

The cost of system for a population of 400, with 10m staging of CWR is about Rs 1,30,4000/-

2 Description of O&M activity Operation

This is done by a skilled caretaker Water is pumped into CWR in morning and evening or as per requirement The water is distributed from CWR The closing & opening of valve is done time to time by the caretaker

Maintenance

Proper repair of existing well apron and surface drain should be done as and when required Check leakage from pump, CWR and distribution pipes Check CWR and clean algae formation etc Clean leaves and surrounding vegetation around the well Remove pump and rising main from well and inspect annually. Check foot valve & suction pipe Replace badly corroded pipes Inspect electric cable and check insulation between cables

3. O & M requirement

activity	frequency	human resources	materials & spare parts	tools & equipment
take pump out of well, clean foot valve/check valve	annually	care taker		chain, pulley, two pipe wrenches, screwdriver, spanner
replace fuse	occasionally	care taker	fuse	screwdriver
replace piping	occasionally	skilled labour	thread pipes	pulley, two pipe wrenches, screwdriver, spanner
Well CWR & pipe repairs	occasionally	skilled labour	Cement, sand, pipes specials & fittings	pipe wrenches and dyes

4. Actors implied and skills required in O& M

actor	role	skills
user	occasionally assist caretaker	no special skills
caretaker	operate pump check water quantity and clearance	operation and maintenance of pump, more than basic skills
area mechanic	perform major repairs	specific skills
external support	check water quality, stimulate and guide organisation	microbial analysis, extension work

Organisational aspects

Organisation has to focus on training for maintenance of system and reliability of caretaker Funds raising and quick mobilisation of the area mechanic is required incase of break down

5. Recurrent costs

This cost will mainly depend on the costs for electricity, pumping head and quantities pumped Wages for a caretaker can also be large Cost of spares, material tools are often low compared to the expenses for electricity

6. Problems

Sand and other particles entering the pump, cause damage/ corrosion of suction pipe and rising main Damage to pipe line due to severe surge pressure caused by abrupt starting and stopping or pumps in case of direct pumping.

7. Limitation

Where existing openwells and electricity is available

8. Remarks

Pump characteristics should match with operating conditions in order to keep power consumption down

Example for calculating cost of openwell piped pumping w/s system

Assumptions

Design population = 400

No of households = 50

- Household connection - 30% of households
- Rest of population will be fed by tapstands
- Rate of water supply for tapstands = 40 lpcd
- Rate of water supply for HH connection(HSc) = 70 lpcd
- Average no of HSc tapstands = 15 nos
- Cattle water demand = 15% of human demand
- Discharge of source = 15 lpm
- Inside diameter of well = 4 m
- Minimum depth of water in well = 1 5 m
- Length of distribution system = 1000 m

Calculation

Water Demand

No of HSc = 30% of 50 = 15

No of HHs fed by tapstands = 70% of 50 = 35

No of tapstands = 35/15 = 2 33 say 3 nos

Total human demand per day (24 hours)

= tapstands demand + household connections demand

= (70% of 400) x 40 + (30% of 400) x 70

= 280 x 40 + 120 x 70 = 19600 lt = 19.6 say 20 cu.m

Cattle demand = 15% of 20 = 3 cu.m

Total water demand = 20 + 3 = 23 cu m

Capacity of clear water reservoir (12 hours storage

= 23 / 2 = 11.5 say 12 cu m

Example for calculating cost of openwell pipe pumping water supply system

Sl. No.	Component	Unit/Size	Quantity	Rate(Rs)	Cost(Rs)
(A)	Renovation of existing well				
1	Cleaning			LS	1000/-
2	Deepening			LS	4000/-
3	Repairs of platform & apron etc			LS	3000/-
4	R.C C Roof slab cover	cu m		2500 /	5950/-
5	Manhole	no	1	350/-	350/-
(B) Installation of electric pump					
1	Foundation for pump	no	1	LS	500/-
2	Motor with pumpset with starter & switch board etc	no	1	LS	12,000/-
3	Suction & delivery pipes	m	15	100/-	1500/-
4	Check valve / foot valve	no	1	250/-	250/-
5	Installation			LS	500/-
6	Electric connection (assuming electricity is available)			LS	2000/-
(C)	Rising main	m , 50 mm ϕ	30	125/-	3750/-
(D)	Overhead Tank (CWR)	no , 12 mm	1	36,000/-	36,000/-
(E)	Distribution system	m , 15 mm ϕ	500	40/-	20,000/-
		m , 20 mm ϕ	250	50/-	12,500/-
		m , 25 mm ϕ	250	70/-	17,500/-
(F)	tapstands	no	3	1200/-	3600/-
(G)	Washing platforms	no	3	1000/-	3000/-
(H)	Cattle Troughs	no	1	3000/-	3000/-
		Total capital cost			1,30,4000/-

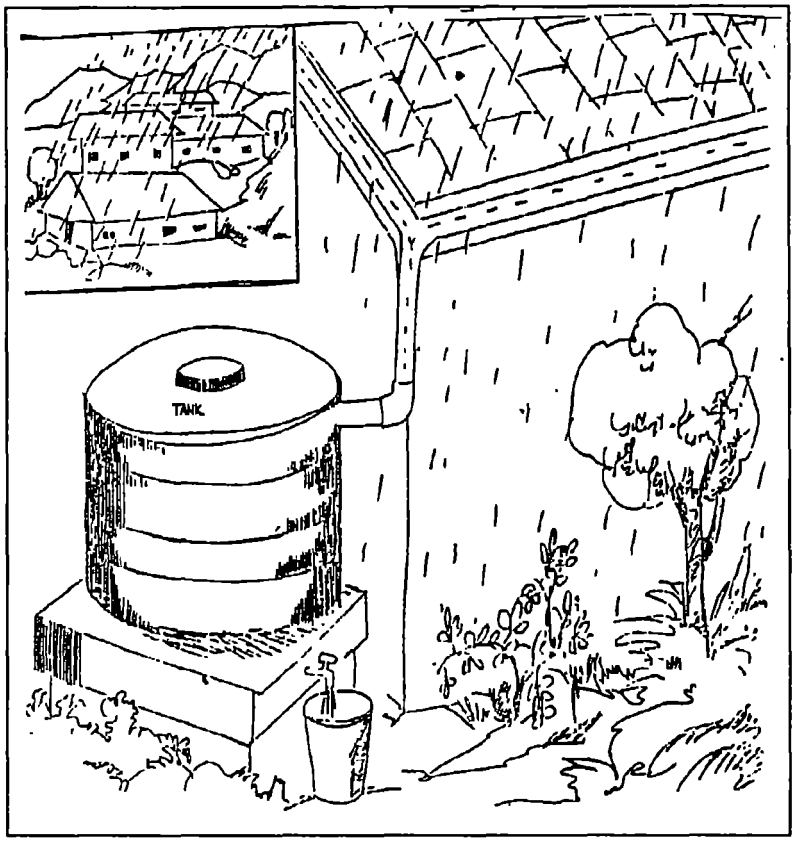
O&M Cost @ 5 % of capital cost = Rs 6520/- per annum

Note Above costs are indicative and will vary with the local site conditions and availability of local materials.

Rooftop Rainwater Harvesting

1. Brief description of technology

Rooftop catchment system collects rainwater precipitated on the roof of a house, school etc. using gutter and downpipes (made of local wood, bamboo, GI or PVC) and lead it to one or more storage containers ranging from simple pots to large masonry concrete, and ferrocement tanks If properly designed, a first flush device or detachable downpipe is fitted for exclusion of the first 20 litres of runoff during a rainstorm, which is generally most contaminated with dust, leaves, insects and bird droppings. Sometimes runoff water is led through a small filter consisting of gravel, sand and charcoal before entering the storage tank Water may be abstracted from the tank by a tap, handpump.



Capital cost:

The capital cost of rainwater harvesting for a family of 5 persons comes out to be Rs 12000/= for a dry period of 250 days

Yield:

Potentially almost 1 litre per horizontal square meter per mm rainfall This quantity is usually sufficient for drinking purposes

Area of use :

At the places where one or two rainy seasons (especially in arid and semi-arid zones with average annual rainfall figures ranging from 250-750 mm) and where other improved water supply systems are difficult to realise

Construction :

Systems are usually produced locally.

2. Description of O & M activities

Operation

In case there is no first flush device, the user has to divert away the first 20 litres or so of every rainstorm. Fully automatic first flush devices often are not very reliable Water is taken from the storage tank by tapping, or pumping

Maintenance

Just before the start of the rainy season, the complete system has to be checked for holes and broken or affected parts and repaired if necessary Taps should be serviced

During the rainy season the system is checked regularly, cleaned when dirty and after every dry period of more than a month Filters should be cleaned every few months, filter sand should washed at least every six months and painting of the outside of ferrocement, masonry, concrete and metal tanks may be needed about once a year. Leaks have to be repaired throughout the year Chlorination of the water is necessary

All operation and maintenance activities can normally be executed by the users of the system Major repairs such as that of broken roof or tank, can usually be executed by a local craftsman, using locally available tools and materials Maintenance is simple but should be given ample attention

3. O & M requirements

activity	frequency	human resources	material & spare parts	tools & equipment
clean system	1-3 times per year	local	water	broom, brush, bucket
divert first flush	every storm	local		
clean filters	twice a year	local	water	screen, spade, bucket
disinfect reservoir	occasionally	local	chlorine	bucket
repair roof, gutters & piping	occasionally	local	tiles, metal sheet, asbestos cement sheet etc , bamboo or PVC pipes, nails, wire	hammer, saw, pliers, tin cutter, chisel
repair tap	occasionally	local area	washers	spanner, screwdriver
paint outside of metal reservoir	annually	local	anticorrosive paint	steelbrush, paintbrush
repair ferrocement reservoir	occasionally	local	cement, sand, metal mesh, wire	trowel, bucket, pliers, steel pan

4. Actors implied and skills required in O & M

actor	role	skills
user	divert first flush ,close taps after taking water, keep system clean	no special skills
caretaker	check functioning, , clean filters and rest of system, perform small repairs	basic skills
water committee	supervise caretaker, collect fees	organisational skills
local craftsman	repair roof, piping and tank	basic plumbing and masonry
external support	check water quality, stimulate and guide local organisation, train users	microbial analysis, extension work

Organisational aspects

The organisation of O&M of community shared roof or ground tank supplies is considerably more difficult than for privately owned systems Rooftop harvesting systems at school for instance may suffer water losses from a tap left open and padlocks are often needed to ensure careful control over the supply Ideally one person should be responsible for overseeing the regular cleaning and occasional repair of the system, control of water use etc.. Where several households have installed a communal system, for instance several roofs connected to one tank, VWSC shall manage distribution and O&M activities which may include collection of fees, control of the caretaker's work and of the water use by each family
VWSC can play an important role in monitoring the condition of the systems and the water quality, providing access to credit facilities in order to buy or replace a system, training of users/ caretakers for management and execution of O&M, and training of local craftsmen for larger repairs

5. Recurrent costs

Recurrent costs for materials and spare parts are very low Generally these costs are negligible The recurrent personnel costs, in cash or kind (for caretakers and craftsmen), will need to be added

6. Problems

Corrosion of metal roofs, gutters etc. Failure of functioning of the first-flush diverter due to neglect of maintenance. Leaking taps at the reservoir and problems.
Tanks may provide a breeding place for mosquitoes which may increase the danger for diseases such as malaria or dengue.

7. Limitations

The water may be insufficient to fulfil (drinking) water needs during certain periods in the year, making it necessary to also develop other sources or go back to traditional sources to overcome these periods

8. Remarks

Thatched roofs produce less and more contaminated water Tiled or metal roofs give the cleanest water The acceptation of rooftop water harvesting as a suitable system may depend on the users' perception regarding the taste of the water

Example for calculating cost of Rain Water Harvesting System

Assumptions

No of persons in family n= 5
Average consumption per capita q= 5 litres/ day for drinking only
Annual rainfall p= 750 mm
Runoff coefficient f= 0 8 (for corrugated metal sheet)
Dry period t=250 days
Size of roof = 5m x 4m

Calculations

Consumption for dry period Qa = n x q x 250
= 5 x 5 x 250 = 6250 litres = 6 25 cum

Required roof catchment A = Qa / (f x p)
= 6 25 / (0 8 x 0.75) = 10 4 sqm

Required Tank Volume

Assuming that the tank will be full at the start of the dry season and only has to satisfy the water needs for the dry period, and no evaporation of stored water will take place, the required tank volume
V = t x n x q = 250 x 5 x 5 = 6250 litres = 6 25 cum say 7 cum

Length of water collecting channel = 2 x length of roof + width + extra upto first flush diverter
= 2 x 5 0 + 4 0 + 2 0
= 16 m

Itemwise Costs

Component	Size/ Capacity	Quantity	Rate(Rs)	Cost (Rs)
1. Ferrocement Tank	7 cum	1 no	8,000/-	8,000/-
2. Water collecting channels of plane GI sheets	0 45 m wide	16 m	100/ -	1600/-
3 Filter unit		1 no	500/ -	500/-
4 Pipes & specials			LS	500/-
5 Screening arrangement			LS	100/-
6 Taps & platform			L S.	1000/-
7 Drains		3 m	100/ -	300/-
		Total Capital Cost		12,000/-

O&M Cost @ 1.5 % of capital cost = 180/- per annum

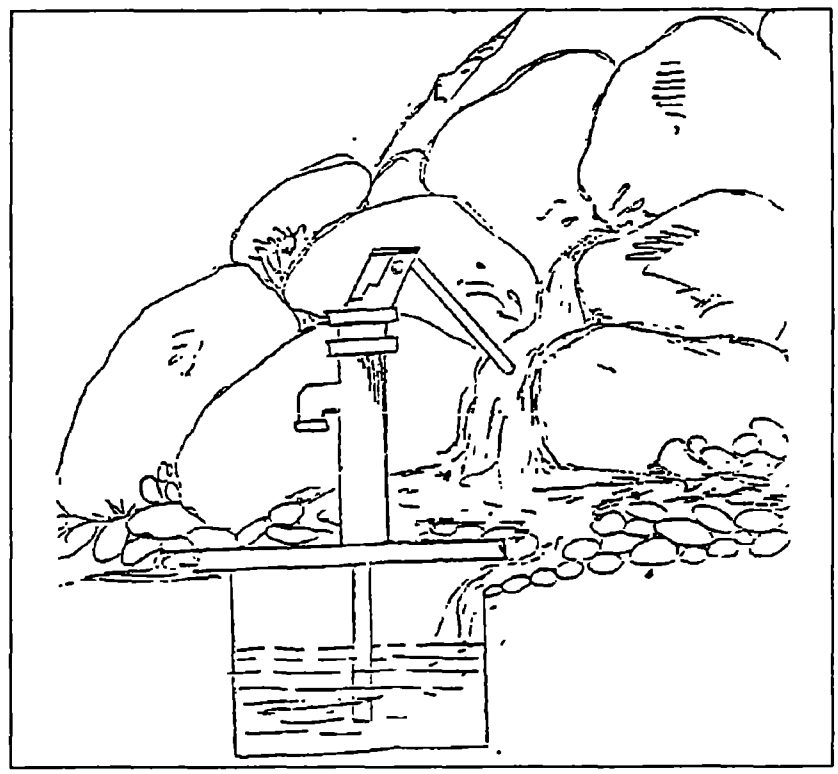
Note

* Above costs are indicative and will depend upon the extent and type and capacity of reservoir These costs will vary with location and site conditions

Spring Hand Pump Water Supply System

1. Brief description of technology

In the hills, springs are widely available Spring water is usually fed from a sand or gravel water bearing ground formation (aquifer), or water flows through fissures and fractures of hard rock When a water line of sub surface flow of water cuts the ground surface, the spring emerges out. At this point a masonry chamber is constructed with stone or brick to collect water Top of masonry chamber is then covered with RCC slab An India Mark II or local hand pump m/c is installed and a proper drainage arrangement is constructed to carry away the surplus water. Water is drawn with the help of handpump m/c



Capital cost

Capital cost of this system is about Rs 25940/-

2. Description of O& M activities

Operation

Operation includes handling of handpump ie water is drawn from well by moving a handle up and down. HP can be easily operated by men, women and children

Maintenance

This can normally be done by a village caretaker or by users themselves using simple tools, basic spare parts and materials
For preventive maintenance of hand pump, refer to the fact sheet of deep bore well handpump water supply system. Spring collection chamber (SCC)should be checked for leakage and silt accumulation.
Large repairs may require higher skilled labour.

3. O & M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean pump and site	daily	community	water	broom
check performance	daily	—do—	–	
check whole pump	annually	—do—	–	spanners, screwdriver
replace cupseals and washers	occasionally	—do—	seal and washers	spanners, wrench
replace pump rod and/or pump handle	occasionally	—do—	pump rods, handle	spanners, wrench, dye set and vice
replace cylinder and /or plunger and /or foot valve	occasionally	—do—	cylinder, plunger, foot valve	spanners, wrench, screwdriver
repair rising mains	occasionally	—do—	PVC tubing, PVC solvent and sandpaper or GI pipe	saw, file and tow pipe wrenches
repair pump platform and masonry chamber	annually	—do—	cement, gravel, sand,	bucket, trowel

4. Actors implied and skills required in O & M

actor	role	skills
user	pump water keep site clean inform in case of malfunctioning	no special skills
caretaker	keep site clean regularly check pump, masonry chamber do small repairs	basic maintenance
water committee	supervise caretaker collect fees	organizing skills
area mechanic	perform more major repairs	some special skills depending on brand
external support	check water quality stimulate and guide local organisation	microbial analysis extension work

Organizational aspects

O & M can be very well organised at community level As maintenance is relatively simple, a good organisation will result in a reliable service

5. Recurrent cost

Recurrent material costs are usually small The recurrent personnel costs in cash or kind will need to be added, but usually will be low as well

6. Problems

Worn washers, plungers and foot valve parts Abrasion of the seal on the cylinder and between the pump rod and rising main (nitrile rubber seals are better). Broken and damaged handles Damaged drain

7. Limitations

High demand of water quality and quantity may not be met by this system.

Example for calculating cost of Spring Hand Pump w/s system

Assumptions

Design population = 100
Dia of masonry chamber D = 2m
Depth of masonry Chamber H = 4m

Calculations:

Capacity of chamber = ^/4 x D^2 x H
= ^/4 x (2x2) x 4 = 12 56 cum (say 13 cu m)

Itemwise Costs

Sl. No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1	Masonry Chamber	13 cu m	1no	10000	10000
2.	India Mark II Hand Pump m/c	–	1no	4500	4500
3	GI Riser pipe	32mm dia	5m	80	400
4.	Installation of Hand Pump m/c & riser pipe	–	1 no	LS	200
5.	RCC roof slab circular	2m dia/ 0 3 cu.m	1no	1800	540
6	Drain		3m	100	300
				Total capital cost =	Rs. 25940

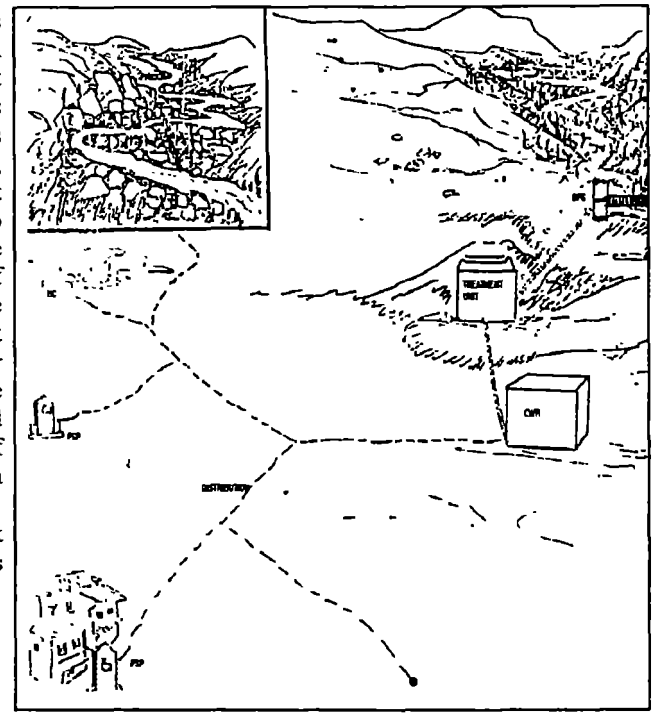
O & M costs @ 1.5% of capital cost = Rs 390/- per annum.

Note All above costs are indicative and will vary with location & site conditions.

Stream/River Gravity Water Supply System

1. Brief description of Technology

River and streams are widely available in hills and foot hills Water from a stream is drawn through an infiltration arrangement across or at the bank of the stream This arrangement is known as boulder filled gallery (BFG) Water is collected in a chamber through perforated pipes, embedded under the bed of the stream. It is built to withstand the damage by floods and to minimise problems caused by sediments These BFGs are sturdy structures, usually made of stone masonry or reinforced concrete and have valves or sluices to flush any sediment that might settle. Often BFG is combined with a weir in the stream that keeps the water at the required level, a sand trap to let sand settle and a spillway to release excess water In case of rivers, water may enter the intake through a screen or a spillway overflow may be provided Other components of the system are treatment unit i e SSF, CWR, distribution, pipes tapstands and house connections (HCs)



Yield: Depends on size etc.

Area of use: In areas where streams and rivers are available at higher altitude than that of community under consideration

Capital costs Capital costs vary considerably and depend on demand of water and distance of water source from community The cost for 1000 users is about Rs. 4,79,500/-

2. Description of O&M activities

Operation

Source works should be inspected weekly. Check the upstream and downstream of the cross wall these should not be damaged. Check the cracks etc in the BFG, treatment unit & CWR A washout, located under the weir and in BFG should be operated weekly Caretaker opens the valve/ sluice at CWR Chlorination is done daily at CWR Cleaning of CWR, whenever required, is to be done by the caretaker and the community Water drains around Intake, CWR, Treatment Unit and CWR are cleaned

Maintenance

Prevent biological contamination i e latrine and use of pesticides, chemicals on upstream side of intake arrangement. Human habitation and cattle grazing is not allowed in upstream of the stream Immediate surroundings of source should be cleaned or fenced. Any erosion damage to bank or bed has to be repaired Check water flow, turbidity of water, algae formation in CWR and treatment unit.
Check SSF, clean and replace the sand and gravel bed. Clean chlorination tank and check for required chlorination of clear water.
Check silting of CWR and distribution pipes Check and clean the platform and drains of tapstand. Small repair should be done immediately before further damage takes place Gasket of valve are checked and sealed properly Taps are closed always and opened only at the time of use. Most of daily maintenance is done by caretaker while annual repair will be undertaken by the VWSC.

