World Health Organization

United Nations Development Programme

CASE STUDY ON INSTITUTIONAL DEVELOPMENT FOR RURAL WATER SUPPLY AND SANITATION, NEPAL

New Delhi, India
1985

SEA/EH/340

World Health Organization

United Nations Development Programme

CASE STUDY ON INSTITUTIONAL DEVELOPMENT FOR RURAL WATER SUPPLY AND SANITATION, NEPAL

New Delhi, India
1985

FOREWORD

This publication is based on a **Case Study on Institutional Development for Rural Water Supply and Sanitation in Nepal.** It was prompted by problems in the implementation of rural water projects, which have been recognized by the Ministry of Panchayat and Local Development (MPLD) and by the Department of Water Supply and Sewerage (DWSS) of the Ministry of Water Resources.

The case study complements other analyses carried out by WHO and other agencies at different times, and is the first detailed evaluation of the functioning of projects. Six schemes were studied, all of them recently completed. The four MPLD projects serve small communities (population range 93 - 346) in the hills district of Ramechhap. The Damauli scheme of DWSS is also in the hills (Tanahu district) and serves 2 433 people, while the other DWSS scheme at Simara (population 2 777) is in the Bara District of the Terai.

The survey team were instructed to investigate all aspects of the projects from design, through construction and into operation and maintenance. The aim was to determine whether institutional or other changes might improve the performance of the rural water and sanitation sector in Nepal, and to make appropriate recommendations to be considered by MPLD and the Ministry of Water Resources.

The case study was funded by a grant from UNDP's International Drinking Water Supply and Sanitation Decade Advisory Services Project and executed by the South-East Asia Regional Office (SEARO) of WHO.

AUTHOR'S NOTE

Improving on Success

The first thing to be said about the six rural water supply projects which made up this case study is that they have been successful. The savings in drudgery for women and children, the health-related advantages of better access to drinking water and greater cleanliness, and the ancillary benefits for livestock and kitchen gardening, highlighted in the villagers' responses to the survey team, are evidence that all six communities welcome the water projects and appreciate their importance.

In recommending changes to institutional, manpower and technical arrangements for rural water supply project management in Nepal, the team believes that such measures will not only maintain and extend the benefits of the present schemes, but also ensure that future investment can yield even better results.

Our findings are not new. Many of the constraints faced by the Department of Water Supply and Sewerage (DWSS) and the Ministry of Panchayat and Local Development (MPLD) have been recognized for years, and serious attempts are continually being made to overcome them. What we have tried to do in this report is to look critically at existing project design, implementation, operation and maintenance, to build on the achievements that have already been made, and to encourage efforts to involve and support villagers themselves in as many as possible of the activities carried out on their behalf.

We hope that our report will be seen as positive. While its recommendations range over a wide field, from specific design suggestions for supply pipelines to proposed linkages between water and health programmes for maximising health benefits, they relate directly to our survey findings and so may be seen as practical rather than theoretical ideas.

Narayan Prasad Bhusal
Principal Investigator

CONTENTS

	Page
BACKGROUND	
1. Rural Water Supply in Nepal	1
2. Institutional Arrangements	2
3. Scheme Selection and Implementation	3
4. Perceived Problems	4
5. The Case Study	5
THE SURVEY	
1. Projects Studied	7
1.1 Damauli (DWSS)	7
1.2 Simara (DWSS)	8
1.3 Maidane (MPLD)	9
1.4 Jorepatal (MPLD)	10
1.5 Nigalpani (MPLD)	10
1.6 Pangchet (MPLD)	11
2. Survey Methods	11
2.1 Sample Size	11
2.2 Interviews	12
2.3 Field Studies	12
PRINCIPAL FINDINGS	
1. Problems Identified	13
1.1 Functioning of New Water Systems	13
1.2 System Design	15
1.3 Project Implementation	18
1.4 Operation and Maintenance	19

