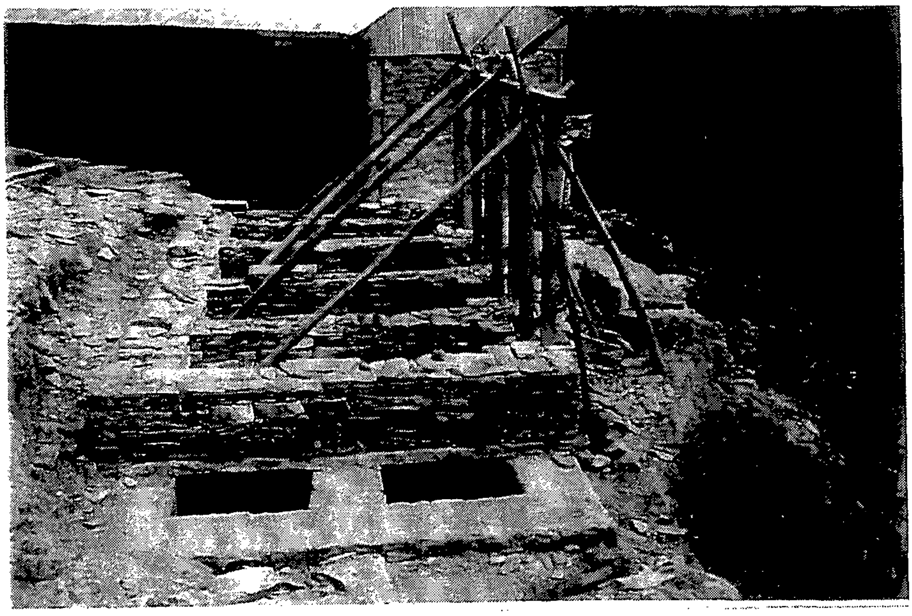
Water, Sanitation and Health project 2000
Sindhupalchok district, Nepal
Final report



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Kathmandu, May 2000

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Preface

This is the final report on the *Water, Sanitation and Health project 2000* in the Sindhupalchok district, Nepal. It's an initiative of Vajra Foundation Nepal, supported by Stichting Vajra Holland.
The main reason for an engineering project in this district is because of the outcome of a Vajra organized health camp in 1999. It showed that most health problems are caused by lack of (proper) drinking water, sanitation and by breathing problems through smoke from open fire.

The readers that would want a quick view of this report, are advised to read the summary or the introduction (Chapter 1) and the conclusions and recommendations (Chapter 29, Section IV)

For Ernst Eisma the project is part of his hydrology study (extra internship) at the *Free University, Amsterdam* (VU). Leo Bouwman is environmental engineer and for him the project is an introduction to other work in developing countries. They focussed mainly on the water supply in Arukharka (section I).
For Anne Wietse Boer and Remco Keijser the project is their working experience period as part of their civil engineering study at the *Delft University of Technology* (DUT). Their main focus was making an inventory of the health camp villages (Apendix III) and the construction of latrines (section I)

We would like to sincerely thank the following people for their help and encouragement. Maarten Olthof (*Stichting Vajra Holland*), for involving us in this project. Ramkaji Paudel and Dor B Bhardari (both *Vajra Foundation Nepal*), for their support and organization during the project, especially on transportation of materials. Whitout you nothing would have happened.
We would also like to thank the Paudel family (especially Didi Mami) in Ramche for their hospitality and ability to put up with us all those months. The three amigo's of Ramche, Narain, Bishnu and Shiva, hearty thanks (Nepali style!) for your support! And Harreram and Damodar for their willingness to skip school to translate for us (right on brother, dig!).
Furthermore we would like to thank Willem Dijk and Maaike Holland (*Traineeship Bureau of Civil Engineering-DUT*). Ian Simmers (*VU*) is also thanked for his support and especially his ability to produce funds for the poor students.
Technical advisor Luuk Rietveld (*DUT*) is thanked for his constructive criticism.

Last but not least we have to thank all the villagers who welcomed us with great hospitality and the other Nepali volunteers for translating for us during the project.

Kathmandu - Nepal, May 2000

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General project information

Project	Water, Sanitation and health project 2000
Team	A.W. Boer L. Bouwman E.H. Eisma R. Keijser
Counterparts	Vajra Foundation Nepal (VFN) Stichting Vajra Holland (SVH)
Period	February 29th 2000 - May 31st 2000
Location	Sindhupalchok district - Nepal
Objectives	Survey technical solutions on health problems in the villages around Barhabise, parallel with vajra organised health camps. Construction of latrines and improved cooking stoves (ICS) as well as water supply.
Co-ordinators	Ir. W.J. Dijk (Delft University of Technology) Prof. Dr. I. Simmers (Free University Amsterdam) Ir. M. Olthof (Vajra Foundation Holland) Ramkaji Paudel (Vajra Foundation Nepal)
Advisor	Ir. L.C. Rietveld (Delft University of Technology)

Summary

This section gives a summary of the works done during the project so that the readers can get the gist if this report. For more detail on the precise steps and decisions taken the full report should be read.

This *Water, Health and Sanitation* project is an initiative of the *Stichting Vajra Holland* and *Vajra Foundation Nepal*. Its objectives are to survey technical solutions on health problems in the villages around Barabise, parallel with Vajra organized Health Camps. Also the construction of latrines, improved cooking stoves (ICS) as well as water supply systems in designated areas are also aims. The report is divided into thres sections: I) Water supply project in Arukharka, II) : Latrine construction in Health Camp villages and III) the other projects.

The first project started was the *water supply project of Arukharka*. Some six months ago the villagers started to build the water system. The catchment was build under the supervision of Rene Veld. The rest of the system (piping in ground, reservoir and public tap posts) was build by the villagers alone while occasionally supervision. One of the objectives was to investigate and evaluate the water system. It was concluded that a lot of finishing work had to be done.

After making a verbal work agreement, work was started. First of all, all the water transport pipes that were not at the correct depth were re-dug and placed at the correct depth (0.6m). A second, written agreement was made for compensation of the farmers whose crop would be destroyed by digging. Only then would they allow digging in their fields: a verbal agreement was not trustworthy enough. If any pipe leakages were detected then they were fixed immediately.

Next, the reservoir was covered so that rain, wind and humans/cattle could not contaminate the water. First a downhill slanted wall was masoned that would support the roof. A wooden frame with a GI-plate roof was then constructed and placed on the wall.

Then, diverting the water from the open cannel into a cement-covered pipe completed the catchment construction. It was decided that the second $0.5m^3$ reservoir, that collects a minimum amount of water from a small spring, was to be excluded from the water system. To make it both invulnerable from outside contamination and the interior accessible was not deemed possible.

The manhole at the reservoir was masoned upwards towards the surface and the pipefittings inside were made leak free and upgraded with gate valves. The faucets of the public tap stands were replaced because they were broken. The water quality of the source and in the system was checked for contaminants. It was found that the spring water is contaminated with bacteria.

A maintenance checklist is made for the villagers so that they can maintain and fix the system when necessary. A table of costs is also made to show the expenditures.

A final evaluation of the water system was done as to get a good, complete picture and some pointers and lessons learned are noted.

The second section of the report describes the *Latrine construction in Health camp villages*. A general design was made for the construction od\f latrines at schools in five of the health camp villages (28 toilets in 14 places).

The design is a double pit latrine, with one to four toilets. A simple and robust design was made. It's a ventilated improved double pit latrine. Each two years the extrecate comes in the other pit, leaving the excreta in the first pit time to compostate. The compostated excreta can be used as fertiliser.

Toilets were constructed in Marming, Barabise and Maneswera VDC (by A.W. Boer and R. Keijser) and in Petku and Attarpur VDC by K. Huisman. Problems occurred in Palati were a

toiletwall collapsed, in an unstable soil. Most of the projects were successful, but not finished at the end of may. They will be finished before monsoon starts.

The third section of this report describes the other, inbetween projects done: the building of improved cooking stoves, the water supply system of the Chulti school, the evaluation of Rathamatha for a water supply system and evaluating the irrigation of the kitchen gardening project in Ramche.
The initial plan was to train several women from Ramche on how to build improved cooking stoves. Contact was made with the Nepali NGO Centre of Rural Technology (CRT) for the training. After breaking contact, approaching another Nepali NGO and then getting together with CRT again, it was eventually decided that the project could not take place this year. This was due to lack of time of the trainees due to the immanent harvest.

The village of Rathamatha was investigated as to see if a future water project could be build there. There already is a water system present but it is not in working condition. There was not enough time to evaluate the complete village and neighbouring Thurdniri to make a full evaluation. Several steps must be taken before the design can be made anyway: comprehension of the Rathamatha and Thurdniri water system and the Ramche/ Maneswera quantity of water supplied and used must be assessed and understood. If a positive result is found (enough water for Ramche, Maneswera, Rathamatha and Thurdniri) only then can the project be started. A meeting must be held between the people of all three villages, the Ramche VDC and VFN to discuss the plans.

One of the initial objectives was to investigate if the kitchen gardening projects in Ramche could be irrigated. Since the other projects took much time, it was not well planned into the time schedule and could not be investigated. What needs to be done is: mapping the complete Ramche water supply system, the discharge pattern in time (yearly passage) of the water supply and the coinciding usage must be known, the water amount needed for the different crops calculated and the type of irrigation must be determined. This investigation takes much time and should not be underestimated. A not correct execution of the evaluation and design could leave Ramche with a water shortage.

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Appendices

1 Vajra in the Sindhupalchowk district

The *Water, Sanitation and Health* (WSH) project is an initiative of Vajra Foundation Nepal (VFN), supported by Stichting Vajra Holland (SVH). VFN is a Nepalese NGO that works in the Sindhupalchowk district, close to the Tibetan border, northeast of Kathmandu

1.1 The Vajra organisation

Stichting Vajra is a Dutch foundation that works in Nepal together with the Nepalese NGO Vajra Foundation Nepal (VFN). They both were founded two years ago. Stichting Vajra helps the VFN by supporting them financially (collecting money from Dutch funds) and sending volunteers to help coordinate the projects.
The *Water, Sanitation and Health* (WSH) program is an integrated project that works to improve the water availability, sanitation, hygiene, and health of a designated area. These projects are mainly focused on women because they are the ones who run the households and therefore form its 'health conditions'. Many projects have been done and some are still in progress in the area.
The WSH program can be split into two separate parts: the *health camps* and the *health-engineering project*. The health camps began last year (1999) in the Ramche district and were very successful. The basic functions of these camps are to investigate what the main health problems of the locals are and which medical facilities they are missing. The conclusions of the health camps are that stomach- intestine and windpipe problems are the most abundant symptoms. What causes these symptoms is the lack of hygiene and sanitation and that they cook above on open fire in their dwellings. The health camps were held again this year in the surrounding districts.
The health engineering projects focus on the water accessibility, quality, sanitation and household health standards. These projects supervise the building of pipelines from a water source the village, check the quality of the water and the sources of contamination are investigated. New for this year is a focus on sanitation, the investigation/calculation of the irrigation of the 'kitchen gardening project' and the design and installation of the 'improved cooking stove' in several pilot households.
In the area that VFN works in, certain children are sponsored to be able go to a private school. The sponsors are Dutch people found by Stichting Vajra in Holland. The members of the child's family are obliged to help VFN in organizing and helping with its numerous projects. In this way the two registered members of VFN (Ramkaji Paudel and Dor B. Bhardari) have many people helping and supporting them.

1.2 The Water, Sanitation and Health project

The objectives of the water, sanitation and health project were formulated already in the project proposal. These objectives were conceived by the head of Stichting Vajra Holland (Drs. M. Olthof) on the basis of the projects of last year. Some of them are an evaluation and continuation of the projects started last year. Others are to be planned and designed this year.
Objectives, as formulated in the project proposal:

1. Evaluation of the water supply project in Arukharka and Chulti.
2. Training to some Arukharka villagers how to maintain the water supply.
3. The construction of a pipe line between the Chulti reservoir and the school.
4. Evaluate the possibilities for irrigation/water supply of the *kitchen gardening project* in the village of Ramche.
5. Guiding the construction of latrines at schools in the health camp villages.
6. Guiding the construction of latrines at private homes in the villages.
7. Advice on the construction of *improved cooking stoves* (ICS).
8. Check the water quality in all villages, and if necessary advice how to improve.
9. Give education on basic hygiene, in cooperation with the Nepali team.

10. Report of all conclusions and give recommendations

1.3 Nepal and the Sindhupalchowk district

Nepal is a landlocked country located in South Asia, between China to the north and India to the east, south, and west. It is one of the poorest countries in the world. It has all the 'criteria' of a third world country; poor health, mediocre education, water problems, large scale environmental problems (erosion due to deforestation) and a unfavourable climate for agriculture (monsoon climate). At present rates of population growth and deforestation, shortages are predicted in fuel wood, fodder, and timber by the year 2010, with the accompanying costs of soil erosion. The large potential for developing hydropower could reduce the pressure on forests. Tourism is one of the few sources of export earnings.

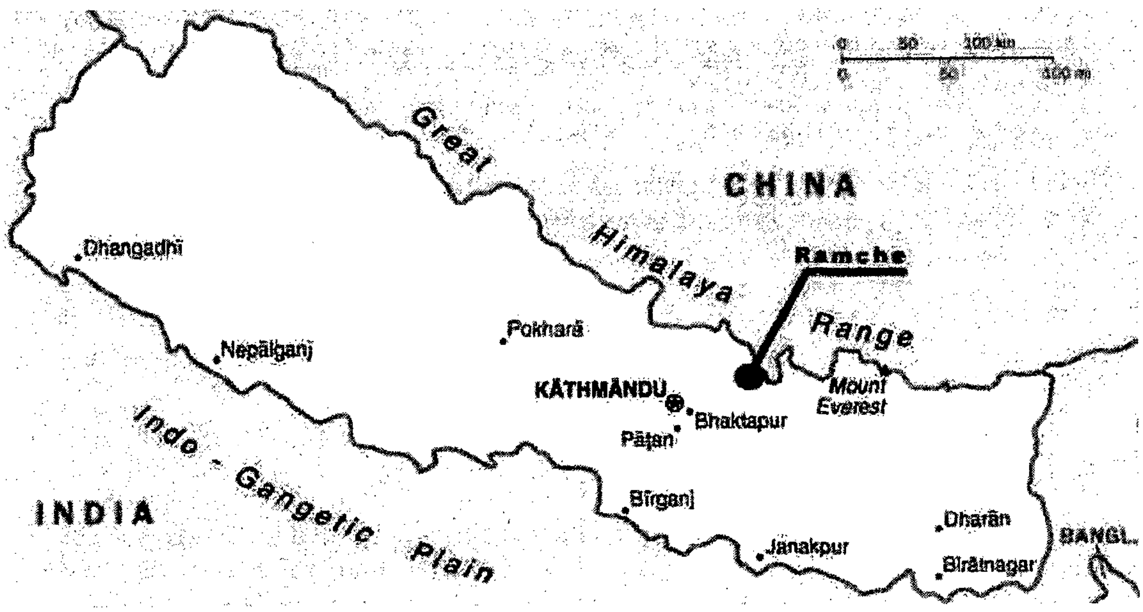


Figure 1.1 General map of Nepal

1.3.1 The physiography of Nepal

Nepal is in one of the most mountainous areas of the world. Of the ten highest mountains in the world eight, including Mount Everest (8,848 meters), the highest, are located entirely or partly within Nepal's borders.

Nepal can be divided into several physiographic regions: the plains in the south, four mountain ranges and the valleys lying between them. Their individual topography, climate and its coinciding vegetation segregate these zones. The lowlands with their fertile slopes, and the southern slopes of the mountains sunny exposure, allow for cultivation and are the main inhabited regions.

Here is a quick summary of some physical features of the area. This is a dramatic area of high, geologically young mountains and glaciers. The deeply incised valleys cut through sedimentary rocks and underlying granites to drain southwards into the Dudh Kosi and its tributaries, which form part of the Ganges River system. The upper catchments of these rivers are fed by glaciers at the head of four main valleys: Chhukhung, Khumbu, Gokyo and Nangpa La Lakes. There are seven peaks over 7,000m. The mountains have a granite core flanked by metamorphosed sediments and owe their dominating height to two consecutive phases of upthrust. The main uplift occurred during human history, some 500,000-800,000 years ago. Evidence indicates that the upliftis still continuing at a slower rate, but natural erosion processes counteract this to an unknown degree (Garratt, 1981).

A topographical and physiographical map are included (figures 1.2 and 1.3 respectively) for a visual of the following ranges.

The Terai

The Nepalese portion of the alluvial plain of the Ganges is called the Terai. This region is a mixture of paddy fields, dense jungle, mango groves and bamboo stands. It forms a belt of an average width of 30-40 km and has an average altitude of some 200m, fairly level land. Water is of no shortage here and the groundwater level is close to the surface.

Siwaliks hills

The Siwaliks hills are the first of the four mountain ranges and they run the length of the country. They have an average height of 900m and the greatest elevations are found in the west, up to 2000m. This zone has an extremely rough landscape with steep slopes and is covered with jungles. The soil is quite immature with rough boulders on the surface. Since the soil is not capable of holding the rainwater which is drained immediately drained into the valleys and rivers. For these reasons the range is not cultivated and large tracks of undisturbed tropical forest remain.

Inner Terai (Duns)

In the area with two Siwaliks Hill ranges, they generally don't have a parallel strike. They converge and diverge thus forming basins between the ranges. These valleys are called in Nepali the *Duns* and have more or less the same elevation as the Ganges plain/Terai (200m). After the annihilation of malaria with huge amounts of DDT in the 50's, resettlement took place of the hill people in search for more fertile soil. They did not find it, but they did find a vast supply of water to irrigate the fields. Most of the area is now cultivated, except for a national park there.

Mahabharat Range

The next mountain range is the Mahabharat Range, which rise slightlty higher than the Siwaliks hills, namely up to 3000m (varies from 1500m to 2700m). It is intersected by very deep, narrow gorges through which the big rivers reach the Siwaliks zone and eventually the Terai. The area are quite rough and the slopes steep, but not so much as the Siwaliks Range. The soils are water retentive and thus the hills are cultivated with extensive terracing. On the lower slopes, remnants of subtropical forests can be found, whereas on the upper reaches, above the cultivated zone, temperate elements begin.

The Midlands

Between the Mahaharat Range and the Himalayas lies a broad belt referred to as the Midlands, or Pahar zone. This includes the fertile valleys (previously large lakes) such as Kathmandu, Banepa and Pokhara. They cover altitudes between 600 and 2000m. The soils are very fertile, but of course vary with the subsoil rocks, from which they are weathered and eroded. The climate varies with the altitude of course, from tropical in the valleys to temperate on the hills. The snow limit also varies from west to east along the valley; just under 2000m in the west and about 2600 in the east. This area, which has been inhabited for centuries, supports nearly half of the Nepal's population. Subtropical and lower temperate forests are found here but due to extensive cultivation and fuel/fodder gathering they have all but been destroyed.

The Himilaya

This is of course the most impressive part of the country, with its snow covered, high peaks just beckoning to be climbed. The range of altitude varies from 3000 to 8848m (Mt. Everest). These mountains are terraced and cultivated up to about 2700m, or at least to the level of clouds and mist that hinders growing crops.
There is a zone in the east and west, before the Himilaya Range called the *Fore Himilaya.* These are defined as the highlands within the Midlands in which the altitudes exceed the

average of 3000m. They contain coniferous forests and great pastures on which rice is grown up to 2000m.
The great range can be separated into two different types of landscapes: the north and south flanks of the mountains. The rain bringing monsoons from the southwest loose all their water on the south flanks. The area north of the flanks has a mountainous dessert character and therefor much less vegetated.

The Inner Himalaya
This area is the valley, which is cradled within the Himilayan range. In these are broad glacier-worn areas rain-bringing winds enter the gorges between the mountain groups. We thus find in the lower part of the northern flanks of those valleys dense vegetation with bamboo and coniferous trees.

The Tibetan Plateau
This is the area north of the northern Himilaya range (the *Tibetan Marginal Range*) which is a pure mountain desert with a small population. Agriculture is only possible with irrigation on the sedimentary plain. Agriculture, however is not the main activity here, it is trading. The area lies in the field of trade between Nepal and Tibet/China where salt is imported and agriculture is exported.

1.3.2 Climate of Nepal

Nepal has a typical monsoon, two season, year. The shifting of the sun over the mountains and the Bay of Bengal causes this. There is the wet season (monsoon) from June to September. The sun heats up the mountains, drags in the moisture-laden air from the bay which is forced to condense as it moves up the range. When the sun heats up the bay in the dry season from October to May, it drags in the weather pattern from the west. This air type contains little moisture when it moves across Nepal.
However, it is not as simple as this because the topography of the region is superimposed over the climate. The eastern Himalaya Range causes the brunt of the monsoon to fall there because it lies more south and closer to the Bay of Bengal. Consequently there is a negative moisture gradient from east to west. In the winter, western Nepal experiences a reverse monsoon caused by the weather pattern that is dragged in from the Arabian Sea. This brings moisture into the region in the form of snow, which is essential for agriculture there.
Rainfall also increases with altitude up to about 2700m where the clouds would have then spent all their moisture. In the high mountain ranges, temperatures remain cold throughout the year. In the Tarai and the Katmandu Valley, summers are hot and rainy and winters are cool. Temperatures are highest from late spring to midsummer. The higher mountain elevations are always snow-covered. The aspect of the mountain face also effects the climate: southern sides receive more sun and are therefor drier.
Temperatures range between a maximum of 40 and a minimum of 8 degrees Celsius in the plains, 32 and 0 degrees Celsius in the Kathmandu valley, and between 16 and -6 degrees Celsius in the mountains.

1.3.3 The Sindhupalchowk district and Barabise

Nepal is divided into several administrative districts in which Sindhupalchok is one. The district borders north- east of the Kathmandu district. One of the main towns in the district is Barabise. Appendix V is a map of the Barabise area.
Barabise is a small village on the Bhote Kosi River, with about 4000 inhabitants. It is on the end of the paved road from Kathmandu (86km north- east, 4 hours) which continues, unpaved, to the Tibetan border (26km, 1.5 hour). It is a transit village for the trucks that to and from China to 'import' (smuggle) clothes and other goods. There are also several white-water rafting lodges located just outside the town, so sometimes a few lost tourists wonder around. But generally there are no tourists in the area. It is a noisy village caused by the horns

of the many trucks and foul- smelling, because of the air pollution and open sewer. The district hospital in Barabise is the main hospital for about 200.000 people in the surrounding hills, but has just 10 beds.

The main working area of Vajra are the VDC's in the surrounding of Barabise. Each district in Nepal is divided in a number of VDCs. VDC comes from Village Development Comity, but is used to describe the covered area as well. The villagers democratically elect the members of each VDC. Its main function is to collect taxes and coordinate and stimulate public works to the benefit of all. Each VDC is divided into nine wards, i.e. Arukharka and Chulti are wards of the Ramche VDC. Apart from Ramche VDC, Vajra is working in the VDC's of Maneswera, Bararabise, Marming, Petku and Attarpur.
Although VFN started its work in the village of Ramche it is now active in more places around Barabise.

I Water supply project Arukharka

List of terminology and explanations

This is a list of some terms which are not explained in the later sections.

Terms	Explanation
Catchment	A V-shaped dam that diverts the water from the source into a pipeline.
HDPE pipe	High Density Polyethylene pipe

2 Present situation

Arukharka is a small agrarian village, which lies above Ramche. The people are very poor but have everything they need to survive and are therefor relatively satisfied. Daily life is occupied by collecting wood and tending to the fields.

2.1 Physiography and climate

Physiography

The village of Arukharka lies 90 km north-east of Kathmandu on the foothills of the Himalayas. It has an estimated elevation of 2000 m and is positioned on the boundary of 2 physiographic regions: the *Fore Himalaya* and the *Himalaya Range* (see figure 1.2 in the introduction). Deep river valleys cut through the area, which create a very accentuated morphology: steep mountains and valleys. Because of deforestation there are many mudslides on the steeper slopes. Luckily, the village lies on a relatively flat piece of the area: between the cliffs above Ramche and the hills below Chulti (see Appendix V). This area has been cultivated into dry sawahs.

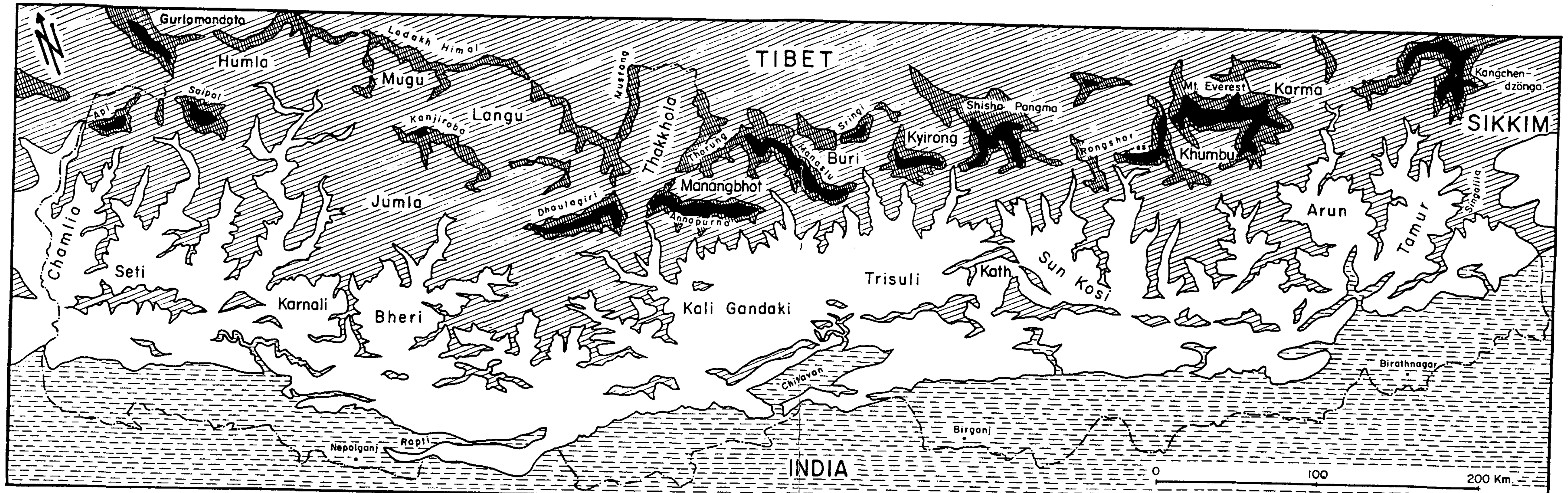
In this area there is a mix of different types of forests and vegetation. The subtropical chir pine is the predominant forest member while many oaks, alders, birches, mosses and dense understoreys, typical of the lower temperate zone river forests, are also present. Rhododendrons of the upper temperate zone are numerous as well as the fire resistant blue-pine forests. The later flora lies higher up in the region. The mix of the different types of vegetation is due to the fact that the village is positioned between two different physiographic boundaries. Each zone has a specific vegetation cover and here both types can coincide together.

Climate

The climate here is the basically the same is it is everywhere in Nepal, a monsoon climate: Rain during the end of May until August and dry the rest of the year. Since it lies relatively high (around 2000 m), the amount of rain that falls annually is not as much as compared to say Kathmandu. It has already rained out as explained in the Physiography of Nepal (Chapter 1). The winters are quite cold with temperatures ranging from just above zero to 10°C. During the summer/monsoon the temperatures are much higher, ranging from 15 to 30°C.

Fig. 1.2 Topographic sketchmap of Nepal

the very rough topographic sketch shows clear the natural divisions of the country. The altitudes above 7000 m form clearly separated mountain chains rather than large masses. The Tibetan marginal range, with altitudes between 6000 and 7000 m is separated from the Great Himalaya. The transverse Thakkhola graben interrupts both, the Great Himalaya as well as the Tibetan marginal range. The Midlands basins are best developed in central Nepal. West of the Kali Gandaki basin, the Fore Himalaya with its altitudes between 2000 and 6000 m reaches far to the south, and joins almost the Mahabharat Lekh. The latter, as natural barrier protecting the Midlands toward south, is well recognisable.



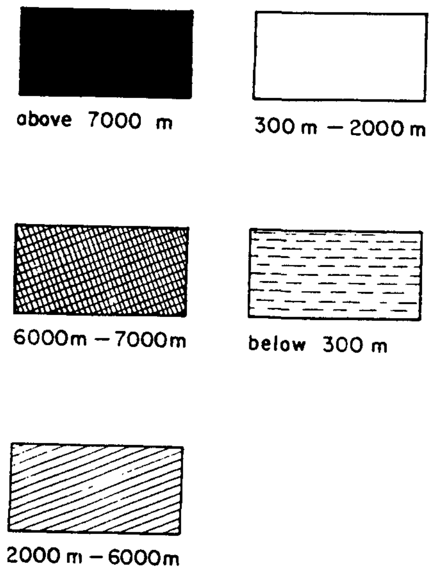
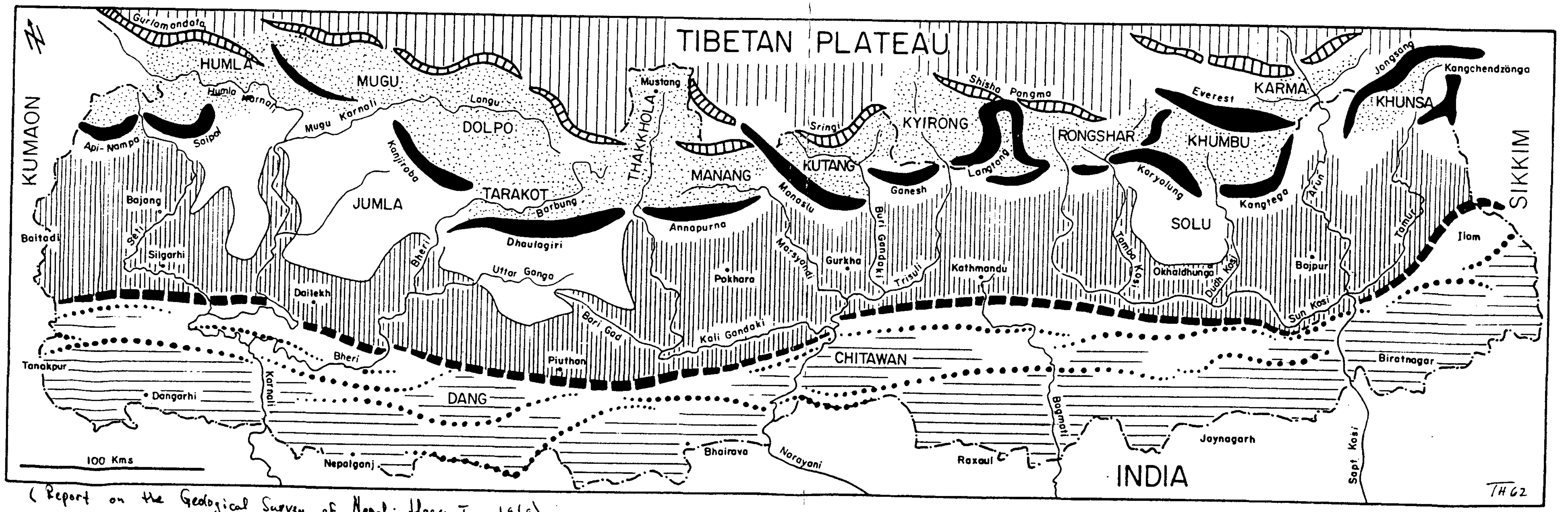
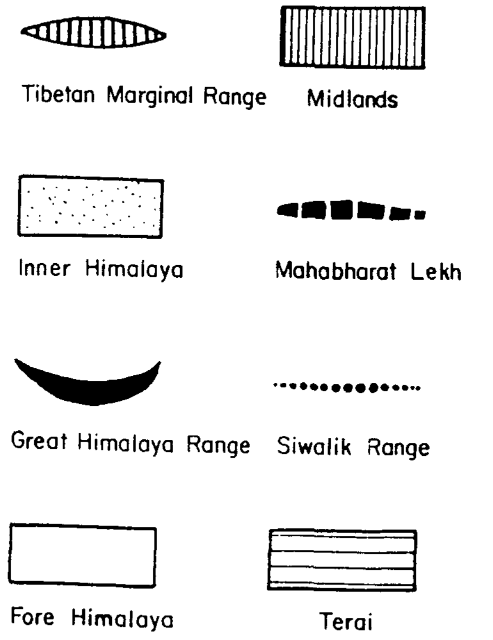


Fig. 1.3 Morpho-Tectonic sketchmap of Nepal, showing the natural divisions and the main drainage pattern

This map has been derived from the topographic map given in fig. 3. All the different natural compartments of the country show their characteristic topography, climate, natural vegetation, population and agriculture.