3. O&M requirement

activity	frequency	human resources	materials & spare parts	tool & equipment
clean properly the surrounding around Intake works, treatment unit, CWR & BPT	weekly	local	water	broom, bucket, hoe, machete
check turbidity	after each rain/ flood	local		turbiditymeter
check water quantity	occasionally	local		bucket, watch
repair fence of pump house, treatment unit & CWR	occasionally	local	wood, rope, wire	machete, axe, knife, hoe, spade, pick axe
check water quality	regularly	area	laboratory reagents	laboratory equipment
wash and disinfect CWR	annually	local	chlorine	bucket, wrench, brush
repair piping, valves and tapstands	occasionally	local or area	spare pipes and valves, cement, sand, gravel	bucket, trowel, wrench, flat spanners
repair cracks in structures	annually	local	cement, sand, gravel, clay	bucket, trowel, hoe, spade, wheel, barrow

4. Actors implied and skills required in O&M

actor	role	skills
user	use water , report malfunctioning , keep site clean, assist in major repairs	no special skills
caretaker	keep site clean, check for damage, perform, small repairs	basic skills
VWSC	organise bigger repairs, control caretaker's work	organisational skills
mason	repair masonry or concrete	masonry
external support	check water quality, guide and stimulate local organisation	microbial analysis, extension work

5. Problems

Damage to BFG or weir and tapping arrangement due to wrong design and site selection, large surface run- off may damage the works. Leakage in BFG, CWR and distribution pipes may cause problem Closing of pipe in BFG & treatment plant & distribution system may also cause problem. Land slide may damage pipe lines. Problem may arise when suddenly large investments are needed for large repairs and replacement of pipes

6. Limitations

Stream and river should be at higher elevation than that of community, and should be perennial. Source measurement is done during dry season Available quantity should be more than design demand Open space required for source works and treatment unit should be available Chlorination is necessary.

7. Remarks

Intake source works and treatment unit should be protected from heavy rains or floods. Regular repair should be made Disinfection should be done carefully by caretaker

Example for calculating cost of Stream/ River Gravity Water Supply System

Assumptions

Design population = 1000

No of households = 200

Household connection(HCs) = 30% of households
Rest of population will be fed by tapstands.
Rate of water supply for tapstands = 40 lpcd

Rate of water supply for HCs	= 70 lpcd
Discharge of source	= 250 lpm
Average no. of HCs/ tapstand	= 15 nos
Cattle water demand	= 15% of human demand
Length of conveyance main	= 1500m
Length of distribution pipes (GI/ HDPE)	= 3000 m

Calculations

No of HCs	= 30% of 200	= 60
No of households covered by tapstands	= 70% of 200	= 140
No of tapstands	= 140/15	= 9.33 say 10 no

Total human water demand per day (24 hours)
= tapstands water demand + HCs water demand
= (70% of 1000) x 40 + (30% of 1000) x 70
= 700 x 40 + 300 x 70 = 49000 litres = 49 cum

Cattle water demand = 15% of 49 = 7.35 cum say 8 cum
Total water demand / day = 49 + 8 = 57 cum
Capacity of clear water reservoir (12 hours storage)
= 57 / 2 = 28 5 cum say 30 cum

Itemwise costs

Sl. No.	Component	Size/ Capacity	Quantity	Rate(Rs)	Cost(Rs)
1	Boulder Filled Gallery BFG	2.0 m x 2 5 m with 3.0 m Cross wall	1 no	50000	50000
2.	Conveyance main GI pipe medium	63 mm ϕ	1500m	125	187500
3	Treatment Unit (Chlorination)		1 no	100000	100000
5	Distribution System HDPE pipes	63mm ϕ 50mm ϕ 32mm ϕ 25mm ϕ 20mm ϕ 15mm ϕ	500m 500m 500m 500m 500m 500m	125 70 50 40 30 25	62500 35000 25000 20000 15000 12500
6	Tapstands		10 nos	1200	12000
7	Washing platforms		10 nos	1000	10000
			Total capital cost =	Rs	479500/-

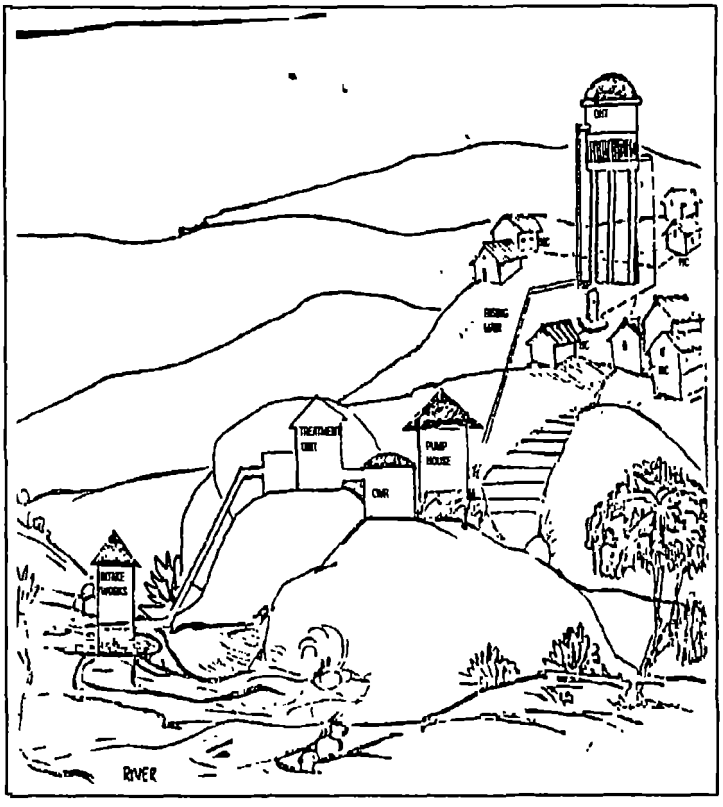
O&M costs @ 3 5% of capital cost per annum = Rs. 25000/- per annum

Note
* All above costs are indicative and will vary with location and site condition
* Dimensions of BFG, CWR & other structures will vary as per site conditions

Stream/ River Pumping Water Supply System

1. Brief description of technology

In stream/ river pumping w/s system, river intakes for drinking water usually constructed in streams and small rivers, where sediment content and bed load transport are low The water is abstracted through a screen over a channel, usually made of concrete, that is built in the stream or river bed The bars of the screen are laid in the direction of the current and sloping downwards so that coarse material can not enter and continues its course. Water is pumped into a raw water sump at raw water treatment plant. Water being surface water, it is treated and clear water is pumped to CWR This water is distributed to the community through distribution pipes, tapstands and house connections



Yield: Depends on size etc

Area of use: In areas where streams and rivers are available and no other economical water supply system is feasible.

Capital cost: Depends on quantity of water and height to which water to be pumped. The cost of this system for 2000 population, for a pumping of 100m height, is about Rs 6,34,800/-

2. Description of O&M activities

Operation

Operation is usually done by caretaker. The inlet must be checked regularly Debris obstructing it must be removed and any damage should be repaired. The sand trap must be cleaned regularly Care taker looks after the raw water (RW) and clear water pump houses (PHs) and treatment unit. Chlorination is done daily Cleaning of RW sump, CWR, PHs, treatment unit and surrounding areas is done as when required

Maintenance

Preventive maintenance consists of painting screens and other metal parts like sluices or valves Depending on silt and bed load transport, screens will have to be cleaned regularly and sometimes the screen or a valve may need repair. Any erosion undermining the structure must be repaired immediately. Each year the concrete structure has to be checked for cracks and repaired if needed Check silting of raw water sump, CWR and scour valves in distribution pipes Check and clean the platform and drains Small repairs should be done immediately to prevent further damage Gasket of valves and pumps are checked and sealed properly Taps are closed always and opened only at the line of use Most of maintenance is done by caretaker, while major repairs like repair of pumps or replacement of pumps, intake arrangement, treatment unit can be managed by VWSC.

3. O&M requirement

activity	frequency	human resources	materials & spare parts	tool & equipment
inspect intake, valves, pumps	daily	local	—	—
clean properly the surroundings around intake works raw water PH, clear water PH, CWR and BPT	weekly	local	water	broom, bucket, hoe, machete
check turbidity	after rains/ flood	local		turbiditymeter
check water quantity	occasionally	local		
repair screen and fence of pump houses, treatment unit & CWR	occasionally	local	wood, wire, nuts and bolts, welding electrodes and welding equipment	machete, axe, knife, hoe, spade, pick axe
check water quality	regularly	area	laboratory reagents	laboratory equipment
repair piping, valves and tapstands	occasionally	local or area	spare pipes and valves, cement, sand, gravel	bucket, trowel, wrench, flat spanners
repair cracks in structures	annually	local	cement, sand, gravel, clay	bucket, trowel, hoe, spade, wheel, barrow
paint building works	as and when required	local	lime and paint	steel brush, which wash and paint brush

4. Actors implied and skills required in O&M

actor	role	skills
user	use water , report malfunctioning , keep site clean, assist in major repairs	no special skills
caretaker	inspection, cleaning, check for damages, perform small repairs, operation of valves	basic skills
VWSC	organize bigger repairs, control caretaker's work	organizational skills
mason	repair masonry or concrete structures	masonry
external support	check water quality, guide and stimulate local organization	microbial analysis, extension work
black smith	repairs steel works	welding

5. Problems

Damage to intake arrangement. Leakage in building works, treatment unit, CWR and distribution pipes may cause problem Land slide may damage pipelines Problem may arise when suddenly large investments are needed for large repairs and replacement of pipes and pumps

6. Limitations

Stream and river should be perennial Source measurement is done during dry season Available quantity of water should be more than design demand Open space required for source works and treatment unit should be available Chlorination is necessary

7. Remarks

Intake works should be protected from heavy rains or floods Regular repair should be made Disinfection should be done carefully by caretaker

Example for Calculating cost of Stream/River Pumping Water Supply System

Assumptions

- Design population = 2000
- No. of households = 400
- Household connections (HCs) = 30% of households
- Rest of population will be fed by public standpost
- Rate of water supply for tap stands = 40 lpcd
- Rate of water supply for (HCs) = 70 lpcd
- Average no of HH/standpost = 15 nos.
- Cattle water demand = 15% of human water demand
- Length of distribution pipes = 2500 m

Calculations

- No of households covered by (HCs) = 30% of 400 = 120
- No of households covered by tapstands = 70% 0f 400 = 280
- No of tapstands 280/15 = 18.66 say 19 nos
- Total human water demand per day = tapstands water demand + HCs water demand
  = (70% of 2000) X 40 + (30% 0f 2000) X 70
  = 1400 X 40 + 600 X 70 =98,000 litres = 98 cu m
- Cattle water demand = 15% of 98 cum = 14 70 say 15 cu m
- Total water demand = 98+15 = 113 cu m
- Capacity of clear water reservoir = 113 cu m say 120 cu m
- Capacity of Overhead Tank (CWR) = 120/2 = 60 cu. m

Item wise costs

Sl. No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1	Intake Works		1 no	LS	60,000
2	Raw water Pump house(RWPH)		1no	LS	30,000
3.	Raw water pumps		2 no	LS	30,000
4.	Raw water rising learn		1 no	LS	15,000
5	Treatment Unit		1 no	LS	50,000
6.	Clear water Sump		1 no	LS	10,000
7.	Clear water pump house(CWPH)		2 nos	LS	30,000
8	Clear water pumps		1 no	LS	30,000
9	Rising Main		300m	LS	45,000
10	Overhead Tank (CWR)	60 cum	1 no	LS	1,60,000
11	Distribution System (HDPE pipes)	50 mm	1000 nos	70	70,000
		32 mm	500 nos	50	25,000
		20 mm	500 nos	27	13,500
		16 mm	500 nos	25	12,500
12	Tapstands		19 nos	1200	22,800
13	Washing Platforms		1 9 nos	1000	19,000
14	Cattle troughs		4 nos	3000	12,000

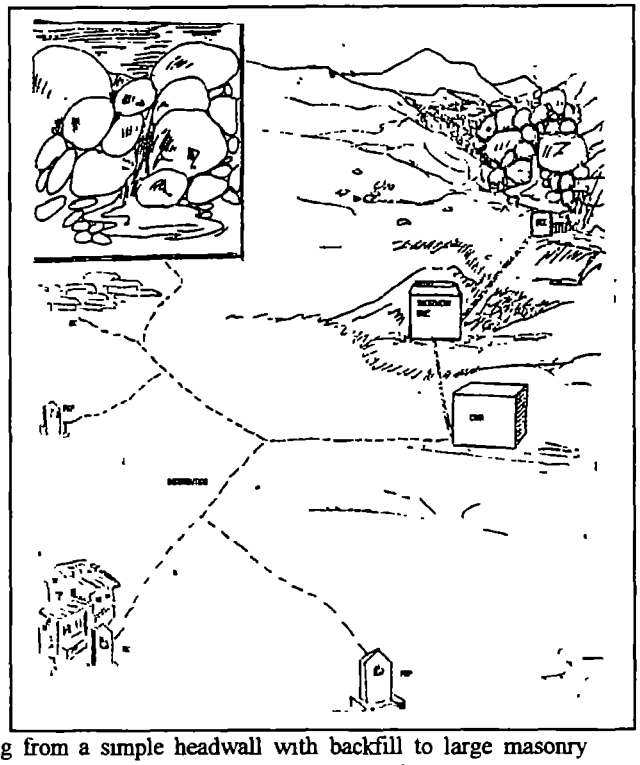
Total capital cost = Rs. 6,34800

O & M costs @ 5% of capital cost = Rs 31740/- per annum

Note The above costs are indicative and will vary with actual site conditions

Spring Gravity W/S System

1. Brief description of technology:



Spring water captation system abducts and protects ground water flow at the points where they arrive at the surface to facilitate their abstraction Spring water is usually fed from a sand or gravel water-bearing ground formation (aquifer), or a water flow through fissured rock Where solid or clay layers block the underground flow of water, it is forced upwards and can come to the surface. The water may emerge either in the open as a spring, or invisibly as an outflow into a river, system or lake The main parts of a spring water captation chamber (SCC) are a drain under the lowest natural water level, a protective structure providing stability and a seal to prevent surface water from leaking in The drain usually is placed in a gravel pack covered with sand and may lead to a conduit or a reservoir The protective structure may be made of concrete or masonry and the seal is usually made of puddle clay, concrete and sometimes plastic A screened overflow pipe guarantees that the water can flow freely out of the spring at all times To prevent contamination from infiltrating from the surface, a ditch, known as the interceptor drain, diverts surface water away from the spring box and a fence keeps animals out of the spring area

There are many types of spring captations, ranging from a simple headwall with backfill to large masonry structures for collecting water from a larger area These structures consist of washout & overflow arrangements Other components of the water supply system are Treatment unit, CWR fed by gravity from the SCC, BPT, network of distribution pipes, tapstands and house connections

Dimensions: From 1 sq m to many sq m

Yield: From less than 0 1 litter/second to many litres/second

Area of use: In areas where ground water arrives at the surface, usually at hill or mountain sides.

Construction: Spring water captation systems are constructed on-site, often by local craftsmen

Capital Cost : Capital costs vary considerably and depend on a large number of factors The indicative cost for 500 users is about Rs 3,63,000 00

2. Description of O&M activities

Operation

Water should be permitted to flow out freely all the time to avoid that it finds another way out of the aquifer Operation may include activities such as opening or closing of valves to divert the water to a reservoir, a conduit or a drain Spring and surroundings must be kept clean The supply of water from CWR is controlled through valves

Maintenance

Prevent contamination (e g open defecation, latrines, cattle gathering places, use of pesticides/ chemicals etc) both in the area where the spring water infiltrates into the ground (if possible) and in the immediate surroundings of the spring The leakages in the CWR, pipe lines and tapstands are checked and repaired quickly SCC and CWR are cleaned occasionally and if silt is found, should be cleared through washouts.

Check the surface drains, animal-proof fence and gate and repair if necessary. Protect the vegetative cover both in the area where the spring water infiltrates into the ground (if possible) and in the immediate surrounding of the spring (prevent clogging of the aquifer by vegetative growth (roots) in the immediate surrounding of the spring).

Check the water flow from the spring captation chamber If there is an increase in turbidity or flow after a rainstorm, surface runoff has to be identified and the protection of the spring improved. If water flow decreases, it has to be suspected that the collection system is clogged It may then be necessary to take out the gravel and replace with new gravel, or in case a seep collection system is used, to clean the collection pipes Regular water samples must be taken and analyzed to check for evidence of fecal contamination.

Annually open the washout of SCC, CWR & BPT to remove all accumulated silt Check all screens; replace(with non-rusting material, e g. copper or plastic screening) if damaged or blocked, clean if dirty. After cleaning, make sure to close the washout valve thoroughly and replace and seal the manhole cover Disinfect the SCC and CWR every time a person has entered to clean or repair it or when bacteriological contamination is suspected Leaks in the protective seal or undermining of the headwall and damage caused by erosion or settlement of soil have to be repaired Check leakages of SCC, CWR, BPT and in distribution system and repair them. Air valves and scour valves must be checked monthly

3. O&M requirements

activity	frequency	human resources	materials & spare parts	tool & equipment
clean properly surrounding around SCC, CWR & BPT	weekly	local		broom, bucket, hoe, machete
check turbidity	after each flood	local		
check water seal & quantity of water	occasionally	local		bucket, watch
repair fence and clean surface drains	occasionally	local	wood, rope, wire	machete, axe, knife, hoe, spade, pick axe
check water quality	regularly	area	laboratory reagents	laboratory equipment
wash and disinfect spring captation chamber & CWR	annually	local	chlorine	bucket, wrench, brush
repair piping, valves and tapstands	occasionally	local or area	spare pipes and valves, cement, sand, gravel	bucket, trowel, wrench, flat spanners
repair cracks	annually	local	cement, sand, gravel, clay	bucket, trowel, hoe, spade, wheel, barrow

4. Actors implied and skills required in O&M

actor	role	skills
user	use water , report malfunctioning , keep site clean, assist in major repairs	no special skills
caretaker	keep site clean, check for damage, perform, small repairs	basic skills
VWSC	organize bigger repairs, control caretaker's work	organizational skills
mason	repair masonry or concrete	masonry
external support	check water quality, guide and stimulate local organization	microbial analysis, extension work

Organizational aspects

In many cases, springs are owned by the community Users may need to establish an organization (VWSC) that can effectively deal with issues such as the control/ supervision of the water use, prevention of water contamination, execution of O&M activities, financing performance etc Proper management may also contribute to preventing social conflict over these and other issues These issues will be dealt by VWSC

For the execution of O&M tasks at the spring site, a person who lives or farms near this site should be appointed This person could also be made responsible for water allocation if water is obtained by the users near

or at the site, and be involved in monitoring activities His or her authority should be clear and accepted by all users

5. Recurrent costs

Recurrent material costs are usually very low. The recurrent personnel costs, in cash or kind (for caretakers, watchmen, labourers, and craftsmen), will need to be added but will usually be low as well. Total recurrent cost are usually less and includes O&M costs for the water transport system Several sources report that "O&M costs are minimal and , for this reason, spring water technology is the technology of choice wherever sites permit."

6. Problems

Erosion or collapse of the SCC due to wrong design, construction errors, large surface run-off flows or damage caused by people or animals. Leakages in the chambers, taps and valves. Contamination of the spring water due to cracks in the seal or to behavior of people Damaged piping because of faulty construction, abuse or corrosion. Improper drainage of surface runoff, outflow and wastewater Clogged pipes because of siltation or plant roots Poor accessibility for water users.

7. Limitations

Springs may not deliver enough water or fall dry during certain parts of the year Not all springs produce clean water of acceptable taste. Springs may be sited too far from the households or on privately owned land In some cases, cost of construction, large repairs or replacement may be beyond the capacity of communities Some spring water is very corrosive

8. Remarks

Usually spring water is of good quality but this should be checked, examples exist where the water was fed from a polluted stream that had gone underground or where the catchment area was contaminated. Unprotected springs are almost always contaminated at the outlet.