2. Water Use 22
2.1 Per Capita Consumption 22
2.2 Hourly Variations in Consumption 24
2.3 Water Collectors 25
2.4 Water Quality 25

3. Community Attitudes 26

3.1 Perceived Benefits 26
3.2 Water Adequacy 27
3.3 Operation and Maintenance 27

RECOMMENDATIONS 33

Recommendation 1: Targets 34
Recommendation 2: Institutional Responsibilities 34
Recommendation 3: Role of Local Panchayats 35
Recommendation 4: Manpower Development 36
Recommendation 5: Design 39
Recommendation 6: Procurement 39
Recommendation 7: Community Motivation 42
Recommendation 8: Technical Support 43
Recommendation 9: Incentives 43
Recommendation 10: Spare Parts 44
Recommendation 11: Cost Recovery 44
Recommendation 12: Role of the Health Department 46
Recommendation 13: Water Quality Analyses 46
Recommendation 14: Quality Protection 47
Recommendation 15: Disinfection 47
Recommendation 16: Sanitation 48
Recommendation 17: Future Evaluations 48

1. Rural Water Supply in Nepal

Rural communities in Nepal obtain their drinking water mainly from mountain springs. Local sources are usually insufficient in the dry season, so water supply agencies have been building pipeline schemes to bring water from higher in the hills.

His Majesty's Government's Sixth Five-Year Plan (1980-85) coincided with the first five years of the International Drinking Water Supply and Sanitation Decade (IDWSSD), and included a target to raise the number of people receiving safe drinking water from 10.9 per cent of the total population in 1980 to 30 per cent by the end of 1985. Urban coverage was intended to reach 87.2 per cent and rural coverage 25.9 per cent. Nepal's IDWSSD Plan aims to lift those coverages to 94 per cent urban and 50.5 per cent of the mountain and hills population by 1990. That would mean at least one drinking water supply scheme in each village panchayat of the mountain and hills districts, or 2 226 gravity piped water systems in all.

While the rural water projects constructed in the past have brought clear benefits to the villagers concerned, problems have arisen with implementation, operation and maintenance. With such an ambitious programme ahead, the water agencies are keen to identify ways of improving the functioning of past and future systems, and so to maximize the health benefits.

In this case study, six recently completed village water supply projects have been examined. Observations and measurements have indicated the way that the schemes are functioning; villagers' views have been sought on the perceived benefits and on operation and maintenance matters; and an analysis has been made of institutional, financial and technical aspects which might influence future programmes.

The aim of the case study being to identify constraints and suggest ways of removing them, the team was asked to make specific recommendations for improving implementation of the rural water supply and sanitation programme.

2. Institutional Arrangements

Three agencies are active in the drinking water supply and sanitation sector in Nepal:

The Ministry of Panchayat and Local Development supports village communities in the construction of self-help water supply schemes as well as other development projects. In the water supply sector, MPLD schemes are for rural communities with populations up to 1 500. The Ministry has substantial support from UNICEF in the supply of materials for water projects, and runs seven integrated rural development projects, some with a drinking water component.

In 1982, MPLD initiated a special programme to encourage villages to build and maintain small community water supply schemes. Funds were allocated and MPLD supplied materials and technical assistance. Community participation is an important element in MPLD projects, usually involving villagers providing voluntary unskilled labour and available local materials.

Completed schemes are handed over to the local community for operation, the policy being that a local maintenance technician is trained and given responsibility for looking after the system. MPLD supplies the technician with a set of tools and fittings.

The Department of Water Supply and Sewerage is part of the Ministry of Water Resources and has responsibility for the design, construction supervision and operation of water supply and sanitation schemes in urban areas, zonal and district headquarters, and rural communities with more than 1 500 population. DWSS policy used to be to hand over completed schemes to local authorities for operation and maintenance, but problems arose and now the Department retains that responsibility.