(Report on the Geological Survey of Nepal; Hagen, T. 1969)

Demographic situation

Population and ethnic background
The village of Arukharka consists of 11 families, each with about 6 members and therefor a total population of around 66 people. They are Tamangs, who are the largest Tibeto-Burmese ethnic group in Nepal. Their religion is closely associated to Tibetan Buddhism, like most of the people of the upper foothills of the Himalayas. This reveals their origin. See figure 3.1for a sketch-map of the village and its structures.

Housing
The houses in the village are small and solitary: they are spread out over the area. The houses are constructed of stone masonry, plastered with mud and have a stone rough. Attached to the house are small, low barns, build in the same manner, which contain the wood and cattle.

Labour
The people of Arukharka are predominantly self sufficient farmers, growing corn, rice and maize. The little extra they have they give to the other villagers in need or sell. Some houses also grow small vegetable gardens to sell on the market. Their second past time are labourers: masonry and carpentry.
There is a sharp division in which gender does which work. Mostly the men work the fields and are labourers. Every man in the family knows the techniques of masonry because they have to build their own houses. Only a few people have the utensils of a carpenter, and they are also men. The women collect and sell the wood and do the housework. During the sowing of seeds, both men and women work together on the fields because all hands are needed.

Food and income sources
Generally the villagers are self supporting, growing enough corn, rice and maize for own consumption. But money is needed to buy other things, such as oil, pans, pots, medicine, roksi, etc. By selling the wood that grows in abundance around them, they have an income source. This wood is sold in the underlying villages who do not have the wood in excess. They also collect wood for themselves for fuel. Some houses sell vegetables from their vegetable gardens and earn extra money.

School and education
There is no school present in the village and all the people are illiterate. The nearest schools lie in the village above, Chulti and the one below, Ramche. Because all the help is needed to work the fields and other chores, the children have no time to go to school. There are three exceptions though, all boys, who occasionally o to the school in Ramche.

Water, Sanitation and hygiene
The people of Arukharka started their own water supply project about six months ago, financed and partially supervised by VFN. This water supply pipeline connects their water source (a spring 2.5 km uphill) and their four public tap stands in the village. This was inspired by last year's VFN water supply project in the village Chulti which lies above Arukharka. The project still has to be completed.
An estimated amount of 40 litres daily consumption: drinking, for cattle, irrigation, washing, plastering, etc. There is little sanitation in the village. There are no toilettes and so the people excrete in the nearby shrubbery. The people also do not clean themselves very often (in their youth, never and therefor the dreadlocks and snotty faces), maybe a full rinse once or twice a month.
The around the existing public stands there is a lot of mud, flies and worms caused by the access water. Since all the people walk on bare feet, many people are sick and have colds. The people cook with open fires in their homes. This is because the kitchen and fire is holy,

so it has to be there for all to see and it keeps the family warm during cold days and nights. Smoke from the open fire rises freely in the house and this causes respiratory problems.

3 Discussion, agreements and contracts with villagers

After the evaluation of the Arukharka water project a plan was made to improve the quality of the project. With the agreement and labour of the villagers the works were done. During the project some problems arose but they where solved with a written contract.

3.1 Boundary conditions

The people of Arukharka had already begun the water project four months before but had not completed it. A contract was made then to agree upon the distribution of costs and labor. During the building then a supervisor from VFN checked the work once to two times a week. During evaluation it was seen that much of the water project was already completed (catchment, reservoir, tap stands, and piping) but not all correct.

- The water project of Arukharka is not completed.
- To complete the project the villagers are willing to work with the supervisors.
- There is already a contract made between the VFN and the villagers before the start of the finishing project.
- A supervisor was not constantly present from VFN during the works before the finishing project.
- Skilled labour (masons, carpenters and plasterers) are paid for their work.
- The village of Arukharka pays 25% of the costs of the project.

3.2 Problem description

In the evaluation of the quality of the Arukharka water project the problems are established in the chapters here under. These problems had to be solved, either by digging, joining, masonry, etc. for the completion of the project.
Before the completion of the water project in Arukharka there already was a contract between VFN and the villagers. A clause in this contract stated that the water supply pipelines had to be placed at the 'correct depth'. Since the villager almost build the whole project without supervision, this term is of course open to much interpretation. The supervisors did not make the boundary demands from the VFN.
Some places are agricultural fields where the water supply pipeline is not placed deep enough. In these fields the pipeline must be dug up and placed at the correct depth. Since the fields already contain young corn plants, some of them will be destroyed during the digging. The skilled labourers in the village have to be paid for their work. VFN has a clause that 25% of the costs of the project are paid by the village/Village Development Committee (VDC). Therefor the distribution of the costs must be planned and agreed upon.

Problems:
- The problems and solutions of the water project are open to too many people's interpretation.
- Corn plants will be destroyed during digging in the fields.
- Distribution of the 25% villager's costs.
- The problems of the water project must be solved or the project is not complete.

3.3 Objectives

- The supervisors, with help of the villagers detect the problems and solutions.
- The farmers, whose fields are dug in and in which corn plant destruction occurs, will be compensated.
- The distribution of the 25% villager's costs will be done by free unskilled labour.
- The completion of the water supply project.

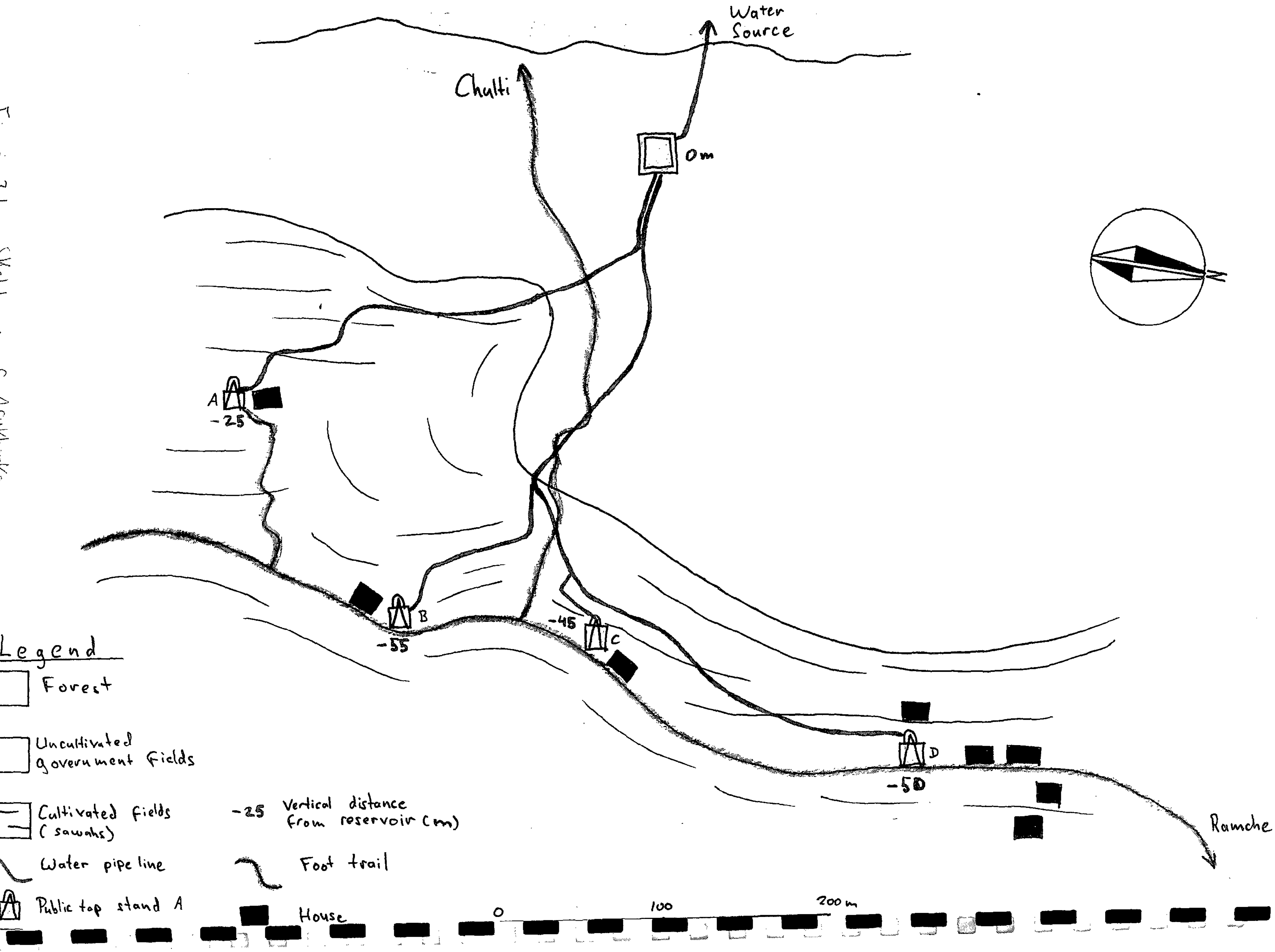


Figure 3.1 Sketchmap of Arukhurka and its structures

3.4 Solutions and procedure

Since the villagers where enthusiastic to complete the water project there was no problem in collecting volunteers to work.
Before the project was started a new verbal contract, on top of the old written one, was made. The villagers agreed upon the fact that they will fix anything that the supervisor's see fit. But most of the problems detected where already known by the villagers and therefor solved with ease together. Also, by having a supervisor on site every working day, the problem of 'misinterpreting' a boundary demand was avoided. An example of this is the fact that the 'correct depth' of a pipe (as stated in the previous contract) is 0.6 m underground and not 0.3–0.4 m as the villagers wanted it to be.

Another verbal agreement was made so that the VFN would compensate for any destruction of crops. The density of the crops (corn plants/m^2) would be measured. From here the amount of crop destroyed could be calculated. But when digging was to occur in the first agriculture field, the villagers did not want to. They then said that they did not trust certain members of the VFN who said that they would get compensation. Therefor, a new written contract was made that said that they would be compensated in the equal amount of corn that was destroyed. All the people of VFN and the villagers signed this contract.

In this contract the price of unskilled labour (except portering) was also settled: for free. Skilled labour (masonry), however, would be paid the normal market price of Rs 80/day and cement mixing Rs 70/day.

4 Water source catchment completion

During the construction of the water system before evaluation, a lot of work was already done at the source. Rene Veldt supervised the building of the masonry intake structure, which is the actual start of the system. The villagers themselves have made a concrete reservoir with a volume of approximately 0.5 m^3 located after the catchment.

4.1 Boundary conditions

The water from the source comes from a spring and is therefor classified as groundwater. The water seeps through cracks of the rock and is collected by a masonry intake. The intake consists of 2 stone walls that acts like a damn, which, together with the rock is made watertight. The lid of the intake is made of galvanized iron plates (GI-plates) which are partly pressed into the rock wall to prevent rain runoff to contaminate the groundwater. The GI-plates have a slight angle so that the rainwater runs of easily. The GI-plates are connected to the stone walls with cement, in which they are pressed firmly. Large stones are put on the plates to prevent people from opening the intake. Inside the intake stones are placed to prevent the GI-plates collapsing. At the point where the 2 concrete walls meet (at a 90° angle) a 1" HDPE pipe is placed to transport the collected water. Near this pipe smaller stones are placed so the whole structure works like a simplified horizontal flow roughing filter.

The water from the HDPE pipe flows through a small open canal made of cement. Eventually the water ends up inside a small (0.5 m^3), open reservoir. Inside the reservoir a perforated pipe collects the water to be transported to the second reservoir. Already a concrete cover for this small reservoir is made, but it has not been put in placed.

In one of the corners of the small reservoir a gutter is made to collect a small amount (approximately 5% of the total flow) of water from another spring. For this water no intake structure is made.

4.1.1 Other boundary conditions

It needs to be stated that the villagers of Arukharka made the 0.5 m^3 reservoir without supervision of Vajra Foundation Nepal or the Stichting Vajra Nederland.

4.2 Problem definition

Several problems were encountered at the site of the source. First of all the water flowing out of the intake came into contact with air and rainwater, which increased the chance of contamination. Second, the 0.5 m^3 reservoir was not covered, (a lid, though, was already made and lies 200 m away) as well as the small spring running into the 0.5 m^3 reservoir.

Another complicated problem is the covering of the 0.5 m^3 reservoir. If the water is collected and used inside the reservoir the lid has to be watertight to prevent outside contamination. This means that the lid has to be sealed with concrete. This makes it almost impossible to make easy repairs and/or changes. If the lid is not watertight the water cannot be collected in the 0.5 m^3 reservoir. This means that for the smaller source an intake structure has to be made in the same manor as the large one.

An overall problem is that the source structures are now very vulnerable to outside influences; not only rainwater, but also humans who drink from the open tank or stand on the pipe sticking out of the intake.

Problems
- open flow of water from intake to 0.5 m^3 reservoir
- open 0.5 m^3 reservoir
- the water inside the 0.5 m^3 reservoir can be contaminated
- the future structure is not strong enough to withstand human influences[1]

4.3 Objectives
- The first 3 problems have the same sort of background: to prevent contamination from rainwater and or animal/ human excreta.
- The last problem is caused by a solution of a prior one.

Objective
Prevent the water to be contaminated with rainwater runoff and/or animal/human excreta and to make sure that the future structure is strong enough to withstand human influences.

4.4 Solutions and procedure
The water from the catchment, which flows from the 1" pipe, now flows through another 2 m 1" pipe. This new pipe is placed over the pipe coming from the intake. The pipe has been placed in the old gutter, which has been dug to a depth of 0.2 m. The whole gutter has been filled up with concrete.

After a long discussion with the villagers it was decided that the second, smaller, source was not to be included. The small gutter in the corner has been closed with cement and the water is de-routed. The pipe coming out of the catchment has been put inside the 1.5" pipe after which the 2 pipes were sealed together. The smaller reservoir has been cleaned and the drain has been put open. Therefor any rainwater entering the reservoir will flow out immediately. The prefabricated lid was also put on. In this way the water from the catchment would not come in contact with any other water or air. At this (dry season) time there is enough water for the villagers. If in the future the village grows, or a kitchen gardening project is started, the use of this source can be considered and implemented.

[1] When placing a pipe from the catchment to the small reservoir another problem is caused if the pipe is not covered correctly, it is a problem caused by a solution.

5 Digging of pipeline to its correct depth

Approximately 6 months ago the villagers of Arukharka started the construction of a drinking water system. Old HDPE pipes (from an Australian irrigation project) were used for transportation of the water. Some parts were equipped with new piping.

5.1 Boundary conditions

Starting at the source approximately 1 km of 1.5 " old pipeline (dug in during the Australian project) transports the water to the first reservoir. Near the source, and halfway, the pipeline lies at the surface and further down its depth is between 0.2 and 0.4 m. From the reservoir two 1" pipelines transport the water to the tap stands. One of the pipelines travels directly to one tap stand and does not split up into smaller pipes. The second pipeline splits up 25 m after the reservoir. One of them transports the water directly to the lowest tap stand. Of this pipe, approximately the last 100 m pipeline is new and paid by VFN. The other pipeline continues for 250 m after which the pipe is split again by a ½ " T-piece. The ½ " pipe facilitates a tap stand 10 m below. The 1" pipe continues to the last tap stand. All pipeline routes and structures are shown in figure 3.1.

At many places where the pipe was dug in, wet spots were visible at the surface. At these points the pipeline had leaking joints or was damaged by ploughing.

Between the source and tap stands the depth of the pipeline differed enormously. At some places the pipeline lays at 0.6 m but at other places the depth was 0.2 m

5.1.1 Other boundary conditions

Besides the conditions of the water pipeline, another thing to be dealt with are the people who have to dig in the pipeline. Prior to this digging the villagers of Arukharka already dug in the pipeline, but not at the correct depth. UNICEF states that the minimal depth should be 0.9 m. The villagers did not agree to dig to this depth. They only wanted to dig to 0.6 m. Some resistance existed against digging again.

5.2 Problem definition

Several problems may occur when a pipeline is not placed at the correct depth. First of all, if the pipeline lies at the surface, villagers can damage it by walking over it or by cutting it with a knife. Cattle walking over the pipeline can do the same. If the pipeline is placed in a field, ploughing can damage or even break the pipe if it is not placed at the correct depth.

Problem

- Parts of the pipeline were not placed at 0.6 m depth.

5.3 Objectives

The overall objective is to dig in the pipeline at 0.6 m where possible. At places where the underground is too hard, the pipeline should be dug in as deep as possible. It should be then covered with a thin layer of soil and on top of this stones should be placed.

Objective

- The pipeline has to be dug in as deep as possible to a maximum of 0.6 m. If this is not possible the pipeline has to be covered with soil and stones.

6 Solutions and procedure

The 1.5" pipeline that lay between the source and the reservoir was partly redug to depths between 0.1 and 0.4 m. At several places the pipeline could not be dug in deeper because of solid rock. In these cases soil and stones were used. The pipeline that was not on the surface was not re-dug because it was not deemed necessary. It lies in dense forest and was placed there 20 years ago for the Australian irrigation project. During these 20 years it has not been damaged or showed signs of leakage.

The pipeline that serves the single tap stand was completely redug to a depth of 0.6 m. except for the first 150 m from the reservoir. This is government owned land without any agricultural use except for feeding cattle. Here the pipeline was dug in to 0.5 m. The pipeline crosses 1 rocky path, were it was dug in at 0.3 m and covered with soil and stones (dunga). The remaining pipelines ran trough cornfields; all of them were not at the desired depth but were redug to 0.6 m

7 Pipe leakage's

During construction/digging of the pipeline the pipe broke several times or it was leaking at points where it had been put together. One of the villagers (Bibi), who helped building the Australian irrigation project, knew how to join the HDPE pipe. A thick iron spatula was put in a fire and heated. After heating both pipes were put against the 2 sides of the spatula. When enough of the plastic of both pipes was melted they were firmly pressed together and the pipes were joined.

7.1 Boundary conditions

The piping used for this project was mostly old (reused from the Australian irrigation project). Throughout the whole pipeline old joints leaked, or the pipe was damaged by ploughing or digging with a 'godhalo' (hand tool to work on fields). In the past pipes were not only joined by heating but also through the use of metal sockets which were placed over both HDPE pipes. To ensure that this connection did not leak, plumbing tape was used. Unfortunately all of these connections leaked.

7.2 Problem definition

Leaking water systems need more water then is actually used by the villagers. A second problem is the possibility of contamination of the drinking water with bacteria or other constituents through the leaks.

Problem

- Water is lost through leakage and the water can be contaminated.

7.3 Objectives

- The objective is to ensure that the pipeline does not leak water.

7.4 Solutions and procedure

In the final solution the complete pipeline has been made leak-free. All the metal sockets have been removed and replaced by connections made through heating and joining. In critical places where the pipe joining was hampered by very short pipes new pieces were used. In some cases the pipe could not be put back at 0.6 m. In these places big stones were put under the joint to ensure that the joint would not start leaking under the pressure of the above ground.

8 Covering of the reservoir

One of the sections of the Arukharka water system is a 12 m^3 reservoir. The reservoir is build to collect the water coming from the source and fills up during nighttime. During the day the villagers use the water and so the reservoir is empties.

8.1 Boundary conditions

The reservoir has been made out of masonry and is plastered. The outside wall in total is 0.4 m thick. The inner (0.1 m thick, dark grey in the figure) is 0.05 m lower than the outer wall (light grey). The plasterers of Arukharka wanted wooden beams to fall into the 0.1 m inner wall onto which GI-plates are attached as to cover the reservoir.

Inside the reservoir a lot of litter had accumulated as well as growth of algae on the plastered walls.

The reservoir was not built on a flat piece of land but on top of a hill. Water flows downhill and around the structure from high to low (See Table 8-1)

8.1.1 Other boundary conditions

The villagers already had collected 4 beams with the following dimensions: LxWxH as 3.06 x 0.09 x 0.07 m. These were already painted with primer. The villagers of Arukharka also complained that people from other villages, on purpose, spit and swim in the reservoir.

8.2 Problem definition

The reservoir had been open since it was build thus a lot of dirt/leaves/stones were blown/thrown in. At the same time people used the influent pipe for the collection of drinking water. This could damage the pipe. Sometimes goats or ox's walked on the outer wall.

Problem

- The water inside the reservoir can be contaminated with animal excreta and/or litter blown in by wind or rainwater.

8.3 Objective

This problem has the same sort of background as the problems encountered at the source (chapter 4: Water source catchment completion); the objective thus is to prevent contamination from rainwater, wind or animal excreta.

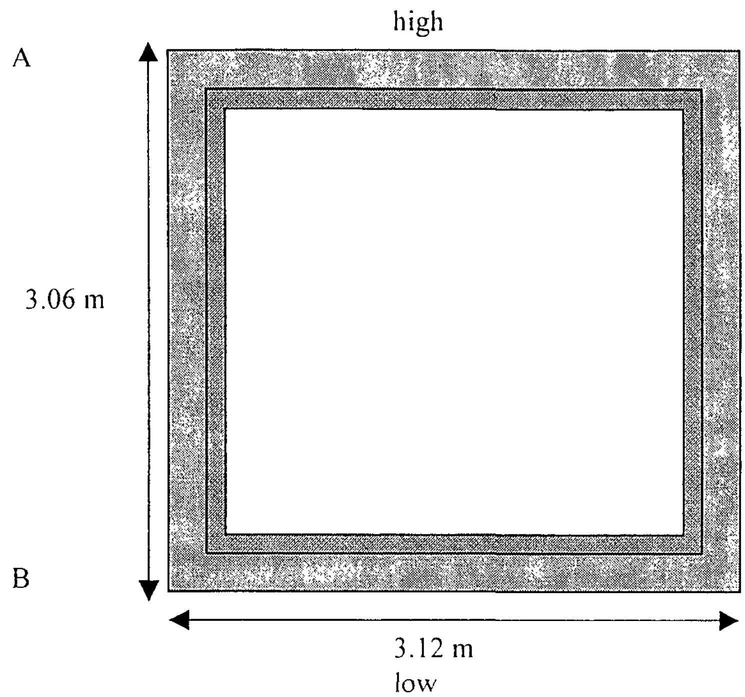


Table 8-1: Top view of reservoir

8.4 Solutions and procedure

The obvious solution to all the problems is the covering of the reservoir. Because there was no time to order new wood, old (but good) wood had to be used. To make sure no water was to stand still on top of the lid and therefore create extra pressure, it had to be put on an angle.

Since the reservoir was built on a hill, the best way to drain the rainwater was to let it flow towards the lower point (from A to B). This caused another problem. If the water flows from A to B it means that the groves in the GI-plates also must have the same direction. To ensure a strong structure the beams have to be placed perpendicular to the GI-plates. The beams have a length of 3.06 m and are therefore too short to cover the complete distance of the tank.

To close the reservoir a stone masonry wall was put on the inside of the outer existing wall (see figures 8.2, 8.3 and 8.5).
The wall had a width of 0.2 m which means that the beams had to be 2.82 m long (3.12 - (2 x 0.10)).
Two of the beams were put on the outer ends of the masonry wall (white, dotted lines in Figure 8-3). The 2 remaining ones were proportionately laid between the other ends (1/3 + 2/3 of the distance black, dotted lines in Figure 8-3).

After the beams were placed a start was made with the attachment of the wood to ends of the beams. Wooden planks (L x W x H) 1.80 x 0.02 x 0.34 m were used to cover the sides of the new stone masonry wall to protect the reservoir from litter blowing in. The planks were cut to the correct size and nailed on the beams. Since the planks were too short to cover the total length, 2 were used and joined together by a small piece of wood. The right and left side were strengthened with thinner beams (L x W x H) 3.06 x 0.04 x 0.07 m. They were nailed over the wooden planks and onto the ends of the beam. This gave the lid torsion stability, so it could be lifted without any damage.

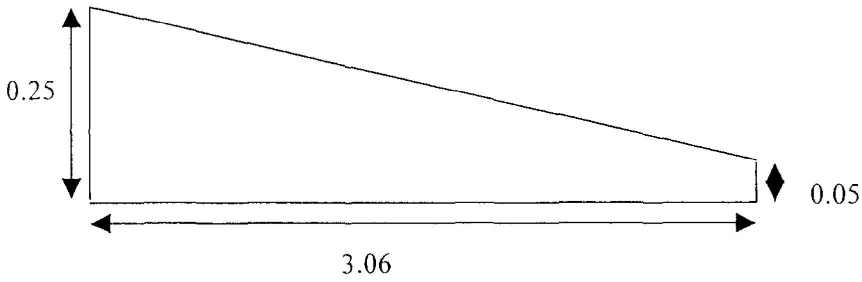


Fig. 8-2: **Side view of stone masonry wall**

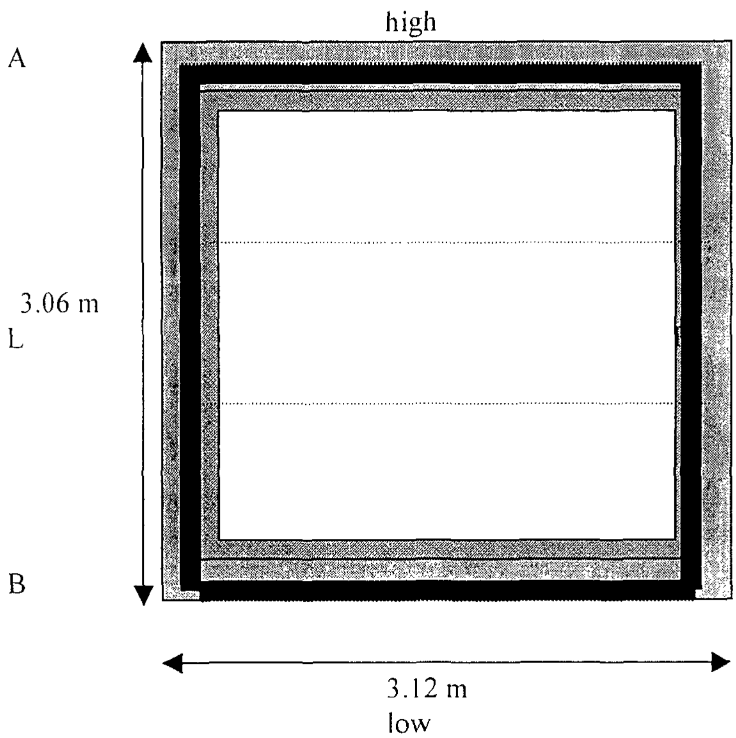


Fig 8-3: **Top view of reservoir with extra masonry wall and beams**

The perpendicular beams stuck out (0.01 m) over the stone masonry wall to create a little space. This made lifting easier.

After the wooden construction was finished, 5 GI-plates were placed and nailed to the beams. Unfortunately no long nails were available to nail the plates through the high curves.

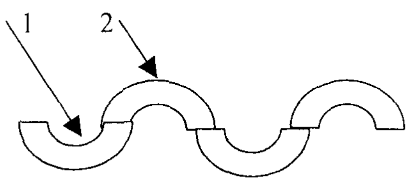


Fig 8-4: **GI-plate (1 = low curve 2 = high curve)**

If the GI-plate was nailed through the high curve (see figure 8-4) the water could have drained more easily. If this becomes a problem in near future the GI-plates can be turned around and nailed through the same holes (thanks to Rene). To ensure water-tightness pieces of slipper have been put between the nail and the GI-plate.

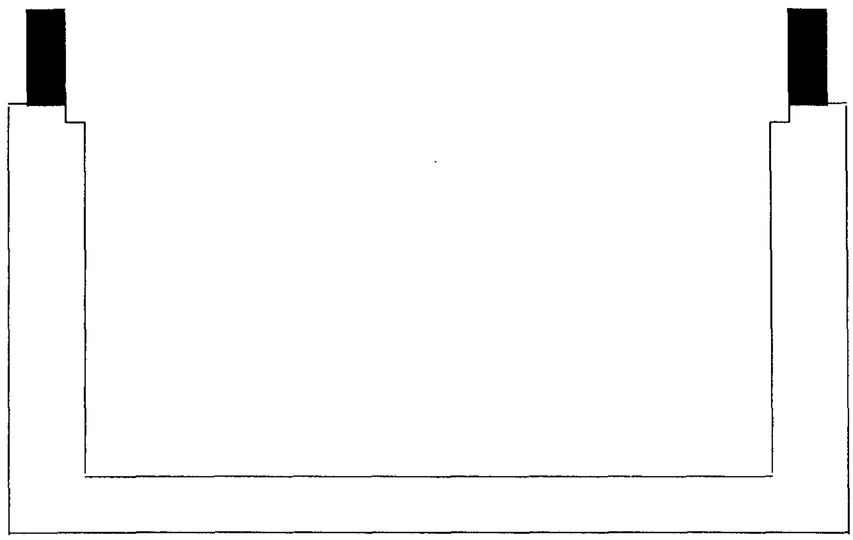


Fig. 8-5: Front view reservoir (blue new, stone masonry wall)

To ensure extra strength metal elbow pieces have been put on all corners. Finally stones were put on the GI-plates to keep the villagers from lifting the lid and thereby damaging the stone masonry and/or the lid.

9 Manhole by reservoir

Travelling from the reservoir are two pipelines which supply the village with water; one to serve one tap point and the other to serve three tap points. A drainpipe is also present for emptying the reservoir when needed. These pipes pass through a manhole which is directly build on the reservoir. Inside the manhole are all the connections between the metal outlet pipes and HDPE water supply pipes and any gate valves.

9.1 Boundary conditions

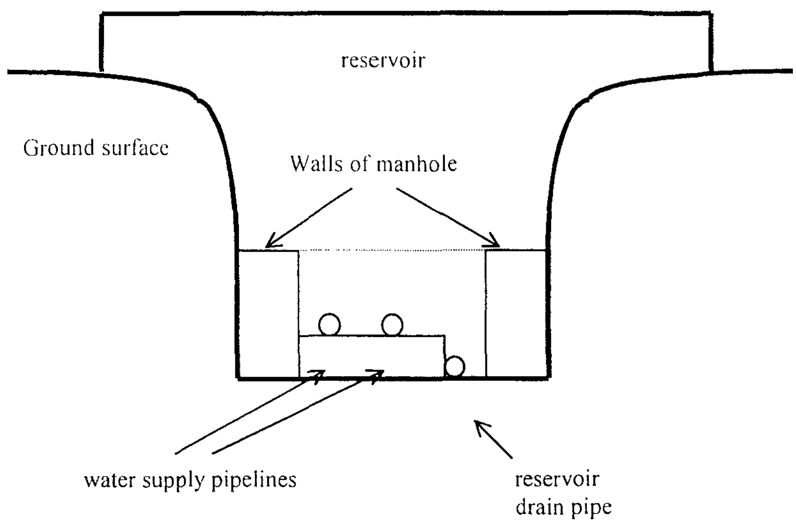


Fig 9-1: Front view of the manhole before works

There is a gate valve on the pipe that supplies three public tap stands with water. To connect the metal and HDPE pipes the locals used two systems. A metal socket and plumbing tape is used on one pipe and the other HDPE pipe is placed over the slightly smaller metal pipe. Both connections leak water. The drainpipe is 0.3 m long and has a metal socket in which a screw top is placed to close it. There is concrete lid that fits over the top of the manhole. Since the metal, outlet pipes are at the bottom of the reservoir the locals have dug a long hole in front of the manhole so that the HDPE pipes can be connected to the metal ones.
The ground surface around the reservoir is steep sided (50 ^{o}).

9.2 Problem definition

One of the demands of the project is, where possible, to have the water supply pipeline at a depth of 0.6 m. Therefore the hole in front of the manhole must be covered completely. When the manhole is also covered and it's accessibility decreases greatly.
All the connections between the HDPE pipes and metal outlet pipes leak water.
There is only one pipe that can be closed and opened easily. It is the water supply pipeline that serves three public tap stands, which has a gate valve. The other water supply pipeline and drainpipe do not have a gate valve and therefore are very difficult to open or close: one by pulling of/pushing on the HDPE pipe and the other by screwing of the top (drainage pipe). If the hole is covered then the water from drainage pipe, when used, has no possibility to drain away.
After covering of the pipeline hole in front of the reservoir, the connections between the pipes are no longer accessible.

There is always some access water in the manhole, either from future leakage points, from infiltration of water from the sides or rainwater that seeps by the concrete lid. This access water can slowly degrade the bottom of the cement structure.
Round the reservoir, the ground surface is steep sided. During the monsoon period these sides will erode greatly or even mud slides can occur which could damage the construction.
Problems
- Inadequate accessibility of the manhole after covering of the pipeline hole.
- All the connections between the HDPE pipes and metal outlet pipes leak water.
- The closing and opening of two pipes is laborious and inefficient.
- Drainage of water from drainpipe is impossible when hole is covered.
- After closure of the hole in front of the reservoir the pipe connections are no longer accessible.
- Access water in the manhole has no possibility to drain away.
- The steep sides of the surrounding ground are very vulnerable to erosion.

9.3 Objectives

- The manhole must be made accessible after the hole is closed.
- All the leakages between the connections must be stopped.
- The closing and opening of the pipes must be made more efficient.
- Drainage water from the drain must be able to drain freely.
- Making the pipe connections accessible after pipeline hole closer.
- The access water in the manhole must be able to drain freely.
- The sides of the surrounding ground must be made less vulnerable to erosion.