Example for Calculating cost of Spring Gravity Water Supply System

Assumptions:

Design population	= 500
No of households	= 100
Households connections (HCs- 30% of HHs	
Rest of the population will be fed by tapstands.	
Rate of water supply for tapstand	= 40 lpcd
Rate of water supply for house connection	= 70 lpcd
Discharge of source	= 30 lpm
Average no of HH/ stand post	= 15 nos
Cattle water demand	= 15% of human demand
Length of distribution line of GI/HDPE pipes	= 2000 m
Length of conveyance main	= 1500m

Calculations:- Human Water Demand

No of tapstands	= 70/ 15 = 4 66 say 5
No of household connections	= 30
Total human water demand per day(24 hours)	= Tapstands demand + HCs demand = (70% of 500) x 40 + (30% of 500) x 70 = 350 x 40 + 150 x 70 = 24500 lit = 24 5 cum say 25 cum
Cattle water demand	= 15% of 25 0 = 3 5 cum say 4 cum
Total water demand	= 25 + 4 = 29 cum
Capacity of clear water reservoir (12 hours storage)	= 29/ 2 = 14.5 say 15 cum

Itemwise Cost:-

Sl. No.	Component	Size/ Capacity	Quantity	Rate (Rs)	Cost (Rs)
1	(i) Spring captation chamber (SCC)	2 x 2 x 2 m	1 no	15,000	15,000
	(ii) Spring captation chamber (SCC)	1 x 1 x 0 75 m	1 no	6,000	6,000
2	Conveyance main GI pipe medium	40 mm ϕ	1500 m	100	150,000
3	Treatment Unit (Chlorination)		1 no	6,000	6,000
4	Clear Water Reservoir (CWR)	18cum	1 no	60,000	60,000
5	Distribution System GI pipes medium quality	25 mm ϕ, m 20 mm ϕ , m 15 mm ϕ, m	10000 500 500	70/ - 50/- 40/-	70,000 25,000 20,000
6	tapstands	nos	5	1200 /-	6,000
7	Washing Platforms	nos	5	1000/-	5,000
Total Capital Cost				Rs 3,63,000	

O&M Costs @ 3.5% of capital cost per annum = Rs 12705/- per annum

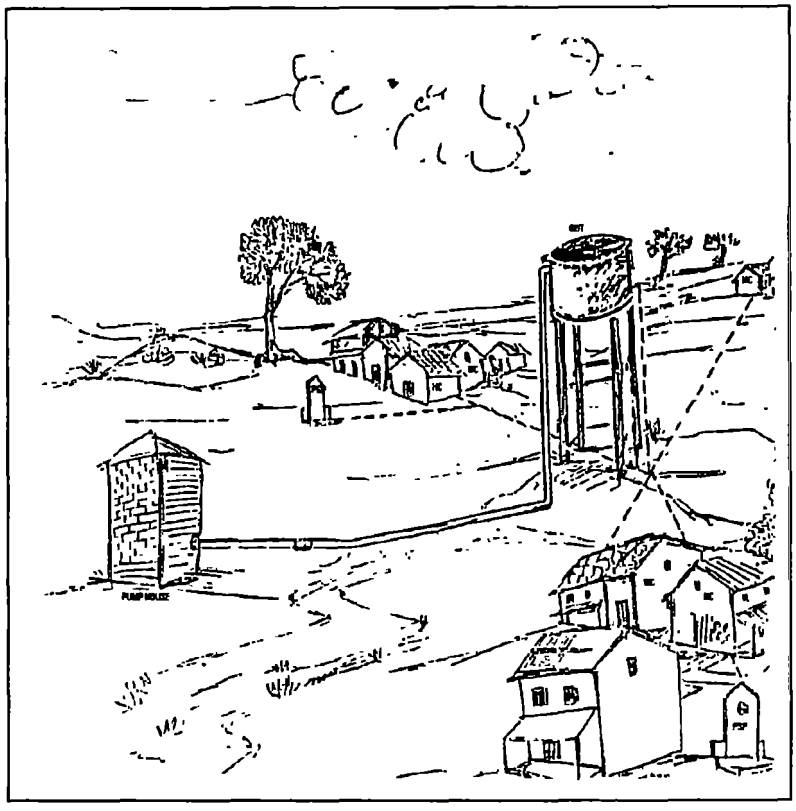
Note:-

* All the above costs are indicative and will vary with location & site conditions
* Dimensions of SCC, CWR & others will vary as per actual conditions

Deep Tubewell Pumping W/S System

1. Brief description of technology

For deep tubewell applications, centrifugal pumps come in a single unit combining a common housing fitted with an electrical motor Because pump and motor are submerged under water, this is called submersible pump Usually it is a multi-staged pump, placed above the motor and under a non return valve which leads to the rising main. Submersible pumps are self-priming . In order to prevent the pump from running dry, the water level in the well must be monitored and pumping must be stopped if the water level drops to the intake of the pump. Power is delivered through a heavily insulated electric cable connected to a switch panel at the side of the well It may come from an AC mains connection. Water is pumped to a overhead tank (CWR) and sometimes even by directing pumping into distribution pipes The water is distributed to the community through Tapstands and house connections.



Capital cost range

The cost of tubewell pumping system for a population of 2000 is about Rs 5,75,540 00

area of use

Where underground water, technical service and electric power are available

2. Description of O&M activities :

Operation

During pumping, check water flow, clearness and power consumption of pump If water is turbid only during the first stages of pumping, the rising main is corroding. If turbidity continues, the well has to be cleaned or the pump will wear quickly Report running hours, problems, servicing, maintenance and repairs in logbook Pump operation and closing of valves is done by a caretaker. Pressure chlorination is done and dosing is so adjusted that 0 2 ppm chlorine is available at the remote water point. CWR is filled by pumping water from tubewell The supply of water is controlled with the help of valves

Maintenance

Remove pump and rising main from well and inspect annually Check inlet screen, check valve and pipe threads and re-cut corroded or damaged threads Replace badly corroded pipes Inspect electric cables and check insulation between cables Check leakage in CWR, pipe lines tapstand & HCs CWR is checked and clean occasionally and if silt is found , should be cleared through washout All the repairs should be attended immediately
All other repairs, like replacement of stages, involve high costs and have to be done by a qualified technician

3. O & M requirement:

activity	frequency	human resources	materials & spare parts	tools & equipment
take pump out of well, clean inlet screen and check valve	annually	care taker		chain, pulley, two pipe wrenches, screwdriver, spanner
replace fuse	occasionally	care taker	fuse	screwdriver
replace piping	occasionally	skilled labour		chain, pulley, two pipe wrenches, screwdriver, spanner
replace stages	occasionally	skilled labour		chain, pulley, two pipe wrenches, screwdriver, spanner, specialised tools
pump house, CWR, pipe and tapstand repairs	occasionally	skilled labour	cement sand pipe specials & fittings	pipe wrenches, dyes
cleaning of CWR	occasionally	skilled labour	lime	broom and bucket

4. Actors implied and skills required in O& M:

actor	role	skills
user	occasionally assist caretaker	no special skills
caretaker	operate pump, check water quantity and clearness	operation and maintenance of pump, CWR, more than basic skills
area mechanic	perform major repairs	specific skills
external support	check water quality, stimulate and guide organisation	microbial analysis, extension work

Organisational aspects

Submersible pumps can function for years with hardly any maintenance at all VWSC has to focus on training and reliability of the caretaker, fund-raising and quick mobilisation of the area mechanic in case of breakdown of pumps or leakages

5. Recurrent costs :

Recurrent costs will mainly depend on the costs for electricity, pumping head and quantities pumped. Wages for a caretaker can also be large cost element. The costs for spare parts, materials, tools and equipment are often low compared to the expenses for electricity

6. Problems:

Sand or other particles entering the pump, causing abrasion Corrosion of rising main Damage to pipeline system due to severe pressure surges caused by abrupt starting and stopping of pump Leakages is in distribution pipelines and tapstands

7. Limitations:

Price and reliability of electricity and high technology level are the main limitations

8. Remarks:

Since submersible pumps are designed for specific ranges of flow and pressure, it is important to match pump characteristics with operating conditions in order to keep power consumption down. Promptness in attending the leakages in the system is also equally important, as to have the water supply at required pressure

Example for calculating cost of Deep Tubewell Pumping w/s system

Assumptions

Design population = 2000
No of households = 400
Household connections (HCs) - 30% of households
Rest of population will be fed by tapstands
Rate of water supply for tapstand = 40 lpcd
Rate of water supply for HCs = 70 lpcd
Average no of HCs /tapstand = 15 nos
Cattle water demand = 15% of human demand
Minimum pumping time = 8 hrs per day
Length of distribution system = 2000 m

Calculations

Human water Demand
NO of HCs = 30% of 400 = 120
No of HHs fed by tap stands = 70% of 400 = 280
No of tapstands = 280/ 15 = 18 6 nos say 19

Total human water demand per day
= tapstands demand + HCs demand
= (70% of 2000) x 40 + (30% of 2000) x 70
= 1400 x 40 + 600 x 70 = 98,000 lit = 98 cu.m

Cattle water Demand = 15% of 98 = 14 7 say 15 cu.m
Total water demand = 98 + 15 = 113 cu.m
Capacity of clear water reservoir (12 hours storage)
= 113/2 = 56 5 say 58 cu.m
Required pumping rate/ hrs. = (113 x 1000)/8 = 14125 lit/hrs = 235 lpm
Required tube well discharge assuming 60% yield as safe pumping = 235 / 0.6 = 392 lpm
This discharge report / expected yield of any aquifer should be checked from Remote Sensing Application Centre (RSAC) and Ground Water Investigation Organisations, before starting drilling of tubewell

Itemwise Costing

Assuming the drilling of tubewell is done by DC rig in alluvial soil

Sl. No.	Component	Unit / Size	Quantity	Rate(Rs)	Cost(Rs)
A	Tube well cost				
1	Geophysical survey		one job	1000/-	1000/-
2	Transportation of rig m/c & accessories		one job	LS	5000/-
3	Drilling charges				
	(i) Pilot bore 200 mm	m	65	140/-	9100/-
	(ii) Bore 300 mm	m	65	140/-	9100/-
	(iii) Bore 450 mm	m	35	140/-	4900/-
4	Lowering of pipe assembly				
	(i) 150 mm slotted pipe	m	18	425/-	7650/-
	(ii) 150 mm MS class B plain pipe	m	12	350/-	4200/-
	(iii) 200 mm MS class B plain pipe for housing	m	32	550/-	17600/-
	(iv) Plug 150 mm	no	1	100/-	100/-
	(v) Cap 200 mm	no	1	150/-	150/-
	(vi) Clamp 200 mm	no	2	250/-	500/-
	(vii) Reducer (200 x 150) mm	no	1	350/-	350/-
5	Shrouding of tube well		8	800/-	6400/-
6	Development of tube well by air compressor		10	450/-	4500/-
B	Construction of Pump House Size 3 0 m x 3 0 m x 3 0 m with 2 nos R.C C column of 4 5 m height fitted with a girder 200 mm depth for lowering and lifting of pump assembly	nos	1	LS	30000/-
C	Submersible				

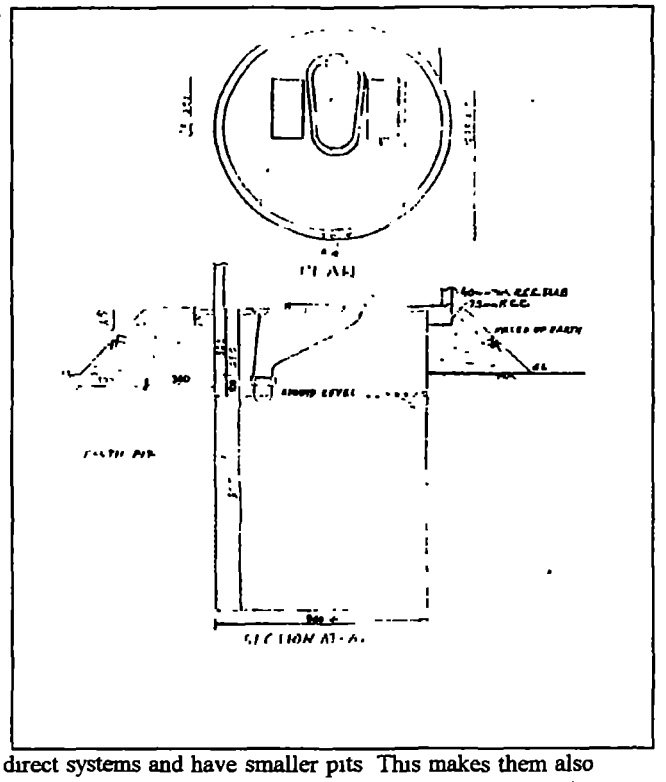
	(i) Pump (10-15HP)	nos		25000/-	25000/-
	(ii) Control panel, Switch board Capacitor etc		one job	4500/-	4500/-
	(iii) Connecting cable 4 sqm- 6 sqm	m	8	20/-	1600/-
	(iv) 75 mm GI Medium delivery pipe	m	32	170/-	5440/-
	(v) Sluice valve		1	750/-	750/-
	(vi) Installation of switch board & lowering of pumpset			LS	1500/-
D	Electric Connection (assuming power is available in the village)			LS	5000/-
E	Rising Main	65 mm ϕ ,m	50	150/-	7500/-
F	Overhead Tank (CWR)	60 cumϕ		LS	180000/-
G	Chlorination Unit			LS	6000/-
H	Distribution system	15 mm ϕ ,m	500	40/-	20000/-
		20 mm ϕ ,m	250	50/-	12500/-
		25 mm ϕ,m	250	70/-	17500/-
		32 mm ϕ, m	500	90/-	45000/-
		50 mm ϕ ,m	500	125/-	62500/-
I	Tapstand	nos	20	1200/-	24000/-
K	Cattle Troughs	nos	4	3000/-	12000/-
L	Washing Platforms	nos	20	1000/-	20000/-
Total capital cost					Rs 5,75,540/-

O&M Cost @ 5% of capital cost = Rs. 27,567 per annum

Note Above costs are indicative and are for DC boring in alluvial soil. This will vary with the type of underground strata, its permeability and depth encountered

Pour -Flush Latrine with Leaching Pit

1. Brief description of technology



Pour-flush leaching pit latrine overcome the problems of flies, mosquitoes and odour by the installation of a pan with a water seal (a U-shaped conduit partly filled with water) in the defecation hole. After using the latrine, it is flushed by pouring water in the pan. The concrete floor slab with the pan is either on top of the leaching pit (direct system) or a short distance from one (single offset) or two (double offset) pits. Pits are usually lined for strength, but adequately permeable for infiltration.

The double offset system enables alternating use of the two pits When the first pit is full it should be left for at least twelve to eighteen months, the period required for effective pathogen destruction When after this period the second pit gets filled up, the decomposed contents of the first pit can safely be removed by hand and used as organic fertiliser Each pit has a sealed access hole for manual emptying. The positioning and shape of the pits is largely determined by the space available. If possible the distance between the pits should not be less then the depth of a pit to reduce the possibility of liquid from the pit in use entering the pit not in use If pits are built adjacent to each other, the dividing wall should be not-porous and preferably extended beyond the side walls of pits to prevent cross-contamination. Alternatively, the pit lining can be constructed without holes for a distance of 300 mm or either side of the dividing walls Offset systems usually have a more permanent character than direct systems and have smaller pits This makes them also suitable for areas where it is impossible to dig deep pits Pour-flush latrines are most suitable where people use water for anal cleansing and squat to defecate Leaching pits and the floor of the latrine should not get flooded A superstructure, preferably made of the materials locally used for building houses, provides privacy to the users

Capital cost

The cost of the latrine with stone masonry sub structure and stabilised mud block super structure is about Rs 3030 and with brick masonry sub structure and super structure is about Rs 4200

Area of use Rural areas where water is sufficiently available and soil is permeable

Flushing About 2 to 5 litre per flush, depending mainly on the pan design and the distance to the pit

2. Description of O &M activities

Operation

Before use the pan is wetted with a bit of water to avoid sticking of faeces to the pan After use flush the pan with a few litres of water If water is scarce, bathing or washing water may be used. No material that could obstruct the U- trap should be thrown into the pan. The floor, squatting pan(or seat),door handles and other parts of superstructure have to be cleaned daily with brush and water Wastewater from bathing or washing clothes should not be drained into the pit(unless used for flushing), but disposed off elsewhere

Maintenance

Every month, pan and U-trap have to be checked for cracks, and the junction chamber for blockage Rainwater should drain away from the latrine and pit Any damage must be repaired. Repair of the superstructure may also be necessary If the excreta does not flush quickly, the PVC pipes and/or junction chamber may be choked. Deblocking without delay using scoops and long twigs is then needed. The sludge in the leaching pit contains more water than that in dry latrine systems, which facilitates decomposing and shrinking of solid organic matter

When the soil is permeable and water can easily soak away the pit does not fill up that quickly Single pits have to be abandoned and covered with at least 0.5 m soil when full

In a double pit system the user should regularly monitor level of contents in pit. If the level is up to 50cm below the top, switching is necessary. In practice however, users often only switch when the pit starts overflowing, causing serious health hazards If the first pit is about full, the other pit has to be emptied If this pit was properly closed for at least twelve to fifteen months, it can safely be emptied by hand. The contents have decomposed into harmless humus which forms a good fertiliser. Leave some of the humus in the pit to facilitate the decomposition of the new load The pipe leading to the full pit should be closed and the other opened properly to avoid leakages into the full pit. The lids of the pits are to be closed properly to avoid foul air coming out and insects breeding This sealing can be done with clay or a soil cover. The location of the lids and junction chamber must be clear for emptying and deblocking

3. O & M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
clean squatting pan or seat and superstructure	daily	household	water	brush, bucket, broom
inspect floor, squatting pan or seat and U-trap for cracks	monthly	household	–	–
inspect junction chamber for blockage	monthly	household or local sanitation worker	water	–
deblock U-trap, PVC pipes or junction chamber when blocked	occasionally	household or local sanitation workers	water	bendable twig or other flexible tools
repair squatting pan or seat, U-trap or superstructure	occasionally	household or local sanitation worker	cement, sand, water, nails, local building materials	bucket or bowl, trowel, saw, hammer, knife
close pit with soil and dig a new pit(in case of single pit system, if applicable)	every one to five years	household or local labour	soil, possibly several local building materials and nails	shovels, picks, bucket, probably hammer, knife, saw etc.
empty pit (in case of single pit system, if applicable)	every one to five years	by hand household or local labour (not recommended)	by hand	by hand shovel, bucket
divert excreta flush to other pit (in case of double pit system)	every twelve to eighteen months)	household or local sanitation worker	water, sand , cement, bricks, clay etc	shovel, bucket
empty pit (in case of double pit)	every twelve to eighteen months	local sanitation workers, farmers, household	–	long handle spade shovel, bucket , trolley

4. Actors implied and skills required in O & M

actor	role	skills
user	use latrine, flush, keep clean, inspect and perform small repairs	understanding and awareness of hygiene
sanitation worker	use latrine, flush, keep clean. inspect and perform small repairs	understanding and awareness of hygiene
local mason	build and repair latrines	basic masonry, latrine building

Organisational aspects

The following organisational aspects are specific for pour-flush latrine programmes.

- **Support responsibilities**

Responsibilities for support with and execution of O & M activities should be clearly defined among involved organisations and users and it is important that all understand the concept of pour-flush, especially where double pit systems are concerned

- **User education:**

Both prior to and after the construction the support organisation(s) (NGOs & CBOs) must give the households information about the pour-flush concept, its functioning and required O & M. These issues should be discussed in the context of environmental health, especially where a scheme involved first introduction and new construction, and efforts are to be directed towards awareness and motivation to create an effective demand. But the technical aspects of O & M should also be discussed. A pamphlet or small poster illustrating the required actions can be provided to the households to make understanding easier issues to include are why, how and when to switch to the other pit, trouble shooting in case of blockages; emptying of pits and sealing off the lids of pits and pipes between junction chamber and pits, safe use of decomposed excreta(humus)

- **Private sector involvement in manufacturing latrine components**

Private companies and individuals can produce and supply all pour-flush latrine components. Local manufacturing is possible for lining of pits, building materials for junction chamber (blocks or bricks),lids, floors, pans and superstructure. The pan can be made of different materials (smooth concrete, ceramic, glass fibre, plastics) The design of the pan and U-pipe is very critical for effective flushing with a minimal amount of water Quality control of all these construction materials is required

- **Gender issues**

Women usually fetch the water Their opinions and ideas on how water can be reduced and their preferences should therefore be the basis of any pour-flush latrine programme

Recurrent cost

These costs are usually low as most O & M activities can be carried out by the households themselves, provided the latrine is well designed and constructed. Costs may have to be incurred when poorly designed or used U-traps block and break while deblocking The main cost is probably incurred when the pit needs to be emptied, although this is often less frequently necessary than anticipated If pits cannot be emptied and new ones are to be dug, the superstructure of the old latrine can be transferred Labour costs for digging and costs for lining material are to be paid directly however, which may be a problem for households

5. Problems

Poor quality of the floor slab due to unsuitable materials or improper curing of concrete Frequent obstruction of U-trap because of bad design or improper use Damage of U-trap caused by improper deblocking (sometimes U-trap are broken on purpose to prevent blockage)
Blocked junction chambers and /or PVC pipes Wrong site or design causing flooding and undermining problems (e.g in soil with poor permeability, pit too near to building foundation etc) or contamination of groundwater. Improperly sealed pit access holes. During transport ceramic pans crack or get damaged. Pans break when hot water is poured into them in winter Contents in pit do not decompose safely because the double pits are too close to each other without an effective seal between them, allowing liquids to percolate from one pit to the other Leaking of drain pipes going to the pits Where pour-flush pans are not available full-flush pans may be used, but they require more water (7-12) litres causing problems if water availability is limited.
Foul air can come up from the leaching pit when 1) water evaporates from U-trap in case latrine is not used regularly, 2) water completely washed out of U-trap because it was poured too forcibly, 3) model has no U-trap

Pour-flush latrine use is often not optimal. Some reasons: latrines only built for use by the guests or used as store room; children often not allowed by parents(fathers) to use latrine 'they make it dirty or throw stones or other bulky materials in it that cause obstruction', women would feel shameful if guests saw them leaving the latrine and therefore do not use it, latrine location does not enhance its use(e.g. use is more frequent when attached to a guest room); lack of water often prevents use, latrine was very costly, therefore only use expensive toilet paper while in other latrines you can use stones or other materials for anal cleansing, using a pour-flush latrine is not part of tradition, fear of more odour problems with intensive use; freezing during winter which may damage pan or block latrine thus latrine not used during winter; children afraid in dark superstructure, people don't want to use humus from double pit systems as fertiliser because of cultural/religious beliefs

6. Limitation

Leaching pits only function in permeable soils and are preferably constructed above groundwater level Latrines must be 10 to 30 metres away from water sources Only to be used in areas where sufficient water available for flushing.