Most of the urban population served by DWSS schemes has some form of drainage system and a few houses have septic tanks. Very recently, a policy of encouraging community participation in construction was introduced.

DWSS provides house connections at a fixed rate of Rs5.0/month, and is considering whether to introduce a Rs5.0/month charge for families using public standposts.

The Water Supply and Sewerage Board is a semi-autonomous body mainly responsible for water supply and sewerage in the urban centres (population greater than 5 000).

3. Scheme Selection and Implementation

Three main criteria are meant to govern priorities on DWSS schemes: the community's existing difficulties in obtaining water; the scarcity of available resources; and the desire to keep a regional balance. Except for zonal and district centres for which DWSS has already assigned priority, local authorities submit requests for schemes they wish to promote. Political influence can then play an important part in advancing particular projects.

Having established the schemes which will form its programme, DWSS assumes responsibility for design and construction, sometimes using the district office to select local contractors. Private consultants are usually hired to carry out a feasibility study, working to DWSS published guidelines, which include an evaluation of the extent of community participation which can be expected.

Handing over completed schemes to local authorities has been found not to work, and DWSS currently assumes responsibility for operation and maintenance itself, using funds from the Ministry of Water Resources for repairs.

On MPLD schemes, the selection depends on a series of commitments from the local community. Applications from villages must include preliminary information about possible sources, an approximate calculation of costs, and the amount which will be borne by the communities. In endorsing the application, the village panchayat has to sign an agreement with MPLD promising to supply all the manpower needed to transport construction materials from the nearest roadhead and to provide locally available materials for the construction. It must also guarantee future operation and maintenance by

signing a hand-over form. MPLD's ranking of schemes is said to be on the basis of a felt need, priority for hill areas, and the community's difficulties in obtaining water from existing sources.

Once a scheme has been selected, MPLD sends a technician to carry out a preliminary survey. The idea is that the technician should then prepare a detailed design in consultation with the villagers, supervise construction work, and make periodic follow-up checks after the scheme has been completed.

Difficulties have arisen because technicians are frequently transferred from one district to another, so are not available to check on operation and maintenance. The MPLD philosophy is that at least one villager should be involved in all stages of construction and should then become the scheme caretaker. The caretaker should be reimbursed for his services by the five-member water committee which is always set up to coordinate community activities on MPLD schemes, or by the village panchayat, using funds collected from the project's beneficiaries.

4. Perceived Problems

Both DWSS and MPLD have recognized for some time that the schemes are suffering from a number of deficiencies, the most obvious being inadequate maintenance. Community participation in construction has not been successfully extended into operation and maintenance.

DWSS has endeavoured to remedy the situation by resuming responsibility itself but has not yet evolved a good mechanism for doing so. In the case of MPLD, the idea of using the water committee to manage schemes after construction ends has generally proved unworkable because of a lack of the necessary skills.

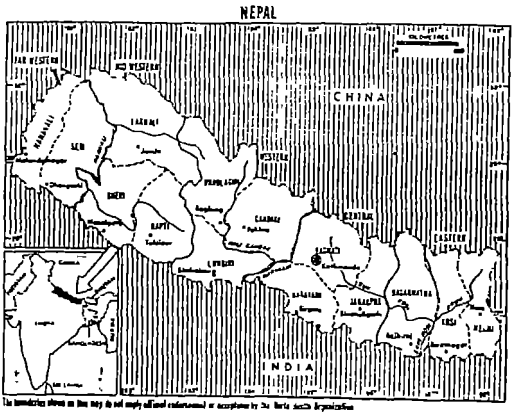
The agencies have also been worried about design adequacy as gravity pipeline schemes have suffered damage in the hilly terrain, where landslides are a continual threat. Leaks, illegal connections and vandalism have been reducing the

effectiveness of the projects, and there is concern that maximum health benefits are not being obtained because of contamination of water sources and an inadequate appreciation of the need for good sanitation practices among the beneficiaries.