9.4 Solutions and procedure

There is only one alternative solution to make the manhole accessible after the closure of the hole: to raise the manhole to the surface before closure. The masons of the village raised the manhole until the top and lid was 0.3 m above the surface. Hereby the concrete lid was easily accessible. The only problem encountered was that the lid was too long for the manhole itself so that at one side (downhill) it protruded from the manhole. It was concluded that this would not bring about any problems and so this could be left.

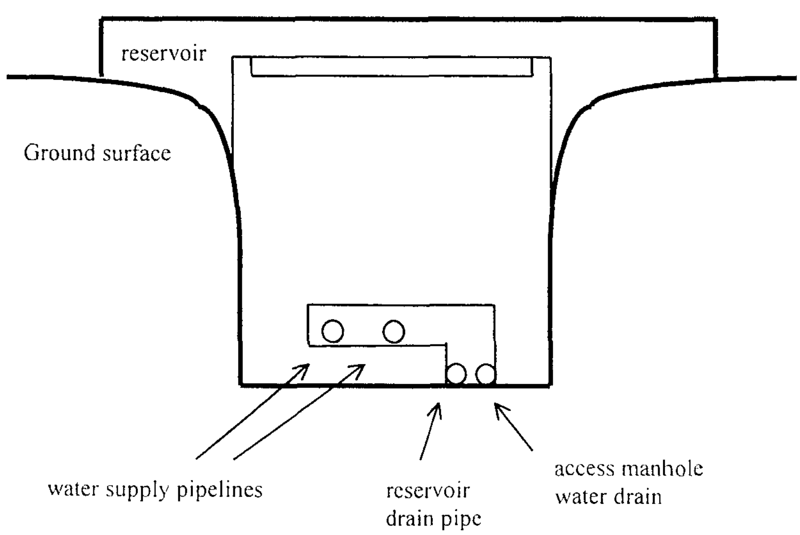


Fig.: 9-2 Manhole after the works, before the filling of the pipeline hole.

To stop the leakages between the pipe connections a system with rubber tubing and tube clamps was used. A piece of 0.1 m rubber tubing was placed over the two ends of the

different pipes so that there was only 0.05 m was left between them. Then a tube clamp was placed over the rubber tube and pipe on either end and screwed shut. This system made sure that no air, and therefore water, comes into the connections. For all the connections 0.02 m diameter rubber tubing was used. For the two pipes with a bigger diameter (0.025 m) the rubber tubing was heated and made malleable and then placed over the pipes. See figure 9-3 for a visual description.
To keep the rubber connections accessible for maintenance, the large opening where the pipes leave the bottom of the manhole was left. It was covered with two lose stones that rested on the pipes which were covered with soil and supported underneath with soil and stones. Then the pipeline hole in front the manhole was filled with soil. If they needed access to the rubber connections, the villagers would need to dig down until the hole in the manhole is reached and the lose stones can be easily removed.

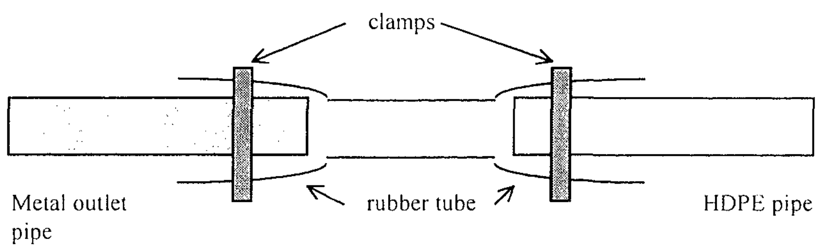


Fig.: 9-.3 Rubber tubing connections.

Since a gate valve is already used on one of the pipes, the solution is to connect a gate valve onto the other two pipes. The two pipes that needed a gate valve were the water supply pipeline with one public stand post and the drainpipe. On the drain pipe a gate valve was placed. On the water supply pipeline a gate valve could not be placed. When turning on the gate valve the pipe next to it was in the turning path and therefore it could not be used. There was no other solution that could be used as to make the opening and closing of the pipe more efficient.
There is only one solution to drain the water from the drainpipe: connect a HDPE pipe to the drain. Its outlet emerged at the surface 5 m down hill.
To drain the access water inside the manhole, a HDPE pipe is placed on the bottom and emerges 5m down hill. Its outlet was made to be lower than the inlet so that the access water could be drained by gravity.
To lessen the vulnerable surrounding ground from erosion the sides were made less steep. This was done by digging away the top half of the surrounding hill.

10 Tap stands

In total the village of Arukharka uses 4 public tap stands which are made out of stone masonry. The walls have been plastered to prevent excessive growth of algae and to make cleaning easy. Each tap stand is used to collect water for the families and cattle. Spilled water is used for irrigation by the villagers who live closest to the tap stand.

10.1 Boundary conditions

Around the tap stands the, normally dry, soil is wet and grass and rice husks lie around it. The grass and husks, together with ashes, are used for cleaning pots and pans. Flies are all around. The tap stands themselves are clean. The tap stands are equipped with self-closing taps. Due to the high pressure of the water from the reservoir all taps are leaking or have blown of.

All connections between the HDPE pipe and the iron pipes from the tap stands are leaking.

10.2 Problem definition

The area around the tap stand is muddy, dirty and attracts flies. The women and children who walk to and from the tap stand get dirty and cold feet. Drinking water can be contaminated and diseases can be spread.
Two of the tap stands have no drainage pipe. Water leaks from the taps and the connection between the HDPE and metal pipes at the back of the tap stand.

Problem
- Area around tap stand is muddy
- 2 tap stands have no drainage pipe
- Connections between HDPE and metal pipe leak
- Taps are leaking

10.3 Objectives

The most important thing is to make sure that all of the connections/taps at a tap stand are leak free. If this is the case the problems with dirty unsafe tap stands will be smaller; a drainage pipe will also contribute to this. The objective is to make them dry and therefore clean.

Objective
- Create rock-bed around tap stand
- Insert drainage pipes
- Connect HDPE and metal pipe properly
- Put on new taps with plumbing tape

10.4 Solutions and procedures

In front of all tap stands a rock bed of approximately 0.5 m^2 is created. The tap stands that already had a drainage pipe underneath the tap do not have rock bed drainage system The ones that did not have a drainage pipe, have rock bed drainage system in the form of a piece of HDPE piping. All sockets at the back of the tap stands were made watertight with plumbing tape.

Finally all tap stands got new taps.

11 Maintenance

Water systems can be build perfectly but without maintenance every system will break down within several years. To prevent this happening to the Arukharka water system, a maintenance contract has been made.

11.1 Seasonal changes

During one year several seasonal changes take place which can effect the system. In the dry season it is easy to check the pipeline for leaks but during the monsoon this is almost impossible. The monsoon season is the most dynamic one and therefore this will cause the most problems. So it is best to check the whole water system before and after the monsoon, in March and October.

11.2 Repairs

Inevitably repairs have to be made on the water system which would have to be paid for. Therefore the villagers of Arukharka collect money for maintenance; Rs 5 per family per month. At the time of writing 11 families were present which means a yearly saving of Rs 660. All repairs and materials have to be paid from this account.

It is advisable to record every repair made in a maintenance book. If problems occur often maybe another solution can be found.

11.3 Maintenance checklist

- Check all pipelines on leakage.
  Check ground for wet spots. If a leakage is found, fix it and check 1 week later again.
- Check if the 0.5 m^3 reservoir is still clean and check if drain is not clogged.
  If water stands still inside the 0.5 m^3 reservoir the drain is clogged. Use a stick to clean the drainpipe and also clean the reservoir to prevent future clogging.
- Check reservoir on leakage.
  Close all gate-valves and let the reservoir fill up completely. De-route the water coming from the influent pipe and make absolutely sure no water is added. When the water has calmed down mark the high water level with a pencil. Leave the tank overnight. If the next morning the level is the same, the tank is still watertight. If not the leak has to be found and repaired. After repair the leak the procedure is repeated. It is wise to inform the women of the village a day in advance of the checking of the reservoir; in this way they can collect extra water.
- Check gate valves on leakage and rust.
  The gate valves have to be checked on leakage and rust. If the valves leak at the connection with the pipes they have to be connected again with new plumbing tape or replaced. If the gate valves themselves are leaking they either have left to let leak or replaced. If the valves are hard to open tap grease has to be put in and opened and closed several times for full lubrication.

- Check tap stands on leakage at the connection between the HDPE and metal pipe.
  Check if the connection is leak free. If not repair with plumbing tape. If they still leak fix the two pipes together with a piece of flexible hose and 2 clamps.

- Check taps on leaks
  Taps are most likely to leak at the connection between tap and pipe and through the tap itself. The connection can be repaired with plumbing tape. The tap itself can be fixed with a new leather ring or it has to be replaced.

NOTE

It should be noted that any problem with the system should be repaired as fast as possible. If the problems are left the awareness for maintenance declines and then system will not work correctly.

12 Time schedule

Before the start of project a rough time schedule was made to clarify and order the work that had to be done. The total time planned for the project was thought to be three weeks. This schedule was, however, not followed. It was due to the fact that parallel working was not possible (see section IV: Conclusion and recommendations), unforeseen 'holidays' and underestimation of the work. This first draft of the time schedule was unfortunately lost. On the next page is the actual time schedule of the works.

The first three days was spent on evaluating the system and one day was spent on discussing with the villagers the works that were needed.

Hereafter the re-digging of the water supply pipes was done. This is the most time consuming section of the works (in total 16 days). There are some gaps in this section due to days not worked on. The first hiatus was Nepali new-year (2057). The second was a protest day organised and forced by the Moaists. On this day nobody was to work in protest of the regime. If one did then you openly protest the Moaists and therefor are in risk of your life. The third hiatus was when a new written agreement was made for the compensation of the farmers whose crops are destroyed by digging. Any found pipe leakages were fixed during the re-digging.

The covering of the reservoir took eight days to complete. The water source catchment completion was done inbetween the work of the reservoir and took two days.

The manhole of the reservoir completion took longer than expected (6 days). One reason was because the ordered material was incorrect and had to be ordered again. Also, the upgrading of the pipe connections was not as simple as it seemed. It took some time before it was deemed impossible to connect the one gate-valve (Solutions and procedure, chapter 8: Covering of the reservoir). Much time was also consumed brain storming on how to connect the two ends of the pipes. Eventually it was done with the rubber garden hose (Solutions and procedure, chapter 8: Covering of the reservoir).

On the morning of the closing party the manhole was finished and the tap stands were replaced. After the party and with a slurred tongue, the water samples were collected to bring to the ENPHO the next day.

Two weeks later the maintenance training was given in one day. That morning, before the training, the villagers quickly filled up the hole before the reservoir.

Work done	Time (days)																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	1
Evaluation of the water system	■	■	■																																		
Discusion and agreements				■												■																					
Re-digging of pipe line					■	■	■			■	■	■		■	■		■	■	■	■																	
fixing pipe leakage's					■	■	■			■	■	■		■	■		■	■	■	■																	
Covering the reservoir																																					
collecting and cutting stones for wall																					■	■	■														
building the wall																								■	■												
building the roof																												■	■	■							
Water source catchment completion																																					
digging of pipe canal																										■											
connecting pipes																										■											
de-routing second spring																										■											
cementing pipe canal shut																											■										
Manhole completion																																					
collecting and cutting stones for wall																															■						
fixing and upgrading pipe connections																																■	■	■			
masoning up the wall																																		■	■	■	
covering hole infront of manhole																																					■
Tap stand tap replacements																																				■	
Water sampling																																				■	
Closing party																																				■	
Mainenence training																																					■

Fig 11-1: Time schedule Arukharka

13 Water quality

A system that works and is being maintained is a success, but if the quality of water is poor then the system is a step in the right direction. Therefore to test the water quality of the source and in the system is a logical step in the evaluation of a water project. Field kits to test ammonia, nitrate and phosphate were available. Also, contact was made with a Nepali NGO, Environment and Public Health Organisation (ENPHO) that could test the water for bacteria.

13.1 Boundary conditions

The source of water is a spring, so it is defined as ground water. At the source the catchment is water tight (no water from the outside can come in). From hereon to the reservoir the water travels in HDPE pipes under the ground.
This water is then collected in the reservoir tank. The tank is closed with a lid, which has minute gaps.
At the bottom of the reservoir HDPE pipes transport the water to the four public stand posts. One water supply pipeline transports the water to one public stand post, the other to the remaining three posts.
On the day of the measurements there was one pipe leakage detected between the reservoir and the fourth public tap stand.

13.2 Problem description

Many health problems are caused by poor water quality that the locals drink. Therefore checking the water quality of the original water from the source is necessary. The system in which the water passes through contaminants can also enter through leakages. Therefore checking the water quality that comes in and out a pipeline is also necessary for contamination.

Problem:
- What the quality of the water from the source is.
- If any contaminants come in the water supply pipeline system.

13.3 Objective

By collecting water samples at the spring, at the reservoir and at the public stand posts all the system's sections can be checked: water source, pipeline from source to reservoir and the reservoir and it's pipelines to the public tap stands. From here conclusions can be made about the water quality at the source and if there is contamination in any of the pipelines.

Objectives
- Measure the water quality at the water source
- Measure the water quality at the reservoir for quality of pipeline between source and reservoir.
- Measure the water quality at the public stand posts for quality of pipeline between reservoir and tap stands.

13.4 Solutions and procedure

A water quality check has two sections. The first is the done by the ENPHO itself. Two samples of water, at each measuring point, are collected in glass bottles which are placed in a cooling box with cooling elements. The samples and cooling box are taken back to Kathmandu to the ENPHO within 24 hours. Here they can test the water samples for bacteria (total coli's and E. coli's). If the bacteria is present, then there is a good chance that there is contamination from excreta from humans or animals.

For the second section field test kits were used on site to measure ammonia, nitrate and phosphate. They test for possible contamination by fertilisers and pesticides. These tests were done at the same places and at the same time as where the water samples for the ENPHO were collected. As with the water sampling they were done twice to get a proper distribution and exclude any human mistakes.
Remco Keijser later stated that checking the water quality between two points wouldn't say anything about leakages in the system. This is because at a leakage the water streams outwards by its own pressure therefore not letting any water flow inwards from outside. So contaminants in the surrounding soil would never enter the water pipeline. So this water quality check is only to investigate if there are any contaminants at the source.

13.5 Results and conclusions

As seen from the water quality results in Appendix VI, the water is contaminated with coli's. One could say that there are trends to be seen in the results. First of all the total coliform results show that the concentration decreases from the source to the individual tap points (960 CFU/100ml to 149 CFU/100ml for sample2). Second of all the E. coli concentration is high at the source (73 CFU/100ml, source sample 1), decreases at the reservoir (5 CFu/100ml, reservoir sample 1) and then increases at the tap points (22 CFU/100ml, tap point D sample 1). But as stated by Roshan Shrestha from the ENPHO, these oscillations in the results are relatively not very big. They are due to the variations in concentration in time and not by outside factors. Big variations in the hundreds would mean that there is an outside factor in the system.
So, it can only be concluded that the water from the source is contaminated and that the contamination comes from elsewhere above the source. It may come from where the water feeds the ground water system (direct rain or from a river). Here, on the soil or in the river, the people or livestock would defecate. A later field study would be needed to determine this.

14 Costs

The water project in Arukharka was mostly finished before this internship started. Most of the costs therefore had already been made. The following table shows the distribution of the costs for finishing the project.

Material	Costs (Rs.)
HDPE-piping	300
Garden hoses	125
Taps	320
Valves	500
Socket	20
Plumbing tape	25
Clamps	280
Elbow plates	125
Cement (4 sacks)	990
Sand	500
Wood	400
Nails	100
Skilled Labour	
Masonry	1535
Pipe joining	200
Portering	
For wood and cement	1550
Miscellaneous	
Party	1300
Water quality analyses	6400
Total	14670

Table 14-1: The distribution of costs of the project

As stated already before in chapter 3, discussion, agreements and contracts with villagers, unskilled labour was to be unpaid. This is so that the villagers would pay their share of 25% of the costs. Portering of the sand from Barabise was also in the villager's costs of 25%. Skilled labour was already set: masons Rs. 80/day and cement mixing Rs. 70/day. The party costs were for the sacrificial goat (Rs. 900) and for the local pani/roksi (Rs. 400 worth, enough for a good time!).

15 Final Evaluation

Before the start of the internship a small evaluation was made of the work that had been performed by the people of Arukharka. Unfortunately some irreversible work was done e.g. the building of the catchment and reservoir. In this final evaluation the project will be evaluated as it is now (June 2000).

Catchment
The catchment has been build properly and can withstand human influences. Six months after construction the stone masonry structure was still is in perfect condition. The catchment does not seem to leak, although this is not sure because all of the surroundings (even in dry season) are wet.
The catchment unfortunately is very hard to open. The GI-plates have been pressed into cement. If the catchment needs to be cleaned the GI-plates have to be broken from the construction which makes replacement difficult.

0.5 m^3 Reservoir
The second structure after the catchment is a 0.5 m^3 reservoir. This reservoir was intended to be used as a catchment for the second small spring. This reservoir did not have the capacity or the possibility to collect water in a safe way. It now only covers the joint between a 1" and 1.5" pipe and is not used in any other way (see chapter 4: Water source catchment completion).

HDPE pipeline
For this project mostly old pipeline was used from the Australian irrigation project. This pipeline had been joined many times already in the old project. The villagers dug up the pipeline which caused more damage, and thus more joints had to be made. The redigging of the pipes to 0.6 m did not make it better. Several times the 'godhalo' (digging tool) cut open the pipe.
All these pipe joints make the pipe more vulnerable (weak points) and therefore leakages could occur more often. Another problem caused by the joints is that on the inside of the pipe there is a melted plastic ring. This causes friction and could cause clogging. It cannot be detected from the outside.

Reservoir
The 12 m^3 reservoir is situated on top of a hill. The reservoir itself is in good shape; all stone masonry is strong and the tank is not leaking. The only problem with the reservoir is that it is situated relatively high. UNICEF states that the vertical distance between a reservoir and the highest tap stand should only be 3m. The distance between the two in Arukharka is estimated at 30 m. So 10 times more pressure than needed pushes against the taps. This causes them to leak eventually and sometime blow of. The new taps should be able to withstand the pressure.

Manhole
The manhole that is connected to the reservoir was easily accessible before the finishing project. This was because there was hole in front of it that was not covered. After raising the manhole and covering the hole the working space inside became very small. If big repairs have to be done (to fix the connections) part of the ground has to be dug away to get to the reparation hole. This is time consuming but the dimensions of the manhole where already fixed. Therefore, widening of the manhole was not possible

Water distribution

From the reservoir 2 pipes travel down to transport the water to the tap stands. The problem is that 1 pipeline serves 3 tap stands while the other pipeline serves only 1. In this way the water was distributed unevenly. If the single piped tap stand is used for irrigation a water shortage could occur.

Monsoon

At the first signs of the monsoon the people of Arukharka dig trenches along their fields to make sure that the large quantities of rainwater do not wash away the fertile soil. Unfortunately the trenches have been dug in exactly the same place as the pipeline. Not only does the depth of the pipeline decrease (from 0.6 to 0.3 m) but a lot of the soil above the pipes will also be washed away by rainwater runoff. If the trenches are not placed elsewhere and this continues for several years the pipes could surface.

The amount of tap stands

In total there are 4 tap stands in Arukharka. UNICEF states that a tap stand should to be 250 meters horizontally /50 vertically of each other. In Arukharka 2 or 3 tap stands would be sufficient because they are nearly all closer than 250 metes horizontally. Since there is enough water it is not a big problem when all the taps are used. If and when water becomes scarce problems can arise if all the taps are used (faster depletion of their water).

15.1 Some pointers learned from this project

During construction/negotiation several problems arose. From these problems useful things were discovered. To insure that the learned experience is not lost and that the next engineers wouldn't have to learn them the hard way, these tips are noted down in this chapter.

- If possible, digging has to be started before the planting season. It is very hard to convince a farmer to dig in his own field afterwards and therefore destroy his own crops. This also avoids extra costs for compensation for the foundation.

- If repairs need to be done on existing water pipes it is necessary to check if problems can arise with air blockage. When working it is best to put wooden stick in both ends of the pipe to prevent air coming in and therefore blockage.

More lessons were learned, but they can be applied on projects in general. Therefore, these general pointers are included in chapter 36, with the pointers learned by the other engineers.

II Latrine construction in Health Camps

List of terminology and explanations

Term	
Pit	Tank for excreta
Flush system	Pipe system with water seal
Latrine	Toilet without sewer system
Vent pipe	Black 4 inch pipe for ventlation of the pit
Traineeship/practical period	Stage

16 Introduction

The Health Camps in the spring of 1999, organised by Vajra Foundation Nepal (VFN) proved that a lot of people in the Sindhupalchok district suffer from diseases caused by lack of hygiene. Poor sanitation, or no sanitation at all, is one of the reasons for this lack of hygiene. For this reason VFN agreed to support, both technical and financial, the building of 35 toilets in five VDC's. The VDC's are Marming, Barabise, and Maneswera. Petku and Attarpur.

The pilot projects toilets had to be build at several schools, to both teach the children and set an example for the villagers. In the (near) future VFN may support the construction of private latrines in the district.

This part of the report describes the design of the pilot toilets and the building of seventeen of them in three VDC's (Marming, Barabise and Maneswera). The construction took place in the spring of 2000, after the second Vajra Free Health Camps. Some remarks on the construction of toilets in Petku and Attarpur VDC can be found in Appendix II. The building of these toilets is no part of this report because the supervision has been done by Ir. Koert Huisman.

17 Problem description

17.1 Hygiene, present situation

The main problem of poor sanitation is the relatively high risk of faecal-oral transmission. This can happen directly, by dirty hands or indirectly through the soil, the drink water, the preparing of food and through vectors (flies). A survey in the VDC's proves all transmissions are present. People defecate in fields, bushes and streams. The amount of excreta found on the dry banks of some streams is literally breathtaking.

In all VDC's some families have private toilets. These toilets are usually single pit and none ventilated. The general public takes no benefit from these toilets.

It should be taken in mind that in rural Nepal the building of private toilets has no priority and is only in reach of the (very) rich. Given the poverty of the villagers, the constructions of school toilets, though being a good start, does not guarantee general improvement of the sanitation situation.

17.2 Problem definition

Because of lack of latrines and knowledge of transmission of diseases, the hygienic situation in the VDC's of the Sindhupalchok district is insufficient. The economic situation and lack of knowledge on how to build, prevents the villagers to construct latrines.

17.3 Objective

The objective of the latrine construction program is the realisation of pilot projects in some VDC's where the Vajra Health Camps took place. The pilots and health education should be at schools to acquaint the children with hygiene. The objective is that the villagers copy the latrines at other schools in the VDC.

18 Toilet design criteria

There are a lot of criteria and conditions given from an environmental, cultural, technical and economical point of view, when designing latrines. Furthermore there are some conditions regarding the period in which the latrines are constructed. These *boundary conditions* are given in §17.1. The assumptions made on the design are given in §17.2, followed by the list of demands (§17.3).

18.1 Boundary conditions

18.1.1 Natural

N1. Springs/water tap points
  The toilets should be both close to tap point and away from the springs. Water should be available for daily cleaning of the toilets and washing hands. The distance from water springs and rivers is o prevent the water from getting filthy by the excreta.

N2. Groundwater
  The groundwater should be under the pit bottom

N3. Permeability
  The ground should be able to drain the water and urine from the latrine pit

N4. Monsoon/heavy rainfall
  In Nepal there is a monsoon climate, dry from September to May, wet in June, July and August.

N5. Sunshine, temperature (-5°C to +35°C)

N6. Lack of water/dry season
  At the end of the dry season (April/May) there is lack of (drinking) water in some of the villages. Water for anal cleaning and for cleaning the toilets, might not be available at all times.

N7. Soil stability
  The soil should be stable enough to support the construction.

N8. Slopes/terraces
  The terrace slopes are 1:5; this is a stable slope (from experience in the district)

N9. Decomposing time > 1 year
  The excreta should be left untouched, before emptying the pit, and using the excreta as fertiliser

18.1.2 Cultural

C1. Knowledge
  The knowledge of latrine construction and latrine use is minimal; the construction of latrines should therefor be done together with education.

C2. What are people used to?
  There are some private latrines in the villages, but not all people use these. Most of the villagers defecate in the fields (Preferably at the riverbanks)

C3. Locals and excreta
  People are used to working with excreta (fertiliser). Villagers do not seem to feel any adversary against human faeces

C4. Women/men
  Although the locals wish to have separate toilets for man and woman, using one toilet does not give any problems. Women tend to go further from the houses when defecating in the fields.

C5. Children behaviour
As their parents, most children are not familiar with the use of a toilet.

C6. Amount of people on a toilet
Nepali tend to build only one toilet per school, no matter how many students it has. Clearly with only one toilet for 450 students, the children will defecate in the traditional way again (in the fields)

C7. Water for anal cleaning
Water is used for anal cleaning. Whenever there is no water available (dry season, see N6) stones are the alternative for anal cleaning.

18.1.3 Technical

T1. Materials, types quality and quantity
Almost anything is available. Most of the materials have to come from Kathmandu though and are therefor expensive. Cheaper local materials are nature stones, and sand. Concrete stones can easily be made from these rocks. Wood is available, but expensive

T2. Technical knowledge/skills villagers
The technical know how on how to construct, is available in the 'rich' villages. Carpenters, bricklaying and plastering is more of a problem in some of the more remote area's

T3. Tools
The tools for digging and bricklaying, as well as the tools for the carpenters are all available

T4. Latrine lifetime
The intended lifetime of the latrines is 10 years. Because of inexperience with operation and maintenance, training should be given

T5. There is little space at school grounds
Most of the school areas leave little or no choice on where to build.

T6. Not always water tap at schools
Not at all schools water taps are near the school. Vajra makes agreements with the VDCs to construct a tap point near the toilet(s).

18.1.4 Economical

E1. Vajra ¾: VDC ¼
Vajra made agreements with the VDCs on the financing of the projects. These agreements are not clear. Vajra should pay 75 %, the VDCs 25 %, but agreements are mostly made on Vajra pays for the materials and skilled labour, VDCs pay the unskilled labour. These agreements may conflict.

E2. Prices of labour
Labour is paid by the day.
Skilled labour is Rs120-Rs150 per day
Unskilled labour is Rs 80-Rs 100 per day
Only porters are paid by there work. Depending on the distance, they are paid or one load, no matter how long it takes.

E3. Prices of materials
See for prices of materials the cost estimate (Chapter 22). These prices are from August 1999 though.

E4. Rural state/poverty of the people
Most of the villages are poor. They should benefit from both the use and the construction of the latrines (local labour)

E5. Future economical benefit
The villagers can benefit, from fewer costs on both fertiliser and health costs.

18.1.5 Building

B1. Monsoon

The construction must be finished before monsoon starts (June)

B2. Agreements on building times

Agreements are made with the VDC to finish construction before monsoon start.

B3. Supervision

Vajra engineers do the supervision of the construction. The engineers should be supported by a respected local person/translator

B4. Building sites

Vajra intends to build at 14 sites, this means the engineers can only guide the projects.

B5. Simple

A design should be made that lead to an easy building process

18.2 Assumptions

A1. Excreta production/person/year is 0.04 m^3 per year

A2. How much time is spent in school each day

School time is from 10h to 16h, six hours

A3. Number of students will grow due to a) better conditions (more children will be able to come) and b) natural population grow

School latrines should be sufficient for a student number expansion in the coming year

A4. School/VDC/toilet committee will take care of the toilets

A Latrine committee formed by the VDC takes care of operation and maintenance

A5. Minimal decomposing time is one year

Before the excreta can be used as fertiliser two years is better

18.3 List of demands

- Robust
- Rustic
- Simple
- Standard
- Sustainability
- Keep out surface water
- Make enough toilets so nobody have to wait

19 Preliminary design

Given the list of demands a first design is made. This preliminary design is not complete; it describes the latrine design in a very rough way. With these sketches and some more conditions a final design has been made (See chapter 19).

Vajra Foundation Nepal already had a basic design before this project. This design has been used to make a cost estimate, which has been used to raise funds. The elements of this primal design can be found in this chapter though most of these elements are rejected, because they do not fit into the list of demands.

First the flush system and the type of latrine is taken care of. After that the pit volume and the number of latrines in relation with the number of users (schoolchildren) are discussed. At that point a rough sketch is made including the layout and the shape of the structure. Finally some remarks on the switch system and the ventilation pipe are given.

19.1 Water flush or direct drop

19.1.1 Alternatives/possibilities

There are two options for a flush system. One can either use a water flush system or a direct drop system.

The first system, using 1.5 or more litres of water each time, has the advantage of a water seal, which prevents odours and flies to come out of the latrine. This system gives the possibility of placing the superstructure not above the latrine pit, using pipes. The system needs a permeable soil to get rid of the water.

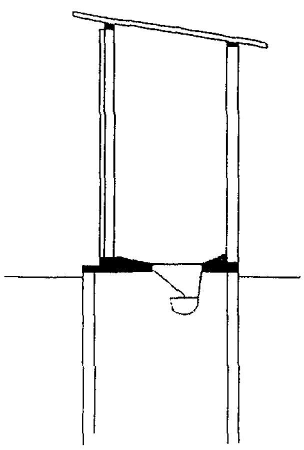


Fig 18-1: Water flush system

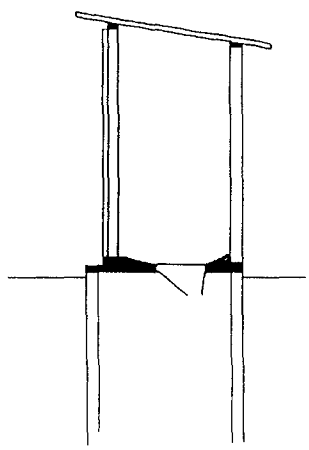


Fig 18-2: Direct drop system

The second option, the direct drop system, needs no water for the flush. The excreta can fall directly into the latrine pit. The squatting place has to be directly above the pit.

19.1.2 (Dis) advantages

These two alternatives both have their advantages and disadvantages.

The water using type provides odour and fly prevention. When a pipe is being used the superstructure can be build at another place than the pit. Most Nepali use water for anal cleaning, so water is needed anyway. The problem of this relatively high water use is the fact that not every school has a water tap nearby. Those schools that do have a water tap are not sure of water during the dry season. When there is no water available children seem to use stones for cleaning, throwing them into the latrine after use. The water seal may become stuck with these stones.

The direct drop system needs no water to flush, though it does need water for (anal) cleaning. Because there is no water seal it cannot be broken when stones are used. The superstructure must be build on top of or just near the pit (using a very short and steep pipe) to make sure the excreta can fall freely into the pit.

19.1.3 Conclusion

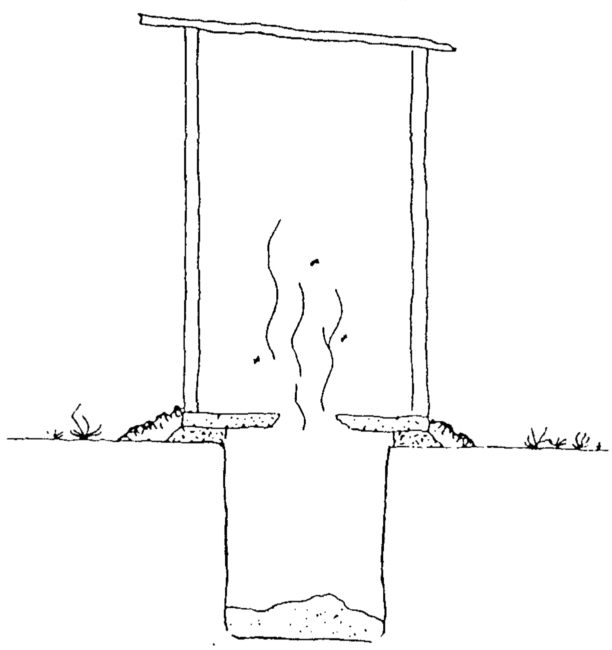
Given the demand for a standard design, and the demand of robustness, the direct drop system is the best option. The water supply at all schools is not certain so the water flush system is too vulnerable to be implemented at all schools. This means that the squatting place has to be directly above or just next to the pit.

19.2 Single or double pit

19.2.1 Alternatives/possibilities

When building a latrine one can make either one or two pits.

A single pit latrine uses only one pit, which may be filled in three to five years. The pit is relatively deep and space needed is relatively small. When it becomes full the pit is covered with soil and a new pit has to be dug. The superstructure has to be rebuilt.