7. Remarks

Pour-flush latrines are unsuitable where it is common practice to use bulky materials for anal cleansing such as corncobs or stones which cannot be flushed through the U-trap Double offset pits are usually much smaller than single pits because they need to last for twelve to eighteen months only after which they can be emptied by hand In a direct pit system less water is needed for flushing than in an offset system Pour-flush latrines may be upgraded to a septic tank with drainage field or soakpit Advantages of water-economic pans are reduced amounts of water required for flushing and with that reduced risks of groundwater contamination

People often over-estimate the cost of a pour-flush latrine, which prevents them for constructing one A pour-flush latrine is often a status symbol and construction may be motivated by social reasons Many people build a pour-flush latrine only for their guests The main reasons for people to build a pour-flush latrine in an Indian province were(in order of preference). privacy, convenience(especially when built in the house),cleaner than when going outside (no faeces and

odour around, cleanliness was not mentioned in relation to disease), protection from diseases, use of water for anal cleansing instead of stones

Example for Calculating the cost of Pour Flush Latrine with two pits

(A) **Sub structure : Stone masonry**

(B) **Super structure: Stabilised mud block**

S. No.	Description of Works	Unit	Qty	Rate (Rs.)	Cost (Rs.)	Remark
(A)	**Sub Structure**					
1.	RR. masonry in mud mortar	cu.m	1 23	200.00	246 00	
2.	Lining of pit by bricks	Nos.	400	1.25	500 00	
3.	Sand	cu.m	0 16	200.00	32.00	
4.	Cement	Bag	0 20	135.00	27.00	
5.	WC pan & Foot rest (Ceramic)	Nos.	1	300.00	300.00	
6.	Pit Cover (Precast concrete)	Nos.	2	180.00	360.00	
7.	PVC pipe (90 mm dia)	m	3.00	30.00	90.00	
8.	Stone ballast 20 mm	cu.m	0.15	200.00	30.00	
9.	Labour	Nos	3	35.00	105.00	
10.	Mistri	Nos.	1.5	90.00	135.00	
				Total	= Rs. 1825.00	
(B)	**Super structure**					
1.	Mud block (20x10x10)cm	Nos.	500	0 40	200 00	
2.	Hampyaran adhesive	Kg	0 01	100.00	1.00	
3.	Cement	Kg	10	3.00	30.00	
4.	Coarse Sand	Cum	0.03	200.00	6 00	
5.	Hinges 100 mm	No.	23	10.00	20.00	
6.	Bamboo 75 mm x 6M long	No	1	40.00	40 00	
7	Mason	No	1	90.00	90.00	
8	Helper	No.	2	35.00	70.00	
9.	Door and Ventilator(wooden)	No	1	600.00	600.00	
				Total cost Rs =	1057 00	
				Total cost (A + B)	**2882.00**	
	Site clearance and other unforeseen @ 5% of above total cost				144 00	
				Total Cost = Rs. 3026.60		
				say Rs. 3030.00		

Example for Calculating the cost of Pour Flush Latrine with two pits

(A) Sub structure : Brick masonry

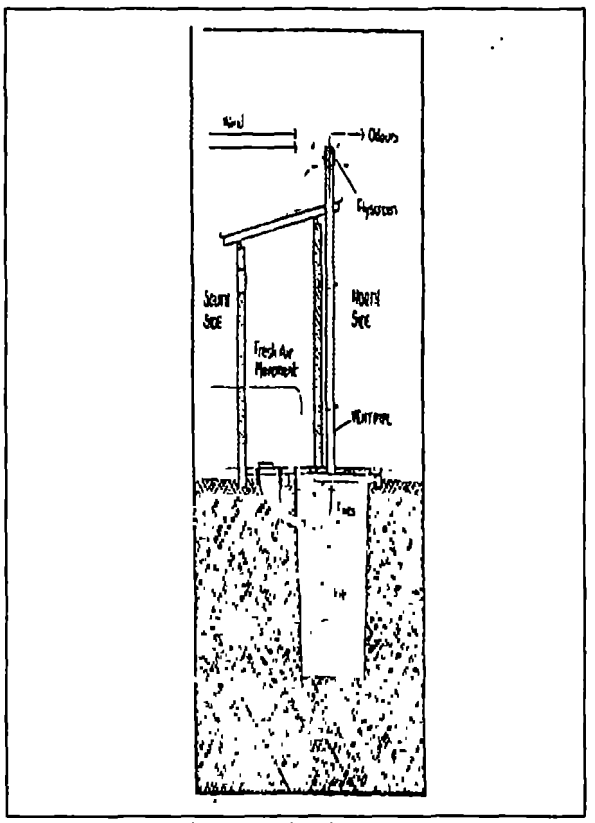
(B) Super structure: Brick masonry

Sl.No.	Description of works	Unit	Qty	Rate	Cost Rs.
(A)	**Sub structure**				
1	Bricks	No.	600	1.25	750.00
2	Cement	Bag	1	135 00	135.00
3	Coarse Sand	cu m	0 43	200.00	86 00
4	WC Pan trap & footrest (Ceramic)	Set	1	280.00	280.00
5	Pit covering (Precast cement concrete)	No.	2	180	360.00
6	PVC Pipe 90 mm dia	M	3.0	60.00	180.00
7	Stone ballast 20 mm	cum	0.17	250.00	42 50
8	Labour				
	Mason	No	2	90.00	180.00
10	Helper/Majdoor	No	4	35 00	140.00
				Total Rs.	2153.50
Note:	Labour required for Earth excavation is already for in the above cost				
(B)	**Super structure**				
1	Bricks II	No.	400	1 25	500 00
2	Cement	Bag	2	135.00	270.00
3	Coarse Sand	cu m	0.28	200.00	56.00
4	MS bar 10 mm dia	Qtl	0 05	1450.00	72.50
5	WC Pan with footrest (Ceramic)	No.	1	280.00	280.00
6	Wooden doors with fitting 600 mm x 1600 mm	No.	1	500	500.00
7	Labour				
	Mason	No	1	90.00	110.00
	Helper	No.	2	35.00	90.00
				Total. = Rs	1838.50
			Total cost (A + B)		3992.00
Site clearance and other unforeseen @ 5% of the above total cost					199.60
				Total Cost	4191.60
				say 4200.00	

Ventilated Improved Pit Latrine

1. Brief description of technology

Compared to many traditional latrine systems, a Ventilated Improved Pit (VIP) latrine smells less, and attracts fewer insects. It consists of a pit covered by a floor slab with a drop hole, a superstructure that lets only very little light in and a vent pipe covered with a fly screen Wind passing over the top of the vent pipe causes airflow from the pit through the vent pipe to the atmosphere and a down draught from the superstructure through the squat hole or seat into the pit This removes smell resulting from the decomposing excreta in the pot and vents the gases to the atmosphere at the top of the vent pipe rather than through the superstructure for proper air circulation The superstructure, preferably made of materials locally used for building houses, must be dark inside to prevent flies from getting attracted to the drop hole. Insects, that come out at night may still find their way out of the pit



The floor is easy to clean and self draining towards the drop hole. It should be at least 0.15 m above ground level to prevent flooding, and an adequate foundation is needed to prevent damage of the floor slab and superstructure. For technical safety reasons, a pit should have a maximum diameter of 1 2 m Maximum depth depends on soil and groundwater conditions but is usually 3 to 4 m In unstable soil or if the pit will be emptied, some kind of lining is needed. Materials for lining can be wood, concrete, bricks, old oil drums, stones, etc

VIP latrines can also be constructed with a double pit The two pits are usually located side by side under a single superstructure. Only one pit is in use at a time When the pit in use is nearly full (0 5 m from floor), the other pit is emptied, the drop hole of the full pit is sealed with soil and the contents of the pit are left to rest and further decompose for at least a year, during which a sterile humus is formed. This permits more permanent structures, safe emptying of pits by hand and safe use of the organic matter as fertiliser Each pit has its own sealed access hole for manual or mechanical emptying

The vent pipe has to be placed on the other pit during the switch- over Double pits are usually designed much smaller than a single pit as they can be emptied each year (which also makes manual emptying easier) Therefore they are also very suitable for sites where rock or groundwater lie within one or two metres below the ground surface.

Capital cost

Cost depends on (1) pit volume, (2) quality of lining , slab and superstructure, (3) extent to which locally available materials are used The cost of this latrine with bamboo, mud blocks and thatch superstructure is about Rs 2525.00

2. Description of O&M activities

Operation

No special operation is required When sitting is preferred, a seat can be installed over the drop hole The space around the drop hole and the seat, if present , have to be cleaned daily with brush and water The door must always be closed so that the superstructure remains dark inside

Maintenance

Every month the floor slab has to be checked for cracks (which could become a breeding place for parasites) and the vent pipe and fly screen must be inspected (broken screens or vent pipes should immediately be repaired and spider webs in the vent pipe should be removed at least twice a year by pouring water down the pipe). Rainwater should drain away from the latrine Any damage should be repaired Repair of the superstructure (especially light leaks) may be necessary too. When the contents of the pit reach the level of 0.5 m below the slab, a new pit has to be dug, the old pit covered with soil

up to about 0.5 m above ground level and the whole structure replaced. Another possibility is to empty the pit mechanically and reuse it.

In case of a twin pit system, one should switch over to the other pit when a pit is full. The full pit can be emptied safely by hand, after it has been standing for a year or more and provided no leakage towards this pit has occurred. Provisions are needed for easy and safe access to the pits for manual emptying

2. O&M requirements

activity	frequency	human resources	materials & spare part	tools & equipment
clean drop hole , seat and superstructure	daily	household	water and ash	brush, bucket, broom
inspect floor slab, vent pipe and fly screen	monthly	household	–	–
clean fly screen and vent inside	every one to six months	household	water	twig or long bendable brush
repair slab, seat, vent pipe, fly screen or superstructure	occasionally	household or local mason	cement, sand, water, nails local building materials	bucket or bowl, trowel, saw, hammer, knife
dig new pit and transfer latrine slab and superstructure(if applicable)	every one to five years	household or local labour	sand, possibly cement, bricks , nails and other local building materials	shovels, picks, buckets, hammer, saw, etc
switch to other pit after emptying it (in case of double pit system)	annually	household or local labour		shovels, buckets, wheelbarrow, etc.
empty Pit (if applicable)	every year to five years	household or local labour		bucket, long handle spade, trolley

Actors implied and skills required in O&M

actor	role	skills
user	use latrine, keep clean, inspect and perform small repairs, empty filled pit , dig new pit and replace latrine	understanding of hygiene
local unskilled labour (sweepers / scavengers)	dig pits, transfer structures, empty full pit of double pit systems, small repairs, solving small problems	knowledge about the concept of a double pit system(when working with such system), knowing how to solve simple problems
local mason	build and repair or transfer latrines	basic masonry, latrine building

Organisation aspects

VWSC should monitor the following aspects of maintenance for the latrine programme.

- Execution of O&M tasks usually completely arranged at the household level, either by the household itself or labour hired by household
- If pits are to be emptied, which should not be done by hand for single pit latrines.

5. Recurrent costs

These costs are usually very low, as normally maintenance activities are few (mainly cleaning) and can be done by the households themselves When a latrine has been well designed and constructed only minor repairs are needed. Emptying a double VIP pit can be done by hand, either by the household itself or by hired labour. Sometimes the humus can be sold to farmers

6. Problems

Bad quality of the slab floor due to inappropriate materials or improper curing of concerte Inferior quality fly screens get damaged easily by the effects of solar radiation and foul gases. Improperly sited latrines can get flooded or undermined. Children may be afraid to use the latrine because of the dark or because of fear of falling into the pit. The defecation hole must be left open to allow free passage of air If the superstructure allows too much light to come in , flies will be attracted by the light coming through the squat hole and may fly out into the superstructure, this may jeopardise the whole VIP concept The problem any be solved when a fly- catching squat hole cover is used made of screen material It is important that the cover is always put in place well and the screen is not damaged Odour problems may occur during the night and early morning hours in latrines relying more on solar radiation for the air flow in the vent pipe than on wind speed. In double pit systems switching from one pit to the other is often difficult because things that have to be replaced (vent pipe) or opened (access hole for emptying) are fitted too tight in place, often with cement or other mortar difficult to remove

7. Limitations

In hard soils it may be impossible to dig a proper pit. Pits should preferably not reach groundwater level and latrines must be 10 to 30 metres away from ground and surface water sources VIP latrines cannot prevent mosquito breeding in the pits People may not be able to bear the much higher costs for construction of a VIP latrine in comparison to a simple pit latrine

8. Remarks

When children are afraid of using a latrine, special children's latrines may be constructed with a smaller drop hole and a superstructure which is not dark (hole should be covered by a tightly fitting lid if no superstructure is built) For the introduction of double pit system the cultural resistance against handling of human excreta can only be overcome when a well- designed educational campaign and a support programme are run during a sufficient prolonged period of time

Example for Calculating the cost of Ventilated Improved Pit Latrine

Item wise cost

(A) Substructure Latrine platform with Cement concrete & pit lining with bricks.

(B) Super structure with bamboo, mud block masonry and thatch.

S. No.	Description of Works	Unit	Qty	Rate (Rs.)	Cost (Rs.)
(A)	**Substructure**				
1.	Bricks	Nos.	400	1.25	500.00
2.	Cement	Bag	0.75	1.35	101.25
3.	Coarse sand	cu.m	0.30	200.00	60.00
4	Precast R.C.C. cover (1.2 m dia) 75 mm thick	cu.m	0.082	2400.00	198.00
5.	WC pan & Foot rest (Cement Concrete) & cement pipe	Nos.	1	100.00	100.00
6.	Labour	Nos.	3	35.00	105.00
7	Mason	Nos.	1.5	90.00	135.00
				Total	= Rs. 1199.25
(B)	**Super structure**				
1.	Mud block (20x10x10)	No.	500	0.04	200.00
2.	Hampyaran adhesive	Kg	0.01	100.00	1.00
3.	Cement	Kg	10.00	3.00	30.00
4.	Coarse Sand	cu.m	0.03	200.00	6 00
5.	Hinges 100 mm	No.	2	10.00	20 00
6.	Bamboo 75 mm x 6m long	No.	1	40.00	4 0 00
7.	Mason	No.	1	90.00	90.00
8.	Helper	No.	2	35.00	70.00
9.	Door and Ventilator	No.	1	LS	600.00
10.	Cost of ventilating pipe	m	3	50.00	150.00
				Total	1207.00
				Total Cost (A + B)	**2406.25**
Site clearance and other unforeseen @ 5% of above Total cost					120.31
				Total Cost = Rs	**2526.56**
				say Rs.	**2525.00**

Drainage Field (Trenches or Leachlines)

1. Brief description of technology

Drainage field consist of gravel- filled underground trenches called leachlines or drainage trenches, into which the liquid effluents coming from a solids interceptor tank are led through open-jointed (stoneware) or perforated (PVC) pipes, allowing the effluents to filter into the ground. Initially the infiltration into the ground may be high, but after several years the soil clogs and an equilibrium infiltration rate is reached. To overcome this either over- design drainage field or construct two drainage fields, which allows for switching every year to the other field so that the trenches can recover over a year time

Trenches are usually 0.3-0 5m wide with a depth of 0 6-1 0 m below the top of the pipes, 15-30 m long , laid with 0 2-0 3% gradient and containing 20-50 mm diameter gravel with 0 3 to 0 5 of soil on top, with a barrier of straw or building paper to prevent soil from washing down They should not operate in parallel through distribution boxes, but in series so that as each trench fills, it overflows to the next one This ensures that each trench is used either fully or not at all, avoiding the formation of an impermeable crust on the sides and allowing empty trenches to recover under aerobic conditions

Laid in parallel, all trenches will usually contain some effluent., thus not allowing any recovery to take place Trenches should be 2 m apart, or twice the trench depth if this is greater than 1 m. The bottom of a trench should be at least 0 5 to 1 m above groundwater, bedrock or impermeable soil and land slope should not exceed 10% For specific situations , where land area is limited or , where high groundwater exists, pipelines can be laid in absorption beds rather than trenches or in mounds

2. Description of O&M activities

Operation

Hardly any activities for operation are required, except for observing if overflowing occurs and switching to the other drainage field every 6 to 12 month and administrating the dates of switching (if applicable) Compared to soakpit, drainage fields are often used where larger quantities of liquid effluents are produced

Initial cost: no data found
Area of use: Rural areas where sufficient water and space are available and soil is permeable

Recommended infiltration capacities of settled sewage(equilibrium rates in lit/ m2 per day)

coarse or medium sand	50
fine sand, loamy sand	33
sandy loam, loam	25
porous silt clay and porous silt clay loam	20
compact silt (clay) loam and non- expansive clay	10
expansive clay	<10

Maintenance

Check situation of drainage field from time to time. Clean tank outflow and check if still in order(if not it should be cleaned or repaired) Deblocking of delivery pipe may be necessary sometimes Division boxes have to be cleaned from time to time Control plant growth to prevent roots from entering the pipes/trenches In case of a failed field, empty the trenches, scrap off the clogged layer (under dry soil conditions) and rebuild the leachlines

3. O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
control plant growth	regularly	household or caretaker		shovel, bucket, etc.
switch to other drainage field	once every six to twelve months	household or caretaker	bricks or other material to block pipes	key to open distribution
deblock delivery pipe	occasionally	household, caretaker or local artisan	water, piece of pipe , glue	brush, shovel, long stick or flexible brush, knife, saw
clean division boxes	every month	household or caretaker	water	shovel, brush
check outflow of tank and clean	once a month	household or caretaker	water	brush, tools to open access hole

4. Actors implied and skills required in O&M

actor	role	skills
household/ user or local caretaker	check outflow tank and performance of drainage field and do bookkeeping, control plant growth	understanding of hygiene , some technical knowledge of tank and field and bookkeeping skills
local artisan	repair parts if broken , remove obstructions in delivery pipes(s)	basic masonry, piping techniques, knowledge of system techniques and functioning
external support organisation	monitor performance of systems, train users/ caretakers and local artisans, provide assistance with large problems	training skills, technical skills for repair and maintenance of drainage fields, monitoring skills

Organisational aspects

Minor O&M and bookkeeping organised and executed by households, groups of households or VWSC External support is needed on .

- monitoring (1) bookkeeping by users or caretakers, (2) performance of drainage fields,
- training of users, artisans and/ or caretakers on technical aspects or O&M.
- promotion of technology(hygiene education is less relevant as system is often an upgrade of former sanitary system and future users are already aware of hygiene aspects),
- assistance with large technical problems (e.g failing fields).

5. Recurrent costs

If the system is well designed, repairs are needed only very occasionally Sometimes deblocking delivery pipes may be necessary

6. Problems

Overflowing leachlines, unpleasant odour, groundwater contamination and social conflict (over sitting of the drainage fields, odour etc) are often a result of uncontrolled poor design and construction by the users themselves or by professionals with insufficient know-how(field size too small for effluent flow, faulty installation plugged lines, not enough stones in trenches, smeared soil interface or uneven grades).

7. Limitations

Unsuitable where insufficient space, water or financial resources for construction are available , where the permeability of the soil is poor or where bedrock or groundwater are at shallow depth .

8. Remarks

Pressure can be taken off from drainage fields by reducing the amount of water and solids flowing into the solids interceptor tank, e g by improved design of toilets which use less water, by preventing sullage from entering the tank and by using separate drainage field for showers, baths etc The advantages over soakpit are : installation possible where groundwater is shallow, easy to install, can be unclogged/ scrapped if it has failed, no danger of falling in higher degree of aerobic biodegradation , lower construction costs.

Drainage System (Surface Drains)

1. Brief description of technology

The basic purpose of a drainage system is to remove unwanted or used water from the houses and inhabited areas, in a safe manner, as early as possible. The drainage to sullage (house hold waste water which contains bathing, washing and cleaning water only) is provided to avoid ponding, rapid deterioration of road/path surfaces, damage to buildings and to avoid unsanitary conditions like breeding places for mosquitoes and flies.

The quantity of sullage produced from the community varies with the quantity of water supplied, and local bathing and washing practices. Drainage systems are constructed in different regions in different ways This depends mainly on type of terrain, soil condition, slope of ground and availability of local materials etc

Broadly, the drainage systems are divided into,

1. Surface drains
2. Underground drains(separate fact sheet)

Surface drains

In this system, open surface drains are constructed to carry liquid waste to a disposal point The following two types of surface drains are suitable for rural areas,

(a) Kerb and Channel (K&C) drain
(b) Semi- Circular drain

These are open drains provided for carrying water from kitchens, bath rooms, washing platforms and partly rain water. These are usually provided at sides of the lanes and streets and along the boundary lines of buildings. For efficient drainage, the surface drains should have a gradient to develop self cleaning velocity and a reasonable free board at the top. The joints and inside should be smooth finished These drains should be cheap in construction and maintenance

Calculation of discharge and required size of drain will be done by Manning's formula

(a)- Kerb and Channel (K& C) Drains

On the basis of discharge carrying capacities, these drains are classified into three types

Sl. No.	type	component	where to be provided
1.	Type-I	- surface width 0 27 m - cross-section area 0 017 sq. m	for individual houses
2.	Type-II	- surface width 0 43 m - cross-section area 0.032 sq m	after junction of type- I drains
3.	Type-III	- surface width 0.49 m - cross-section area 0.06 sq. m	main drains

These drains can be constructed by using locally available materials as given below-

Sl. No.	drain component	construction materials		
		M1	M2	M3
1	KERB	Brick masonry	Brick masonry	R R Stone masonry
2	Cunnette	Cement concrete	Brick on edge	Slate (Patia)

Capital cost

2. Description of O&M activities

Operation

Operating a drain system requires only cleaning and clearing of blockages

Maintenance

In open drains the major problem is of falling garbage, leaves, animal waste and dry fodder which blocks flow of sullage in the drain. These should be removed and washed regularly The problem of breaking and damages of drains, by animals, bullock-carts, tractors etc. is very frequent. These damages should be taken care of and repaired immediately.

3. O&M requirement

activity	frequency	human resources	materials & spare parts	tools and equipments
cleaning of surface drain	everyday	household user or hired labour	water	broom, bucket, long stick & trowel etc
deblocking of delivery pipe/drain	occasionally	household, caretaker or local artisan	water, piece of pipe	broom, shovel, long stick or flexible brush, knife, saw
repair of damages of drain	occasionally	caretaker or local artisan	cement, sand, bricks, slate, concrete, stone	trowel, bucket, steelpan, chisel, hammer, brush

4. Actor implied and skills required in O&M

actor	role	skills
household user or local caretaker	cleaning of silt catcher, surface drain, and removing of earth, tree leaves, garbage etc	understanding of hygiene, some technical knowledge of drain system
local artisan	repair parts, if broken, remove obstructions in delivery pipes/channel	basic masonry, piping, knowledge of system functioning
external support organization	monitor performance of systems, train users/caretakers and locals artisans, provide assistance in large problems	training skills, technical skills for repair and maintenance of surface drains

Organisational aspects

Minor repairs and O&M activities are usually executed by the household users itself or by hired labour who is paid for his activities by the household users. If common repair is to be done , the cost shall be collected and repair will be managed by VWSC

External support may be needed on

- training of users and artisan on technical and O&M tasks
- assistance with large technical problems

5. Recurrent cost

Recurrent costs are almost negligible. Some provisions for labour costs should be made for deblocking clogged delivery pipes, repair of cracks and damages of drains etc This will be about 1-2 % of the capital cost

6. Problems

Unpleasant odour emanates, if proper cleaning is not done regularly Sometimes community disputes arise because of problem of blockage of drains and damages caused

7. Limitations

Insufficient space for construction of drains in lanes and streets

8. Remarks

Open surface drain cannot function satisfactorily until the street and lanes are paved. Every house should be connected through an effective silt catcher or a trap with screen. Street side drains are generally constructed on street slopes.

Example for Calculating the cost of Surface Drains

K & C drains

Material (M_1) - **Kerb** - brick masonry
- **Cunnette**- cement concrete

Sl. No.	Component	Unit	Quantity	Rate (Rs)	Cost (Rs)
	Type-I				
1	Earth work in excavation	cu m	0.2	16 00	3.20
2	Cement Concrete. 1:3 6	cu m	0.046	850.00	39 10
3	Cement Concrete 1 2:4	cu.m	0.015	1200 00	18.00
4	Brick Work 1 6 cement mortar	cu m	0 07	1000 00	70.00
5	Pointing 1:2 cement mortar	sq m	LS	2 00	2 00
6	Neat cement finish	sq.m	LS	LS	4 00
					136 30
				Unforeseen expenditure @ 3%	4 00
				Total cost per r m	140 30 Rs. say 140.00
	Type-II				
1	Earth work in excavation	cu m	0.25	16.00	4 00
2	Cement. Concrete 1:3 6	cu m	0.06	850 00	51 00
3	Cement Concrete 1:2 4	cu m	0 02	1200 00	24.00
4	Brick Work 1:6 cement mortar	cu.m	0 07	1000 00	70 00
5	Pointing 1.2 cement mortar	sq.m	LS	2 00	2.00
6	Neat cement finish	sq m	LS	LS	4 00
					155.00
				Unforeseen expenditure @ 3%	5 00
				Total cost per r m	160 00 Rs say 160 00
	Type-III				
1	Earth work in excavation	cu.m	0.32	16 00	5 12
2	Cement. Concrete 1:3·6	cu m	0.065	850.00	55 12
3	Cement Concrete 1 2 4	cu.m	0.025	1200 00	30 00
4	Brick Work 1 6 cement mortar	cu m	0 09	1000.00	90 00
5	Pointing 1 2 cement mortar	sq m	LS	1.50	1 50
6	Plastering 1:4 cm	sq m	0 2	25.00	5.00
7.	Neat cement finish	sq m	LS	LS	4.00
					190.74
				Unforeseen expenditure @ 3%	5 70
				Total cost per r m	196.44 Rs say 200.00

Material (M_2) - **Kerb** -brick -masonry
- **Cunnnette**- brick on edge

Sl. No.	Component	Unit	Quantity	Rate (Rs)	Cost (Rs)
	Type-1				
1	Earth work in excavation	cu.m	0 2	16.00	3 20
2	Brick ballast concrete 1.3.6	cu m	0 046	650 00	29 90
3	Brick work. 1 6 cement mortar	cu.m	0 07	1000 00	70.00
4	Brick on edge in 1:4 cement mortar	cu.m	0.03	1100 00	33 00
5	Pointing 1.2 cement mortar	sq m	LS	LS	2.00
				Unforeseen expenditure @ 3%	138 10 4 14
				Total cost per r m.	142.24 Rs say 142 00
	Type-II				
1	Earth work in excavation	cu.m	0.30	16.00	4 80
2	Brick ballast concrete 1:3 6	cu m	0 06	650 00	39 00
3	Brick work. 1 6 cement mortar	cu.m	0 09	1000.00	90 00
4	Brick on edge in 1 4 cement mortar	cu.m	0 046	1100.00	50 60
5	Pointing 1.2 cement mortar	sq m	LS	LS	2 00
				Unforeseen expenditure @ 3%	186 40 5.59
				Total cost per r m	191 99 Rs say 192.00
	Type-III				
1	Earth work in excavation	cu m	0 36	16.00	5 76
2	Brick ballast concrete 1 3 6	cu.m	0.061	650.00	39.65
3	Brick work 1·6 cement mortar	cu m	0 11	1000.00	110 00
4	Brick on edge in 1 4 cement mortar	cu m	0 06	1100 00	66 00
5	Pointing 1.2 cement mortar	sq m	0 2	LS	2 00
					223 41
				Unforeseen expenditure @ 3%	6 70
				Total cost per r.m say, Rs	230 11 230.00

Material (M_3) - **Kerb**- random rubble masonry
- **Cunnette** - slate (patia)

Sl. No.	Component	Unit	Quantity	Rate (Rs)	Cost (Rs)
	Type-I				
1	Earth work in excavation	cu.m	0 22	16.00	3 20
2	Cement Concrete (1.3 6)	cu m	0 046	850 00	39.10
3	R. R. stone masonry (1 4 cement mortar)	cu.m	0 1	500.00	50 00
4	50 mm Thick slate	cu.m	0.27	50 00	13 50
5	Pointing in 1.2 cement mortar	sq.m	LS	LS	2.00
					107 80
				Unforeseen expenditure @ 3% of above	3 23
				Total cost per r.m.	111.03
				Say Rs	110 00
	Type-II				
1	Earth work in excavation	cu.m	0 28	16.00	4 48
2	Cement Concrete (1.3:6)	cu m	0 056	850.00	47 60
3	R. R stone masonry (1:4 cement mortar)	cu m	0.1	500 00	50 00
4	50 mm Thick slate	cu m	0 46	50 00	23 00
5	Pointing in 1.2 cement mortar	sq.m	LS	LS	2 00
					127.08
				Unforeseen expenditure @ 3% of above	3 81
				Total cost per r.m	130 89
				Say Rs	130 00
	Type-III				
1	Earth work in excavation	cu.m	0 39	16 00	6 24
2	Cement Concrete (1 3:6)	cu m	0 06	850 00	51 00
3	R R stone masonry (1 4 cement mortar)	cu m	0.12	500 00	60 00
4	50 mm Thick slate	cu m	0 46	50 00	23 00
5	Pointing in 1:2 cement mortar	sq m	LS	LS	2 00
					142 24
				Unforeseen expenditure @ 3% of above	4 26
				Total cost per r m	147.00
				Say Rs	147 00

Example for Calculating the cost of Semi circular Drains

Material- cement concrete and bricks

S. No.	Component	Unit	Quantity	Rate(Rs)	Cost(Rs)
	Type-I				
1	Earth Work in excavation	cu m	0.10	16.00	1 60
2	Cement concrete 1 3:6	cu m	0.30	850.00	25.50
3	Cement concrete 1:2:4	cu m	0.30	1200.00	36 00
4	Brick Work 1·4 Cement mortar	cu m	0 025	1100 00	27 50
5	Neat Cement finish	sq m	LS	LS	4 00
					94 60
				unforeseen expenditure @ 3% of	2 83
				Total cost per r.m	97 43 Rs. say 98.00/m
	Type-II				
1	Earth Work in excavation	cu m	0.33	16.00	5 28
2	Cement concrete 1 3.6	cu. m	0.067	850 00	56 95
3	Cement concrete 1 2 4	cu. m	0.038	1200.00	45.60
4	Brick Work 1 4 Cement mortar	cu. m	0.034	1100.00	37 40
5	Neat Cement finish	sq m	LS	LS	5 00
					150.23
				unforeseen expenditure @ 3% of	4.50
				Total cost per r.m	154 73 Rs say 155 00/m
	Type-III				
1	Earth Work in excavation	cu m	0.24	16.00	3.84
2	Cement concrete 1 3 6	cu m	0 084	850 00	71.40
3	Cement concrete 1 2 4	cu m	0 044	1200 00	52 80
4	Neat Cement finish	sq m	LS	LS	6 00
					134.04
				unforeseen expenditure @ 3% of	4.02
				Total cost per r m	138 06 Rs say 138.00/m
	Type-IV				
1	Earth Work in excavation	cu m	0 25	16 00	4 00
2	Cement concrete 1 3 6	cu m	0 10	850 00	85 00
3	Cement concrete 1.2 4	cu m	0 05	1200 00	60.00
4	Neat Cement finish	sq m	L S	L S.	6 00
					155.00
				unforeseen expenditure @ 3% of	4.65
				Total cost per r m	159 65 Rs say 160.00/m

3. O&M requirements

activity	frequency	human resources	material & spare parts	tools & equipment
household cleaning	daily	local	water	broom, bucket
community cleaning	daily	local	water	broom, bucket
cleaning of stand post, platforms drains & surroundings	daily	local		broom , bucket hoe, machete
repair platform & drains etc	annually	hired labour, caretaker	cement, sand, gravel, clay	bucket, trowel, hoe, spade, wheel barrow
burning of waste	weekly	local, caretaker	–	–
dumping of inert material	weekly	local, caretaker	–	bucket spade travel.
composting of decomposable matter	weekly	local, caretaker	–	spade, trowel, bucket

4. Actors Implied and skill required in O&M

actor	role	skills
user	general cleaning of household and community area	no special skills
care taker	keep platform/ drains clean, check for damage, small repairs, sorting the waste into inert, carbonaceous and decomposable matters	basic skills
VWSC	organise bigger repairs, control caretakers work	organisational skills

5. Organisational aspects

Clean up campaigns and competition like clean clusters, healthy homes can be organised by VWSC which will motivate the community and in turn help cleaning the village.

6. Recurrent costs

These are generally of low magnitude

7. Remarks

The community mobilisation should be done in such a way that cleaning should form an integral part of their daily chores. Motivation and health education will help in boosting cleaning campaign.

Drainage System (Underground drains)

1. Brief description of technology

The liquid waste from the houses is collected in a chamber called silt catcher, and is then carried to a disposal point through underground pipe system. In this system silt catcher, connection chamber, inspection chambers, drains [(i) Pipe & lid, (ii) T or Junction & lid, (iii) Bend & lid] and final disposal point are important components Such a system was executed by Plannir Research & Action division (PRA) Lucknow UP at Banthra. It has been experienced that it is a:

1. low cost and much effective for rural sanitation
2 not likely to be misused by the community
3 not needs much repair and maintenance
4 easy to maintain
5 community can be trained easily to cast pipes in the village itself

Capital costs:

The cost of underground drainage system consisting 100 mm diameter cement, coarse sand (1:3) pipe is about Rs 112 / m-run

Area of use

These drain can be constructed and used in a village where trenches can be excavated up to depth of 0 70 m at least, for laying of pipe. This system is not suitable for rocky strata.

2. Description of Operation and Maintenance

Operation

- The pipe should be laid 0 75 m approximately bellow ground level so that it is safe against load of carts & tractors
- Cleaning of silt catcher should be done every week or as and when required
- There should always be flow of sullage in the pipes to avoid cracks in the joints

Maintenance

- Inspection chambers should be checked regularly so that any blockage in the pipe line can be removed.
- House connection pipe should be checked periodically.
- If drain closes then it should be cleaned by opening T&Y-Junctions.
- Any breakage / damage of the pipe line should be attended and repaired immediately

3. O&M requirements

activity	frequency	human resources	material & spare part	tools & equipment
check silt catcher and connection chamber and clean	weekly	household	water	broom, brush, tool to open access etc.
deblocking of house connection pipe and connection chamber	occasionally	household or caretaker	water, piece of pipe	broom, brush, shovel, long, stick or flexible brush, knife, saw.
repair of drains and inspection chamber	whenever necessary	household or caretaker	water	broom, shovel, tool to open access. material to dismantle pipes
monitoring, training, activities , support with drainage problems	regularly	VWSC	writing materials	means of transport, documentation etc

Example for Calculating the cost of 100 mm internal diameter under ground Drain

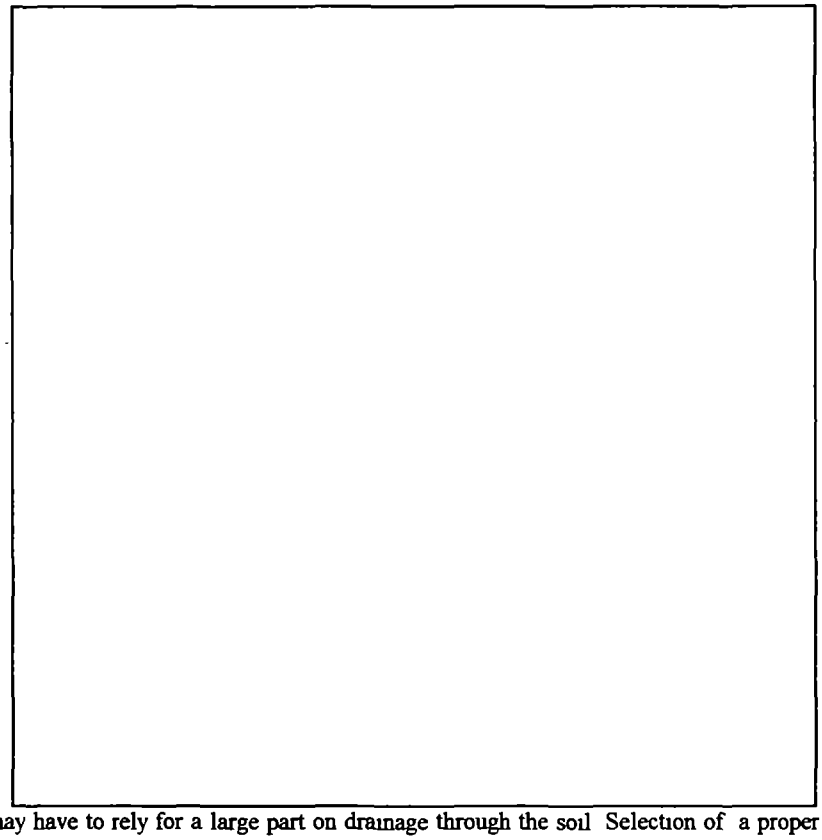
Material : Cement : sand (1:3), for 100 m.
Assume 100 m main drain and 50m house connecting drain

Sl. No.	Component	Unit	Quantity	Rate(Rs)	Cost(Rs)
1	Earth work for drain, width, 0 65 m at top and 0.3 m at bottom, depth, 0.7 m. from ground level.	cu m	50	16 00	800 00
2	100 mm diameter cement pipe with cover	m	100	50.00	5000 00
3	62 mm diameter sub main cement pipe with cover	m	50	44.00	2200 00
4	Silt catcher (assuming line nos for each 100 m drain)	nos	10	40	400 00
5	Bends with cover	nos	2	26.50	53 00
6	Y. Junction with cover(assuming the nos in 100 m main drain)	nos.	10	37 00	370 00
7	Inspection chambers (L S)	nos	2	500 00	1000 00
8	Cement for joining of pipe with (1.2) cement mortar.	bags	3	130	390 00
9	Sand for jointing of pipe	bags	12	8	96 00
10	Labour for jointing (1 Mason, 2 labours)	-	L S	-	160 00
11	Rifling of trenches	-	50	800	400 00
			Total		Rs 10,869.00
		unforeseen expenses 3%			Rs 326 00
		Total cost for 100 m drain			Rs 11,195 00
		Cost, per r m = Rs 11,195/100 = Rs 111 95 say, Rs.112 00			

Evapotranspiration Mound

1. Brief description of technology

An evapotranspiration mound is used to let liquid effluents from interceptor tanks, transpirate through plants growing on the mound and evaporate from the soil. In most mounds, infiltration also plays a role unless this should be avoided for example, to avoid groundwater contamination, the bottom is tight and strong enough to also resist burrowing animals. Usually the mound is partly below ground level The top of the bed is somewhat mounded or sloped so as to shed precipitation and thereby minimise the amount which seeps into the system The liquid effluents flow into a perforated pipe leading through the mound. The pipe is surrounded by gravel or rocks which again are covered by sand. If a layer of rocks is used around the pipe this layer must be rather shallow, or there must be finer capillary material between the rocks to avoid liquids from rising to the surface through capillary forces The volume of the voids in the gravel and sand actually constitutes the storage volume from which the wastewater can reach the upper soil and plants and evapotranspirate. The system should provide sufficient volume at any given time to store any wastewater and precipitation which exceeds the amount lost from evapotranspiration and percolation.



In cold and / or low radiation months a system may have to rely for a large part on drainage through the soil Selection of a proper top soil and appropriate types of grass and vegetation are also important to promote evapotranspiration Where impermeable layers underlying the surface it may be possible in certain circumstances to dig through this layer to reach more permeable layers at greater depth This would enable construction of a mound with improved percolation.

2. Description of O&M activities

Operation

Hardly any operation is needed apart from observing if the mound overflows (especially in times of high precipitation) and if so, making sure that the effluent flow into the mound is reduced. A measure to prevent overflowing can be to switch to other mound(s) every six to twelve months and to use all mounds at the same time during very wet seasons. Dates of switching should be administrated.

Capital cost

No hard data found

Area of use

Where there is a risk of groundwater contamination, where soil is impermeable or difficult to excavate, where water is sufficiently available to allow for interceptor tank systems, and where precipitation does not limit the applicability of the system too much

Evapotranspiration rate

5-15 l/ m^2/ day, for a lined system with no percolation, based on bottom area of bed, depending on rainfall, providing the system is properly constructed and maintained

Maintenance

Check mounds from time to time Clean tank outflow and check if still in order(if not it should be cleaned or repaired) Deblocking of delivery pipe may be necessary sometimes Division boxes have to be cleaned regularly Control plant growth and cut grass to prevent roots from entering the pipes/trenches. In case of a failed mound a new mound will have to be built

3. O&M requirements

activity	frequency	human resources	materials & spare parts	tools & equipment
control plant growth	regularly	household or caretaker		shovel, bucket, etc
switch to other mound(s)	once every six to twelve months	household or caretaker	bricks or other material to block pipes	Key to open distribution box
deblock delivery pipe	occasionally	household, caretaker or local artisan	water , piece of pipe , glue	brush , shovel, long stick or bendable brush, knife, saw
clean division boxes	every month	household or caretaker	water	shovel, brush
check outflow of tank and clean	once a month	household or caretaker	water	brush, tools to open access hole.

4. Actors implied and skills required in O&M

actor	role	skills
household / user or local caretaker	check outflow tank and performance of mound(s) and do bookkeeping, control plant growth	understanding of hygiene , some technical knowledge of tank and field and bookkeeping skills
local artisan	repair parts if broken, remove obstructions in delivery pipe(s)	basic masonry, piping techniques, knowledge of system techniques and functioning
external support organisation	monitor performance of systems, train users/caretakers and local artisans, provide assistance with large problems	training skills, technical skills for repair and maintenance of drainage fields, monitoring skills

Organisational aspects

Minor O&M and bookkeeping organised and executed by households, groups of households or VWSC. External support is needed on:

- monitoring (1) bookkeeping by users or caretakers, (2) performance of evaporation mounds
- training of users (and their organisations), artisans and /or caretakers on technical aspects of O&M
- promotion of technology(hygiene education less relevant as system is often an upgrade of former sanitary system and future users already aware of hygiene aspects)
- assistance with large technical problems(e.g failing mounds)

5. Recurrent costs

If the system is well designed, repairs are needed only very occasionally Sometimes deblocking of delivery pipes may be necessary. Cutting grass is needed regularly.

6. Problems

System fail when not enough volume is provided to store the liquid when total amount of wastewater and precipitation entering the system exceeds the loss from evapotranspiration Also salts may build up, especially in completely or partly closed systems where percolation into the soil is limited or non-existent Surface discharge may appear due to leaking effluents at the down slope and/ or wrong design of the mound. In many cases failures are due to improper designing of the mound and distribution pipe

7. Limitations

Many systems cannot sufficiently get rid of all liquids by evapotranspiration alone and need at least partial percolation of liquids to the underground

Bunding

1. Brief description of technology

It is a small earthen embankment of trapezoidal shape built across the slope to reduce speed of run off and soil erosion. These bunds will serve as a guide line for contour farming. Impouded run off water behind bunding is infiltrate gradually in to the soil profile to increase soil moisture There are two type of bunding namely (1) Contour bunding and (2) Graded bunding.
The provision of Bunding depends upon the intensity of rainfall Contour bunds are suitable for the area where rainfall is less than 600mm and permeable soil Graded bunds are suitable for the relatively high rainfall area where excess water is removed safely out of field with some provision of grassed water ways.

Capital cost

Capital cost of Bunding is about Rs. 47 25/m run, for a specific cross section of 1.35 m2.

Area of use

Contour bunds are suitable for the area where rainfall is upto 6mm and permeable soil. Graded bands are suitable for the area with relatively high rainfall (more than 600mm) with provision of grassed water ways

Construction

Bunds can be are constructed by the community

Description of O&M activities

Operation

Manually operated

Maintenance

Proper maintenance and prompt repair of the bunds is a must Ordinary repair should be attended year to year just before the monsoon

3. O & M requirements

activities	frequency	human resources	material required	tools & equipments
maintain soil profile	annually	local	loose earth	Phawada, Gaiti, Tasla, durmut, roop, axe etc

4. Actors implied and skill required in O&M.

actor	role	skills
user/ caretaker	maintain soil profile and warn in case of major damage	No special skills
committee	supervise caretaker and collect fee	organising skills
area of organisation	perform major repair	some special skills

Organisational aspects

CATCHMENT PROTECTION

It is the area of land form where runoff water collected

Precipitation = surface runoff + infiltration + losses

CATCHMENT PROTECTION

It includes the following components

1. Checking surface runoff.
2. Increasing the infiltration rate.
3. Reclaimation of wasteland.
4. Proper land use by adopting correct farming practices
5. Control of erosion.
6. Afforestation and reforestation.