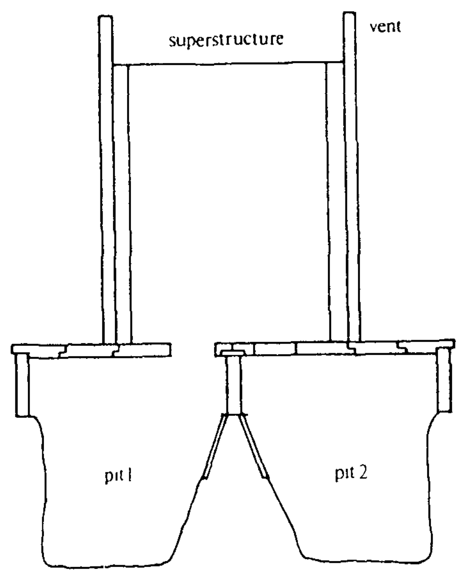


Fig 18-3: Single pit Latrine **Fig 18-4: Double pit latrine**

A double pit latrine has two pits, which are in use one at the time. When a pit is not in use the excreta are composting. After some time the used pit becomes full. The decomposed pit is emptied (the compost can be used as fertiliser) and this empty pit can be used again.

19.2.2 (Dis) advantages

A single pit seems to be easier to build and it does not need a switch system to serve different pits. The maintenance (or the destruction and reconstruction) is easy but it takes a lot of time en reinvestments. When a new latrine has to be built a new building site has to be chosen. This may be difficult when there's lack of space.

A double pit compost latrine is a sustainable option. If well used and maintained it may last for 10 to 20 years. The fertiliser coming out of the pit can be very useful for agriculture. Although it needs a more frequent maintenance, it is less time and money consuming, than the single pit latrine. The switching between the two pits makes the design a little more complex. People are not experienced with this type of latrine

19.2.3 Conclusion

A double pit system is more rustic and sustainable than a single pit system. The trouble of finding a new site for a full single pit latrine and the amount of money involved in reconstructing a single pit latrine may be too big to overcome. Given these considerations a double pit compost latrine is the best option. This means that two pits have to be made that can be cleaned separately.

19.3 Pit volume

19.3.1 Main factors

When calculating the needed effective pit volume the following factors are important.

- Number of people using the latrine
- Amount of excreta produced by each user
- Needed time for composting

19.3.2 Number of users

The latrines are going to be used by schoolchildren. The number of schoolchildren at each school ranges from 100 to 450. For the determination of the needed pit volume cohorts of 100 students have been used. The pit volume is calculated using the highest number in each cohort.

19.3.3 Excreta production

The amount of excreta produced by one person is 0.04 m^3 per year. A school latrine is not in use when there are no classes. So this production can be reduced by three factors.

- 10/12 During the holidays the latrines are not in use
- 6/7 On Saturday there are no classes
- 6/24 Children are only six hours per day (Note that it's assumed that the children defecate any time of the day at random. It may be possible that the children who don't have a latrine at home are going to use the school latrine only)

Using these factors the excreta per person per year becomes 0.007 m3. It should be stated that this figure is very 'soft'; it is hardly possible to predict the lifetime of a latrine.

19.3.4 Composting

The human excreta need a minimum composting time of one year. After that year it is safe to take out and it's absolutely harmless. To be on the safe side the pit volume is calculated using a composting time of two years. This second year is a kind of buffer, because it might be possible that the amount of excreta is miscalculated, or the composting situation is not optimal or the number of users changes.

19.3.5 Conclusion

The composting process takes two years and the excreta production per student is 0.007 m^3, so for each child two 0.014 m^3 pits are needed. This next table gives the pit volumes that belong to each cohort of 100 students.

Number of schoolchildren	Needed effective pit volume m^3
0-100	1.4
100-200	2.8
200-300	4.2
300-400	5.6
400-500	7.0

19.4 Number of latrines

19.4.1 Western world

In the western world people expect to have enough toilets. In most public buildings one does not have to wait to go to the toilet. In the UK primary schools must have one toilet per 15 children up to 100 students, for each 25 children above 100 there's one toilet more required. Building such a large amount of latrines is unaffordable.

19.4.2 Nepal

Using a latrine is not very common in Nepal. Having a latrine is a kind of luxury. Baring this in mind it is not very surprising that even the Kathmandu schools have only one toilet for all their students. The chances of children defecating out in the open again because they have to wait to use the latrine are big. The number of latrines must be sufficient to make sure everybody can use them.

19.4.3 The Nepali way

There is a big gap between what number of latrines would be wise to build and what number of latrines the Nepali people are used to have. The situation was even more complicated because of agreements between the VDC's and Vajra Foundation Nepal. It turned out that they had agreed on a certain number of latrines, mostly one or two at a school. Furthermore the VDC was going to pay 25% of the costs. If they would have to build more latrines, they wouldn't have enough money.

Presuming every child has to use the latrine not more than one time a day, and the teachers let them go, even during classes, knowing that each school day is six hours, one latrine per hundred schoolchildren would mean that each child can use the latrine for 3 minutes and 36 seconds each day. This is enough time for each child, though it's very unlikely that the children have to go exactly after each other.

Although more toilets are necessary it has been decided to build one toilet for every hundred children or part of that figure. So 135 children would mean two toilets.

19.4.4 Conclusion

The decision that has been made, to build one toilet for each hundred students or part of that, is a compromise between what number is necessary and what number is affordable.

19.5 Pit shape and latrine layout

A choice must be made on what pit shape and latrine layout is most effective for this case. For the pit shape two main possibilities seem appropriate. The first one is the round pit and the second one is the rectangular pit. The latrine layout requires the possibility of attaching more latrines easily. The question is how to fit one to four latrines in one site at a school ground.

19.5.1 Alternatives/possibilities

During designing many sketches of latrine layouts, using rectangular or circular pit shapes have been made. Fourteen of them are given below. The pit walls are single lined and the walls of the superstructure are double lined. Circles mark the squatting place and arrows show in which direction the excreta should be drained.
See for possible latrine layouts next page (Fig 18-5)

19.5.2 (Dis) advantages

The following points are important:

- The pit must be entered every two years and the compost must be dug out
- The standard design must easily be extendible, ranging from one to four latrines
- Building superstructure walls on top of the pit can be difficult and expensive
- The excreta must drop directly into the pit or use only a short, steep pipe

The last two points are conflicting, because the direct drop system requires the superstructure to be above the pit. Most options use a pipeline to transport the excreta from the toilet pan to the pit. As stated under 18.1 *Water flush or direct drop*, a direct drop system, using no or only a short steep pipe is the best option. Therefore much layout options with the superstructure next to the pit instead of on top are not possible.

Double pit latrines with two round pits mostly use a water flush system. To place the superstructure above or directly next to both pits is hardly possible, especially when more superstructures use the same pits. Major advantage of round pits is more stability.

A double pit latrine with rectangular pits gives more opportunities for attaching several superstructures to the same pits. Digging only one pit is cheaper and easier than building more pits and it is easier to come to a standard design that can be used at all different schools with only minor differences. Furthermore combining more latrines into one structure requires less space.

Some configurations need long pipes to bring the excreta to the other pit.

19.5.3 Conclusion

Given the demand of a standard design, a direct drop system and the condition of little space at the schools, a rectangular double pit with the superstructure partly founded on the pit walls is the best solution. (See fig 18-5) Special attention most be given to the stability of the pit walls and the foundation of those superstructure walls that cannot be founded directly on the pit walls.

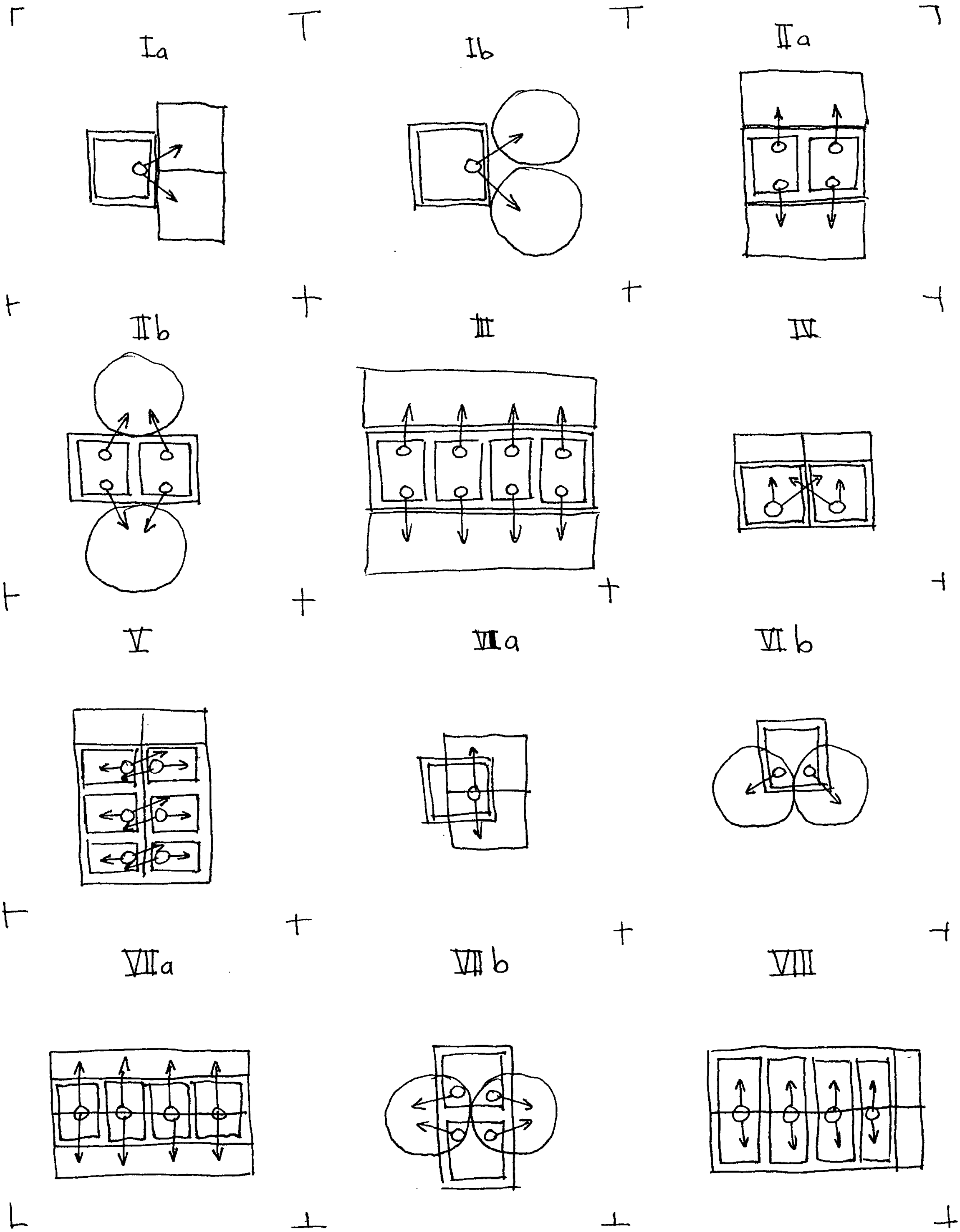


Fig 18-5: 12 Latrine lay outs

19.6 Switching between two pits

Each two years every latrine must switch pits, when the pit in use is full. It is important that the way of switching is simple, but it should not been done unauthorised

19.6.1 Alternatives/possibilities

The first alternative is to use two toilet pans. One of the pans must be covered, while the other is in use, see fig 18-6.

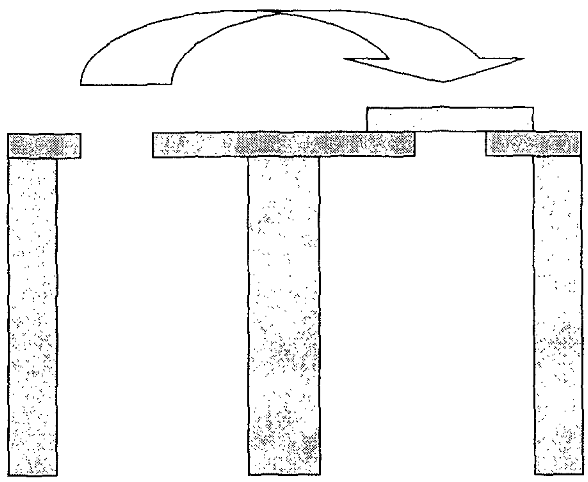


Fig 18-6: Changing the pits

The second alternative is to make one toilet pan in the middle just above the dividing wall. A short and steep ramp is used to transport the excreta in the right direction. To switch the ramp one has to be in the pit under the latrine.

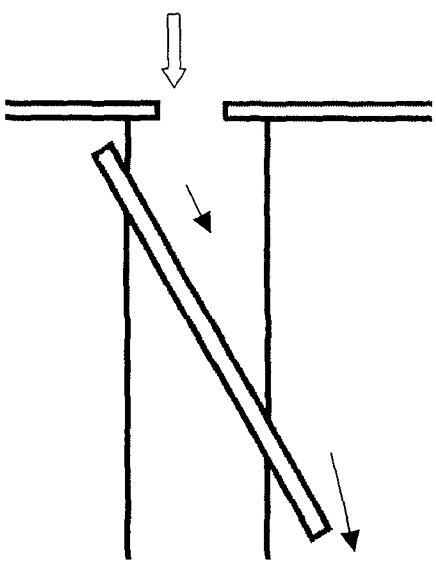


Fig 18-7: Principe of the ramp

19.6.2 (Dis) advantages

Making two holes requires two toilet pans (extra costs) and a cover. This cover can be taken away and the cleaning of the latrine may be more difficult because of the cover stone. When the pan closest to the door is in use people may step in it when entering the latrine. Main advantage of such a system is that the excreta always drop directly.

The option of one toilet pan requires a deeper pit because the first part, almost one meter, cannot be used for storing excreta. The making of this kind of switch system can be difficult. The major advantage is that it can hardly be switched by playing children and the toilet pan is in the middle of the latrine preventing people to step in it.

19.6.3 Conclusion

Using a smoothened ramp provides more assurances of good operation. The option of the two toilet pans is likely to be less rustic.

19.7 Ventilation pipe

A vent pipe is not necessary but it improves the latrine in two important ways: odours are ventilated away and flies are trapped. A vent pipe sucks air out of the latrine because of the wind flowing over the pipe; the odours are ventilated that way. Flies that are inside the pit will fly to the light coming in through the pipe. On top of the pipe an insect screen is placed. Being trapped by the screen most flies will exhaust themselves and die.

Another way to prevent odours and flies is using a water seal but as stated in 18.1 *Water flush or direct drop*, this is not possible for this project.

20 Final Design

Given the list of demands a preliminary design has been made. This design describes the latrine in a very rough way. With the elements of the preliminary design a final design is made, which gives a complete view of the latrines.
In this chapter materials and measurements, strength, stiffness and stability and the details are discussed, after a short summary of the preliminary design, with the main outcomes.

20.1 Summary preliminary design

As shown in chapter 18 *Preliminary design* a double pit latrine, with a direct drop system has to be designed. The latrine layout and switch system, the pit volume and the needed number of latrines are known. A vent pipe is used to ventilate the pit.

20.2 Materials and measurements

20.2.1 Pit

These are the demands and boundary conditions that are important when designing the pit sizes.

- It must be possible to dig when being in the pit, so the pit must be wide enough for a man working with a shovel.
- Some superstructure walls cannot be founded on the pit walls, these walls cannot span to long a distance. Therefore the pit must not be too wide.
- The sizes of the superstructure determines the area of the pits, the needed volume can be obtained by choosing the right depth. A toilet must be 85 cm wide and 110 cm long to have enough space inside.
- One must be able to enter each pit separately, so each latrine block needs two holes with covers.
- The stability of the soil is not enough to make a pit, the hole must be lined.
- Nature stone is available everywhere and cheaper than wood, bricks or concrete.
- The workers stated that making 40 cm walls is easiest, 30 or 25 cm walls are more difficult.

The wide of the pit is very important. On the one hand it must be wide enough for digging and on the other hand it must not be too wide to carry the superstructure walls. When a reinforced concrete slab is being made as a floor this slab can be used to carry the superstructure walls.
Placing the pit walls 80 cm from each other makes it both possible to dig and to carry the superstructure walls.

The length of the pit is determined by the wide of one latrine and the inner and outer walls and by the size of the entrance holes.
The entrance holes (80 cm wide) do not have to be used very often (approximately every two years) so they may be a little uncomfortable. A length of 50 cm must be enough.
One latrine must be 85 cm wide inside.
Most outer walls are placed on the pit walls; only one outer wall is spanning the pit. This wall is 40 cm wide. The inner walls are 25 cm wide.

Pit sizes					
	Length (m)	One latrine	Two latrines	Three latrines	Four latrines
Entrance holes	0.5	0.5	0.5	0.5	0.5
Outer wall	0.4	0.4	0.4	0.4	0.4
Inner wall(s)	0.25	-	0.25	0.5	0.75
Latrines	0.85	0.85	1.7	2.55	3.4
Total pit length (m)		**1.75**	**2.85**	**3.95**	**5.05**
Pit wide (m)		0.8	0.8	0.8	0.8
Pit area (m^2)		**1.4**	**2.28**	**3.16**	**4.04**
Needed effective pit volume (m^3)		1.4	2.8	4.2	5.6
Needed effective pit depth (m)		**1**	**1.2**	**1.3**	**1.4**

The 'needed effective pit depth' is the depth that is needed for storage given the needed effective pit volume and the pit area. The depth of the pit that has to be dug is effected by the height of an anti rainwater brim and the switch construction.

All measurements are inside measures. The pit walls must be added when digging the pit. The pit is lined with 40 cm nature stones dry wall. Nature stone is easiest to get, 40 cm is easiest to make and it must be dry walls to make sure the moisture can soak away. The dividing wall between the two pits is also made of 40 cm nature stone, but this wall is cemented to prevent moisture entering the pit not currently in use. Some part of the dividing wall is not made of stones. These parts are used to place the switch system.

The last 50 cm of all walls is cemented to provide a strong foundation for the slab and the superstructure walls and to prevent surface water entering the pit. For this purpose there is also a 20 cm brim on top of all walls, so the latrine floor is higher than the surface. Note that when digging the pit the 20 cm brim contributes to the effective pit depth, so this 20 cm does not have to be dug out.

20.2.2 Slab

On top of the pit a 7 cm thick reinforced concrete slab is placed. This slab is the latrine floor and it supports the inside walls. Each slab has the size of half a latrine and it is supported by the two outside walls and the middle wall of the pit.

Main reasons for using a reinforced concrete slab:

- The superstructure walls have to cross the pit and therefore they have to be supported.
- Concrete is more sustainable than the other options: wood (bamboo) or clay and wood.

The slabs are made prefab in the ground on site and after drying they have to be carried to the pit. The toilet pan must be fitted in the middle of the slab, To fit the round shape of the toilet pan into the concrete slab in the right way, the pan is placed upside down in the slab frame before adding the concrete. See picture.

After a few hours the pan can be removed and used to make the shape into the other slab. Note that the slab is being made upside down, before placing it on the pit walls it has to be flipped.

20.2.3 Superstructure

The latrine design as described in this report is totally new to the villagers. It is the first (semi) public toilet and it is the first double pit latrine they see. The most important and difficult part of this design is underground. The superstructure is rather standard.

The purpose of the superstructure is to provide privacy and to stop sunlight and rainwater entering the pit. The compost double pit latrine is supposed to last for many years. The superstructure does not need rebuilding during the lifetime of the total system. It must therefore be strong and sustainable.

For wall material there are four options.

1. Stone, easy to find but heavy though strong and long lasting
2. Brick, sustainable and relatively light but expensive
3. Wood, if painted very resistant but expensive
4. Mud and wattle and bamboo, easy to get and cheap but easily damaged

Nature stonewalls is the best alternative for it is robust and found everywhere. Inside walls could be made of less strong materials but these are expensive or not strong enough to stop children from breaking it. The inside of the latrine has to be plastered to be able to clean it and to prevent children picking little stones out of the walls for anal cleaning

Most outside walls can be carried by the pit walls, these are 40 cm wide. The inside walls have only a dividing task, they don not need to be very wide, these are 25 cm wide. This also prevents the complete latrine from getting too long.

The width and length of the latrine have to be at least 85cm and 110 cm. The latrine is 85 cm wide, but 200 cm long, because the two pits have to be 80 cm wide (see 19.2) and the middle wall is 40 cm (80+40+80=200).

As well as the walls the roof has to be solid and long lasting. It can be made out of CGI sheets or lay stones. These last ones are too expensive.
The galvanised iron sheets have to be supported by three beams to which they are attached by nails. One beam in the front and the rear wall and one in the middle of the latrine. It is recommended to paint the wooden beams for conservation, although they can last a long time, because they do not get wet. These beams have to be thoroughly attached to the walls to prevent the roof for blowing of in a storm.

Doors and doorframes are made of wood. This is rather expensive but it assures privacy for a long time. The latrines are 85 cm wide and the doorframes 70 cm. The frames themselves are 7 cm wide so the doors are 51 cm wide. Frame height: 185 cm, door height: 171 cm.

Most latrines that have been visited are too low to be able to stand, even for a lot of Nepali people. The toilet pan is in the middle of the toilet. One must be able to stand there freely. The walls have to be 185 cm in the middle of the latrine. Front wall is 190 cm and the rear wall is 180 cm. The beams that carry the roof come on top of these walls. This way there is enough space to be able to stand and the rainwater runs off to the back on a 3.5% slope.

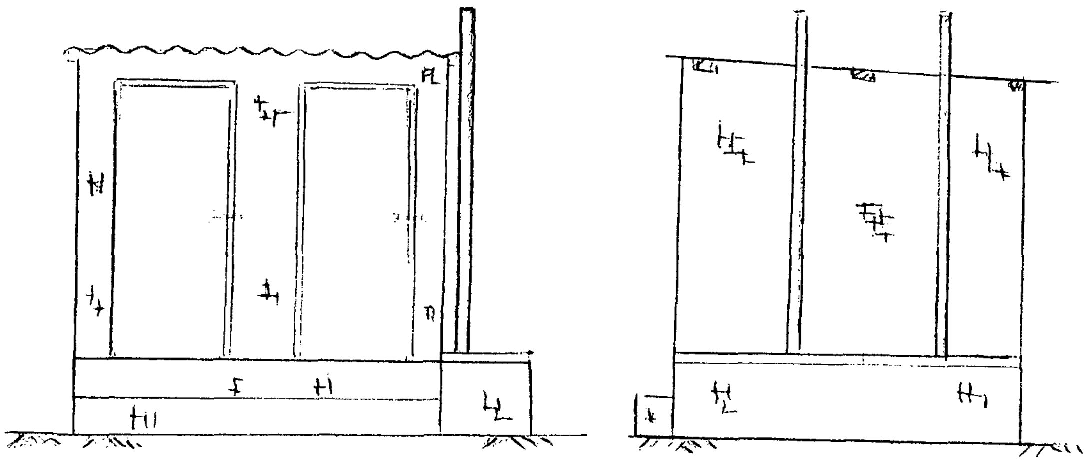
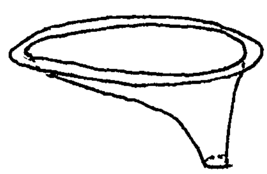


Fig 19-1: **Superstructure**

20.3 Details

20.3.1 Toilet pan

First criteria for the toilet pan is that is has to be smooth and steep to make sure the excreta can flow into the pit, without using water. Furthermore it should be strong so children may throw stones into the pit without cracking the pan.



Vajra supplied a polythene pan, also used by UNICEF in other projects. Although it has not been tested on its excreta transportation capacity it seemed to be smooth and steep enough to do the job. The polythene is stronger than other ceramic options.

Fig 19-2: **Toilet pan**

20.3.2 Ramp and block

A construction has to be made to transport the stool from the bottom of the toilet pan to one of the pits. These points are important for this design:

- There is little or no water so the ramp has to be smooth and steep (1:2).
- Every two years the ramp must be switched, to transport the stool to the other pit.
- The bottom of the toilet pan is 20 cm under the slab and 10 cm wide.

The stool is transported from the middle of the 40 cm dividing wall to the side of it. The hole of the toilet pan is almost 10 cm. So the transportation length is 30 cm. Using a 1:2 slope the height must be 60 cm. The ramp must be 67 cm long, see picture.

To make the ramp switch three options are given. One is to hang the ramp on two 'ears', one is to make it turn able with an axe and one is to let is rest on top of the dividing wall. See picture.

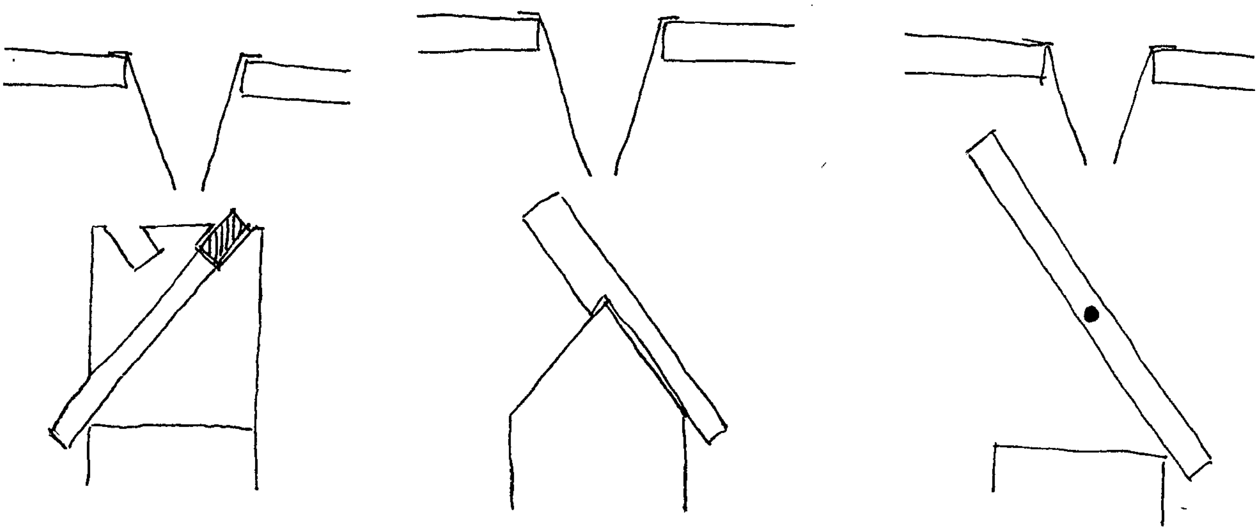


Fig 19-3: Three options for ramps

Alternative 1 is the best option, for it has no moving parts, which can easily break down, and its stability is the best, so nobody can easily switch it by accident.

The ramp and the hanging system (block) are made prefab, with the help of two frames. This way it's possible to let the two parts fit exactly.

Note that the drop height of the ramp is 60 cm, the space between the bottom of the toilet pan and the slab is 20 cm, and so these first 80 cm of the pit are useless for storage. When digging the pit this have to be added to the effective pit depth as calculated in 19.2.

20.3.3 Covers and vent pipes

On one end of the latrine there is no superstructure. This is the entrance to the pits when they have to be cleaned. These holes have to be covered.

The covers are made of reinforced concrete for the same reasons as the slabs. They have a hole trough which the vent pipe reaches the pit. This hole is made during construction by using a small piece (15 cm) of the vent pipe that has been made fit into the rest of the vent pipe, by cutting and rejoining.

This end of the latrine is also the place where the vent pipes that ventilate the pit are placed. The pipes are in direct connection to the pit through the covers. Each pit has one vent pipe to obtain the best success.
The vent pipe can be made of bamboo, mud and wattle, Ferro cement masonry or plastic. Of these options the best one is the plastic one, because it's is easy to get and it can last for a long time without breaking down. Black 4" polythene pipe is used. The black colour can add to the ventilation, when placed on the south side, for the air inside gets warm and will go up, sucking odours away.

On top of the vent pipe is a fly screen to prevent flies coming out of the pit. The openings of the fly screen must not be more than 1.5 mm wide. For this project zinc covered steel is used, because the better stainless steel screen was not available.
The pipe is attached to the superstructure with two rings.

21 Building plan

Before construction a building plan has been made. Because of lack of knowledge or information about building time, no construction time has been estimated. The plan below only shows the different actions and their relation to each other.

Carpenter	Making frames	Ramp	■								
		Block		■							
	Making doors				■						
	Install doors							■			
	Making roof									■	
Bricklayers	Pit walls			■							
	Superstructure walls								■		
Plasterers	Plastering inside latrine										■
Concrete workers	Making concrete stones		■								
	Collecting sand		■								
	Collecting cement		■								
	Making slabs			■							
	Making covers				■						
	Making ramp				■						
	Making blocks				■						
Diggers	Digging the pit		■								
Unskilled Labour	Placing blocks					■					
	Placing slabs						■				
	Placing vent pipes								■		

Table 21-1: Building plan

The plan shows which actions can be done parallel and which actions have to be done after each other.

At the start many things can be done parallel. Digging the pit and making the pit walls is supposed to take the most time. The drying of the concrete parts is another time consuming factor, therefore the making of the slabs, covers, blocks and ramps has to be done a soon as possible.

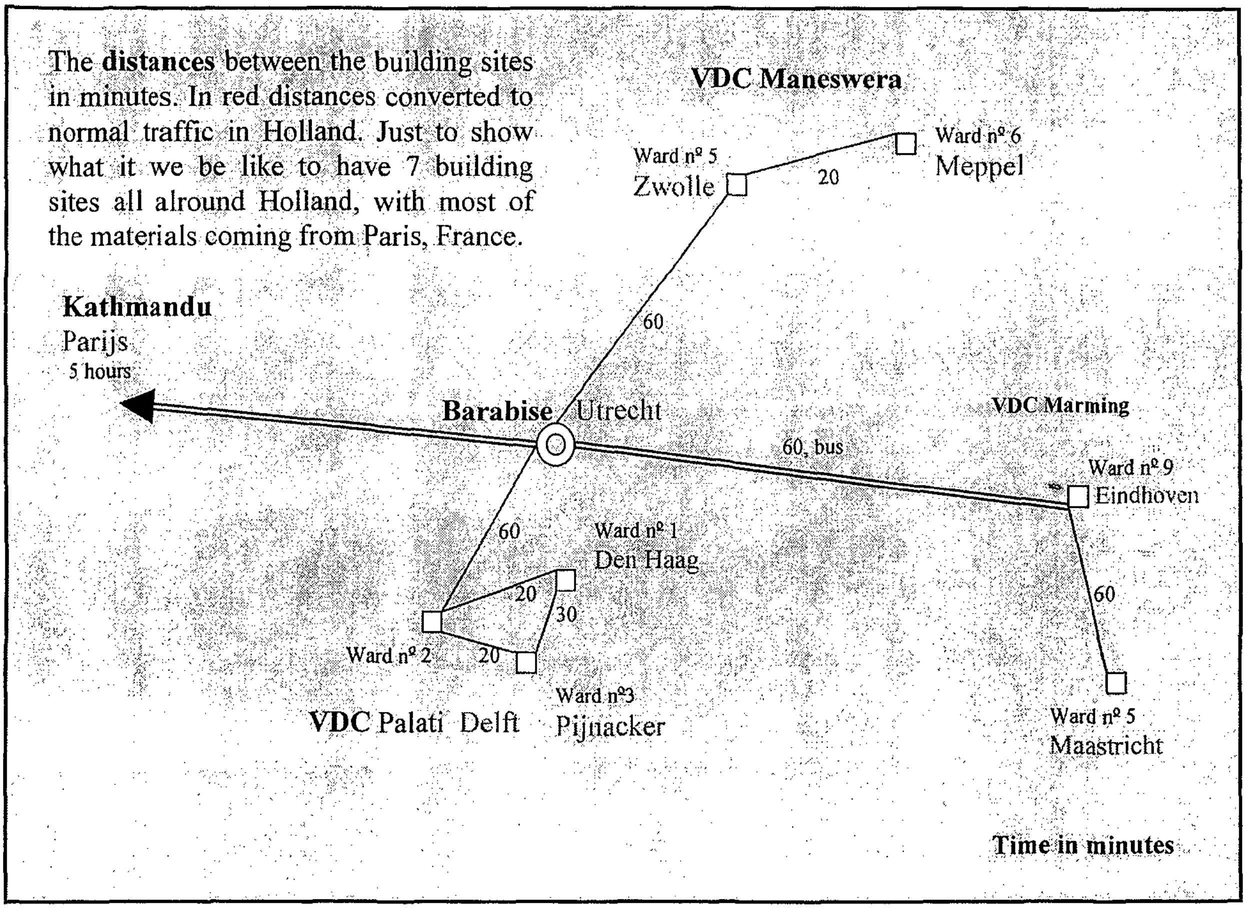
It is clear that the placing of the blocks, the placing of the slabs and the making of the superstructure walls are the critical actions of the construction time. These actions cannot be done parallel. Therefore the building time depends on the time these actions take.

If well planned the critical path is: digging the pit, making the pit walls, placing the blocks and the slabs, install the doors, making the superstructure walls, making the roof and plaster the inside. All other actions can be done parallel to this path.

22 Building reality

22.1 Time schedule

For the time schedule see the next two pages.



22.2 Situation at time of leaving

At the end of the practical training, 19[th] of May, none of the supervised toilets has been finished. The continuing of the projects has become the responsibility of VFN and the VDC's. Ramesh has promised to visit all sites to see how things are going. These were the situations at the last visit.

Chaku, two-toilet block, 16[th] of May 2000
The floor has been made in situ. The concrete is drying. From May the 21ste the construction of the toilet house can be started. The covers and the T-shapes must be made prefab and the vent pipes must be connected. According to experiences at other sites this may be finished in two weeks.

Marming, two-toilet block, 16[th] of May 2000
The plan was to finish the floor in situ on the 17[th], cement had to be brought up and the frame had to be made. Presuming, the floor will be made about the 19[th] of May, t the construction of

the toilet house cannot start nit until the 25th. As in Chaku this toilet can be finished in two weeks from then.

Maneswera, Mahakali primary school, two-toilet block, 17th of May 2000
The walls of the superstructure were about 1.5 meter high. The doorframes had been placed. The covers have been made, but the T-shapes still have to be made fit. After the walls, the roof and the vent pipe can be connected and the inner walls can be plastered.

Maneswera, Bhadrakali secondary school, four-toilet block, 17th of May 2000
Same situation as in Mahakali except for the walls, which were not higher than 50 cm.

Palati, ward number 2, four-toilet block, 19th of May 2000
Two nights before the last visit the long sidewalls of the pit have collapsed, probably because of the heavy rainfall. Some days before that event the floor had been made in situ. It is not recommendable to repair the pit at the same place. It seems to be better to find a new location for the toilets. It may be the best to take out the things that have not been broken, store everything and reconstruct after monsoon. The building time of this four-toilet block is about six weeks and monsoon is very likely to start before the toilets have been reconstructed.

Palati, ward number 3, one toilet bock, 19th of May 2000
This toilet has almost been finished. The carpenter has to make the roof, the T-shape has to be made fit and the covers have to be placed. After connecting the vent pipe, this toilet is finished.

Palati, ward number 1, two-toilet block, 19th of May 2000
At the time of the visit the workers were just starting to make the walls. The floor was not supported properly so this has to be taken care of first. Furthermore the T-shapes and the covers have to be made and all elements of the toilet house

	week 16							week 17							week 18							week 19							week 20							week 21							week 22				
A= Annne Wietse present	April														May																														June	
R= Remco present	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2
Chulti																											AR																				
Barabise village (materials)	AR			R		AR	AR	AR	AR	AR	AR	AR				AR	AR	AR	AR	AR	AR	AR		AR	AR	AR	AR	AR	AR	AR	AR	AR	AR														
Kathmandu												AR	AR	AR	AR	AR											AR						AR														
Ramche			R																																												
Maneswera ward no4, 2 toilet		AR	AR	AR	A	A	A		AR	AR							AR	AR					AR	AR							AR																
Digging of the pit																																															
Making frames																																															
Door construction																																															
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Pit walls																																															
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Door placing																																															
Toilet walls																																															
Roof																																															
Ventilation pipe																																															
Plastering																																															
Maneswera ward no7, 4 toilet	AR	AR	AR	AR	AR	AR	A		AR	AR							AR	AR					AR	AR							AR																
Digging of the pit																																															
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Door placing																																															
Toilet walls																																															
Roof																																															
Ventilation pipe																																															
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Pit wall collapse																																															

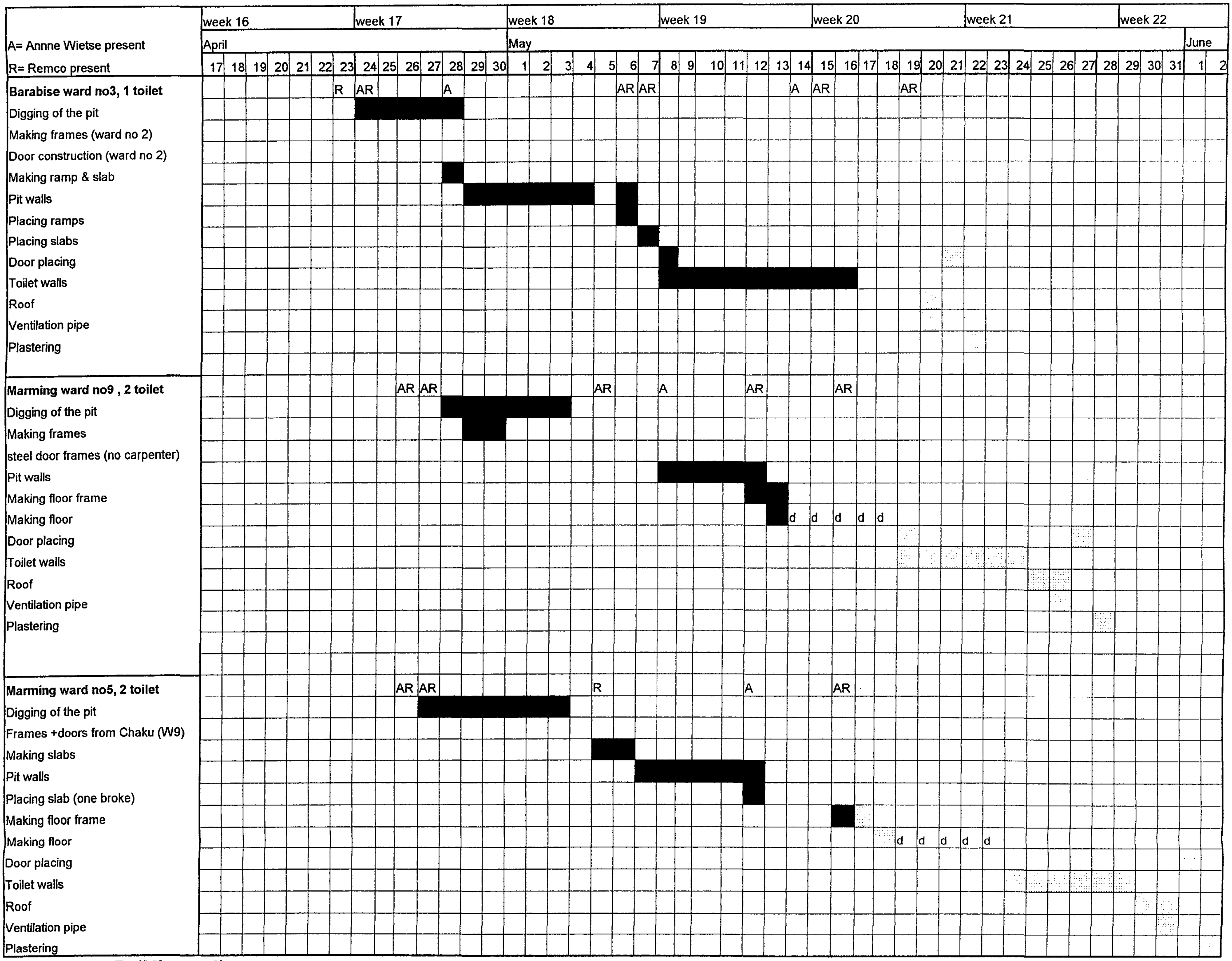


Fig 20.1 Building reality

23 Costs

23.1 Introduction

VDC's pay one quarter of the costs
Vajra supports the constructing of projects if the villagers are willing to pay 25 percent of the price. Apart from this Vajra makes agreements on which part of the costs are paid by the VDC. For example the costs off stones and unskilled labour is paid by the VDC. If this is not 25 %, nobody knows how will pay for what.
The contract in which the agreements are made should be made in Nepali and in English.

Cost and design
The cost estimate (presented below) is made for a different design, a private single flush toilet. Because the Vajra board decided to build 28 toilets in 14 places (in five weeks) there was not enough time to make a proper cost estimate. The original cost estimate was not available until half way the project.
Apart from that in designing the engineers should have freedom in choice of materials (given the costs). Now the Vajra board insisted on five bags of cement per toilet, because that amount was in the cost estimate for the private flush toilet.

Paying per day, paying per achievement
There is a conflict in paying labor by the day. Especially if the engineers control more places (and are not at each site every day). If the workers do not do too much one day, they can work again the next day. A lot of delay is caused by this problem. Where possible Vajra should consider paying the worker by achievement, as is done in portering.

23.2 Cost estimate and actual expenses

The cost estimate from Vajra Foundation Nepal was made on base of a design for a double pour flush latrine, with circular pits. Apart from that, the cost estimate was not available until after the design and there were no reservations for unforeseen costs.

The final design (Chapter 19) is does not give a costs per toilet, the price per toilets will be less if 2 or 4 toilet blocks are build. To be able to compare the actual prices (table 21.2) with the estimated prices (Table 21.1) there is an average toilet price in table 21.2. This average price comes from the total costs of the toilets divided by there number (28 in the spring of 2000)

The difference explained
Comparing the two tables (estimated and actual costs) there are a number of differences.

On materials:

- Cement: There was more cement used than estimated and the price was higher (although one is inclusive of transport and the other isn't). The obvious reasons for that is the different design, although there are doubts if 2 1/2 bags would have been enough for the pour flush toilet. Apart from the fact that a lot of mortar (1 cement on 5 sand), was used in the walls. The reason is that walls had to be made out of nature stones.
- Sand: For the same reason there were of course extra costs in sand
- Concrete steel: The concrete steel was not estimated at all
- Wood: There was more wood estimated than necessary
- Pan: A plastic plan was thought to be stronger if stones are used for anal cleaning, this happened to be cheaper

- CGI sheet: used for the roof, is more expensive than estimated but was used less
- Nails, handle, lock: slightly more expensive
- Ventilation pipe: The 4" pipe was not as expensive and only 6m per toilet block (not per toilet) were needed. The 2' pipe was estimated for the flush parts.

On labour:

- Skilled labour was estimated at 2 days. This proved to be not sufficient. The plaster man can do the work in one day. The carpenters had more work on the construction of the frames, the doors and the roof.

On transport and porter costs:

- The transport from Kathmandu and the porter costs are organised by the Vajra board and VDC members. The engineers do not know the difference.

	Price		Per toilet	
Materials	Unit	NRs	Amount	Costs
Cement	Bag	310	2.5	775
Sand	Muri	200	4	800
Concrete steel	piece (4.77m)	7	0	0
Wood	cub.	200	8	1600
Pan	piece	1075	1	1075
CGI sheet	10 feet	462	3	1386
Nails, handle, lock, etc.	per toilet	310	1	310
Pipe 4"	1.00m	250	4	1000
Pipe 2"	1.00m	125	3	375
Skilled Labour				
Together	Day	130	2	260
Transport +porter costs				
All together	per toilet	450	1	450
Total				8031

Table 23.1: Cost estimate august 1999

	Price		1 toilet block		2 toilet block		4 toilet block		Average per toilet	
Materials	Unit	NRs	Amount	Costs	Amount	Costs	Amount	Costs	Amount	Costs
Cement (incl. transport)	Bag	400	10	4000	15	6000	24	9600	7.39	2,957.14
Sand	Pathi (=1/8 bag)	7	270	1890	410	2870	570	3990	192.14	1,345.00
Concrete steel	Piece (4.77m)	45	9	405	13	585	22	990	6.61	297.32
Wood	Per toilet	1000	1	1000	2	2000	4	4000	1.00	1,000.00
Pan	Piece	525	1	525	2	1050	4	2100	1.00	525.00
CGI sheet	10 feet	596	3	1788	4	2384	7	4172	2.11	1,255.86
Nails, handle, lock, etc.	Per toilet	400	1	400	2	800	4	1600	1.00	400.00
Ventilation pipe	1.00m	125	6	750	6	750	6	750	3.00	375.00
Skilled Labour										
Plaster man	Day	130	1	130	2	260	4	520	1.00	130.00
Carpenter	Day	130	7	910	14	1820	28	3640	7.00	910.00
Transport +porter costs										
All together	per toilet	1055	1	1055	2	2110	4	4220	1.00	1,055.00
Total				12853		20629		35582		10,250.32

Table 21.2: Actual costs (28-05-2000)

24 Operation and maintenance

Building a latrine is one thing, proper use, careful upkeep and adequate maintenance is equally important.

> **Operation and Maintenance**
> On our first visit to the Bhadrakali secondary school in Maneshwara, we found out they already had two schooltoilets. One of them was locked, for the teachers, and one of them was a stinking mess of faeces, apparently because it was broken.
> The principal explained that the children had used stones for anal cleaning, instead of water, because there was no. The stones were thrown into the latrine breaking the ater seal toilet pan.
> "How long has this toilet been in working order?"
> "Three days ", is the smiling answer.

Beside this, the success of a pilot project like this depends on the way people pick up the idea of the importance of good sanitation. Therefore health education is a very important part of this engineering project.

Good operation and maintenance need an institute that takes full responsibility for the latrines. Only if this is clear for everybody, the upkeep of the latrine can be successful.

24.1 Health education

The results of the Vajra Health Camps of 1999 and 2000 make clear that a lot of health problems in the Sindhupalchok district are caused by a general lack of hygiene. This lack of hygiene is partly because of the poverty of the people, there is not enough money to build latrines for instance, but a great deal of the problem is the lack of knowledge about basic hygiene.
Education determines the welfare of the future generation. For that reasons Vajra Foundation Nepal (VFN) decided to combine the building of toilets at schools in several VDC's in the surrounding of Barabise, with health education to the schoolteachers and students.

In each Health Camp one half day was used to give health education, to teachers health workers and villagers about several subjects. In the period of constructing this education has been proceeded at the schools where latrines have been built. Vajra Foundation Nepal is planning to organise training for health workers, teachers and VDC members when the latrines are finished.

Good health education is very important, now and in the future. It can make people aware of the problems of poor hygiene and it can show the benefit of good sanitation.
Latrines may contribute only a little to the health situation of the Nepali people, but knowledge of the benefits and experience with latrines may change the attitude of the next generation.

24.2 Responsibility

For good operation and maintenance it is very important that somebody is responsible. Vajra Foundation Nepal agreed with the VDC's that a Latrine Committee had to be formed, though in none of the three VDC's this committee has been formed during the construction.

The latrines are financed by the VDC and situated at school grounds. It is wise to have representatives of both the school and the VDC in the Latrine Committee. It may also be good to have some parents in the committee to make sure the knowledge about latrine is spread among the villagers.

24.3 Operating the latrines

Operation must be done in three different levels, on three different timescales. There is of course the daily use, how one should use the toilet (minutes). There has to be regular upkeep and cleaning (days/weeks). And at last the pits have to be changed when they are full (years). This information is distributed to the villagers by means of the manual 'How use the latrine'

24.3.1 Daily use

These notes are of great importance for the children that use the toilet every day. If these rules are followed the effect of hygiene improvement is much higher.

- When using the latrine, put on shoes to prevent from worms entering the feet. Many Nepali people suffer from worms and have to take medication repeatedly.
- After defecating put some water (sparingly!) in the pit to clean the toilet pan. If the stool stays in the pan the latrine will become a mess. Flies and other insects may breed in the latrine and spread diseases.
- Only throw organic materials in the pit. When there's no water, use grass ore leaves for anal cleaning. Never throw stones in the latrine for this will damage the system. Stones can break the toilet pan or may fill up the pit too fast.
- Wash hands well with soap or ashes. This will prevent the users spreading diseases to other people.
- Close the door when leaving the latrine. If the door is not closed, light will enter the pit. Flies will go to this light instead of the light entering the pit through the vent pipe.

24.3.2 Regular upkeep

Somebody has to take care of the regular upkeep. Children using the school latrine will not feel responsible for it. The Latrine Committee should take care of these points.

- Make sure there's a bucket with water next to the latrine all day long. It can be used for cleaning both hands and toilet pan. This bucket has to be cleaned once a week, to prevent flies breeding in it. If there is temporarily no water available place a can with ashes so the children are able to clean their hands.
- Every day somebody has to clean the latrine very well with water and a brush. If the latrine is not clean flies and smells will occur. If the latrine is clean children will feel more responsible for keeping it clean.

24.3.3 Changing pits

One pit can be used for two years. By that time it will be filled until one meter below the slab. At that time one should change pits. Only the first time the second pit will be empty, after four years, when changing back to the first pit again, the compost has to be dug out before switching.

The vent pipe has to be taken of carefully before taking of the cover. The compost can be taken out using a shovel and a bucket. Not everything has to be removed; some compost can be left in the pit to give the new pile a good start. The compost should after two years be fairly dry, soil-like and completely odour-free. It is not sterile but it's not dangerous for the health anymore. The compost can be used as fertiliser on the nearest fields.

When the pit is emptied the switch must be turned. One has to be inside the pit that just has been emptied to take out the ramp and place it the other way around. The smooth side has to be up. When the ramp has been turned the cover and the vent pipe can be replaced.

24.4 Maintenance

A maintenance-free latrine system does not exist. The Latrine Committee should have the power and the funds to make sure the latrine can be repaired whenever it's broken. Though the design is very robust, the latrines can be broken in many ways.

Two things are especially important: keep out surface water and make sure the pit is fly-tight. Surface water should be drained away from the latrine. During rainy season, special care and attention should be given to this point. If water is entering the pit in big amounts the composting process is slowed down.
Flies breeding in the pit can come out through every tiny crack. All openings, holes and cracks should be repaired and covers must be tight fitting.

25 Conclusions and recommendations

By the end of the project the conclusions are to give answers to the questions asked in the beginning. This latrine construction project was about two objectives from Vajra, points five and six in the project proposal.

1. Guiding the construction of latrines at schools in the health camp villages
2. Guiding the construction of latrines at private homes in the villages

The second point was already rejected before the start of the project by stating that this years school latrines are pilot projects. These pilots should lead to private sanitation at the family homes, next year.

Which goals have been reached:

The objectives of this project were (see also chapter 16 objectives) to build *pilot latrines*, to make the children acquainted with the use of latrines and to teach the villagers how to build public latrines.

The building of seventeen latrines at seven schools in three VDC's has been started. The *situation at the time of leaving the field* (see chapter 21) promises thirteen of these latrines at six schools to be finished before monsoon. The four toilets not finished are in Palati (Barabise VDC). The reason for this is a misjudgement of the soil stability. Time should have been taken to do test on soil stability. Time was limited because of the will of the Vajra board to build 28 toilets in 14 places in just five weeks.

The health education at the health camps and during the construction at the schools has taught the children about personal hygiene and the use of latrines (see ch. 23). When the children use the latrines at school the coming years, they will more and more get used to heaving proper sanitation.

Villagers of three VDC's have build latrines, the school principals and other teachers have co-supervised the building process and the booklet 'How to build a double improved ventilated pit latrine' will be translated into Nepali and distributed between the VDC's (see 'How to build a pit latrine').

Overlooking these results it can be concluded that the objectives of the latrine project as stated in chapter 16 are partly fulfilled.

Advices

During the project some problems have occurred. To avoid making the same mistakes again, some advices are listed below.

- Keep the working field in which Vajra operates, in line with the scale of the foundation
- Vajra should concentrate more on the Health education and Engineering . The assistance of engineers during the health camps, was not as effective as Vajra expected.
- Vajra should consider working with a more experienced engineer to support students. This will prevent the area of becoming a practical playground for students.
- Make a calendar with all the festival dates on which there is no work
- Working parallel in more than one place is possible only if you are able to visit the building sites daily. This is not possible working in three different VDC's
- A local supervisor on the site should be someone responsible and powerful.
- At the design the engineering team should have access to costs and alternative costs
- Labour should be more often paid by the work and not by the day.

- English teachers from secondary schools function well as translators around their school. For others side Vajra should arrange translators from outside.
- The coordination of materials and information should be centralized in one place (book) and/or person
- The design of the latrines for the public schools should not be used for the construction of private latrines. Another year, some other volunteers should design and construct private latrines.
- Chaku: don't work with Surendra anymore, he is uninterested in any project and not even willing to walk up to Marming to translate at that project
- Given the fact that this was a pilot project both for the villagers and for VFN, it would have been better to construct latrines at one place, just to see how it works out.
- Supervising seven building sites at the same time is very hard especially when problems occur.
- Agreements made with the VDC's about the latrines prior to the design of the latrines can create false expectations for the VDC's, for Vajra and for the engineers.
- There should be more time for designing; no design is standard, it takes time to find out what design is the best for each given situation.
- The survey of the health camp villages can be used as a guideline for future Vajra projects and it may be useful to create a long-term vision for the foundation.

III Other projects

26 Introduction

Besides the two main projects of this WSH project, thereare other, smaller projects that were studied. They were done in between or after the main projects. Some of them were not completed or ever started due to the prevailing circumstances. They all do though have conclusions and recommendations for if they are ever continued, so therefore do need to be documented.

27 Improved Cooking Stoves (ICS)

27.1 Introduction

One of the objectives for this practical period was "giving advice on the construction of ICS". Soon after the arrival in Nepal this objective was adjusted to not only giving advice but also to start a project in the form of training villagers. The first people to be trained were the women of the kitchen gardening group of Ramche. This group has proven to be well organized and showed great interest in the construction of ICS's. In this chapter all events/meetings will be described chronologically and will end with recommendations.

27.2 Chronological order of events

After writing the project proposal in the Netherlands it was soon clear that a lot of knowledge about ICS's was already present in Nepal. One Nepali NGO that is specialized in ICS's is the Centre of Rural Technology (CRT). The CRT has started numerous projects concerning the construction/implementation of ICS all over Nepal.

During the first preliminary meeting the possibilities of cooperation between VFN and CRT were discussed and some information about ICS was studied.

After this meeting a plan was made to train 4-6 women of the Ramche kitchen gardening group. These women would train/guide the construction of the ICS's at other houses.

At the second meeting with the CRT, Ram was also present to discuss the financial side of training and after care. During this meeting the following points were agreed upon:

1. The CRT would provide 2 trainers who, in total, could train up to 16 women
2. During the training all materials needed to build ICS's would be present (i.e. clay, cow manure, rice husks)
3. The 16 women would construct 3 to 4 ICS's and the two trainers would guide the construction
4. The training would start at 25-05-2000 and would take 5 full days
5. The training would not officially be given by the CRT to avoid 25% overhead tax. However all materials needed would be provided by the CRT, including CRT trainers.

Some weeks later a meeting was held with Maarten, Ram, Ernst and Leo to discuss the final details of the ICS training. The women that would be trained would become skilled labourers, as it were. They can be hired, for a small cost of 50 rupees, to build an ICS at the customers home. They would also give introduction presentations, 'Tupper wear parties', of the ICS's to the women in their neighbourhood. Incentives on how to make households buy and build their own ICS's were also discussed, i.e. they would get x-amount of rupees if build before a certain date.

Some problems had arisen between the CRT and VFN. It was then impossible to avoid the 25% tax and at the scheduled date the CRT would not be able to provide two trainers for five days.

At the same time contact was made with the World Luther Federation (WLF). The WLF could also provide a trainer for ICS under the same conditions. This trainer still had to confirm that he/she was able to come on 25-05-2000. Contact with the CRT was put to a stop.

One and a half weeks after the contact with the WLF was made more problems arose. First of all the women of the kitchen gardening group were very busy working on the fields for the preparation of the coming monsoon.

Secondly, 2000-3000 stone bricks have to be made before the training. These bricks need special clay, which, in Ramche, can only be found in one place. At the time corn was planted on this place. Last of all the trainer of the WLF still had not reacted to the request.

At this time it was decided that the construction of ICS would be postponed until October 2000. Contact was again made with the CRT and so they would probably do the training.

27.3 Conclusions and recommendations

It can be concluded that a lot of time and energy has been put in the ICS project and that the results were minimal. All contacts made have been troubled by miscommunication and/or stopped completely. It is still very important to start with an ICS project although the involvement of (Dutch) engineers is not really necessary. All the knowledge is readily available in Nepal and therefore the project can be completed by VFN.
An inventory has to be made before an ICS project starts to determine which materials are already available and if not, what is needed. Then, where they have to be and at what time.

28 Chulti, water supply to the school

Last year spring, a water pipeline was constructed between the water source (a spring) and the village of Chulti (Ramche VDC) under the supervision of two DUT civil engineer students. One of the objectives of this years engineering project was to extend this pipeline, to connect the school to the water supply system.

Project proposal

Jan Post, former Vajra volunteer, has already made some preparations by making a preliminary design. (See project proposal). A pipeline will be constructed from the village reservoir to a school reservoir below the school. From this reservoir the water can be pumped up to the school using a hand pump. To prevent spilling water a self-regulating floater system can stop the water flow from the village reservoir to the school reservoir.
Major questions about this proposal are the availability of water in the dry season and the difference in height between the school and the village reservoir.

Situation in Chulti

- This spring Vajra has rebuild the school in Chulti, many villagers were helping to complete that project. Rene Veldt, supervising the school construction, claimed that the villagers are a little 'constructing tired'.
- The village reservoir is 18 to 21 meters below the school (two measurements), it is uncertain if this height can be overcome by using only one hand pump.
- The distance between the reservoir and the school is covered by a small valley (maybe 50 meters deep); a pipeline would be 500 to 600 meters long.
- Unlike last year, the village reservoir was overflowing, even in the dry season; water seems to be available all year, if not being spilled.

Advises about the water supply

After talking to VFN and Maarten Olthof it has been decided not to extend the water pipeline this year. Main reason was that the construction of the pipeline would influence the construction of the school (which has been finished the 13th of May).

The following points have to be taking into consideration, in future design:
- Some solution has to be found to the 20 meter height difference
- The extension of the water pipeline as not a small project, it involves a lot of work (500 meter pipeline, a reservoir, maybe a pump)
- If Vajra wants to build latrines at the Chulti School, there has to be a water supply.

29 Kitchen gardening, irrigation in Ramche

29.1 Introduction and description of Rathamatha

The village of Rathamatha (red earth) is approximately a 1-hour walk north from Ramche. VFN asked us to make an inventory of the present situation and to look at the possibilities of starting a water project in the future.
Rathamatha itself consists of ± 27 houses and has a population of 250 inhabitants.
Rathamatha is a well-organized community, which feels strongly responsible towards its villagers. A committee was formed to guide different projects. These projects were fully paid by the villagers. Each family saves Rs. 20 a month for community purposes. For example, from these savings a Shiva temple and a water system have been constructed. Currently the villagers are constructing a new community building. The money is also being used to support those families who need financial aid to survive.
The income of Rathamatha is mostly generated by agriculture. Not only corn and rice but also a large diversity of vegetables, i.e. cucumbers, tomatoes and eggplants, are being grown. The whole village is mostly from the Chettri cast and at the time of research no translator was available in the village.

29.2 Evaluation of the existing water supply system

Two years ago the villagers constructed a water system consisting of a tap from a water system for a tree nursery, 1 reservoir/break pressure tank and 3 public stand posts.
In the past two years the system has only supplied the village with water for two months. The other 22 months no water was present. The complete system has broken down and the piping lies on the surface. All public stand posts are out of use and are in bad shape. During the monsoon a small stream supplies the village of water but in dry season the villagers collect their water from a large stream from its neighbouring village, Maneswera.
The pipe that serves Rathamatha also serves Thurdniri. Thurdniri is a village below Rathamatha and with its lower elevation has therefore had more water during the last two years. This is probably because in the water system the water flows to the lowest point, Thurdniri, and short-circuits the Rathamatha piping system. The precise amount of water that Thurdniri has gotten over the last two years is unknown.

Problems:

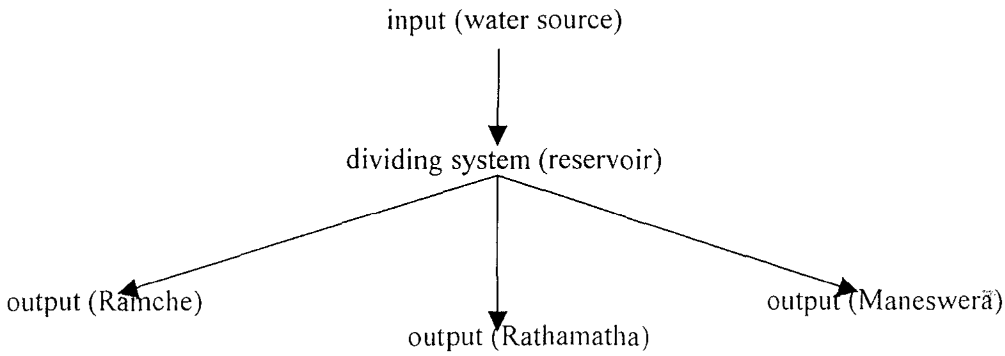
- The system has only worked for two months out of 24.
- The system is not of working order.
- The piping lies at the surface
- The public tap stands are in bad shape.
- The Rathamatha villagers now get their water elsewhere.
- The Thurdniri water system probably short-circuits the Rathamatha water system.

29.3 Conclusions and recommendations for future project

The villagers or Rathamatha want to connect a pipe to the Ramche/Maneswera water supply system to ensure a constant water supply. The first, small reservoir tank halfway Ramche and Arukharka seems to be appropriate for this purpose. The villagers of Rathamatha have asked the VDC of Ramche several times for permission to connect a pipe to this reservoir tank. The VDC has not, however, already approved.
During the evaluation an altitude meter was not present. Therefore it is unknown if there is enough vertical elevation to supply the village of Rathamatha from the reservoir tank by gravity.

Secondly, the village of Thurdniri should also be included in the project since they also depend on the same existing water supply system.

Further research is needed to determine if it is possible to supply Rathamatha with water from the Ramche/Maneswera system. The elevation difference between reservoir and tap stand location needs to be measured. A complete understanding of the Rathamatha water system is needed to find out why the Thurdniri system does get water and the Rathamatha doesn't.
Last of all but probably the most important, if Ramche and Maneswera can do with less water. If the Rathamatha and Thurdniri project taps water from the Ramche/Maneswera reservoir, then their water supply will diminish. Therefore the Ramche quantity of water supplied and used must also be assessed and understood before the project is undertaken. This also counts for Maneswera. One can see it as a box system:



This is very important; otherwise the project is only a shift of the problem. If undertaken, then first the Ramche water system must be upgraded. This is done by fixing the leakage at the water source: the metal water pipe 2 m away from the intake loses ¼ of its water!

Furthermore a meeting should be held between the villagers of Rathamatha, the villagers of Thurdniri, members of VDC Ramche, members of VFN and Nepali/Dutch engineers to talk about the possibilities/problems concerning this project.

Things to be done before possible project start:

- Measure the elevation difference between the Ramche reservoir and Rathamatha and Thurdniri.
- Comprehension of the Rathamatha and Thurdniri water system.
- Ramche/Maneswera quantity of water supplied and used must be assessed and understood.
- Meeting between the villagers of Rathamatha, the villagers of Thurdniri, members of VDC Ramche, members of VFN and Nepali/Dutch engineers to talk about the possibilities/problems concerning this project

30 Evaluating the irrigation of the kitchen gardening project in Ramche

30.1 Introduction

One of the objectives of this water, sanitation and health project is to evaluate the possibilities for irrigation / water supply of the *kitchen gardening project* in the village of Ramche. This was to be done in-between the other projects. This chapter will be a short summary of what was done, not done and some suggestions concerning the project.

30.2 Evaluation of the possibility for irrigation

The kitchen gardening project was started two years ago and is comprised of 90 women who are spread all over Ramche. These women have made the time, next to their extraneous daily work, to grow some vegetables on small plots of land. These vegetables are then sold to the people in Ramche or in the bigger town of Barabise, generating a little extra income. The main crops are tomatoes, potatoes, spring onions, cauliflower and different types of herbs. These women have asked VFN to look into the possibilities of irrigating their plots so that larger crops could be grown. They do irrigate a little, which is done by hand or a garden hose.
To evaluate the possibilities of irrigation, first of all, the water supply system and its discharge in time must be known and understood. The source of Ramche's water is a river that lies just under Arukharka. Here it is dammed and de-routed through a large metal pipeline. This pipeline takes the water to Ramche via a smaller and then, 500m downhill, a larger break tank/reservoir, both located uphill from Ramche. After the large reservoir the pipeline route, amount of pipes and its separations are not known. This was because there was never any time planned to investigate this. Also, the amount of public/private tap stands (or open pipes) is not known.
The discharge pattern in time (yearly passage) of the water supply and the coinciding water usage was also not investigated. This was never possible in the slotted time the investigators had: three months.
The water amount needed for the different crops was also not calculated. The manner in which this is done was already explained in the project proposal.
The type of irrigation was also not investigated. One thing is for sure; it should be cheap, sustainable and easy to use.
All in all, not much was done. But, as stated before, there was no time planned to investigate this.

30.3 Conclusion and recommendations

There is much to be done before the project could start, as stated above. The willingness and dedication of the users is already there, so this poses no problem. Below are the steps to be taken for the evaluation of the project and its possibilities.