PLANNING OF CATCHMENT PROTECTION

Following points should be considered while planing of catchment area protection programme

1 Physical setup of the village, habitation, ponds, agricultural fields, forest, wasteland, grazing land, drainage system, roads etc.
2. Land use as per land capebility classes.
3 Type of lands, wet land dry, land water logged land etc

TECHNOLOGY OPTIONS

Catchment area protection measures can be classified in the following two categories

1 Engineering or Mechanical methods.
2. Biological methods.

ENGINEERING OR MECHANICAL METHODS

1. **Engineering protection works**

The following structures can be constructed against the flow of water to check the movement of the soil.
They are classified in the following types as under.
Check Dam: It is a barrier build accros the stream Some of them are as under according to the construction, material used:

(a) Earthen Dam: They are also of different types according to core wall material & filter used such as clay core wall, masonary core wall, RCC core wall, Seat (Iron Plastic) core wall, horizontal filter, & inverted filter (vertical) etc.
(b) Masonary Check Dam: It is build by masonary, Some of them as are under.

(i) Stone masonary
(ii) Brick masonary
(iii) Concrete Block masonary

(c) RCC: The check dam span constructed by RCC wall (slab) is called RCC Check Dam
(d) Wooden Check Dam: Check Dam constructed by wooden planks, bamboo are called wooden check dam.
(e) Sand filled bags check dams· The check dam constructed by sand fill bags are called sand fill bags check dam

GULLY PLUG

It is a small structure built accross the gully to prevent errosion, down cutting of gully bed and to reduce erosive velocity. Gully plugs are classified into various types depending on the local material used for construction :

(I) Masonary gully plugs
(ii) Boulder / Gabion structures
(iii) Brush wood gully plug
(iv) Sand fill bags Gully plug
(v) Earthen Gully plug

RETAINING WALL

It is a wall built to retain the soil and water. Various type of retaining wall according to construction material used are :

(I) Stone Masonary
(ii) Brick Masonary
(iii) Concrete Block Masonary
(iv) R.C. C. Retaining wall
(v) Dry stone Masonary

2. TERRACING

Steep slope of hills are converted into mild slopes by cutting them and making benches. That is bench terracing.

3. BUNDING

It is a small earthen embankment of suitable height constructed in field to protect erosion and increasing the infiltration There are three types of bunding :

(i) Contour bunding - on hills slope.
(ii) Terrace bunding - on the edge of terrace
(iii) Graded bunding - on the steep slopes

4. CONTOUR TRENCHING / STONE DYKES

It is a long pit of size of 3.0m x 0 60m x 0 45m dug on steep slope to reduce erosive velocity and avoid damage to the flat land. Contour trenching are of two types.

(1) Staggered contour Trenching.
(2) Continuous Contour Trenching.

Number of trenches and intervals between them will depend upon the slope of ground and intensity of rainfall.

STONE DYKES

It is a low height (30-45 cm) dry stone wall constructed along the contours of the slopes where inner depth of soil is not available. Stone dykes are substitute of trenches on rocky hills.

BIOLOGICAL METHODS

1 Vegetative barrier : It reduces the velocity of the erosive agent (wind, water etc.)
   (a) Wind Brakes/shelter belt: Rows of trees, shrubs and grasses around a field or around a large area to protect it from high wind velocity are known as shelter belts.
   (b) Vegetative Hedges along contour . Planting of crysopogon, vetiver (Species of grass), along the contour of the slope will help to reduce soil erosion by slowing down the velocity of the water.

2. Vegetal Cover : This is the most important measure to check soil erosion and increase infiltration into the ground water table. Vegetal cover may be provided through -
   (a) Agronomic measures This involves growing agromomic crops along scientific lines. It also involves growing crops supplemented by mechanical measures for example - Inter cropping, Strip cropping, Crop rotation, Mulching etc.
   (b) Growing grass and legumes : Grass and legumes can be grown either independently or in combination with trees/ crops to improve soil binding and to provide fodder.
   (c) Tree Plantation : Depending upon the altitude and the suitability of the climatic and hydrogeological conditions, tree species can be planted for water recharging and prevention of soil erosion.
   Plantation of fruit species in the catchment and preparation of nursery can also lead to income generation.

Suitable trees are as under·
Acacia albida
Acacia nilotica
Acacia nilotica var. cupressiformis

Annona squamosa	Kardhai
	chirol
Albizzia lebbek	*Acacia catechu* (khair)
	Tectone grandis (teak)
Azadirachta indica	Ber
	mango
Dalbergia sisso	Banse
Gliricidia sepium	Anwla
	Amrood
Grevillea robusta	Eucalyptus
	Albizia procera

Leucaena leucocephala
Species that can be planted according to altitude of locality as under

Altitude (mft)	Species recommended
Hills	
500-1000	Sal, teak, khair, seesam. tun
1000-2000	Sal , tun
2000-3000	Sal , tun, chir
3000-5000	Banjh,chir, karaya, bhimal
5000-6000	Banjh, chir, deodar
76000	Banjh, chir, deodar

(d) Agroforestry: It is a sustainable land management system which increases the yield of land, combines with production of the crops including tree crops and forest plantation of animal both simultaneously or sequentially on the same unit of land and applies management practices that are compatible with the cultural practices of the local population i.e. Agrisilvi System, Silirpastoral system, etc.

(3) Utilization of land according to capability. The capability classes, (I-VIII) show general capability of the soil for agricultural and other usage Classes from I to IV denote land suitable for cultivation , class V, VI and VII denote land not suitable for cultivation but suitable for pasture and forestry and class VIII denote land not suitable for cultivation, pasture and forestry but suitable for wild life, water supply or other recreational purposes.

LAND CAPABILITY CLASSIFICATION

The different land capability classes are briefly descried bellows

Class I - Few limitations, wide latitude for use, good quality land.
Class II - Moderate limitations in use, good quality land.
Class III - Severe limitations in the use regular cultivation possible if hazards are controlled, moderately good land.
Class IV- Very severe limitations in use. Suited for occasional cultivation.
Class V - Unsuitable for cultivation because of excess of water, presence of stones, etc. Few limitations on use for grazing or forestry
Class VI - Too steep, stony, wet, etc., for cultivation, Moderate limitations on use for grazing of forestry.
Class VII - Very steep rough, dry, wet, etc , Severe limitations on use for grazing or forestry.
Class VIII - Extremely rough, dry, swampy, etc Unsuitable for cultivation, grazing or forestry. Suitable for wildlife, water shed protection or recreation.
The following land use system are recommended for various situations.

Bare hill slopes	. Grassess and trees.
Shallow soils with slopes > 3%	: Grasses
Deep soils with slopes > 6%	· Cropping after bench terracing
Deep soils having 3 - 6% slope	: Rainy season crops followed by post rainy season crops and intercroping
Deep soils, 1% slope	: Rainy season crop with land treatment or keep fallow for post rainy season crops.

Reinforced Cement Concrete Check dam

1. Brief description of technology

It is the barrier across the direction of flow in which head wall are constructed with RCC and other component parts such as side walls, head wall extensive, toe wall, cutoff are of masonry with CC apron. The foundation of each case of masonry check dam
These type of check dam are suitable for shallow streams or naula, and requires less maintenance cost with less treatment of foundation in the case of black cotton soil.

Capital cost Capital cost of RCC check damof 2 17 m height, per meter run is about Rs - 7710.00

Yield Dependent on the catchment area and precipitation occur

Area of use These type of structure are suitable for small shallow streams especially in black cotton soil area

Construction It requires special type of skills

2. Description of O&M activities

Operation

It is naturally operated but in the case of distribution of water among users it is operated by water committee

Maintenance

Usually less maintenance is required but in the case of major damage it is not repairable This type of structure once damage are not repairable only the solution " Reconstruction"

3. O & M requirements

activities	frequency	human resource	material required	tools & equipments
Do silting	annually	local	sand bag etc	Tasla, Phawada, gaiti
maintain Bunding profile	annually	local	clay	Durmut roop, Tasla, Phawada, gaiti, Axe etc
Patty repairs in the structure	annually	local	cement, sand etc	Phawada, gaiti, etc.

4. Actors implied and skill required in O& M

actor	role	skills
user/ caretaker	maintain soil profile of bunding and warn in case of major damage	No special skills
committee	supervise caretaker and collect fee	organising skills
area engineer	perform major repair	some special skills

Organisational aspects

Check dam committee has to organise themselves in order to maintain good working condition and coordinates activities

5. Problems

Silting is the common problem in the storage basin, and burrowing & grazing animal also create some problem in either side of bunding.

6. Limitation

At least 1% reinforcement is to be provided

7. Remarks

RCC structures are neither repairable nor changeable

8. Calculation of capital cost

Assumption Length of structure = 10.00m
Storage height = 2.00m

Sl. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1.	Survey of site	—	—	LS	500.00
2	Site elegance	—	—	LS	500.00
3.	Marking approach road	—	—	LS	500.00
4	Earth work in cutting banks up to bed level in soft soil	34.375	cu. m.	30.0/ cum.	1031.25
5.	Earth work in excavation of foundation in soft soil.	39.750	cu. m.	"	1192.50
6.	Cement concert work in 1:3:6 in foundation	18.27	cu m.	875 0/cum	15986.25
7.	random rubble stone masonry in 1:4 csm	18.12	cum	730/cum.	13227.60
8.	Coursed rubble (CR) stone masonry in 1:4 csm	34.718	cu. m.	845/cum.	29336.71
9	RCC work in 1.2:4	2.99	cu. m	2632/cum.	7869.45
10.	Pointing/ plastering work in 1:3 csm	—	—	LS	1000.00
11.	Coping work in 1,2:4	—	—	LS	1500.00
12.	5m long Bunding either side of Naula. at v/s side	156.00	cu. m.	35.00/cum	5460.00
				Total cost Rs. =	**77103.76**

Capital cost: Per m. run is about Rs.-7710 37
say Rs - 7710.00

9. Maintenance cost

@ 1.5% of capital cost Rs - 115.65/Annum/m. run.

Earthen Check Dam

1. Brief description of Technology

It is an earthen embankment built across the direction of flow of water in a stream or nallah to check the surface run-off and soil erosion It is suitable for plain areas where local construction material is available and maximum capacity of water could be stored. It has an impervious core wall cut off in the middle of embankment to control seepage A relief well or toe filter is also provided at downstream side toe to reduce pore water pressure. An outlet is provided at suitable site just below the (high flood level) for the safety against surplus water A sufficient provision of free board should not be less than 50 cm in any case. Both sides of embankment are provided with a slope of 1:3 at up stream side and 1.2 at down stream side in order to control soil erosion by waves resisting shear stress and reduce pore water pressure Top width of crest should not be less than 2 0 m to permit maintenance work. The downstream side slope should be maintained with suitable provision of berms and turfing

Capital Cost

The capital cost of an earthen check dam for 1 0 m. length and 4 m height having sufficient provision of pre-board, side slopes protection, seepage and pore water pressure is about Rs 4128/- per m-run

Yield

Dependent on catchment and amount of surface run off comes into reservoir.

Area of use

It is suitable for any type of topography But it is also economical in the case of clay foundation with least provision of foundation treatment

Construction

There is not much skill required upto 2 0 m height beyond this it is necessary.

2. Description of Operation of Maintenance activities

Operation

It is naturally operated but in the case of distribution of water among users it is operated by check dam committee

Maintenance

It requires proper maintenance for fully functioning i e slope, toe drain and crest should be maintained periodically

3. O&M Requirement

activity	frequency	human resources	material	tool and equipment
Clearing of to drain	Monthly	Local		Tasla, Phauara, Bucket
Maintain side slopes	Annually	Skill person	Boulder Earth	Hammer, Sabbal, Drumit
Maintain creast	Annually	Skill person	Boulder Earth	Phaura, Tasla
Watching	Daily	Local		Sop watch, Toro etc.

4. Actors implied and skills required in O&M

actor	role	skill
User	Keep clean and economical use, they should do small repair and warn in case of well functioning	No special skill
Water committee	Supervise care taker and collect fee	Organising skills
Area Engineer	Perform major repair	Some special skill
Watchman/ care taker	Watch level of water and follow instructions by committee.	Some skill

5. Organization aspect

Committee has to organize themself in order to maintain the check Dam in good working condition. Often a care taker / watchman is appointed and check dam committee coordinates activities.

6. Problems

Common problem in earthen check dam or burrowing and grazing animals, dispute between users for water distribution, catchment effected by other barriers approach road, settlement structure and silting etc

7. Limitations

Pre board should not be less than 0.50 m in any case and adequate provision of production work,. Such as toe drain, cut off and core wall to reduce seepage and pore water pressure respectively

8. Remarks

Silt deposit of upstream bed of storage basis could be use as manure. Compaction at every 20 cm of layer of soil during construction play and important role in earthen check dam.

The cost of structure will vary with the construction material used in the pore wall and cut off.

9. Maintenance cost

@ 1.5 % of capital cost per annum. = Rs 61.92 / annum / m- run.

10. Calculation of capital cost

Assumption Length = 10 m Height = 4 m

sl. no.	item of work	qty.	rate Rs.	cost Rs	remarks
1	Site cleaning		L.S.	500 00	
2	Earth work in cutting in soft soil	6 22 m3	30/cu. m	186.60	
3	Earth work in Embanking	479 5 m3	30/ cu. m.	14,385.00	
4	Const. of core wall and cut off with clay.	13 65 m3	200 m3	2,730.00	
5	Stone pitching at U/S slope and construction of toe drain	66 125 m3	175/ m3	11,571.87	
6	Turfing at D/S slope	94.00 m2	15/m2	1,410 00	
7	Approach Road		L.S	500.00	
8	Outlet	1 no	L.S.	10,000.00	
			Total	**41,283.47**	

Cost of structure per Mtr. run = Rs. 4128.35

Sand bag check dam

1. Brief description of technology

It is a low height barrier across the stream to prevent soil erosion and to recharge ground water It is suitable for small and shallow depth stream or naula where sand is locally available In this type of structure two parallel and staggered layer of sand bags are provided and in between them a compacted layer of clay is also provided to reduce seepage through them Sufficient extenoions shall be provided on either side of the banks to reduce side cuttings

Capital cost capital cost of 1 50m sand bag checkdam of 1.987m2 cross sectional area is about Rs 661 00.

Yield - It is dependent on the catchment and the precipitation

Construction It is locally constructed by community.

Area of use:- It is useful for small and shallow streams or nalla, gully where sand is locally available.

2. Description of O&M activities

Operation

It is naturally operated and can be individually constructed, operated and maintained.

Maintenance

Maintenance is costly therefore it is suggested to reconstruct in case of major damage or in every rainy season But small repairs can be done by users

3. O & M requirements

activities	frequency	human resource	material required	tools & equipments
replacement of sand bags	quarterly	local	sand bag etc	Tasla, Phawada
maintain clay layer	quarterly	local	clay	Tasla, Phawada, clay et.

4. Actors implied and skill required in O& M

actor	role	skills
user/ caretaker	maintain soil profile and warn in case of major damage	No special skills
committee	supervise caretaker and collect fee	organising skills
area of organisation	perform major repair	some special skills

Organisational aspects

Check dam committee has to organise themselves in order to maintain good working conditions and coordinate activities

5. Problems

Occasionally, in the case of heavy rain the structure could be washed out.

6. Limitations

It is not suitable for more than 1 50m height of water storage.

7 Remarks

It is cheap because constructional material is locally available at silt. These type of structures are always reconstructed every year after heavy rainfall

8. Calculation of capital cost

Assumption

Length of structure = 10 00m
Cross sectional area of structure = 1 9187m2
Profile of cross sectionalc/s area = 1/2{1.80+0 90}x 1.50 = 1 987m2

Sl. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1.	Site clearance	—	—	LS	250.00
2.	Earth work in cutting of excavation of foundation in soft soil.	13 40	Cu m	30 00/ Cu.m.	402.00
3.	Placing of sand bags in the shape of wall with filling and compacting of clay layer between sand bags layer including cost of sand bags by filling, stitching, transportation etc.	19.87	Cu m.	300.00/Cu m	5961.00
				Total cost Rs. =	**6613.00**

Capital cost

Per m. run of 1 987m2 c/s area is about Rs.- 661.30

9. Maintenance cost

@ 10% of capital cost/ Month is about Rs- 66.13/month/m. run.

Stone masonry Check dam

1. Brief of Technology

Masonry check dam is a barrier provided across the direction of flow of steam or nalla to check soil erosion and to recharge ground water aquifer The foundation bed of the structure should be on had firm base Main component of the masonry check dam are, head wall with extension, side walls, toe wall, apron, wing walls, cut off foundation concrete etc. These type of structure are feasible in that area where construction martial is locally and easily available and foundation strata is geological sound

Head wall is provided to check the flow of water and side wall is provided for strengthen the head wall and stabilize the banks Apron is provided at down stream side to minimise failure due to underminning and crushing

The toe wall at the end of apron is met to dissipate the kinetic energy of water generated after flowing over the apron The cut off just below the toe wall is provided to check the seepage through foundation.

Head wall extension is essential for the safety against side cutting and sliding Masonry structures are long life, in comparison to other structures They require minimum maintenance cost i e about 0 5 % of the capital cost

Capital Cost

The capital cost of masonry check dam for unit length having storage height 2 0 m with sufficient provision of extension and crest width down stream better are about Rs. 10,822/- per annum per m -run.

Yield

Dependent on catchment and precipitation.

Area of Use

Masonry structure is suitable for that type of topo graphy where hard firm base is founded except black coton soil

Construction

It requires special type of skills during construction

2. Description of O&M activities

Operation

It is naturally operated but in the case of distribution of water among users it is operated by water Committee

Maintenance

Usually least maintenance is required but in case of major damage it requires special maintenance

3. O&M requirements

activities	frequency	human resources material	Material	tools & equipment
desilting	annually	local	-	phawde, gatti, tasla
bund repair	annually	local	loose earth	phawde, gatti, tasla
petty repairs	annually	local	loose earth	phawde, gatti, tasla
plaster & loose joints repair	occasionally	skill	Cement sand	phawde, gatti, tasla

4. Actor implied and skill required in O&M

actor	role	skills
user	keeps site clean and warn in case of major damage	no special skills
committee	supervise & collect fee	organizing skills
area Engineer	perform major repair	some special skills

5. Organization Aspects

Check dam committee have to organize themselves in order to maintain it in good working condition and coordinate activities

6. Problems

Silting is the common problem in the storage side.

7. Limitation

Slope of steam should not be steeper than 1 in 300 and extension of head wall also should not be less than 2 00 m either side and foundation depth of head wall should not be less 0.60 m in any case.

8. Remarks

In steep slope steams, it is necessary to provide some barrier to reduce silting problem with the provision of gabion structure

9. Maintenance cost

It is about 0 5 % of capital cost per annum.

i.e. Rs 541/- per annum per metre run.

10. Calculation of capital cost

(Assume length of structure 10m and height of storage 2 m)

sl.no.	item of work	qty	rate	cost
1	survey of site	-	L.S	500.00
2	site clearance	-	L.S.	500.00
3	making approach road	-	L S	500 00
4	earth work in cutting	34.374 cu.m	30/-cu.m	
5	earth in excavation of foundation	92 095 cu.m	30/-cu.m	2762.82
6	c c in 1:3:6 in found	21.87 cu m	875/-cu.m	19136 25
7	RR stone masonry in 1 4 CSM	46.295 cu m	730/- cu.m	33795.35
8	CR stone masonry in 1 4 CSM	50.218 cu m	845/- cu m	42434 21
9	pointing in 1 3 CSM	59.25 sq m	25/- sq m	1481 25
10	plastering in 1.3 CSM	46.00 sq m	25/- sq.m	1150.00
11	coping in 1:2:4 cc	0.45 cu.m	1120/- cu m	504 00
12	bunding along nalla banks	156.00 cu.m	35/- cu.m	5460 00
			Total	**1,08,223.88**

Cost of structure per metre run Rs. 10822.40.

Wooden (log) Check dam

1. Brief of Technology

It is a wooden barrier across the stream or nalla to reduce the soil erosion and recharge ground water

It is suitable for small and shallow depth stream or nalla where constructional materials (wooden logs) are abundantly available locally at site so that it is economical.

It this types of structure, wooden planks are placed one above the other supported from down side with help of a buttress

Capital Cost

Capital cost of 2 0 m high wooden check dam per metre run is about Rs 590/-

Yield

It dependent on the catchment and precipitationin the area.

Construction

It can be constructed by local community.

Area of use

Usually it is suitable for small or shallow streams or gullies where wooden posts, logs, planks are abundantly available

2. Description of O&M activities

Operation

It is naturally operated and can be individually constructed, operated and maintained

Maintenance

Its maintenance is costly therefore it is suggested to reconstruct in the ease of major damage or every rainy season but small repairs can be done by users

3 O&M requirements

activities	frequency	human resources	materials required	tools & equipment
replacement of sand bags	quarterly	local	sand bags etc	tasla, phawda etc
maintain clay layer	quarterly	local	clay	tasla, phawda, clay

4. Actor implied and skill required in O&M

actor	role	skills
users/caretaker	maintain profile clay compaction between layers and warn in case of major damage	no special skill
water committee	supervise care taker and collect fee	organising skills
area engineer	perform major repair	some special skills

5. Organisational aspect

Checks dam committee has to organise themself in order to maintain good working conditions and co-ordinate activities

6. Problems

Occasionally in the case of heavy rain the structure could be washed out.

7 Limitations

It is not suitable for more then 1 50 m height of water storage.

8. Remarks

It is cheap because construction materials is locally available These types of structure are always reconstructed every year after heavy rainfall.

Capital cost calculation

Assumption

Length of the structure = 10 m
Storage height = 2.0 m

Sl.No	Item of work	Qty	Unit	Rate (Rs)	Cost (Rs)
1	site clearance	-	-	LS	250.00
2	earth work in excavation of foundation for Bamboo, logs and preparation of foundation bed by levelling, compaction etc.	-	-	LS	150.00
3	wood work including fixing Bamboo posts, Buttress and logs in proper position	10 00	m	550/m	5500 00
				Total Rs.	5900 00

Capital cost

Per metre run having 2.m height is about Rs 590

10. Maintenance cost

@ 10% of capital cost/ month is about Rs 59.00/month/m-run.

Gully Plugs

1. Brief description of technology

Torrential flow of water cuts into the soil forming rills which are gradually deepended into gullies

Gully plugs prevent the erosion & down cutting of the gully beds by reducing the erosive velocity of flowing water This also contributes to surface water storage for soil moisture regime and increases ground water recharge.

Gully plugs of various materials such as boulder/gabion, brick/ stone/ concrete block masonry, brush wood, sand fill bags, earth, log etc The size and marterial used for a gully plug depends on its width, length and bed slope

Boulder/ Gabion Structure

These structure are constructed by utilising locally available boulders which are put in the shape of a stone wall across the gully. A Gabion structure consists boulders with a wire mesh all around them. As silt fills in the pores of the structure the height of the structure needs to be increased. These type of structure are suitable for the catchment upto 2 00 hectare and bed slope 0-10% across the gully. In this case the cross section of the structure should not be less than 1 30 m^2 with both sides batter at least 1·4 i e 25% It is constructed in the series with the vertical interval 1 50 m and horizontal spacing of 50-60m

Sand Bag

Sand bag gully plugs are suitable where sand is locally available. The sand bags are put in the shape of a wall with or with out clay layer between them These type of structure are also suitable for catchment upto 1 50 ha and bed slope 0-5% In this case the cross section of the structure should not be less than 1 25 m^2 with both sides batter at least 1·4 i.e. 25% These structures are more effective when they are made in series in a same gully with 1.00 m verticals interval & 5–60 m horizontal spacing

Earth/earth composite

Earth is the cheapest and most readily available construction materials and it is therefore easier and economical to construct the earthen gully plugs wherever there are suitable For gullies, where not much runoff is expected from the top, earthen gully plugs of 1.10 m^2 cross suction (with grassed ramp, 20 to 25 cm below the top level) spaced at 45 to 60 m distances are suitable.

For catchment upto 1 60 hectare earthen gully plugs of 2 20 m^2 cross section with pipe outlet (15 cm diameter ACC spun pipe) may be provided above 1 60 hac catchment size, composite checkdams comprising earth in the non over flow section and Brick/stone masonry in the spill way portion should be built. They are located at the confluence of big gullies with the main drainage lines or in the bed of the main drainage system at 1 20 m vertical intervals or 120-150m horizontal spacing as may be required.

Brush wood

Brush wood check dams are constructed in areas where wooden posts are abundantly available However, their use is not recommended due to severe white ant-attack they suffer from and consequential high cost in the long run in their repair and maintenance

The sand bag gully plugs are also not recommended due to high maintenence cost

Specifications for materials and location of gully plugs tried for ravines

Slope gilly bed %	Width of gully bed (m)	Location	Type of gully plug	Vertical interval between two gully plugs (m)
0-5%	(a) upto 4 50 m	Gully bed	Brush wood	upto 3 0 m
	(b) 4.50 to 10.50 m	Gully bed and side branches	earthen	between 2 25 to 3 0 m
	(c) 7.50 to 15 0 m	at the confluence of all of 2 gullies	sand bag	between 1 00 to 1 50 m
	(d) 7 50 to 15.0 m	at the confluence of all branches of a compound gully	brick a masonry	
	(e)4 50 to 15 0 m	gully bed and confluence of all branches of compound gully	Boulder/gabion	between 1 50 to 2.50 m
5-10%	(a) upto 4 50	gullybed	brush wood	upto 3.0 m
	(b) 4.50 to 60 m	Gully bed and side branches	earthen	between 1.50 to 3 0m
	(c) 4 50 to 6 0 m	Gully bed and side branches	boulder/gabion	between 1 50 to 2.50 m

Description of O&M activities

Operation

They are naturally operated but in the case of any dispute among users . It can be operated by committee

Maintenance

Annual repair is required and major repairs occasionally in the misuse case of by the community

3 O& M requirements

activities	frequency	human resources	materials required	tools & equipment's
maintain cross sectional profile	annually	local	locally available	phawda, gulla taste durment axis etc
repair surface plaster & loose joints in masonry	annually	local community	cement sand etc	phawda, gulla taste durment axis etc

4. Actor implied and skills required in O&M

actor	role	skill
user/caretaker	maintain cross sectional profile and warn in ease of major damage	no special skills
committee	supervise caretaker and collect fee	organising skills
Area Engineer	perform major repair	some specials skills

5. Organisational aspects

Catchment area protection committee have to organise themselves in order to maintain good working conditions and co-ordinate activities.

6. Problems

Burrowing and grazing animals are the main problem as it can make a hole on or inside the structure which can becomes major damage due to further widening with rain water.

7. Limitations

Brush wood and sand bag gully plugs require major repair & maintenance cost for long run. Upto 1.50 hectare catchment earthen gully plugs are most economical above this it is 5 required to provide some provisions of spill way for surplus water

8. Remarks

Gully plugs are more effective if they are made in series of a same gully

9. Capitals cost calculations

(A) Boulder/gabion structure

Assumption Length of structure = 10 m
cross section = 1.26 m2

S.No	Item of work	Qty	Unit	Rate (Rs)	Cost Rs.
1	site clearance	-		LS	100 00
2	Earth work in enlling banks upto bed level	5 40	cu m	30/ cu.m	162.00
3	Earth work in excavation of foundation in soft soil	4 50	cu m	30/ cu.m	135 00
4	Proper levelling & compaction of foundation bed with sand layer if require	-		L S	50 00
5	Proper placing of boulder stone in the shape of a stone wall including transportation	19 98	cu m	160/ cu m	3196.80
					3643.80
6	Provide wire mesh all around the boulder structure.	36 00	Sq m	100/ sq m	3600 00
				Total Rs.	**7243.80**

Boulder structure capital cost of structure per metre run Rs 364 38/ m run

Maintenance cost @ 1 5 % of capital cost/Annum
Rs 5 46/ Annum/ m run

Gabion structure

Capital cost

Capital cost per m run is Rs 724 38/

Maintenance cost @ 1 5 % capital cost
Rs 10.86/Annum/m-run

(B) SAND BAG

Assumption

Length of structure = 10 00 m
cross section = 1 26 m2

Sl.No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1	site clearance	-		LS	100.00
2	Earth work in cutting banks upto bed level	5 40	cu.m	30/ cu.m	162 00
3	earth work in excavation of foundation in soft soil	3 00	cu.m	30/ cu.m	90 00
4	proper levelling of compaction if foundation bed including sand layer if required.	-	-	LS	50.00
5	proper placing of sand by in the shape of wall including cost of bag of transportation etc.	18 48	cu.m	75/cu.m	1386 00
				Total Rs 1788 00	

Capital cost

Capital cost per metre run is Rs - 178 80/ m run.

Maintenance cost

@ 100%/ annum Rs 178.80/ Annum/ r run

(C) Earth composite with pipe out let

Assumption

Over all size 3.00 X 2.40 m X 0 90 m. 5m boundary either side of c/s 1 26 m2

Sl.No.	Item of work	Qty	Unit	Rate Rs.	Cost Rs.
1	site clearance	-	-	LS	100.00
2	earth work in excavation of foundation in soft soil	1.015	cu.m	30/ cu m	30 00
3	random rubber stone masonry in 1.6 csm in foundation	1.015	cu.m	65 00/ cu m	659.75
4	coursed rubber stone masonry in 1.6 csm in super structure	1.662	cu.m	750.00/cu.m	1279 74
5	5m long bunding either side of cross section 1.26 m2	12.60	cu.m	35.00/cu.m	441.00
				Total	**Rs 2510.09/ m. run**

Capital cost

Capital cost of a cross section of 1 26 m^2 is Rs 251 09/ m-run

Maintenance cost

@ 1.5 % of capital cost Rs 3 76/ Annum / m run

(D) Earth Composite with spillway

Assumption

over all size 2 50 m x 2 40 m x 0 90 m bundling 5 m either side of 1 26 m^2 cross section.

Sl.No.	Item of work	Qty	Unit	Rate Rs.	Cost Rs.
1	Site clearance	-	-	LS	100 00
2	Earth work in excavation of foundation	2 22	cum	30/ cu m	66 60
3	Random rubber stone masonry in 1 6 csm in foundation	2 22	cu m	65 00/ cu m	1443 00
4	Coursed rubber stone masonry in 1.6 csm in super structure	1 885	cu m	750 00/cu.m	1413.75
5	Cement conerete work 1.3.6 in Apron	0.168	cu.m	875 0 cu.m	147.00
6	5 m long bunding either side of structure of 1 26 m2 cross section.	12 60	cu m	35.00/cu.m	441.00
				Total	**Rs 3611.35/ m. run**

Capital cost

per m run including 5m long bunding either side Rs 361 13

Maintenance cost

@ 1.5 % of capital cost Rs 5.41/ Annum/ m run.

(E) Brush wood

Assumption

Length of structure = 10.00 m
Cross sectional area = 2 50 m2

Sl.No.	Item of work	Qty	Unit	Rate Rs.	Cost Rs.
1	site clearance	-	-	LS	100.00
2	earth work in excavation of foundation of post	22 pits	pit	2.0/pit	44.00
3	fixing posts in position including refilling of ramming	22 pits	pit	2.0/pit	44.00
4	brushes filling between posts including inter taking etc	12 50	cu m	50.0/pit	625.00
5	netting of brushes & posts with jute roop including cost of roop	-	-	LS	100 00
				Total 913.00	

Capital cost

per metre run of 2 50 m^2 cross section is about Rs 91.30/ m run.

Maintenance cost

Can be only used for a period of one year

Retaining wall

1. Brief description of technology

It is a permanent (pucca) structure built across the slope of gully to prevent soil erosion and increase infiltration rate There are various types of retaining walls according to the material used for construction i.e Brick, Stone, Concrete Block, masonry R C.C etc It is suitable where more amount of soil erosion is likely to occur

Capital cost

Capital cost of 1.50m high Retaining wall per m- run is about Rs. 1813/-

Area of use

Suitable where soil erosion is more

Construction

Requires some skilled person

Yield

Dependent on catchment area, slope of basin, permeability of soil, height of barrier, and capacity of reservoir.

2. Description of O&M activities

Operation

It is naturally operated.

Maintenance

Usually less maintenance is required but in case of major damage requires special maintenance.

3. O & M requirements

activities	frequency	human resources	material required	tools & equipments
- desilting, if necessary	annually	local	—	Phawada, Gati
- bund repair	annually	local	loose earth	durmut
- petty repairs	annually	local	loose earth	durmut
- plaster and loose joints repair	occasionally/ as and when required	skilled	cement, sand	durmut

4. Actors implied and skill required in O & M

actor	role	skills
user/ caretaker	Keep site clean and warn in case of major damage	No special skills
committee	supervise caretaker and collect fee	orgainsaing skills
Area Engineer	perform major repair	some special skills

5. Organizational aspects

Check dam committee have to organise themselves in order to maintain good working conditions and coordinate activities

6. Problems

Side cutting is the common problem in the case of Retaining wall

7. Limitation

Slope structure should not be steeper than 1 in 300.

8. Remarks

In steep slopes it is necessary to provide some barrier to reduce silting

9. Calculation of capital cost

Assumptions:- Length of retaining wall = 10 00m
Height of retaining wall = 1 50m

Sl. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1	Site cleaning	—	—	LS	250 00
2.	Earth work (excavation of foundation)	10.00	cum	30 0/sq.m	300.00
3.	Cement concrete working 1 3:6 in foundation	3 00	"	875/sq.m	2625.00
4.	Random Rubblestone masonry in 1 4 csm	4.00	"	730/sq.m	2920.00
5.	Coursed Rubble stone masonry in 1 4 csm	13 50	"	845/sq.m	11407 50
6	Pointing work in 1:3 csm	20 00	sq.m	25.0/sq m	500 00
7	Plastering work in 1:3 csm	5.00	"	"	125 00
				Total	Rs 18127 50

Capital cost permetre run is about Rs - 1812.75

10. Maintenance cost

Maintenance cost required is @ 1.5% of capital cost/ Annum is about Rs.- 27 19/ Annum/ m-run

Terracing

1. Brief description of technology

Steep slopes are converted into mild slope by cutting them for reducing scouring action of run off water With provision of terracing we would provide gentle slope with a substitute for steep slope. It is helpful in uniform distribution of soil moisture and better application of irrigation Bench terracing is practiced normally in the area of 16-33% slope There are three types of bench terracing according to slope at top and rainfall intensity i.e. level (Table top) terracing sloping inward terracing, and sloping outward terracing. Table top (level) terracing is generally practiced in the area where rainfall is good and paddy cultivation is practiced The out ward sloping terracing is recommended for low rainfall area and shallow soil, but inward sloping terracing is suitable for high rainfall area with deep permeable soil

Capital cost Capital cost of terracing having 20% slope per meter run is about Rs 405/m- run.

Area of use It is suitable for ravenous land having slope range between 16-33%

Construction It requires some special skills

2. Description of O&M activities

Operation

It is naturally operated

Maintenance

Annual maintenance is required to maintain soil profile especially before monsoon

3. O & M requirements

activities	frequency	human resource	material required	tools & equipments
maintain cross sectional profile	annually	local	loose earth	Phawada, Gaiti, Durmut, roop etc
maintain to drain	annually	local	gravel paval etc	Phawada, Gaiti, Durmut, roop etc

4. Actors implied and skill required in O& M

actor	role	skills
user/ caretaker	to keep soil profile and warn in each of major damage	No special skills
committee	supervise caretaker and collect fee	organising skills
Area Engineer	perform major repair	some special skills

Organisational aspects

Committee has to organise themself in order to maintain good working conditions and coordinate activities.

5. Problems

There are common problem due to burrowing and grazing animals

6. Limitations

Bench terracing always practiced at the slope range 16-33% and recommended specifications for bench terracing are as under.

- optimum vertical interval - between 1 to 1 50m
- average bed width of terrace- 3 0 to 4 0m
- longitudinal gradient - 1%
- in ward gradient - 2 5%
- optimum length of terrace- 100m
- riser slope (better)- 1/2 1 or 1 1

7. Remarks

It is requires proper watch during rainy season and its immediate maintenance

8. Calculation of capital cost

Assume V I = 3 60m
and slope of ground = 20%
with of terrace ground = 200x d/3
where 'd' = depth of cutting in (m) and 's' = slope of ground in %
width of terrace = 200x d/5 = 200 x 1 8/20 = 18 00m

qty of earth work for unit length = 1 x 1/2 x [18 00/2 x 1 8] = 8 10 m3
Rate of terracing is 50 00 / m3
Cost of terracing = 8 10 x 50 = 405/m run

9. Maintenance cost

@ 1.5% of capital cost/ Annum is about Rs - 6 07/annum /m run

Trenching

1. Brief description of technology

These are dug across the steep slope to catch the runoff and to reduce the soil erosion These are dug in the shape of a rectangle. Excavated soil from digging is placed in the form of a berm on the Down stream of the trench.
Contour trenches are of two types viz (1) staggered trenches and (2) continuous trenches Staggered trenches of size 3.00 x 0.50 x 0 50 with 10 00m horizontal interval are provided and in case of continuous trenches equalizers are provided at an interval of 4 0m. The ends of the continuous trenches are hooked. In between contour trenches pits of size 0 50 x 0 05 x 0 05m are made in a row at spacing of 4 0m.

Capital cost

Capital cost of trenching is about RS 4000/hectare

Area of use

Trenches are always the treatment for steep slopes between 10-16% range.

Constructing

These can be constructed by local community

2. Description of o&m activities

Maintenance

Proper maintenance and prompt repair of the trenches is a must Ordinary repair should be attended year to year i e. just before the monsoon

3. O & M requirements

activities	frequency	human resoueces	material required	tools & equipments
maintain depth and profile of trenches	annually	local	—	Phawada, Gaiti

4. Actors implied and skill required in O & M.

actor	role	skills
user/ caretaker	maintain soil profile and warn in case of major damage	No special skills
committee	supervise caretaker and collect fee	orgainsaing skills
Area Engineer	perform major repair	some special skills

Organisational aspects

Village water and sanitation committee should organise and coordinate the activities

5. Problems

The basic problems in the trenches are scouring and silting

6. Limitation

The slope of land should be between 10-16% and spacing (horizontal) between two consecutive rows of contour trenches should be 3-10m distance between two trenches should be 1 0m

7 Remarks

In casw of recky slopes, the stone dykes are the substitutes for contour trenching

8. Calculation of capital cost

Assumtion Area of catchment 1 hectare
The number of trenches in a hectare should not be less than 300 The rate of digging is Rs 15/trench

Calculation. Capital Cost of trenching / hectare = 300 x (Area in hactare) x 15 00
= 300 x 1 x 15 = Rs 4500

Capital cost is about 4500/ hactare

Maintenance cost

@ 10 - 20% of the capital cost/ Annum (about Rs.- 900/ hectare/Annum).

Garbage and Cattle Dung Disposal

1. Brief Description

Indiscriminate dumping of garbage and cattle dung poses a serious environmental hazards Proper disposal of this waste is imperative. Compost pit can be made for their disposal Segregation of biodegradable material from nonbiodegradable materials, such as plastic, should be resorted

Capital cost

The capital cost of a compost pit of size (2m x 1m x 1 5m) and (3m x 2m x 3m) is about Rs 50/- and Rs 325/- respectively

Area of use

Covers the household area, the community area where final disposal of garbage/ cattle dung is done

2. Description of O&M activities

Operation

Community motivation should be done for effective handling of solid waste Dustbins can be kept in the kitchen and in other parts of the house for collecting household garbage Small cane baskets or card board / wooden boxes or tin containers can be used as dustbins Segregation of nonbiodegrable wastes such as plastics glass, grit can also be done at the household level A garbage pit can be constructed in the backyard into which the household garbage can be thrown Separate cattle sheds using locally available material can be constructed to manage their waste disposal effectively. Cattle dung should also be disposed off in the garbage pit. Garbage can be converted into compost using a garbage pit.

The garbage or cattle dung can also be disposed off by constructing a compost pit away from the houses at cluster or community level The management can be doen by VWSC

Maintenance

The garbage pit should be covered by leaf stalks If necessary, the pit can also be fenced off using local material to prevent children entering into the area The cattle sheds should be cleaned properly The cattle wastes can also be utilised as low dung cakes which can be used as fuel The compost obtained from compost pit can be used as a fertiliser in the kitchen garden

3. O&M requirements

activity	frequency	human resource	material & spare parts	Tools & equipment
household garbage cleaning	daily	local	water	broom, dustbins
cattle dung disposal	daily	local	water	broom, trowel, scraper, garbage collector
cleaning of cattle sheds	daily	local	water	broom, scraper

4. Actors Implied & skills required in O&M in O&M

actor	role	skills
household	segregation of different wastes, dumping in garbage pit	no special skills
care taker	keep cattle sheds clean & small repair	basic skills
VWSC	organise cleaning on cluster level & subsequent motivation for sustaining a cleaner environment	organisational skills

Organisational aspects

Community motivation level should be sustained by VWSC by undertaking routine organisation & orientation camps regarding a safe and cleaner environment.

5. Recurrent costs

These are generally of low magnitude .

6. Remarks

Effective solid waste disposal system leads to compost and low dung cakes production which can be utilised by the community.

Cost of Compost Pit

(A) For house of five person

S. N.	Component of soil	Size/ Capacity	Quantity	Rate (Rs)	Cost (Rs)
1	Earth work in excavation	(2x1x1 5) m	3cu.m	16 00	48.00
2	Add 5% for unforeseen and other miscellaneous item				2 40
			Total cost	Rs say Rs.	50 40 50 00

(B) For a Cluster

S. N.	Component of soil	Size/ Capacity	Quantity	Rate (Rs)	Cost (Rs)
1	Excavation of soil	(3 x 2 x 3) m	18 cum	16 00	308 00
2	Add 5% for unforeseen and other miscellaneous item			Rs	15 40
			Total cost	Rs. say Rs	323.40 325.00

Cleanup Campaigns

1. Brief Description

The objective of clean up campaigns is to inculcate in the community the concept of environmental cleanliness for ensuring better health & hygiene conditions Emphasis is not only on the cleaning of one's household but the community as a whole The community water sources such as public stand posts, handpumps ponds wells, the platforms and drains around them should be kept clean and in good condition .There should be no stagnant water bodies which may be a breeding place for mosquitoes and subsequent diseases like malaria, filaria and dengue etc

The main activities are:-

(i) Health education for cleaning up campaigns
(ii) Collection of wastes from houses and carrying to main collection point in the streets
(iii) Collection of wastes from streets and carrying to main collection point.
(iv) Segregation of wastes into inert, carbonaceous and decomposable matters
(v) Disposal of waste by:-
- Dumping
- Littering
- Composting

(vi) Cleaning of washing platforms, and surrounding of water points (tapstands, handpump, water sources etc)
(vii) Filling up of places with stagnant water

Capital cost

Capital costs are generally of low magnitude, the main costs being involved are of waste disposal containers, buckets, brooms etc which can be made by locally available materials/ can be mobilised by the community itself Filling up of small water stagnant bodies can be done by community without incurring any special capital cost.