- The complete water system route, amount of pipes and separations must be investigated.
  This is to get a complete understanding of the system, which is always needed before starting the project. This can be mapped out by the investigators.
- The amount of public/private tap stands and their location.
  This is so that the location of where the users would tap their water from is known and registered. Again, can be mapped out by the investigators.
- The discharge pattern in time (yearly passage) of the water supply and the coinciding water usage must be known.
  When one irrigates an area, the amount of water that could be used (water supply – water use) at that particular time must be known. Otherwise the water would not be used efficiently. Too much water used for irrigation would deprive the villagers while non-usage of the excess amount (when available) would mean smaller crop

yields. This would have to be measured by a villager a full year around, twice a week. This person would measure the water height in the large reservoir, above Ramche, in the morning and again in the evening. The VDC and/or VFN would pay him/her. The engineers would then interpret this information and see the yearly passage of both water supply and use. From here, they can determine the water excess/deficiency and see when and how much it is possible to irrigate the fields.

- The water amount needed for the different crops.

  This method is already explained in the project proposal.

- The type of irrigation needs to be determined.

  This needs to be determined with both the engineers and the users. There are many types of irrigation but a simple and local technique should be used. This is best known by the users themselves.

This evaluation and investigation would need to be planned carefully. The measurements needed (water supply and use) needs to be collected for a year before the project can be evaluated. Then, the evaluation project and design afterwards would also take sometime, say 1 to 2 months. This all needs to be accounted for before giving the start sign. The most important matter is to use the water efficiently and not overuse it. These would lead to water shortages for the whole village.

The last thing heard was that the VDC would undertake the project by itself and from a different water source, not the Ramche drinking water source. It is recommended that the VFN would advise and check the project before and after with the VDC, to insure optimum efficiency.

31 Survey of the health Camp villages

During the health camps, a engineer survey was done in the health camp villages. See for the results of this Survey Appendix III.

IV Conclusions

32 Conclusions and recommendations

For Stichting Vajra Holland and Vajra Foundation Nepal

- The contacts made during the years should be listed and described. The future volunteers could then be more efficient in finding needed information, here in Holland and in Nepal.

- If a project is to be done simultaneously with the Health Camps, then they should be not dependent on each other. Basically, there should be separate translators for each project who are always there. This avoids the problem of the Health Camps using all the translators and thus leaving the engineers without one. They can then no longer perform their work adequately. Also, Ram and Dor should be able to visit a project without jeopardising the operation of the Health Camps. The other projects occasionally need both of them for meetings, to solve problems and to order material.

- VFN should not, in its enthusiasm, make guarantees with other parties and not inform the engineers beforehand. It is only fare to the engineers that they should know what the agreements are before, in Holland already, so that they know what is expected of them. An example of this was that the VFN had already promised several VDC's latrines. We had discussed in Holland, beforehand, that we would investigate the Health Camp villages and then look afterwards where latrines are necessary. When we heard the news in Kathmandu, we were quite surprised to say the least. When there is more communication between the parties, then both can expect the best of each other.

- If possible, the VFN and Stichting Vajra Holland should get permits for business visas for their volunteers instead of tourist visas. Then they would be working legally (officially not allowed to work on a tourist visa) and it would avoid the hassles of renewing the visa's every so often.

- Keep the working field in which Vajra operates, in line with the scale of the foundation

- Vajra should concentrate more on the Health education and Engineering . The assistance of engineers during the health camps, was not as effective as Vajra expected.

- Vajra should consider working with a more experienced engineer to support students. This will prevent the area of becoming a practical playground for students.

For future students/volunteers

- Do not think that you will be the pioneer of implementing the projects in the area. Many project topics are known and have been already implemented in Nepal. Much information is available in Kathmandu from of the 29,000 Nepali and 14,000 international NGO's.

- Use the contacts listed in the List of Contacts.

- If people are working on a project some problems can arise when the engineer on-site would want the labourers to work parallel. A contract states that the villagers will not get paid for the unskilled labour and get paid for skilled labour. If the people would work parallel there would be a mix of labours, they would be working side by side. This creates friction because of the payment division. This was pointed out by one of the villagers who wanted to avoid the problem (Bibi of Arukharka, head of the water project). Therefore, first all unskilled labour has to be finished before the skilled labourers started working. This only applies when the skilled and unskilled labours are from the same village.

- Villagers (man and woman) in the area of Arukharka and Chulti smoke leaves for pleasure. Cigarettes are too expensive for them to buy. During construction and negotiation it breaks the ice if the engineers pass around cigarettes: talk starts, everybody is smiling and they feel they are respected more. If the engineers on-site do not smoke, it still benefits to pass them round anyway.

- It benefits a project greatly if the engineers are on-site every day of work. If the engineer is not there things might be executed in a wrong way. Then they would have to be done over again. Again another advantage is that if the engineer is on-site, skills can be learned from each other. The villagers benefit from the techniques of the engineer and he or she can learn theirs. Last but not least it shows the interest and dedication a person or organisation has in a project

- Sometimes it happens that people come to work drunk. It is best to make it clear in the beginning that drunken people do not work hard and even slow the others down. Safety also is an issue here. Drunken people are best sent home and they would have to find a replacement for that day.

- Many times during this internship it happened that materials bought for the project were already in Arukharka. Having a meeting before large orders are placed to see if some or all of the material is already present is advisable.

- It happens often that problems arise and, on the short term, do not seem to have an easy solution. Also during preparations problems seem to have a difficult solution. Many times villagers have dealt with these problems before and therefore have simple and good solutions. So, always discus with the villagers the problems as to get their feedback. This also stimulates their awareness of the logic of the system.

For future projects

- For both the *irrigation of the kitchen gardens in Ramche* and *Rathamatha water supply* projects, the yearly passage of water quantity and usage of Ramche must be investigated throughout the village. It must be first known if there is enough water available for either/both projects. If this is not known and water is still taped, then Ramche could have a water shortage at certain times of the year. This would only be then a shifting of problems, not solving.
- Fix the leakage of the metal pipe at the Ramche water source

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Appendices

I Latrines in Attarpur and Petku - *Koert Huisman*

Preface

This is the final report about building latrines in Attarpur and Petku, Nepal, by Koert Huisman (between April 13th and May 14th 2000). It will describe briefly the villages and the designs; these will be described more thoroughly in the final report of Anne Wietse and Remco.

This report will describe the cooperation with the villagers, the locations of the building sites, the progress, the cooperation between me and Vajra Foundation and finally some conclusions and recommendations

Koert Huisman
Attarpur, Nepal
May 2000

1 Attarpur

Location building sites
In this VDC a total of six toilets had to be build at three sites. Two times one and one time four toilets. One toilet near the health post in ward number 4 (site 1), four toilets near a big school between ward number 3 and 4 (site 2) and one toilet near the public mountain school in ward number 2 (site 3). See drawing 1.1.

Cooperation with the villagers
In general there where no problems. The cooperation between the villagers and me had to be done in Nepali, due to the lack of any interpreter, the first week.
The second and third week the English teacher was there but he had to teach between 10 a.m. and 4 p.m.

The reason things went smoothly anyhow is because of the help of Norbu Tenzin Lama. At all three sites we managed the building process together. Norbu is a good contractor and he has a lot of practical knowledge. Every day, due to his influence (he is former chairman of the VDC), he was able to arrange enough people to help building the toilet. He also arranged the school children to carry once and awhile stoned to the building site. It's amazing to see how many stones 400 children can carry in half an hour.

Site 1
Map: see drawing 1.2
Design: a double pit latrine build with urinal; total amount of latrines: 1
Progress: see chart 1.1
Progress until the last day 10th of May
Walls have been made till 2.20 meter; this means 20 cm above ground level. Everything is ready to make the concrete floor. This has already been done at site 3, so the workers know how.
How to continue?
The design is known by Norbu, he will continue the project

Site 2
Site map: see drawing 1.3
Design: a double pit latrine is build with urinal; total amount of toilets: 4

Progress: see chart 1.2
Progress till the last day, 10th of May
Walls have been made up till 1.50 meter. The last 70 cm is difficult because of some special shapes
How to continue?
Drawings have been made for the last 70 cm of wall making, the rest is also known by Norbu, he will continue the project.

Site 3
Site map: see drawing 1.4
Design: a double pit latrine is build with urinal; total amount of toilets: 1
Progress: see chart 1.3
Progress till the last day, 10th of May
The floor has been made; the workers can start building the toilet house
How to continue?
The design is known by Norbu, he will continue.

2 Petku

Location building sites
After discussion with Dhor and the VDC, it has been decided that five instead of six toilets had to be build. Three times one and one time two toilets. See drawing 2.1.

Cooperation with the villagers
The first day, 25th of April, Dhor and I visited site 4 and 5 and we spoke to the teacher of the school near site 5 and to the health worker. This health worker is supposed to be my contact person. We talked about the designs and he promised to distribute the information, so they could start digging at all sites immediately.

The 28th of April returned. At site 4 nothing had been done. Site 5 they had started digging one day before. When we came to site 6, I think they never heard about this idea of making a toilet. Nevertheless they were willing to build a toilet but they did not have any spare land. This problem was easily solved by mentioning that they had one classroom too much and they did not bother to destroy one fourth of the school. I did not agree on this point and I said I was not willing to build a toilet at that particular place. They promised me to contact Vajra again.

At site 7 nothing had been done. The idea of building a toilet was totally new for the teachers, in my opinion. But they also didn't mind getting a toilet, they promised to start the next day.

As one can understand, this was not one of my best days. I promised to come back after one week. After visiting Petku I contacted Ram Kaji about the problems in Petku. A few days later Ram informed me about the conversation the health worker from Petku and he had in Katmandu. Ram told him about the little progress and they agreed and promised to do better.

Together with Ram it was decided not to visit site 6 and 7 in the future because of the big distance between 4 and 5 and the little progress. It would take too much of my time if I would visit site 6 and 7 every time as well.

A week later I returned to Petku, 3rd of May. Little had been done. At site 4 they had just started digging and at site 5 they had almost finished the digging. The health worker told me that site 6 and 7 had just started the digging as well. Site 6 had been able to find some extra land. At this moment I was thinking about quitting the projects in Petku because of the little progress they made. But the health worker insisted in continuing the project. I called for a meeting with the villagers. That evening I spoke with the villagers. There were some problems about the people from ward number 9 who were not willing to help because they were not allowed to help during the building of the health post some time ago. After this meeting everybody promised to help; they promised huge progress.

At the 10^{th} of May I came back and indeed progress had been made. Site 4 had finished the digging and at site 5 a wall of 1.50-meter height had been build. During that day I talked with a woman living next to the health post. She told me the villager's thought the health worker was cheating. The villagers did not get paid for carrying sand, wall making and breaking stones in aggregate. I was not sure about what Vajra promised to pay for, so I told this but I promised to check the contract to find out.

Sundeep translated the contract into English, but we were not able to find the needed details. What we did find out is that the health worker is paying 7 rupees per ... sand and in the contract it says 10 rupees. The health worker told us Vajra was only paying 7 and he had not read the contract. Please, find out the truth!

The woman who told me this, also showed me what they had done last week. She had carried all materials needed for making a slab to site 4. She was really motivated for making this toilet, and she said many people would help on Thursday from 7 to 10 a.m. and from 10 a.m. to 5 p.m. This motivated me and I decided to stay another day.

Near the school the next morning there was a big meeting. All villagers of ward number 8 and 9 made a contract to insure both wards should contribute an equal amount of work. That day a lot of people helped.

Site 4
Site map: see drawing 2.2
Design: a double pit latrine is build; total amount of toilets: 1
Progress
Nothing had been done until the 2^{nd} of May. From that time they started digging and completed one hour before I left. The last thing I did was lining out the pit wall.
How to continue?
Still a lot of difficult activities have to be done. Together with Ram and Dhor we decided they can continue as far as they know for sure what to do. They promised to visit Attarpur and consult Norbu if necessary. In a couple of weeks the instruction manual will be finished and distributed to Petku. With help from the manual they should be able to complete the latrine themselves.

Site 5
Site map: see drawing 2.3
Design: a double pit latrine is build; total amount of toilets: 2
Progress
They started from the 25^{th} of April. But the progress was very little. They probably did not work everyday. The last day they finished the pit wall up to 1.50 meter.
How to continue?
See site 4

Site 6
Site map: see drawing 2.4
Design: a double pit latrine is build; total amount of toilets: 1

Progress
They started late and by the 11th of May they had almost finished the digging of the pit.
How to continue?
See site 4

Site 7
Site map: see drawing 2.5
Design: a double pit latrine is build; total amount of toilets: 1
Progress
See site 6
How to continue?
See site 4

3 Cooperation with Vajra

In this part I'll write my experiences about working together with Vajra Foundation. Let me start by saying that he cooperation was satisfying, in general.

Strong points
The frequent contact I had with Dhor and Ram. The frequency of once a week was sufficient.
The commitment of Ram and Dhor. If you needed them you could always rely on them. They even visited Petku and Attarpur by surprise.
Making a letter of intentions. Both sides know what has to be done and what you can expect and what is expected.

Weak points
The distances between the building sites were to long. It was hardly possible to supervise seven sites, that were 5 hours walking (up and down) apart from each other.
The time pressure was too high. It's hardy possible to build a toilet within four weeks.
I think Vajra Foundation underestimated the designing and building of latrines
Vajra did not supply an interpreter all the time as was agreed. They only did for the last ten days.

Evaluation letter of intension
See letter of intension from volunteer Koert Huisman.

- *Point 1* Thanks to the villagers, working on my own was not that difficult. They were very friendly and kind. It's important to have a good interpreter especially when you are on your own.
- *Point 2* I started in both villages.
- *Point 3* In Attarpur 6 toilets will be build, in Petku 5 instead of 6 toilets (this decision is made by Ram and Dhor).
- *Point 4* It was not possible to finish a latrine in four weeks. Theoretical it should be possible but you'll always depend on the cooperatively of the villagers. In Attarpur they are trained and they are able to continue and finish the toilets on their own. In Petku they are not able to finish the projects on their own. They will consult Norbu and visit Attarpur. To ensure the projects will be successfully finished, Anne Wietse, Remco, Danielle and I decided to write a manual about how to build a latrine. This booklet will be translated into Nepali and send to the villages.
- *Point 5* We designed the latrines together and discussed the progress every week.
- *Point 6* I did.
- *Point 7* We changed it to Barabise, but the meeting we had.
- *Point 8* I did.

- *Point 9* With this report I did.
- *Point 10* They did provide food and lodging.
- *Point 11* Only the last ten days they provided a translator. I shared Sundeep with Maite when she was giving classes.
- *Point 12* Vajra and the VDC arranged the materials in time.
- *Point 13* I did.
- *Point 14* I did.

4 Conclusions and recommendations

Conclusions
The distances between the building sites were too long.
Petku started the cooperation very late, this has affected the progress.
Attarpur was well-organized and easy to work with.
It is hardly possible to build a latrine in four weeks, if you have to depend on volunteering villagers.
The absence of an interpreter will decrease the building progress.

Recommendations
It is better to stay in one VDC, this way the building can be supervised better.
The villagers and workers should be informed about what they will build before they start. This period we gave only a new instruction after the previous one was finished, that way it's impossible for the workers to understand why and what they are building. We had to do like this because our design had to be developed in the same period.
It is very useful if the foreign volunteer is assisted by an important villager. It will ease and speed up the building activities. Because of his influence he can arrange workers, materials, etcetera easily.
It would be very helpful if a volunteer has all the official contracts between Vajra and the VDC in English. This way he or she will know what kind of decisions and agreements have been made.
After completing the latrines a thorough education should be given about the use and maintenance of the latrines.
It should be more convenient if Vajra supplied an excess of materials. After completing the projects Vajra can ask the spare materials to be returned. It is very expensive and time consuming if you need just one extra bag of cement and it must be sent from Katmandu.

5 Final thoughts

I enjoyed my stay in Nepal very much. The time I spent together with the villagers of Attarpur and Petku was sometimes motivating or depressing bet never boring.

Unfortunately I was not able to finish a latrine totally, nevertheless I think we started some useful projects and with help from each other and the manual they should be able to finish the latrines properly on their own.

Finally I would like to thank Norbu for showing me how they build in Nepa and his sense of humor. Sundeep for his help in translating the last ten days. I also would like to thank Ram and Dhor for their commitment and Maarten for giving me the opportunity to do this project. Thank you Vajra and Nepal!

Koert Huisman

SWC Reg. 283/047/048

ENPHO
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WATER ANALYSIS REPORT

Lab Reg. No.: 4642/2000 Code : PD Payment : T

Sample brought by : Leo Bouwman	Source of sample: Groundwater
Address: Nepal	Date of collection: 28th April,2000
Location :	Date of analysis: 28th April, 2000

MICROBIOLOGICAL ANALYSIS

		Sample							
	UNIT	S1	S2	R1	R2	TA1	TA2	TD1	TD2
Total Coliform	CFU/100ml	960	1260	35	435	219	109	132	149
E. coli	CFU/100ml	73	69	5	10	49	26	22	10

2nd May, 2000

Note: S1 & S2 - Source
R1 & R2 - Reservoir
TA1, TA2, TD1 & TD2 - Tap

AUTHORISED SIGNATURE

III Survey health camp villages

Barabise VDC

Date:	18 / 03 / 2000 - 20 / 03 / 2000
Village :	Palati, divided into small-palati an big-palati
Distance to Barabise :	1 1/2 hour walking (up)
Estimated amount of inhabitants :	+/- 7000 people (900 houses)
Central point in the village :	The *Health Camp* was in the school next to the health post of the village, which seems to be the centre of the village.
Description of village/houses/	Building materials: Palati is a relative wealthy village with mainly one or two floor houses of clay. The houses tend to be less wealthy further up hill. Palati is under the Village Development Committee (VDC) of Barabise, and is divided in nine wards. In speaking there is made difference between big and small palati.
General facilities :	Each ward has it's own school. There is a health post in the centre of the village, for further treatment the villagers have to go to the Barabise hospital.
Forested, erosion :	As in the rest of Nepal, open fire is still the way to cook and therefore most of the forests have been cut. There is big danger of erosion. Signs of smaller and bigger land slides are in the entire area.
Agriculture :	The agriculture ground consists of @terraces@
Vegetables grown :	Rice, grane, corn
Soil :	Red clay / rocks
Visited ward numbers	1, 6, 7

Cooking stoves

In big Palati no improved cooking stoves have been seen. In small Palati only one ics is spotted, but this was no longer in use. The reason for not using it seems to be the misconstruction of the smog channel, which was at a place were no wind could make the smoke come out. Furthermore the people had placed their kitchen to upstairs, maybe because of the winter cold.
Ramkaji asked the VDC were they would like an improved cooking stove to be build. The VDC thinks the best place is at the chairman's house, they claim that other villagers will come and see how it works and copy it. The project team has visited the house of the VDC chairman to have a look. The woman that uses the stove seemed to be enthusiastic. She wants a higher stove in the corner, to be able to stand while cooking. It turned out that the family is planning to relocate their kitchen in about two years.

Water supply

There are innumerable water supply systems, which are big and small, long and short, well and not maintained, young and old. Every inhabitant seems to be able to get water all year round within reasonable distance (maybe up to ten minutes walk).

Schools

Ward no 1: "Shree Bharahdevi Primary School"

The school consists of two parts. One built by the villagers (1992), the other by the Japanese (1994).

Students :	150
Teachers :	2
Rooms :	4 + office
Water / latrines :	The water supply pipe line passes by the school up hill, there is a leak put no tap. There's sufficient space for the construction of latrines.

Ward no 6: "Shree Namuna Sunkhani Primary School"

The school is new built in 1999. The school is situated almost at the same altitude as the Health Post in Palati, half an hour walk south-east.

Students :	43
Teachers :	1

Rooms : 1

Water / latrines: There is sufficient space for latrine construction, but availability of water is problematic. The nearest point for water is five minutes up, therefore it's possible to get the water to the school on a gravity- based system

Ward no 7: "Bishnu Adyatmik Sanskrit Primary School"

Small Palati. This ward is about an hour south-east of Big Palati and it's lower on the hill. It's is very near the side valley of the main valley with the Highway in it

Students : 200

Water / latrines: There is a tap at the school, but it's not working all day.

Marming VDC

Date 25/03/2000 to 27/03/2000
Villages/Wards
1. Tyangthali (75 houses, 400 people)
2. Anthali (Hitaraj)
3. Golchi
4. Branga (Bulkote, Jyambaltung)
5. Marming
6. Ghunsa
7. Chhyadi (Jhangmilan Pachhadi, Gondjet, Cheche)
8. Pokhari (Sangmukhani, Chandarku, Bkimthang)
9 Chaku (40 houses, 300 people)

Place of stay Chaku, at the highway, one hour bus drive from Barabise, bumpy road. Health post, two schools (governmental and private). Electricity, beer & coke, some places to have breakfast, no guesthouses.
Visited wards 1, 5, 9 (ward 1: one hour walk; ward 5: one and a half hours walk)
Main crops Wheat, Potatoes, corn (no irrigation)
StandardsVisited places seem to be in good shape, well build stone houses.

Water supply

Tyangthali
Water committee no
Number of systems 3
System 1 and 2 One source and one tap each, one is closable the other not; these get dry at the end of the dry season, alternative source half an hour down hill
System 3 One source, three taps two with closure, one without; closing with piece of wood, no regular tap.
Tap 1 Small, dirty and almost empty reservoir, alt 1530 m, 500 meter from school
Tap 2 alt 1560 m 500 meter from school
Main reservoir $4*2*1$ m^3, alt 1610 m, not covered, tree off takes, one intake, once a month cleaned by using households by turn, (source not visited higher up hill)
Pipes above ground, leeks (not on purpose)

5. Marming
Water committee yes
Source one, ward number 6
Taps 13, with closures
System in general very well

9. Chaku
Water committee
Source unknown
Taps 4 see map, only one with closure, the three others are probably from one other source
System most pipelines are above the ground and are easily and frequently used for other connections
There is a (monsoon) gutter along the main road. This gutter is being used for transport of solid waste and in the near future it will be used to get rid of faeces. At the downstream side of town some latrines will be build above this gutter by the villagers.

Improved Cooking Stoves

1. Tyangthali
Number of ICS in working order 4 or more, three have been seen

Problems with other ics using too much wood, smoke is coming in
Initiative to build the ics training from other village Dadapakhar. Ramkaji has had this free training and he has already build three ics for himself and his neighbours. He has a @mal@ for making chimney bricks and he has also used a metal pipe for one of is neighbours (rather expensive). He is able to improve nonworking systems (as he proved by changing the straight pipe into one with an angle).
Design standard; two holes, one small, one big; for smaller pots people one woman used a metal ring and another woman used a metal tripod.
Chimneys with T-structure, one was broken and fixed, the ics out of order had no T-structure

Petku VDC

Ward	1:	Bhumi Than
	2:	Gurund Tole
	3:	Dhamid Tole
	4:	Karki Tole
	5:	Lamdada
	6:	Sanu Bandan
	7:	Khetri
	8:	Thulo bandan
	9:	Thulo bandan

General on the VDC Petku:
Toilets
There are some private and public toilets through out the VDC of Petku. Most of these are drop latrine (none improved) and some are pour flush systems. Due to lack of water, or a nearby tap point these are mostly broken. All are covered with flies.

Health post, VDC office, post office in ward no 4(Karki Tole)
The complex which houses these facilities, was built in 2052 (1996WT) and is in a very good state. There are two toilets, clean pour flush systems, which work surprisingly well. The main reason is probably the nearby tap point, although there was no water the time of visit.

Asian Rural Life Development Foundation(ARLDF)
This American NGO has its office in this VDC (near the road to Jiri). Their main objectives are in health and agriculture. In February 2056 (2000WT), just two months before the *Vajra Health Camp* , the American foundation organised a Health Camp in the same VDC. At the time of visit there was nobody from the ARLDF, so no contact was made.

Finance committees
In the VDC Petku, both in ward no 8 and 9, as well as in 2 and 3, there is a finance committee. Every member pays RS 10 or RS 5 per month. All member can lent money for investments in cows, latrines, cooking stoves and more. If there is any money from outside the VDC involved is not clear. There are about 30 members in the *finance committee* of ward 2 and 3, and about 100 members in the *women finance committee* in ward 8 and 9, where it is a women initiative.
Because of this financial help and constructive advise from a Nepales NGO, there are a couple of Improved cooking stoves in ward no 3.

Ward 1: Bhumi Than

Amount of villagers:	700
Amount of houses:	70
Electricity:	yes
School:	No school

Water:

Water committee:	yes, payment of NRs 5 per month per house
Sources:	1
Tap points:	4 (all with tap)
General state:	Service only three hours in the morning and three hours in the evening.

Management by the water committee.
In the dry season the amount of water is not sufficient, then the villagers walk to an open stream (10 minutes walk).

Ward 2: Gurund Tole

Amount of villagers:	300
Amount of houses:	70
Electricity:	yes
School:	No school

Water:

Water committee:	no water committee, no payment

Sources:
Tap points: 3 (all with tap)
General state: Not enough water in the dry season. The people walk 25 minutes.

Ward 3: Dhamid Tole
Amount of villagers: 300
Amount of houses: 50
Electricity: yes
School: No school

Water:
Water committee: yes, payment of NRs 5 per month per house
Sources:
Tap points: 2
General state: one tap on the border of ward no 2 and 3 (10 minutes), the other in the village is dry in the dry season

Improved cooking stove:
A Nepalese NGO introduced ICS in this villages. Although the chimney isn't constructed very well, people seem to be satisfied.

Ward 4: Karki Tole
Amount of villagers: 300
Amount of houses: 75
Electricity: yes
School:
School name: Shree Devi lowers secondary school
Amount of students: 250
Teachers: 6
Building: There are to buildings. One constructed in 2018 (1962 Western Time (WT)). The second building was added just three years ago (2054, 1998WT). The old building has 4 rooms, is in very poor state and needs to be reconstructed. The second building (3 class rooms) is in good state, but the school is too small for 8 classes and 250 students.
Amount of classrooms : 7
Toilets: 2 (2 years old, both broken, because water lock without water supply near the school)
Tap point: no

Water:
Water committee: no water committee, no payment
Sources: The water comes from nearby VDC of Thulopakhar
Tap points: 5 (all with taps)
General state: In the dry season there is no water and all the villagers go to other wards or other VDC

Ward 5: Lamdada
Amount of villagers: 500
Amount of houses: 150
Electricity: yes
School:
School name: Panchakanya primary school
Amount of students: 115
Teachers: 3
Building: 2 floor- building in very good state (constructed in 2046 (1990WT)
Amount of classrooms : 6
Toilets: no
Tap point: no (nearest 100 meters uphill, good source, pover catchment)

Water:
Water committee: Water committee and payment NRs 5 per month per house
Sources:
Tap points: 4 (all with taps)
General state: Enough water, even in the dry season

Ward 6: Sano Bandan
Amount of villagers: 250
Amount of houses: 60
Electricity: yes
School No school

Water:
Water committee: no water committee, no payment
Sources: 1 in ward no 6
Tap points: 10 (none can be closed).
General state: Less water in dry season. but sufficient.

Ward 7: Khetri
Amount of villagers: 200
Amount of houses: 22
Electricity: yes
School:
School name: Nahankal primary school
Amount of students: 75
Teachers: 2
Building: state is good, built in 2048 (1992WT)
Amount of classrooms : 6
Toilets: no
Tap point: no, little source close by

Water:
Water committee: no water committee, no payment
Sources: source in ward no 6
Tap points: 4 (all with taps)
General state: not always enough water

Ward 8: Thulobandan
Amount of villagers: 250
Amount of houses: 47
Electricity: yes
School:
School name: Shree Thulobandhan primary school
Amount of students: 140
Teachers: 4
Building: built in 2031 (1975WT), in good state
Amount of classrooms : 6
Toilets: 2 (6 years old, full and broken)
Tap point: 10 meters distance

Water:
Water committee: There was a water committee and payment up to three months ago, but the villages were not satisfied with its work. There is one system for ward no 8 and 9.
Sources: 4
Tap points: 9 public, 26 private
General state: Because of lack of nearby sources, a Swiss NGO, constructed a water supply from a source in Jethal village, in the next VDC. There have been disagreements over this source until Thulobandan decided to use another source, three years ago. There is still some water coming from the Swiss source, but not on a regular base.

The system
The sources
1 An open and dirty source, there is a catchment but at least half of the water is not used. Because the source is spread out over ± 100m, so it's hard to catch all water and to cover the entire source, but it can be done much better.
2 The second source is just inside the next VDC (Jethal). There is at least twice at much water, and the source is not so spread. The intake is again open.
3+4 There are to small sources just inside the village, these are used by a few houses.

The reservoir
There are several reservoirs. The one from the Swiss project (at the Khadichaur-Jiri road) is not in use anymore. The main reservoir in the village is not fully covered and very dirty. It's $4*2.5*1.5\ m^3$. The reservoir has an overflow and cleaning pipe, there is one outgoing pipe to the village and a direct tap point, which can not be closed.

Pipes
There are several leaks in the pipes between the sources and the reservoir, but although the pipes are often above the ground, they seem to be in a good state.

Tap points
There are to many tap points in the village for the amount of water available. Besides that there is a lot of water wasted, because the taps can not all be closed or leak.
Since a year there is a corn-mill in the village with a diesel engine. It is used around 3 to 5 hours a day, and uses a lot of water for cooling, of about 10 litres a minute.

Ward 9: Thulobandan

Amount of villagers:	350
Amount of houses:	58
Electricity:	yes
School:	No school
Water:	See ward no 8

Attarpur VDC

Ward	1:	Nintal
	2:	Lama Tole
	3:	Mhul Khole
	4:	Panchat
	5:	Saza ban
	6:	Pai karka
	7:	Pamche
	8:	Sikre
	9:	Tacmachu bari

General on the VDC Attarpur

Toilets

There are no toilets in this VDC apart from 2 toilets at the schools in wards 8 and 9

Health post in ward no 4(Panchat)

A Health post is being built in ward no 4, but is not finished yet. There are plans to bring water to the health post but no one can say when.

Improved cooking stove (ICS)

There is a good (working) cooking stove in a shop in ward no 4. The users are very satisfied, although there is no proper outlet. Everybody can see the stove and up to now it has been copied by five or six households.

Road construction

The VDC is working on a road from the Lamusanga-Jiri road through the village. It is almost finished. It is financed by the VDC only.

Irrigation Project

There is a 15 year old irrigation project in the VDC witch worked well until last years landslides washed away parts off it. It has not been repaired yet

Ward 1: Nintal

Amount of villagers:	400
Amount of houses:	55
Electricity:	yes
School:	No school
Water:	
Water committee:	One committee for Ward 1,2 and 3, no payment
Sources:	2 small (used mainly for irrigation)+ big source in ward 4 (see ward no 4). There is a reservoir for wards 1 to 3 (build in 2049, 199WT). It's big and looks very well constructed.
Tap points:	12
General state:	Some tap points don't have any pressure. The responsibility for repairing the taps is at the users, so these are often not repaired at all.

Ward 2: Lama Tole

Amount of villagers:	250
Amount of houses:	30
Electricity:	yes
School:	
School name:	Mountain public school (for orphan children)
Amount of students:	55
Teachers:	2
Building:	New building (2055, 1999WT)
Amount of classrooms :	2
Toilets:	no
Tap point:	yes

Water:

Water committee:	with ward 1 and 3
Sources:	the main source in ward no 4 is used
Tap points:	5
General state:	As in ward no 1

Ward 3: Mhul Khole

Amount of villagers:	600
Amount of houses:	56
Electricity:	yes
School:	No school

Water:

Water committee:	Together with wards 1 and 2
Sources:	2 small sources, and main source in ward no 4
Tap points:	6
General state:	problems with the amount of water since two years

Ward 4: Panchat

Amount of villagers:	655
Amount of houses:	89
Electricity:	yes
School:	
School name:	Rama lower secondary school
Amount of students:	400 (160 boys, 240 girls)
Teachers:	8
Building:	3 buildings New building (2048,1992WT) built by Japanese help, not finished 2nd building (2034,1978WT) with help of a Swiss NGO 3rd building (2042,1986WT) same Swiss NGO All buildings in a good state
Amount of classrooms:	11
Toilets:	no, According to the VDC this school is to be the place for a pilot from Vajra
Tap point:	no, there are plans to bring water to the school and the new built, nearby Health Post. The children now drink from a small pool, or from the cutted pipe between source and reservoir. ('Repaired' with bamboo)

Water:

Water committee:	yes, no payment
Sources:	The main water source for wards 1 to 4, is in this ward. There are two catchments, one to the reservoir of ward no 4, interrupted by an old reservoir for extra storage. The other one leads two a reservoir for wards 1 to 3. The pipe to this reservoir is cut by the students off ward no 4, because they don't have any water. A third pipe leads directly from the source to 6 houses in ward no 4.
Tap points:	8
General state:	The entire water supply system for wards 1 to 4, is built in 2048-2049 (1992-1993WT) by the VDC only. The reservoir in ward no 4 is 2.5 *2 *1.5 m^3 constructed in 2048 (1992WT) and looks solid. As in wards 1 to 3, failures of the taps have to be repaired by the users, but the system works surprisingly well.