Area of use

Covers the whole village area with emphasis on houses, lanes, streets, washing platforms & drains around water sources, tapstands, handpumps and water stagnant bodies

2. Description of O&M activities

Operation

Community motivation should be done for cleaning campaign Dustbin can be kept in the individual houses for collection of wastes. These cleanings should be collected to a place away from household After sorting the wastes, inert matter should be dump at a suitable place and carbonaceous matter should be burnt off The decomposable matter should be composted The platforms and drains should be cleaned properly and algae formation, if any, should be scrapped off

Maintenance

The surface of platforms and drains should be checked for their slope, their wear and tear so that the spilt water may not seep into the source The litter should be away from household to prevent smoke/other obnoxious gases polluting the community

3. O&M requirements

activity	frequency	human resources	material & spare parts	tools & equipment
household cleaning	daily	local	water	broom, bucket
community cleaning	daily	local	water	broom, bucket
cleaning of stand post, platforms drains & surroundings	daily	local		broom , bucket hoe, machete
repair platform & drains etc	annually	hired labour, caretaker	cement, sand, gravel, clay	bucket, trowel, hoe, spade, wheel barrow
burning of waste	weekly	local, caretaker	–	–
dumping of inert material	weekly	local, caretaker	–	bucket spade travel.
composting of decomposable matter	weekly	local, caretaker	–	spade, trowel, bucket

4. Actors Implied and skill required in O&M

actor	role	skills
user	general cleaning of household and community area	no special skills
care taker	keep platform/ drains clean, check for damage, small repairs, sorting the waste into inert, carbonaceous and decomposable matters	basic skills
VWSC	organise bigger repairs, control caretakers work	organisational skills

5. Organisational aspects

Clean up campaigns and competition like clean clusters, healthy homes can be organised by VWSC which will motivate the community and in turn help cleaning the village

6. Recurrent costs

These are generally of low magnitude

7. Remarks

The community mobilisation should be done in such a way that cleaning should form an integral part of their daily chores Motivation and health education will help in boosting cleaning campaign

Mosquito & Fly Control

1. Brief Description

Pile of garbage and cattle dung around the houses and in the streets provide breeding places for flies They attract cockroaches, pigs, rats, dogs and other animals which are carriers of various diseases. They block drains & roads Water logging due to garbage and dumps facilitates breeding of mosquitoes which spread malaria & dengue Similarly, stagnant water around water source & elsewhere in the village in the form of small pond looks dirty, smells foul and is a threat to the environment as it can seep through the soil and contaminate ground water .
To control mosquitoes and flies, following activities are to be taken

- Filling up the places of water stagnation
- Disposal of cowdung and garbage in composting pits
- Spraying of DDT in houses, water stagnant bodies, garbage dumps and cattle sheds.
- Fish culturing in large water bodies like ponds etc

Capital Cost

Capital cost basically consists of spraying DDT and filling up of the stagnant water bodies by locally available materials This can be managed by the community itself
The capital cost of a compost pit of size (2m x 1m x 1.5m) and (3m x 2m x 3m) is about Rs 50/- and Rs 325/- respectively

Area of use

Wherever garbage cattle dump has been disposed off and the area around stagnant water bodies.

2. Description of O&M activities

Operation

The activities involved are filling up of water stagnant bodies by using local available materials such as earth, mud, stone leaf, stalks etc Also raring fish at suitable places which feed on mosquito larvae can control mosquitoes Soakage pits and garbage pits should be constructed for handling waste water and garbage A spray of insecticide such as DDT can be done using a hand spray machine in garbage dumps.

Maintenance

Regular spraying of insecticides should be done in open garbage dumps and cattle sheds. Water should not be accumulated in open places. Excreta of children defecating in the open should be covered by earth to prevent flies Regular cleaning of platform / drains around water source is essential

3. O&M requirements

activity	frequency	human resources	material & spare parts	tools & equipment
filling up of water stagnant bodies	occasionally & specially after rains	local	earth, sand, gravel , stone	trowel , hoe, spade, wheel , barrow, bucket
spraying of insecticide	regularly	local	DDT	hard pump machine

4. Actors implied & skills required in O&M

actor	role	skills
disposer of garbage	use garbage pits/ compost pits	no special skills
caretaker	keep water sites clean , spraying of insecticide	basic skills
VWSC	organising village community to fill up large water bodies maintaining compost pits and spraying of insecticides	organisational skills

Organisational Aspects

The VWSC has to motivate the village community to enable them to organise themselves for the solid waste disposal effectively

5. Recurrent costs

These are usually very low

6. Remarks

The VWSC should have liaison with government authorities, regarding the programmes conducted by state or centre governments

Handpump Water Supply System (Naula)

Abstract of cost

S. No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Renovation of existing Naula Chamber				
2.	India Mark II Handpump m/c				
3.	GI Riser pipe				
4.	Installation of handpump m/c and riser pipe				
5	RCC roof slab				
6	Drain				
Total					

Hand Pump Water Supply System (Spring)

Abstract of Cost

S. No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Masonry Chamber				
2.	India Mark II Hand Pump m/c				
3.	GI Riser pipe				
4	Installation of Hand Pump m/c & riser pipe				
5	RCC roof slab circular				
6.	Drain				
	Total				

Handpump Water Supply System (Openwell)

Abstract of cost

S No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Renovation of existing well				
2	India Mark II Handpump m/c				
3	GI Riser pipe				
4	Installation of handpump m/c riser pipe				
5	RCC roof slab				
6	Drain				
	Total				

Hand Pump Water Supply System (Deep Tube Well)

Abstract of cost : Palm and Pressure Method/ Bogie Method/ Rig Method

S No.	Components	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	India Mark III Hand Pump m/c				
2.	PVC pipe				
3.	PVC reducer				
4.	PVC strainer				
5.	GI riser pipe				
6.	T & P & cartage costs				
7.	Boring cost				
8.	Lowering cost				
9.	Extraction of 150mm MS casing pipe				
10.	Installation of hand pump				
11	Cost of platform				
12	Cost of drain				
	Total				

Gravity Water Supply System (Spring)

Abstract of cost

S. No.	Component	Size/ Capacity	Quantity	Rate (Rs)	Cost (Rs)
1	(i) Spring captation chamber (SCC)				
	(ii) Spring captation chamber (SCC)				
2	Conveyance main GI pipe medium				
3	Treatment Unit (Chlorination)				
4	Clear Water Reservoir (CWR)				
5	Distribution System GI/ HDPE pipes medium quality				
6	House connections				
7	tapstands				
8	Washing Platforms				
9	Cattle trough				
Total					

Gravity Water Supply System (Stream/ River)

Abstract of cost

S. No.	Component	Size/ Capacity	Quantity	Rate(Rs)	Cost(Rs)
1	Boulder Filled Gallery BFG				
2	Conveyance main GI pipe medium				
3	Treatment Unit (Chlorination)				
4	Clear water reservoir				
5.	Distribution System HDPE pipes				
6	Tapstands				
7.	House connections				
8.	Washing platforms				
9	Cattle trough				
	Total				

Pumping Water Supply System (Stream/River)

Abstract of cost

S. No.	Component	Size/ Capacity	Quantity	Rate (Rs.)	Cost (Rs.)
1.	Intake Works				
2.	Raw water Pump house(RWPH)				
3.	Raw water pumps				
4.	Raw water rising learn				
5.	Treatment Unit				
6	Clear water Sump				
7.	Clear water pump house(CWPH)				
8.	Clear water pumps				
9.	Rising Main				
10.	Overhead Tank (CWR)				
11.	Distribution System (G.I /HDPE pipes)				
12.	Tapstands				
13.	Washing Platforms				
14.	Cattle troughs				
	Total				

Pumping Water Supply System (Deep Tubewell)

Abstract of cost

S. No.	Component	Unit / Size	Quantity	Rate(Rs)	Cost(Rs)
A	Tube well cost				
1	Geophysical survey				
2	Transportation of rig m/c & accessories				
3	Drilling charges				
	(i) Pilot bore 200 mm				
	(ii) Bore 300 mm				
	(iii) Bore 450 mm				
4	Lowering of pipe assembly				
	(i) 150 mm slotted pipe				
	(ii) 150 mm MS class B plain pipe				
	(iii) 200 mm MS class B plain pipe for housing				
	(iv) Plug 150 mm				
	(v) Cap 200 mm				
	(vi) Clamp 200 mm				
	(vii) Reducer (200 x 150) mm				
5	Shrouding of tube well				
6	Development of tube well by air compressor				
B	Construction of Pump House Size 3 0 m x 3 0 m x 3 0 m with 2 nos R.C.C. column of 4 5 m height fitted with a girder 200 mm depth for lowering and lifting of pump assembly				
	Total				

C	Submersible				
	(i) Pump (10-15HP)				
	(ii) Control panel, Switch board Capacitor etc				
	(iii) Connecting cable 4 sqm- 6 sqm				
	(iv) 75 mm GI Medium delivery pipe				
	(v) Sluice valve				
	(vi) Installation of switch board & lowering of pumpset				
D	Electric Connection (assuming power is available in the village)				
E	Rising Main				
F	Overhead Tank (CWR)				
G	Chlorination Unit				
H	Distribution system (HDPE/GI pipes)				
I	Tapstand				
J	House connection				
K	Cattle Troughs				
L	Washing Platforms				
	Total				

Pumping Water Supply system (Openwell)

Abstract of cost

S. No.	Component	Unit/Size	Quantity	Rate(Rs)	Cost(Rs)
(A)	Renovation of existing well				
1	Cleaning				
2	Deepening				
3	Repairs of platform & apron etc.				
4	R.C.C. Roof slab cover				
5	Manhole				
(B) Installation of electric pump					
1	Foundation for pump				
2	Motor with pumpset with starter & switch board etc				
3	Suction & delivery pipes				
4	Check valve / foot valve				
5	Installation				
6	Electric connection (assuming electricity is available)				
(C)	Rising main				
(D)	Overhead Tank (CWR)				
(E)	Distribution system				
(F)	tapstands				
(G)	Washing platforms				
(H)	Cattle Troughs				
	Total				

Rain Water Harvesting System

Abstract of costs

S. No.	Component	Size/ Capacity	Quantity	Rate(Rs)	Cost (Rs)
1	Ferro cement Tank				
2	Water collecting channels of plane GI sheets				
3	Filter unit				
4	Pipes & specials				
5	Screening arrangement				
6	Taps & platform				
7.	Drains				
	Total				

Pour Flush Latrine with Two Pits (Type I)

(a) **Sub structure : Stone masonry.**

(b) **Super structure : Stabilised mud block.**

Abstract of cost

S. No.	Description of Works	Unit	Qty	Rate (Rs.)	Cost (Rs.)	Remark
(A)	**Sub Structure**					
1	RR. masonry in mud mortar					
2.	Lining of pit by bricks					
3.	Sand					
4.	Cement					
5.	WC pan & Foot rest (Ceramic)					
6.	Pit Cover (Precast concrete)					
7.	PVC pipe (90 mm dia)					
8	Stone ballast 20 mm					
9	Labour					
10.	Mistri					
	Total					
(B)	**Super structure**					
1.	Mud block (20x10x10)cm					
2.	Hampyaran adhesive					
3.	Cement					
4	Coarse Sand					
5.	Hinges 100 mm					
6.	Bamboo 75 mm x 6M long					
7.	Mason					
8.	Helper					
9.	Door and Ventilator(wooden)					
	Total					
	Grand Total					

Pour Flush Latrine with two pits (Type II)

(a) Sub structure : Brick masonry.

(b) Super structure : Brick masonry.

Abstract of cost

Sl.No.	Description of works	Unit	Qty	Rate	Cost Rs.
(A)	**Sub structure**				
1	Bricks				
2	Cement				
3	Coarse Sand				
4	WC Pan trap & footrest (Ceramic)				
5	Pit covering (Precast cement concrete)				
6	PVC Pipe 90 mm dia				
7	Stone ballast 20 mm				
8	Labour				
	Mason				
10	Helper/Majdoor				
	Total				
(B)	**Super structure**				
1	Bricks II				
2	Cement				
3	Coarse Sand				
4	MS bar 10 mm dia				
5	WC Pan with footrest (Ceramic)				
6	Wooden doors with fitting 600 mm x 1600 mm				
7	Labour				
	Mason				
	Helper				
	Total				
	Grand Total				

Ventilated Improved Pit Latrine

(a) Substructure Latrine platform with Cement concrete & pit lining with bricks.
(b) Super Structure with bamboo, mud block masonry and thatch.

Abstract of cost

S. No.	Description of Works	Unit	Qty	Rate (Rs.)	Cost (Rs.)
(A)	**Substructure**				
1.	Bricks				
2.	Cement				
3	Coarse sand				
4.	Precast R.C.C. cover (1.2 m dia) 75 mm thick				
5.	WC pan & Foot rest (Cement Concrete) & cement pipe				
6.	Labour				
7.	Mason				
	Total				
(B)	**Super structure**				
1.	Mud block (20x10x10)				
2.	Hampyaran adhesive				
3.	Cement				
4.	Coarse Sand				
5.	Hinges 100 mm				
6.	Bamboo 75 mm x 6m long				
7.	Mason				
8.	Helper				
9.	Door and Ventilator				
10.	Cost of ventilating pipe				
	Total				
	Grand Total				

Surface Drains

(a) Kerb - brick masonry.
(b) Cunnette - cement concrete.

Abstract of cost

S. No.	Component	Unit	Quantity	Rate (Rs)	Cost (Rs)
	Type-I				
1	Earth work in excavation				
2	Cement. Concrete. 1 3:6				
3	Cement Concrete 1:2·4				
4	Brick Work 1·6 cement mortar				
5	Pointing 1:2 cement mortar				
6	Neat cement finish				
	Type-II				
1	Earth work in excavation				
2	Cement. Concrete 1·3:6				
3	Cement Concrete 1:2:4				
4	Brick Work 1 6 cement mortar				
5	Pointing 1.2 cement mortar				
6	Neat cement finish				
	Type-III				
1	Earth work in excavation				
2	Cement. Concrete. 1 3 6				
3	Cement Concrete 1:2 4				
4	Brick Work 1:6 cement mortar				
5	Pointing 1 2 cement mortar				
6	Plastering 1 4 cm				
7	Neat cement finish				

Surface Drain - KC

(a) Kerb - brick masonry.
(b) Cunnette - brick on edge.

Abstract of cost

S. No.	Component	Unit	Quantity	Rate (Rs)	Cost (Rs)
	Type-1				
1	Earth work in excavation				
2	Brick ballast concrete 1:3 6				
3	Brick work 1:6 cement mortar				
4	Brick on edge in 1 4 cement mortar				
5	Pointing 1.2 cement mortar				
	Type-II				
1	Earth work in excavation				
2	Brick ballast concrete 1 3.6				
3	Brick work 1:6 cement mortar				
4	Brick on edge in 1 4 cement mortar				
5	Pointing 1 2 cement mortar				
	Type-III				
1	Earth work in excavation				
2	Brick ballast concrete 1:3·6				
3	Brick work 1 6 cement mortar				
4	Brick on edge in 1:4 cement mortar				
5	Pointing 1.2 cement mortar				
	Total				
	Grand Total				

Surface Drains - KC Drains

Kerb - random rubble masonry.
Cunnette : slate (patia)

S. No.	Component	Unit	Quantity	Rate (Rs)	Cost (Rs)
	Type-I				
1	Earth work in excavation				
2	Cement Concrete (1 3 6)				
3	R. R. stone masonry (1:4 cement mortar)				
4	50 mm Thick slate				
5	Pointing in 1:2 cement mortar				
	Type-II				
1	Earth work in excavation				
2	Cement Concrete (1.3:6)				
3	R R. stone masonry (1 4 cement mortar)				
4	50 mm Thick slate				
5	Pointing in 1:2 cement mortar				
	Type-III				
1	Earth work in excavation				
2	Cement Concrete (1 3 6)				
3	R R. stone masonry (1 4 cement mortar)				
4	50 mm Thick slate				
5	Pointing in 1:2 cement mortar				

Semi Circular Drains

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Material - cement concrete and bricks

Abstract of cost

S. No.	Component	Unit	Quantity	Rate(Rs)	Cost(Rs)
	Type-I				
1	Earth Work in excavation				
2	Cement concrete 1.3:6				
3	Cement concrete 1 2.4				
4	Brick Work 1:4 Cement mortar				
5	Neat Cement finish				
	Type-II				
1	Earth Work in excavation				
2	Cement concrete 1.3:6				
3	Cement concrete 1.2:4				
4	Brick Work 1 4 Cement mortar				
5	Neat Cement finish				
	Type-III				
1	Earth Work in excavation				
2	Cement concrete 1 3·6				
3	Cement concrete 1 2 4				
4	Neat Cement finish				
	Type-IV				
1	Earth Work in excavation				
2	Cement concrete 1:3·6				
3	Cement concrete 1 2.4				
4	Neat Cement finish				

Under Ground Drain (100 mm internal diameter)

Abstract of cost

S. No.	Component	Unit	Quantity	Rate(Rs)	Cost(Rs)
1	Earth work for drain, width; 0 65 m at top and 0 3 m at bottom, depth, 0 7 m from ground level.				
2	100 mm diameter cement pipe with cover				
3	62 mm diameter sub main cement pipe with cover				
4	Silt catcher (assuming line nos for each 100 m drain)				
5	Bends with cover				
6	Y Junction with cover(assuming the nos in 100 m main drain)				
7	Inspection chambers (L.S)				
8	Cement for joining of pipe with (1 2) cement mortar				
9	Sand for jointing of pipe				
10	Labour for jointing (1 Mason, 2 labours)				
11	Rifling of trenches				

Earthen Check Dam

Abstract of cost

S. No.	Item of work	Qty.	Rate Rs.	Cost Rs	Remarks
1	Site cleaning .				
2	Earth work in cutting in soft soil.				
3	Earth work in Embanking				
4	Const of core wall and cut off with clay.				
5	Stone pitching at U/S slope and construction of toe drain				
6	Turfing at D/S slope				
7	Approach Road				
8	Outlet				

Stone masonry Check dam

Abstract of cost

S. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1	survey of site				
2	site clearance				
3	making approach road				
4	earth work in cutting				
5	earth in excavation of foundation				
6	c.c in 1·3·6 in found				
7	RR stone masonry in 1·4 CSM				
8	CR stone masonry in 1 4 CSM				
9	pointing in 1·3 CSM				
10	plastering in 1·3 CSM				
11	coping in 1:2 4 cc				
12	bunding along naulla banks				

Reinforced Cement Concrete Check dam

Abstract of cost

S. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1.	Survey of site				
2.	Site elegance				
3.	Marking approach road				
4	Earth work in cutting banks up to bed level in soft soil				
5.	Earth work in excavation of foundation in soft soil.				
6.	Cement concert work in 1.3:6 in foundation				
7.	random rubble stone masonry in 1:4 csm				
8.	Coursed rubble (CR) stone masonry in 1:4 csm				
9.	RCC work in 1:2:4				
10	Pointing/ plastering work in 1:3 csm				
11.	Coping work in 1;2:4				
12.	5m long Bunding either side of Naula. at v/s side				

Wooden (log) check dam

Abstract of cost

Sl.No.	Item of work	Qty	Unit	Rate (Rs)	Cost (Rs)
1	site clearance				
2	earth work in excavation of foundation for Bamboo, logs and preparation of foundation bed by levelling, compaction etc.				
3	wood work including fixing Bamboo posts, Buttress and logs in proper position.				
	Total				

Sand bag check dam

Abstract of cost

S. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1.	Site clearance				
2.	Earth work in cutting of excavation of foundation in soft soil.				
3.	Placing of sand bags in the shape of wall with filling and compacting of clay layer between sand bags layer including cost of sand bags by filling, stitching, transportation etc.				

Gully Plugs

(A) Boulder/Gabion structure

Abstract of cost

S.No	Item of work	Qty	Unit	Rate (Rs)	Cost Rs.
1	site clearance				
2	Earth work in enlling banks upto bed level				
3	Earth work in excavation of foundation in soft soil				
4	Proper levelling & compaction of foundation bed with sand layer if require.				
5	Proper placing of boulder stone in the shape of a stone wall including transportation.				
6	Provide wire mesh all around the boulder structure				
	Total				

Gully Plugs

(B) SAND BAG

Abstract of cost

Sl.No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1	site clearance				
2	Earth work in cutting banks upto bed level.				
3	earth work in excavation of foundation in soft soil				
4	proper levelling of compaction if foundation bed including sand layer if required				
5	proper placing of sand by in the shape of wall including cost of bag of transportation etc.				
	Total				

Gully Plugs

(C) Earth composite with pipe out let

Abstract of cost

Sl.No.	Item of work	Qty	Unit	Rate Rs.	Cost Rs.
1	site clearance				
2	earth work in excavation of foundation in soft soil				
3	random rubber stone masonry in 1:6 csm in foundation				
4	coursed rubber stone masonry in 1.6 csm in super structure				
5	5m long bunding either side of cross section 1 26 m2				
	Total				

Gully Plugs

(D) Earth Composite with spillway

Abstract of cost

Sl.No.	Item of work	Qty	Unit	Rate Rs.	Cost Rs.
1	Site clearance				
2	Earth work in excavation of foundation				
3	Random rubber stone masonry in 1:6 csm in foundation				
4	Coursed rubber stone masonry in 1:6 csm in super structure				
5	Cement conerete work 1 3 6 in Apron				
6	5 m long bunding either side of structure of 1.26 m2 cross section.				
	Total				

Gully Plugs

(E) Brush wood

Abstract of cost

Sl.No.	Item of work	Qty	Unit	Rate Rs.	Cost Rs.
1	site clearance				
2	earth work in excavation of foundation of post				
3	fixing posts in position including refilling of ramming				
4	brushes filling between posts including inter taking etc				
5	netting of brushes & posts with jute roof including cost of roof				
	Total				

Retaining wall

Abstract of cost

S. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1	Site cleaning				
2.	Earth work (excavation of foundation)				
3.	Cement concrete working 1:3:6 in foundation				
4.	Random Rubblestone masonry in 1 4 csm				
5.	Coursed Rubble stone masonry in 1.4 csm				
6.	Pointing work in 1:3 csm				
7.	Plastering work in 1:3 csm				
	Total				

TERRACING

Abstract of cost

S. No.	Item of work	Qty	Unit	Rate (Rs.)	Cost (Rs.)
1.	Site cleaning				
2.	Earth work in cutting				
3.	Earth work in filling				
4	Random Rubble stone masonry in 1.4 csm				
	Total				

Compost Pit

(A) For a individual

Abstract of cost

S. N.	Component of soil	Size/ Capacity	Quantity	Rate (Rs)	Cost (Rs)
1	Earth work in excavation				
2	Add 5% for unforeseen and other miscellaneous item				
	Total				

(B) For a Cluster

Abstract of cost

S. N.	Component of soil	Size/ Capacity	Quantity	Rate (Rs)	Cost (Rs)
1.	Excavation of soil				
2	Add 5% for unforeseen and other miscellaneous item				
	Total				