Ward 5: Saza Ban (not visited)

Electricity:	yes
School:	
School name:	Shree Ban primary school
Amount of students:	92
Teachers:	3
Building:	New building (2056, 2000WT), by VDC and japans NGO
Amount of classrooms:	5
Toilets:	no
Tap point:	no (closest tap point 350m)

Ward 6: Pai Karka (not visited)

Electricity:	yes
School:	No school

Ward 7: Pamchre (not visited)

Electricity:	yes
School:	
School name:	Jana Jagniti primary school
Amount of students:	50
Teachers:	3
Building:	build in 2043 (1987WT) in good state
Amount of classrooms:	4
Toilets:	no
Tap point:	no, very difficult to get water, the school is on top of a hill

Ward 8: Sikre (not visited)

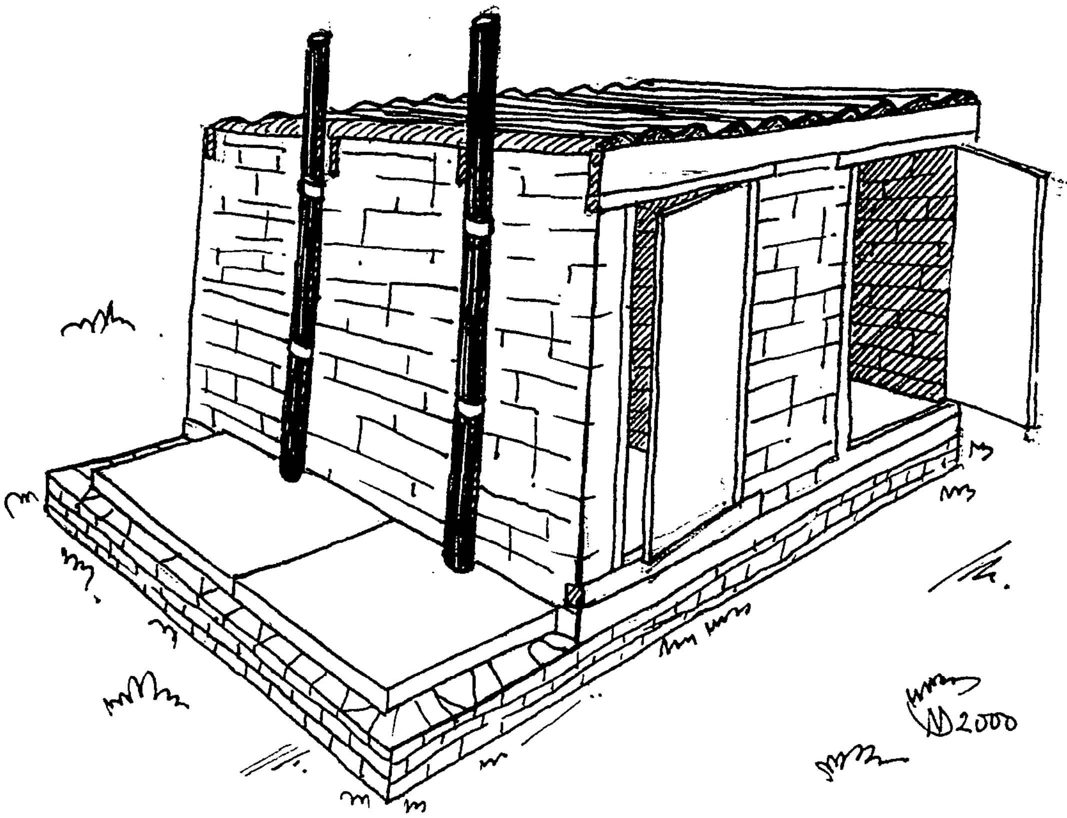
Electricity:	yes
School:	
School name:	Shanti vdaja primary school
Amount of students:	175
Teachers:	4
Building:	buildings one new building (2053, 1997WT) the 2nd was build in 2043 (1987WT)
Amount of classrooms:	8
Toilets:	yes, two toilets, one year old and both in good state
Tap point:	yes

Ward 9: Tacmachu Bari (not visited)

Electricity:	yes
School:	
School name:	Tamakhubani primary school
Amount of students:	125
Teachers:	3
Building:	one year old built by VDC and Japanese NGO
Amount of classrooms:	8
Toilets:	yes, two toilets, same Norwegian project as in ward no 8
Tap point:	yes

How to build a

VIDP latrine



Text:

A.W. Boer
K. Huisman
R. Keijser

Drawings

A.W. Boer
D. Naus

Kathmandu, May 2000

Vajra Foundation Nepal

How to build a VIDP latrine

Introduction
A lot of diseases are related to excreta and can be prevented by better facilities and better personal hygiene. Education determines the welfare off the future generation. For these reasons Vajra Foundation Nepal (VFN) decided to combine the construction of latrines at schools in several VDCs in the surrounding of Barabise, with health education to the schoolteachers and students.

This booklet can be helpful in three ways.

- It shows in 15 steps how to build toilets at your school
- It explains to the students how to use the toilet
- Last but not least it shows how you should operate and maintain the toilet through the years

VIDP stands for Ventilated Improved Double Pit.

- Ventilated Improved comes from the (improved) ventilation pipe system, which takes away smell an flies from your toilet
- Double Pit means you have two pits under your toilet. You use one until it is full (about two years) and switch to the other. You use the second one for another two years, giving the excreta in the first pit time for decomposition. Dig the first pit out (use as fertiliser) and you can switch back to this pit.

Step 1 Determine the amount of users

Amount of users	Number of latrines
0-100	1
100-200	2
200-300	3
300-400	4

Table 1.1 number of latrines

! **It is very important to follow these amounts. If you do not build enough latrines the pit will fill up to fast for the excreta to compost, and the latrine will not work properly**

In this book are measurements for one or two latrines.
If you need three latrines build one of both, if you need four latrines build two blocks of two latrines.

Step 2 Choose a good building site

! **Ask the village health worker to help you to choose a good site to build your latrine**

Choose a site that is:

- Near the school or health post
  so that everyone can easily reach the latrine, but consider privacy and convenience
- Downhill from the water supply and away from rivers and wells (minimum 15 m)
  so that the waste from the latrine does not spoil the water
- On firm and permeable soil
  so that the building will not be in danger of collapsing and the fluid can soak away
- Away from dense vegetation
  so that air can move freely and sunlight can reach to the building
- Away from terrace walls (minimum 2m)
  to prevent excreta draining through the terrace walls

Step 3 Mark out the shape and size of the latrine pit

(Figure 3.1)
Before digging, mark out the shape of the latrine pit

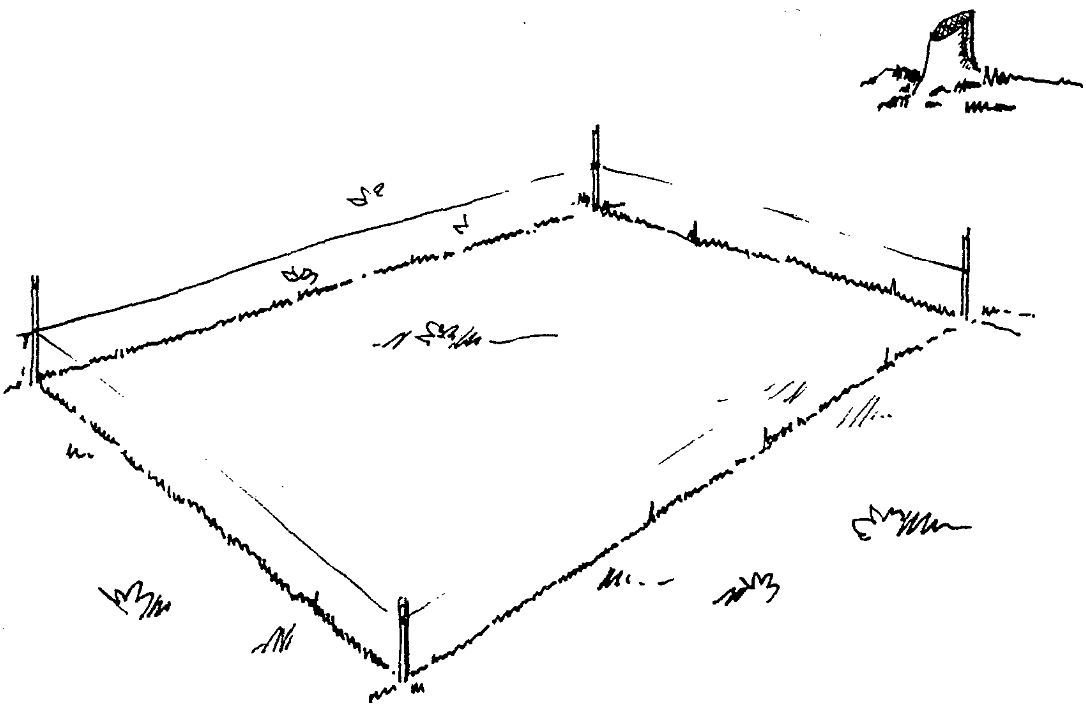
- for one latrine, length 2.55m, width 2.80m, depth 2.00m
- for two latrines, length 3.65m, width 2.80m, depth 2.00m

To mark out the shape of the pit:

- Choose a site so that the latrine entrance faces the wind, and
- that the ventilation pipes will be on the sunny side
- place pegs in the ground
- tie a string to the pegs
- make sure both diagonals have the same length
  (which means the pit is rectangular)

! **Measure carefully (in Meters)**

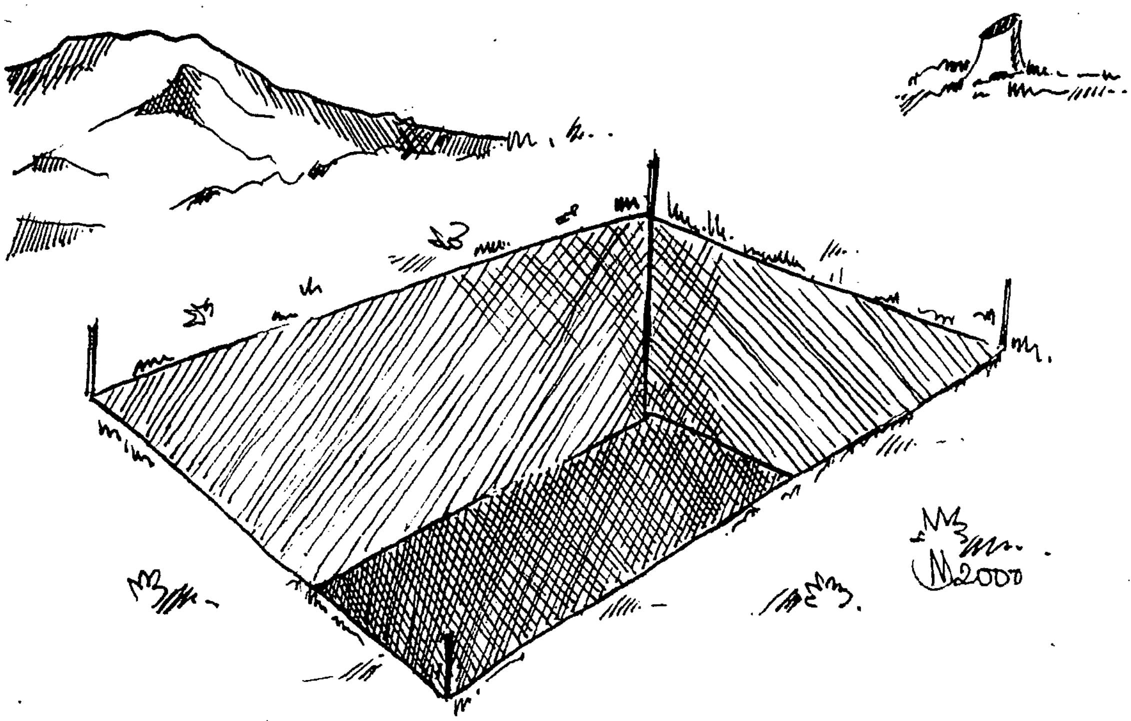
! **Check measurements when finished**



Step 4 Dig the pit

(figure 4.1)

- Dig the pit as marked out in step 3
- Keep the sides of the pit straight
- Keep the pit size the same and rectangular from top to bottom



Step 5 Build the pit walls

5A

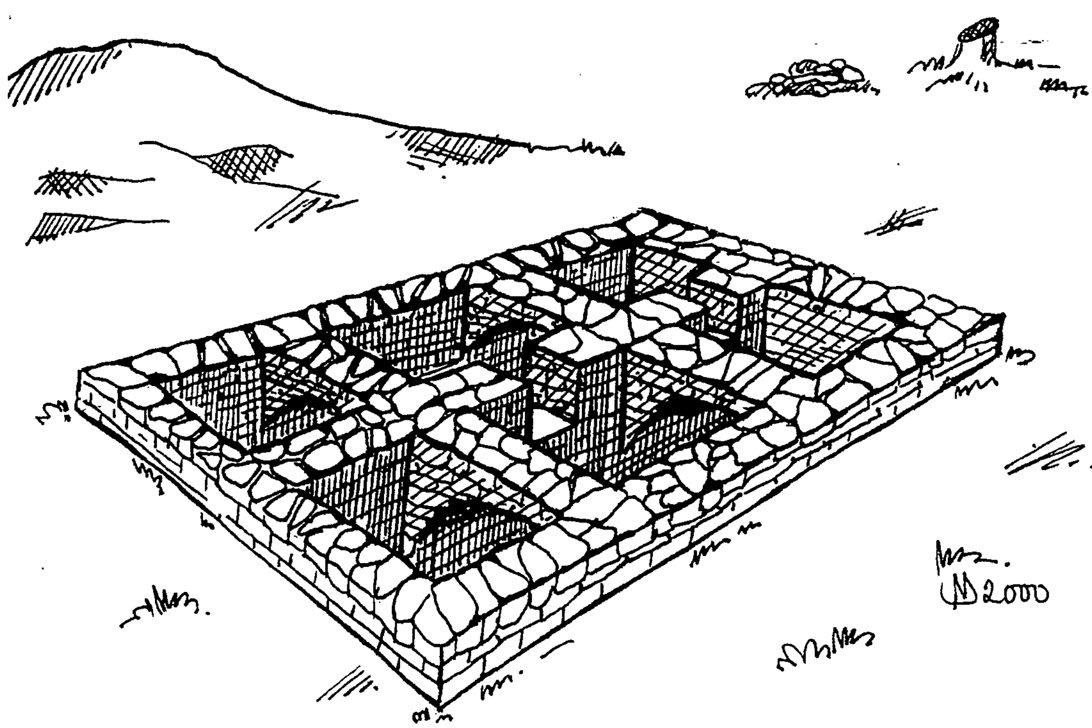
- Line out the pit walls, all walls must be 40 cm wide (figure 5.1)

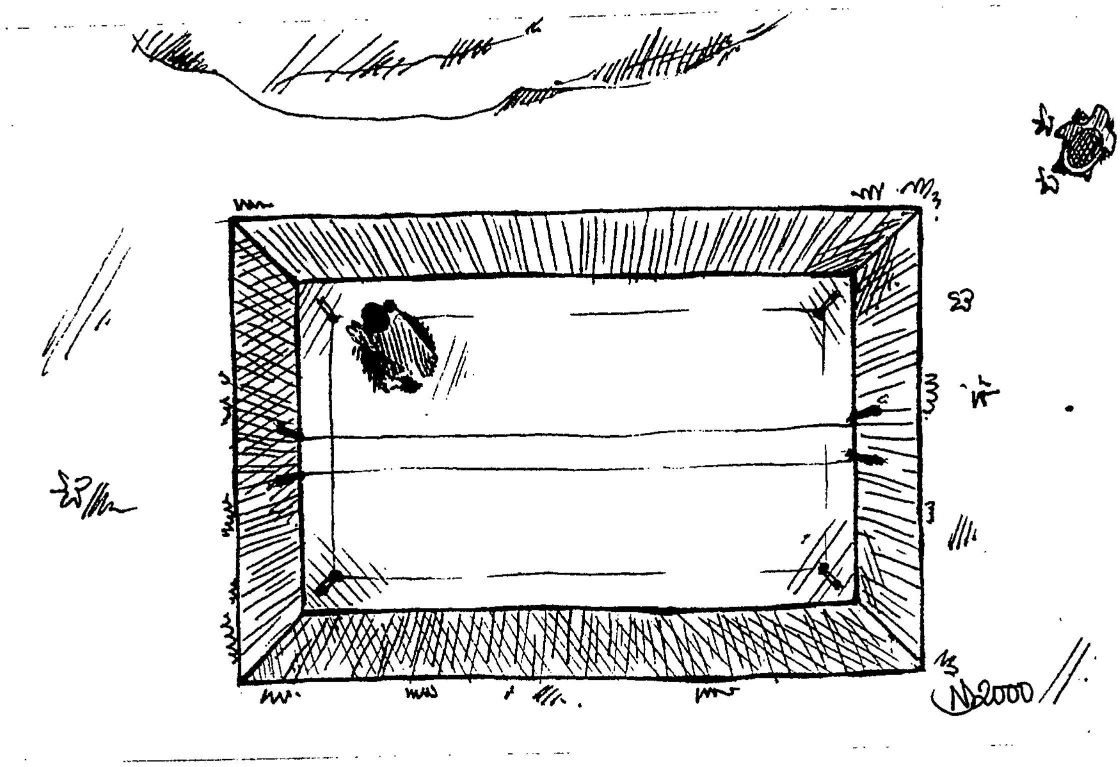
5B

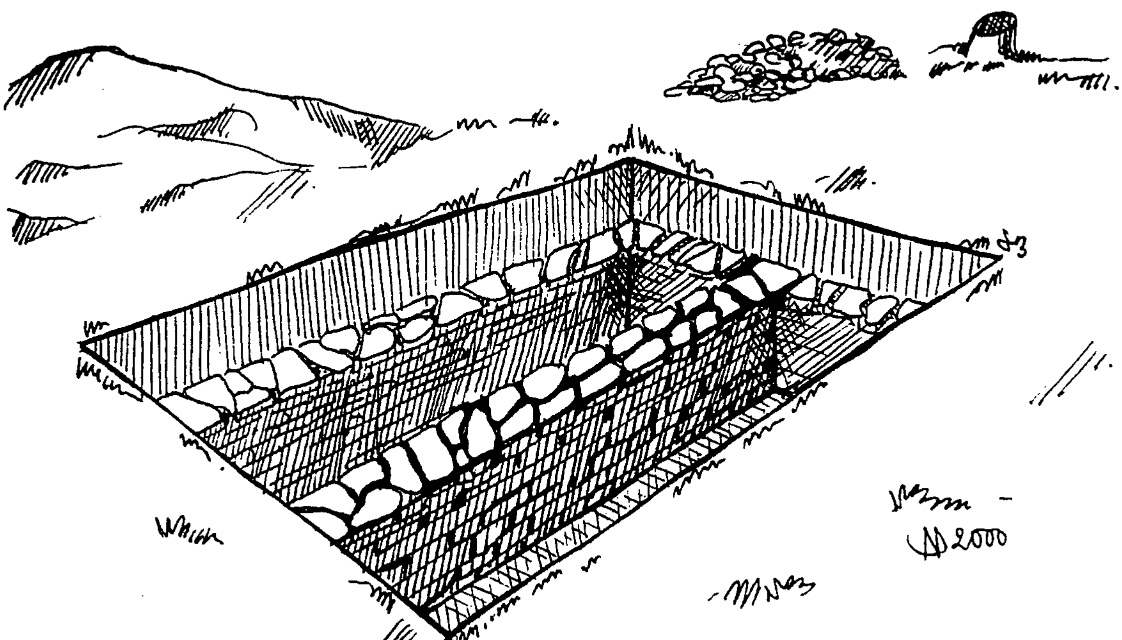
Mortar mix
1 part cement 6 parts sand

(figure 5.2)

- Build the outer wall of stone only (dry wall), so fluid can drain into the soil.
- Make the middle wall all cemented wall, so fluid can not drain from one pit to the other
- Build both walls up to 50 cm below ground level







5C
(figure 5.3)

- Build outer walls up to 20 cm above ground level of cemented wall.
- Build middle wall up to 20 cm above ground level of cemented wall, but leave out space for future ramp (see figure 5.4)

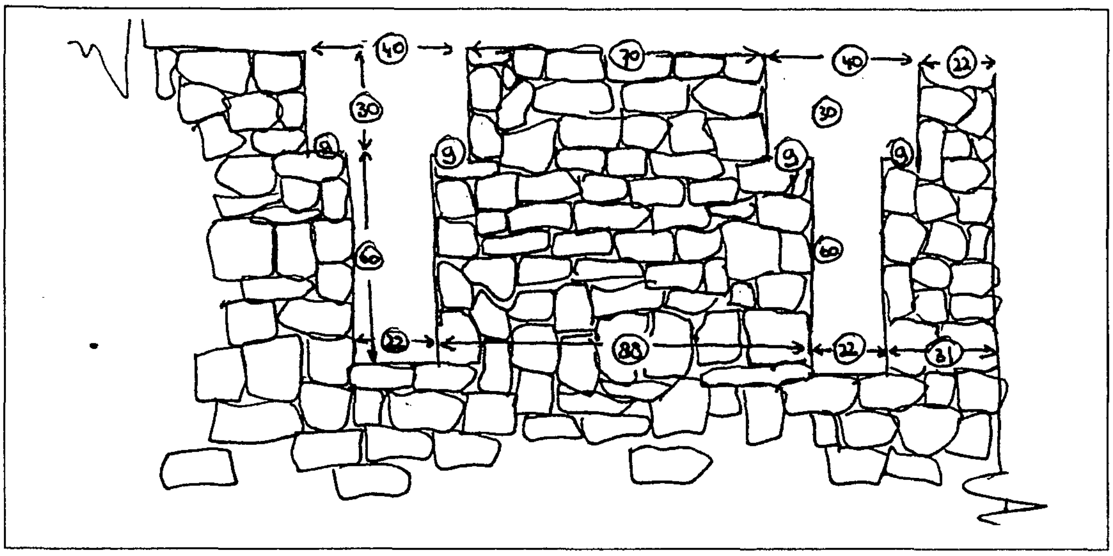


Figure 5.4

Step 6 Make the latrine ramp mould and finish pit wall

- Make wooden mould (see figure 6.1)
- Finish middle pit wall

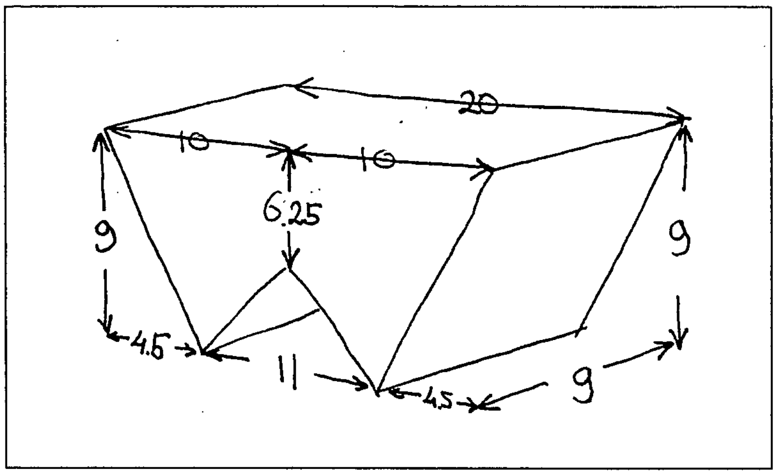


figure 6.1

- Make second wooden mould (see figure 6.2)
- Spread a little kerosene over the mould
- Bend concrete iron (see figure 6.2)
- Put concrete iron in the wooden mould

  Make sure the iron is in the middle so it won't stick out of the concrete.

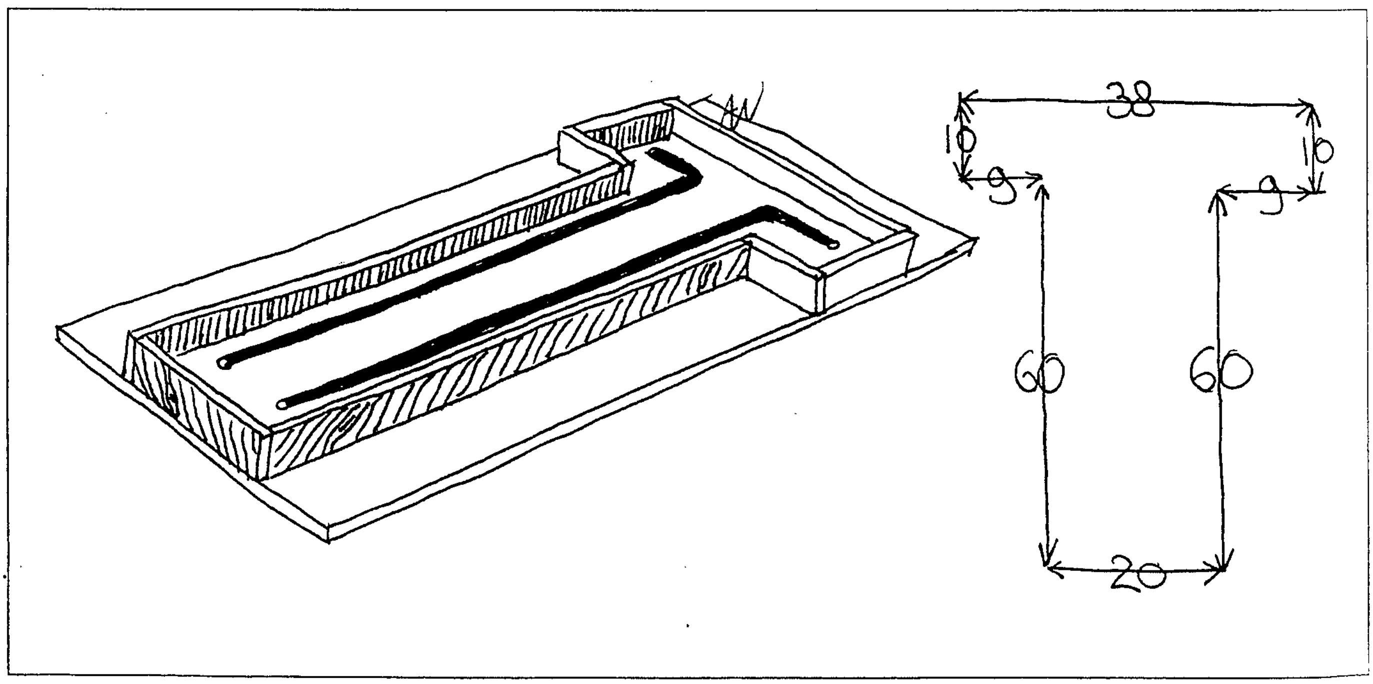
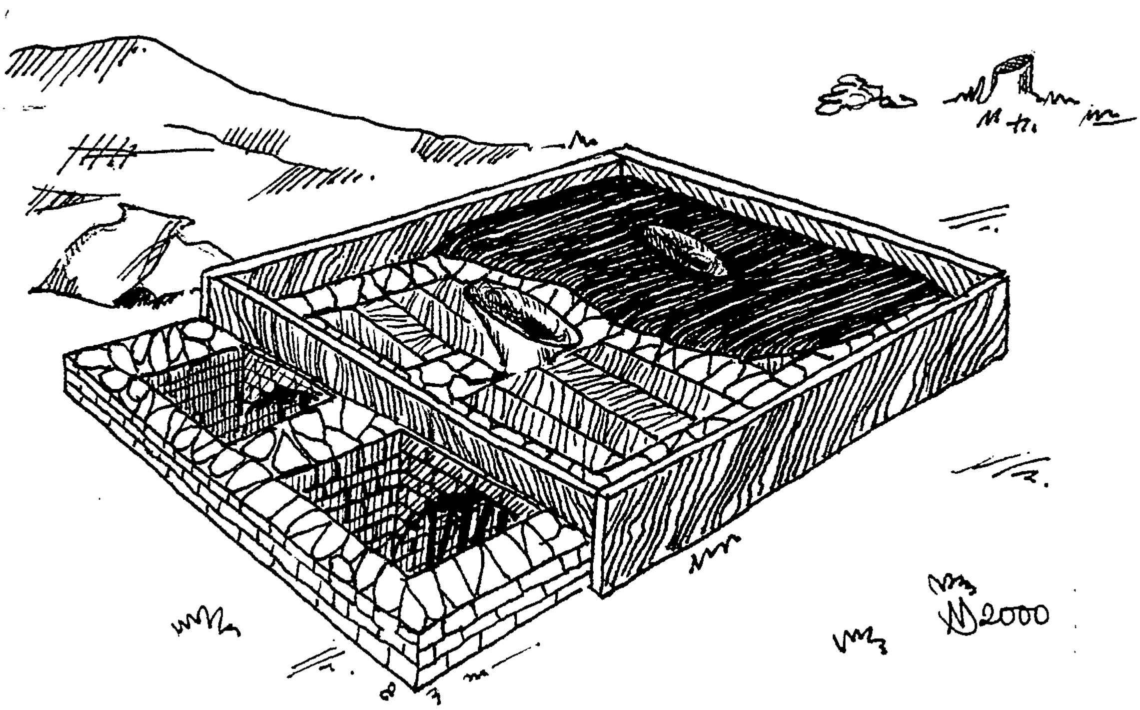


Figure 6.2

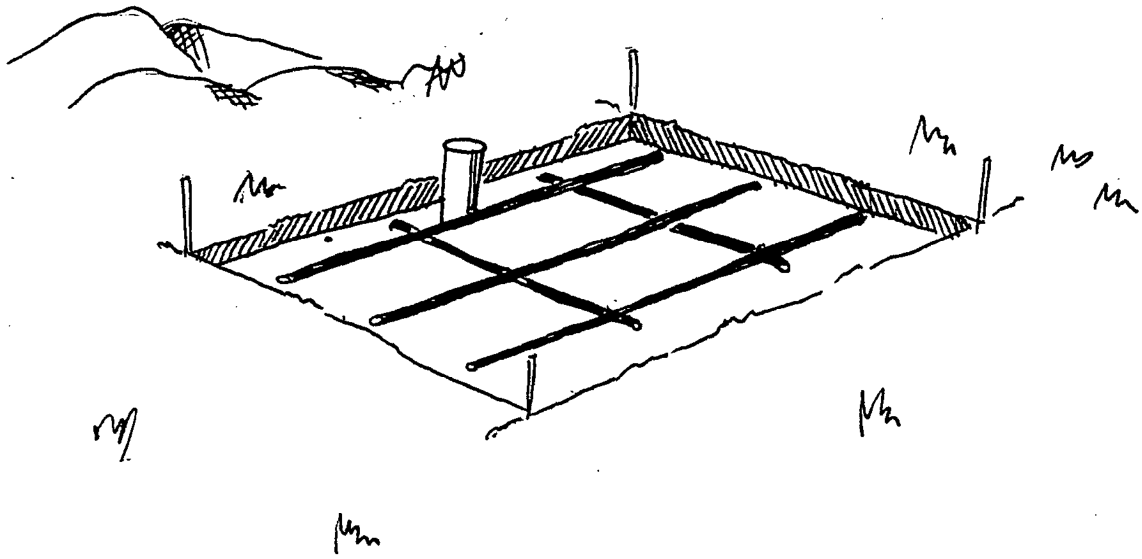
Step 7 Make the wooden floor frame

- Make a wooden frame on the pit walls and above the pit between the pit walls (see figure 7.1)
- Make concrete iron net
- Cover moulds with plastic
- Place the iron concrete net



Step 8 Make the cover slab mould

- Dig moulds in the ground, length 120 cm, wide 90 cm
  Check measurements with the walls you have built
- Make concrete iron net (see figure 8.1)
- Cover moulds with plastic
- Place the iron concrete net (see figure 8.1)
- Mark the position of the ventilation pipes (see figure 8.1)



Step 9 Make the latrine floor, the ramp(s) and the cover slabs

Concrete mix
1 part cement 2 parts sand 4 parts concrete stones

- Make the concrete
- Pour the concrete into the moulds (floor, ramp(s) and cover slabs)
- Make sure the concrete iron stays in place
- Cover the concrete with wet soil, keep wet for a week
- Let all the concrete rest for at least a week
- Take the ramp out of the mould and take away floor frame

Step 10 Position the cover slabs

- Place the cover slabs over the two manholes
  Make sure the ventilation pipes are on the wall side

Step 11 Place the door(s) and build the toilet house walls

- Make the latrine doors. Doors are 70 cm wide, 185cm height (outside measurements), wooden doors (see figure 11.1)

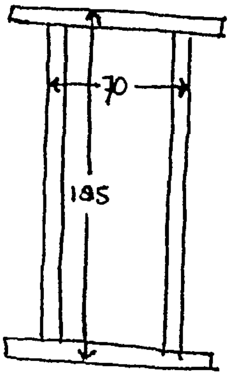
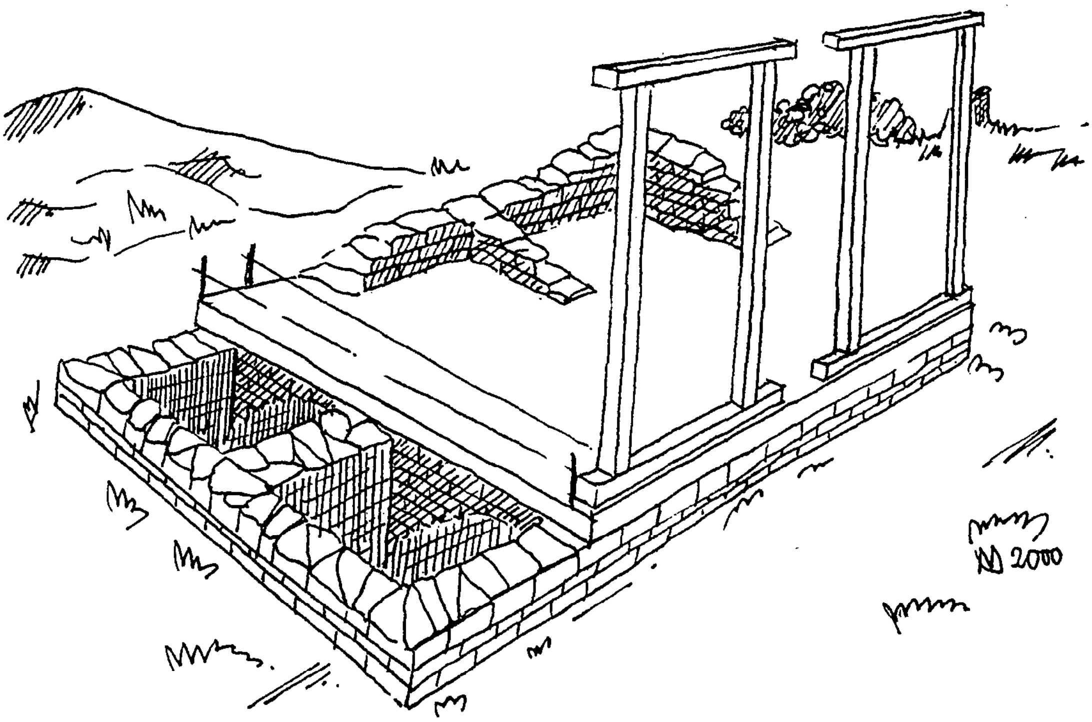


Figure 11.1

- Place the door(s)
  Place the doors leaning a little backwards, so they will automatically close
- Build the latrine walls (see figure 11.2)
  All outside walls are 40 cm wide
  Walls between two toilets are 25 cm wide
  All walls are dry stone walls
- Build the latrine walls 2.0 m height on the door side and 1.9 m height on the other side (to let rain water run of the roof)

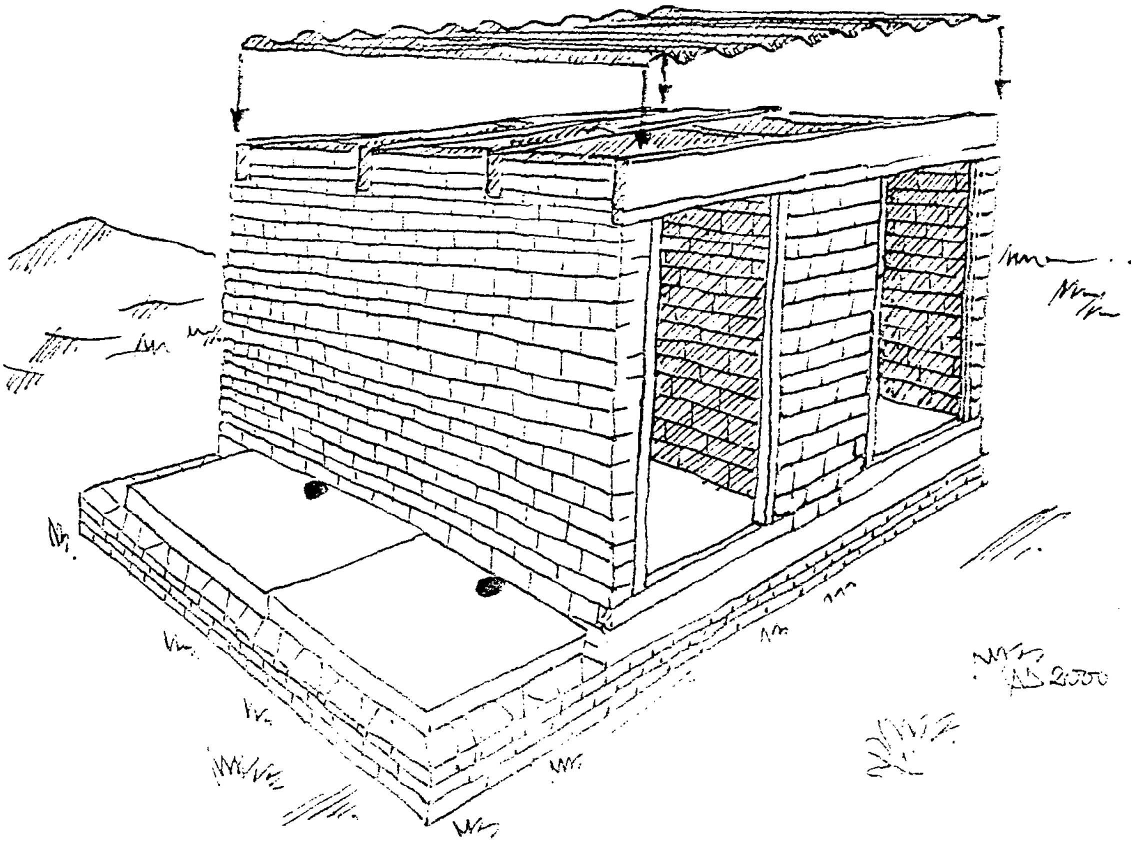


Step 12 Place the roof

(figure 12.1)

- Place 4 wooden beams on the walls, sticking out 10cm on all sides
- Connect the beams to the wall with iron
- Finish walls between the beams

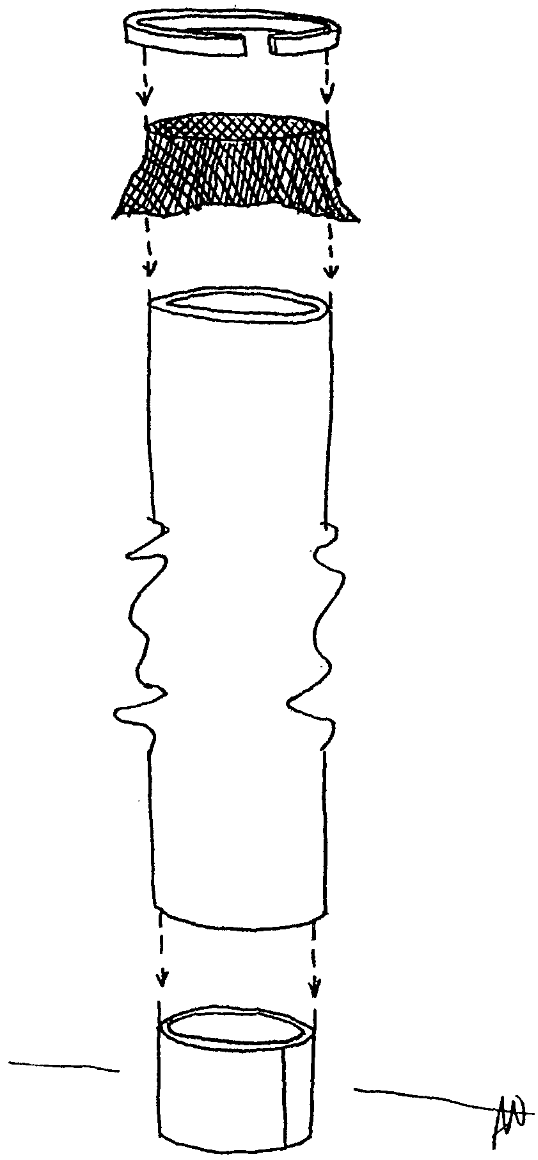
- Place CGI sheets on the wooden beams
- Make sure the slope of the roof is away from the door side
- Connect the CGI sheets with nails (nails in the highest point of a wave !)



Step 13 Place the ventilation pipes and fly screen

(figure 13.1)

- Place the fly screen over the top of the ventilation pipe (4 inch pipe)
- Connect with a small piece of pipe by heating
- Place the ventilation pipes on the cover slabs and connect to the wall



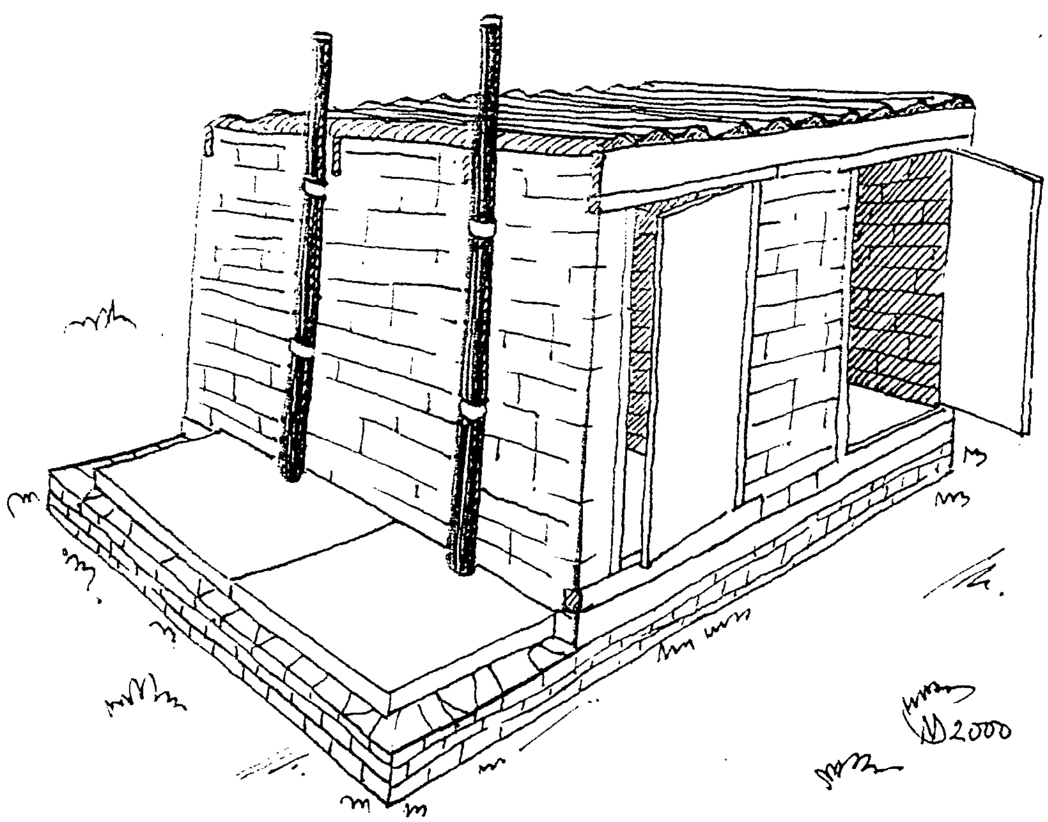
Step 14 Plaster the inside of the latrine, and the ramp

- Plaster the inside of the toilet very thin
- Plaster the floor and the lowest 50 cm thicker (0.5cm)
- Plaster the ramp
- Let the plastering dry
- Make the ramp and inside of the toilet smooth and shiny

Step 15 The VIDP latrine is finished

- Your VIDP latrine is finished

! **Make a tap point close to the latrine**



How to use and maintain the VIDP latrine

Use:

! **Teach the students how to use a latrine**

- When using the latrine, put shoes on
  to prevent worms from entering your feet
- Put a can with water next to the latrine
  to flush the stool and clean after defecating
- Wash your hands after using the latrine with soap or ashes
  to prevent you spreading disease to other people
- Close the toilet door after leaving

- Clean the inside of the latrine daily with water
  to prevent smells and flies
- Lock the toilet door after school hours

Maintain:

- Check the fly screen every month
  Replace it if torn
- If pit one is full, empty pit two and switch to that pit (again)
- Let the excreta in a pit that is just filled, compost until the second pit is full
- Composted excreta can be used as fertiliser
- If anything brakes down the school principle must tell the Latrine Committee
  so that the Latrine Committee can repair

V Personal statements

Working experience in Nepal
Anne Wietse Boer
Civil Engineering student
Delft University of Technology

First time out of Europe, first time on an airplane, far away from family and friends, touching down in New Delhi, a miserable night on a train packed with Indians and two bumpy busses. That's how I arrived in Nepal for my working experience period of 2.5 months. A working experience not to make me a better technician but to make me a better engineer. I came to learn about the developing world, the NGO's, the small scale help, what I can do for them and what they can do for me. And I did learn, a lot.

In the nine weeks I've spent in the field, I've met a lot of Nepali people. Young people who want to help their country, making plans for a better future. Old people who are happy and satisfied, despite the poverty they life in.

I've learned about The Asian Way, not to disappoint or blame anyone for anything: respectful and polite, but not honest. I've seen the effects of foreign help on the daily life of the Nepali. Some things work out fine, other things don't. I've seen the inexperience of Vajra. It's such a young NGO and I really think the Vajra people have to learn a lot to help Nepal grow.

I've enjoyed working together with other Dutch volunteers, especially with Remco. We have formed a good cooperative team together. I've enjoyed the scenery, the hill walking, the Nepali hospitality, the daily dal bhat, the local busses, the Kathmandu holidays, the commitment of the Vajra people, the uncomplicated way of living of most villagers.

This working experience has shown me a lot about Nepal, the Vajra Foundation, the sanitation project, what I can do for Nepal and what Nepal can do for me. And although Nepal is not the entire developing world and Vajra is not the only NGO, I think this experience has given me some idea about this kind of sports.

I'm very glad I had the opportunity to do this during my study so when I've become an engineer, I will have a founded opinion about this kind of developing work. I hope and I think that the lessons I learned in this project are very useful in my future career.

Working experience in Nepal
Remco Keijser
Civil Engineering student
Delft University of Technology

Finally on a real project, working with people and actually constructing something. After five years of studying and working on imaginary projects, my working experience was a relief.
Although I had been in developing countries before, that was mainly while travelling. I expected working in Nepal to be different, and one of my personal objectives in this working experience was to find out if I want to work for a small NGO, like Vajra or work in a bigger western company.

Ever since I saw pictures of the Himalayas years ago, I have been longing to go to Nepal.
Nepal is beautiful. I enjoyed the views and walking through the mountains. Nepali people are very friendly. Coming in from India one notices the difference in attitude. I have learned that Asia and I are not the perfect match though. I was born and raised in Holland, and trained to be an engineer in Delft, of all places. I am direct in my opinion, if I disagree I will let you know, and expect others to do the same. Nepali leave space for the others to save face; sometimes say 'yes' when they mean 'no' to save their own face. They will always, always remain friendly. I'm not saying either of these are wrong, but it is very different.

Because of the small-scale project and organization, I got the chance to do both the analyses of the problems, the design and construction in just three months. I enjoyed seeing all these aspect and found out that I take great pleasure in planning and working with people on the actual building site. My interest in economics (I studied Economics once), is not completely gone, as I like the cost aspect of a civil project.

Vajra is a very constructive organization. Thanks to Ram and Dor it does not take ages for a project to start. They are very straightforward in motivating people, or transporting materials from Kathmandu. I once phoned Ram, in Kathmandu for materials at eight in the evening; the materials arrived in Barabise at *ten the next morning.*
"How does he do that?"

One big lesson I learned is on the special relation between engineers and management. I don't think this is any different in a small NGO or a western company. For example: our technical advice not to build a new toilet design in 14 places conflicted with the promises Vajra made to the villagers. Being inexperienced engineers we gave in and learned that, as Rietveld warned us, technical misjudgments under time pressure will still be blamed on the engineers.

Last but not least I enjoyed working with the Dutch volunteers. People from different working fields, technical and medical, which made work and discussions very interesting. Working and living with Anne Wietse (sanitation project) and Maite (health education) was great. They are both very easy going and just smiled when I had one of my bad days, thanks for that!!

All together my working experience Nepal taught me a lot of technical skill and gave me even more insight on where my place in a (civil engineering) future will be.

Working experience in Nepal
Ernst Eisma
Student Hydrology
Free University Amsterdam

I did this internship to see how it is to be at the direct link between doing a project, and who you do it for. Last year's internship in Indonesia was quite scientific and what I did didn't help the people directly. Now I wanted to see the other side of the coin.

To work as a volunteer was an extra dimension on the project. Usually, a firm and its projects on which you would work on are directed towards paying customers. The customer either likes it, or he/she doesn't. For the later, they would return the product and ask for a refund or they would have you do it again. But, working as a volunteer on projects that you don't know much about (at least in my case) and with people who have a completely different life priorities, is quite different. First of all, there is much more humane pressure on you to do the job right. You work with the people for who it is. So, if it fails then the people you already have a bond with are directly effected (no refunds on feelings!). Secondly, you are not only building things for the people but you also have to convey the knowledge. To make a system of a project logical to the villagers is quite hard. At least all this seemed so in the beginning.

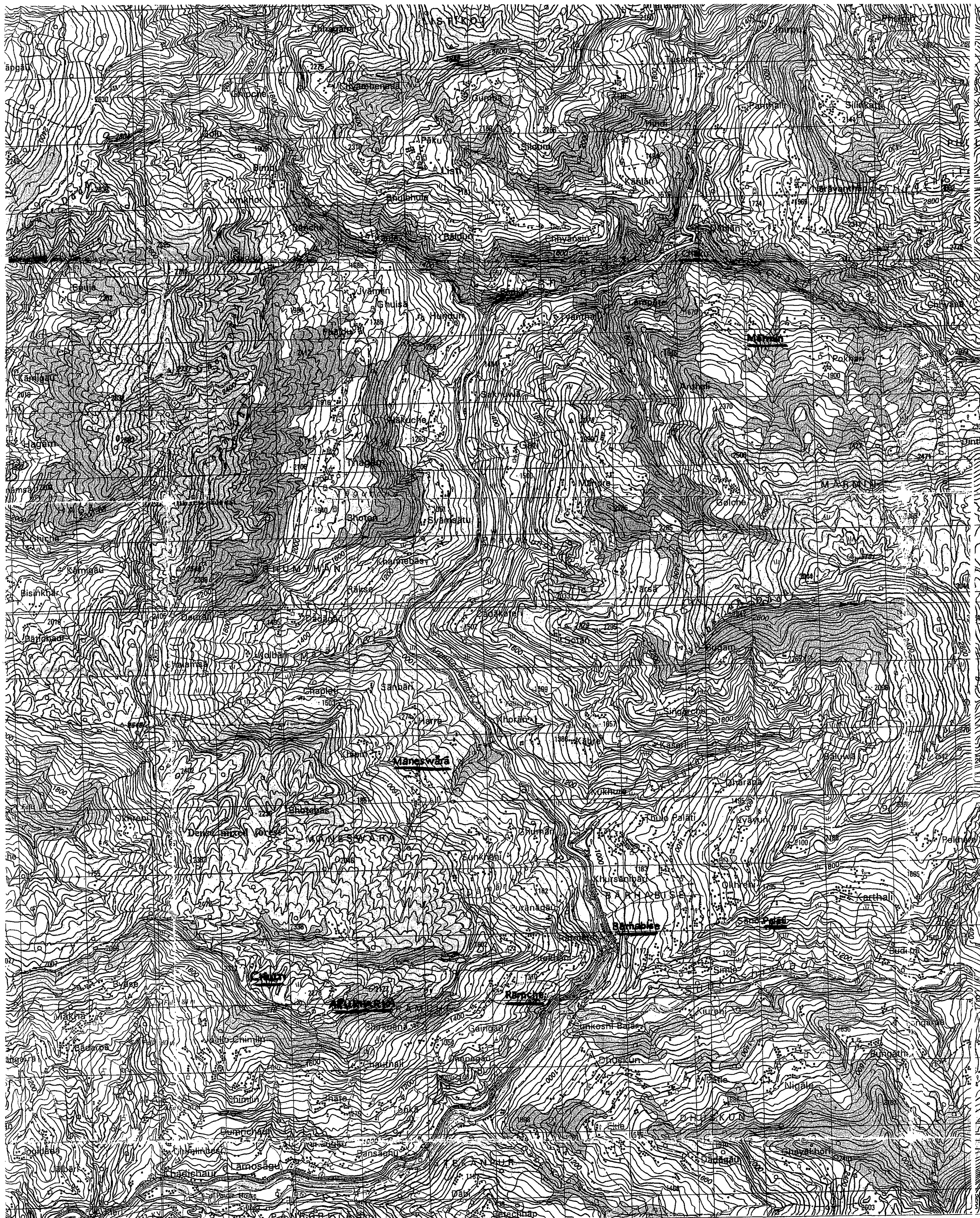
Afterwards I see that it is not so hard. The villagers are completely capable of understanding what you would want them to do and know. Never underestimate them! And, if you are sure of yourself, then what you are building will work. Since the projects are a success I have become surer of myself, which was one of my goals. So, all in all, the goals of everybody have been achieved.

Basically, I learned the organisational side of a project and how to rub elbows, something that I knew little of and wanted to learn. To work in Nepal was great. To work in a small NGO were one gets involved on all levels was better. To party with the locals and see the completion of your project was the best. Now I know which direction I want to be involved in later. I only want it to be more profitable for me!

VI Addresses and contacts

During the first week, before the projects started, information was obtained in Kathmandu at certain NGO's. This information includes books for the health education program during the health camps, information on latrine designs, improved cooking stove designs and many other things. It is beneficial for Stichting Vajra Holland and VFN to have a list of contacts with their specific contribution to the projects. Then it is not necessary for the next students to find the contacts again.

NGO	Address & e-mail	Contact person	Description of information given
Centre of Rural Technology (CRT)	Tripureswor, P.O. Box 3628 Kathmandu, Nepal Phone: 260165 / 256819 Fax: 977-1-257922 e-mail:crt@wlink.com.np	- Er. Rajan Thapa (good person, contact him if info needed) - Lumin K. Shrestha (Director, a-hole, try to avoid)	-Information/ design/ books on the improved cooking stoves. Able to give trainings on how to build them. Very experienced in this area. - Info. on solar cookers and boxes
Environment and Public Health Organisation (ENPHO)	New Baneshwor P.O. Box 4102 Kathmandu, Nepal Phone: 491376 e-mail: enpho@enviro.mos.com.np	-Roshan Shrestha (good person, contact him if info needed) -Amresh Karmacharya (didn't work with him, but ok person)	-Test water samples for quality (total coli's & E. coli's) -The place to be for water quality
Nepal Water for Health (NEWAH)	Baluwatar, P.O. Box 4231 Kathmandu, Nepal Phone: 01-417603 / 418248 Fax: 01-414099 e-mail: newah@mos.com.np	-Raju Khadka -Michelle Mofat	-Water. Haven't contacted them.
United Nations Children's Fund (UNICEF)	-UN House Pulchowk P.O. Box 1187 Kathmandu, Nepal Phone: 523200 Fax: 977-1-527280	-Hans D. Spuijt (Chief, water & environmental sanitation section, good person to contact)	-Thanks to Hans we collected many needed folders for the health education program. -Info about sanitation, water projects, etc..
	-UNICEF Central Region Field Office Jawalakhel, Lalitpur P.O. Box 1187 Kathmandu, Nepal Phone: 524991 / 526029 Fax: 977-1-527280	-Devendra Gauchan (Field Officer, good man and engineer)	-Info about the latrines -Lots of practical and local knowledge about many project available here.



Scale 1:50 000

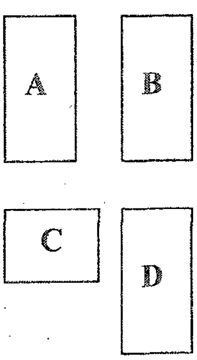
Metres 1000 500 0 1 2 3 4 5 Kilometres

A B C

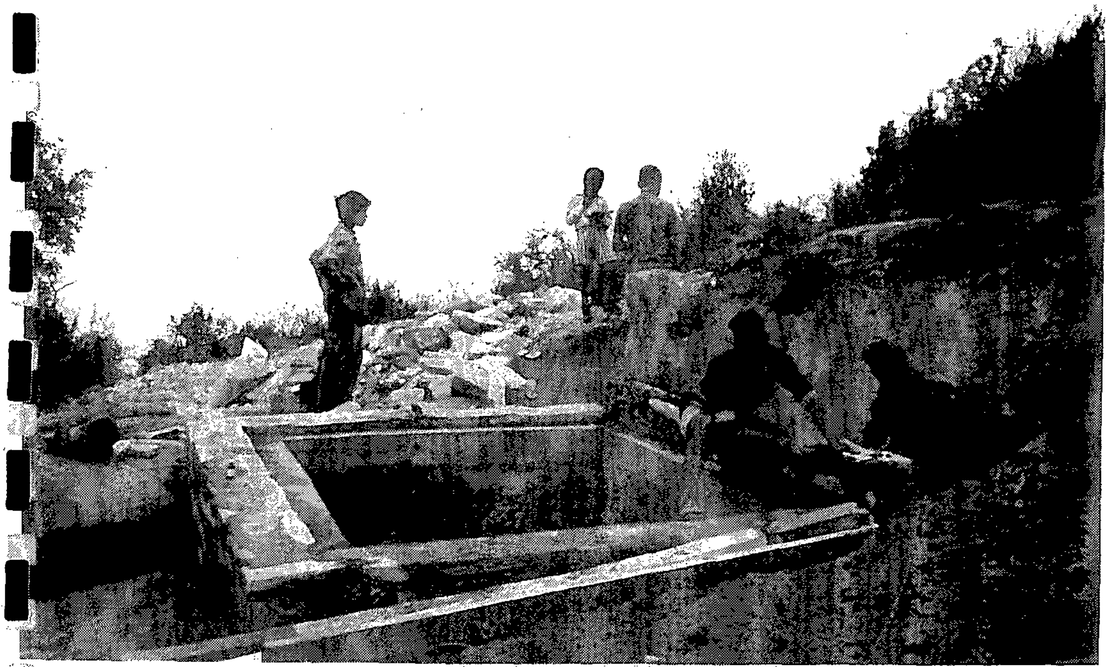
D

E

A: **Bibi 1 -** ***Arhukarka***
B: **Bibi 2 -** ***Arhukarka***
C: **Bim & Bibi 1 -** ***Arhukarka***
D: **Bim & Bibi 2 -** ***Arhukarka***
E: **Bim -** ***Arhukarka***



A: **Digging 1 - *Arukharka***
B: **Carpenter - *Arukharka***
C: **Catchment – *Arukharka***
D: **Digging 2 – *Arukharka***



A

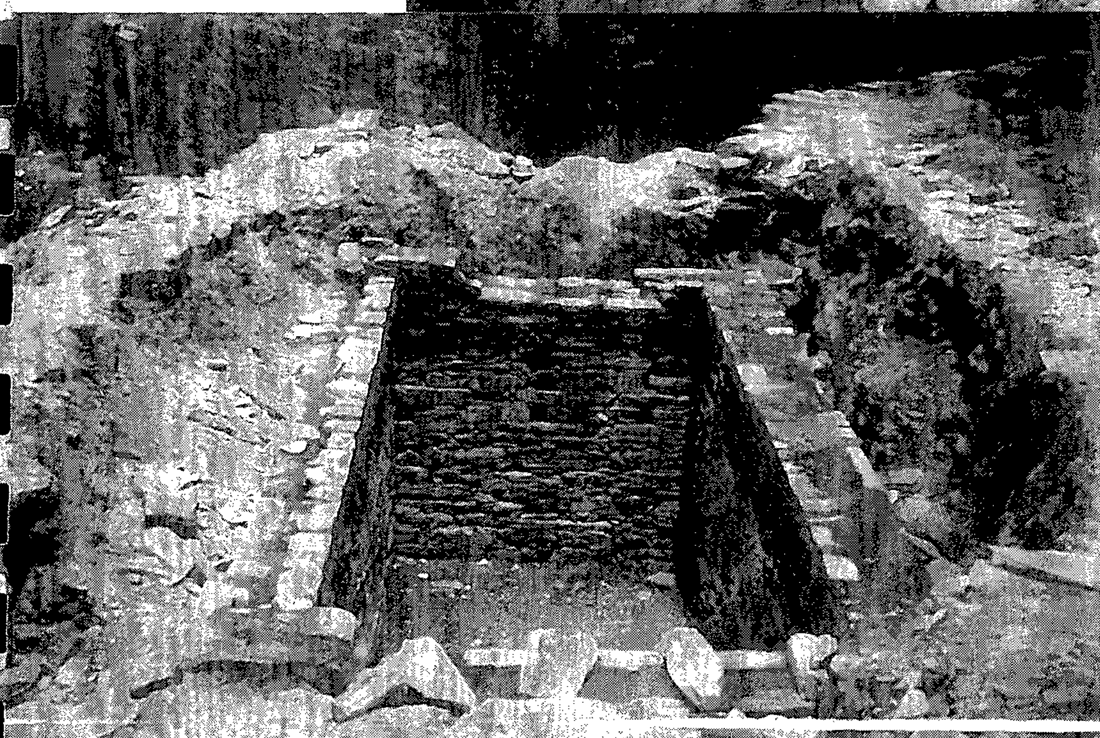
B

C

A: Construction reservoir - *Arukharka*

B: Reservoir - *Arukharka*

C: Improved cooking stove – CRT - *Kathmandu*



A

B

C

A: Clearing of building site - *Maneswera*
B: Start of pit wall - *Maneswera*
C: Pit wall finished - *Maneswera*

D

E

F

D: Construction of slabs - *Maneswera*

E: Slabs and blocks- *Maneswera*

F: Blocks on middle wall - *Maneswera*

G

H

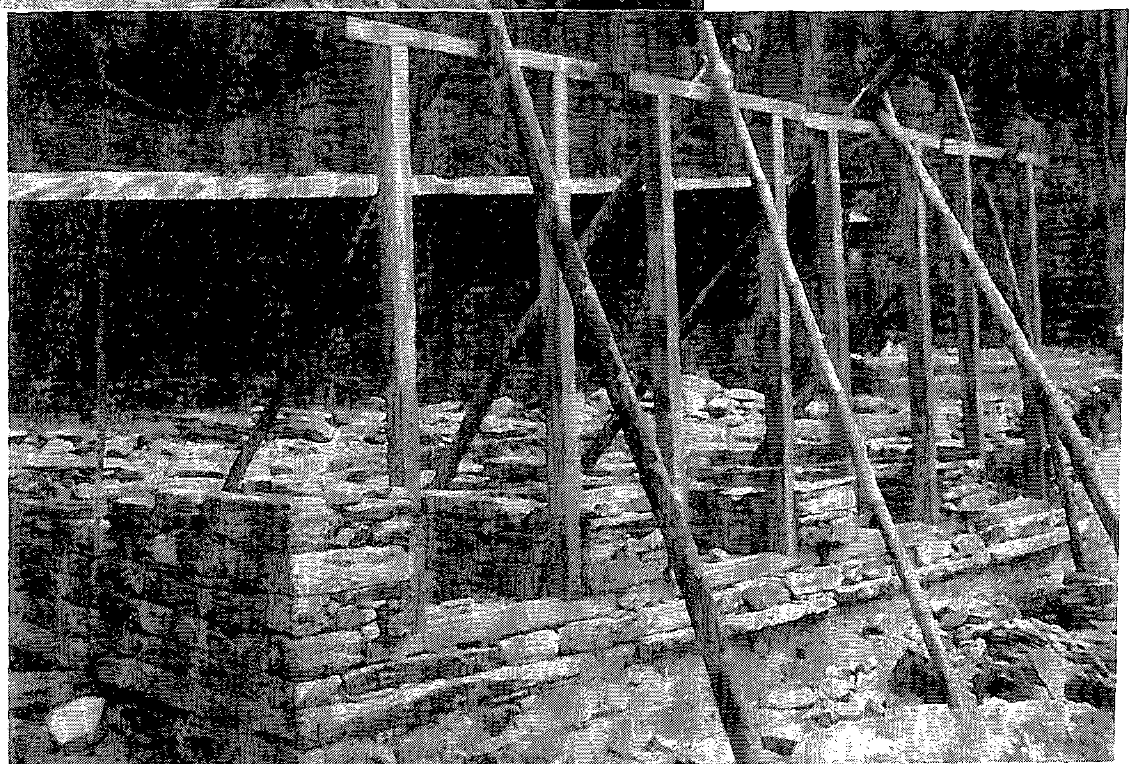
I

G: Place the slabs - *Maneswera*
H: Slabs on pit wall -*Maneswera*
I: Walls superstructure - *Maneswera*

J

K

L



J: pit outlet - *Maneswera*

K: Toilet doors - *Maneswera*

L: Latrine finished - *Palati*