5. The Case Study

Several agencies, including WHO, have carried out analyses of the rural water supply and sanitation sector in Nepal, and have identified constraints and institutional deficiencies. However, no evaluation had previously been made of the functioning of completed projects, or of the views of the communities.

The aim of this case study is to assist DWSS and MPLD to develop plans of action to overcome institutional, technical, and manpower deficiencies, based on experience from recently completed projects. The case study was funded by a grant from UNDP's IDWSSD Advisory Services Project and executed by the South-East Asia Regional Office (SEARO) of WHO.



1. Projects Studied

Two drinking water supply schemes managed by DWSS were included in the study:

The Damauli scheme in Tanahu district is in the mid-western hills at the roadhead of the highway between Kathmandu and Pokhara.

The Simara scheme is in the Terai, in Bara district on the Kathmandu-Birgunj highway.

The four MPLD projects selected were all self-help drinking water schemes serving small village communities in the Ramechhap district in the eastern hills. The individual villages selected were: Maidane, Jorepatal, Nigalpani, and Pangchet.

1.1 Damauli (DWSS)

Completed in 1982, the Damauli scheme serves 2 443 people in 485 households. Prior to its completion, the people had to spend 45 minutes to two hours fetching water from the Madi river or nearby springs. The project took a long time to come to fruition, the first request to DWSS having been made in 1972 and a preliminary survey having been initiated in 1973 with a target completion of three years.

The water source is a spring 5km west of Damauli in another panchayat on the Kathmandu-Pokhara highway. A simple intake structure diverts the spring water into a collecting chamber, from which a 5km-long high-density polyethylene (HDPE) pipeline runs alongside the highway to Damauli.

The gravity pipeline passes a low point (Madi Bridge) part way along its route and then climbs steeply again to a 258m^3 masonry reservoir covered with galvanized-iron sheets. Cast-iron pipe replaces the HDPE near the low point, where the head is greater than 100m.

Because the rock level is high, the pipe has only very shallow cover in several places and the route passes through an area prone to landslides.

The distribution system, also HDPE pipe, feeds 192 private connections (representing 45 per cent of the population) and 14 public taps. Supply is intermittent, in two shifts - 5am to 10am and 4pm to 7pm.

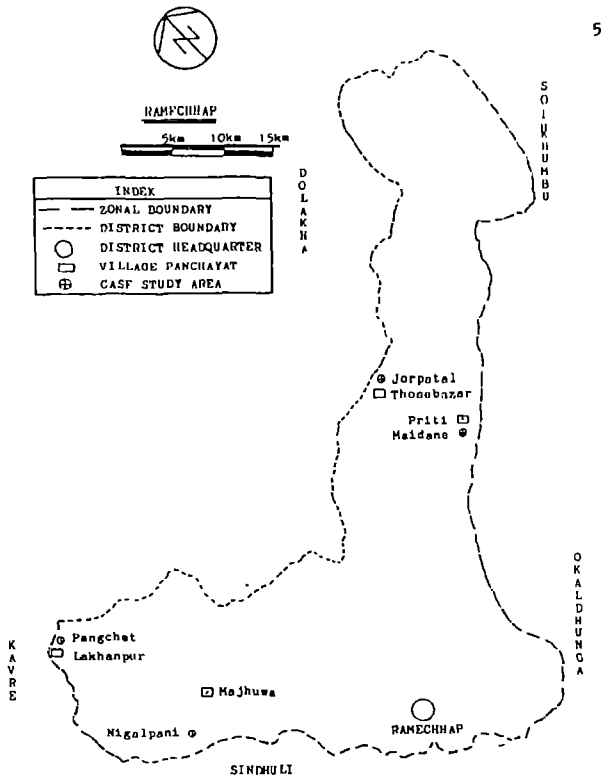
1.2 Simara (DWSS)

Also completed in 1982, following requests in 1976 which included a letter to the king, the Simara scheme serves 2 777 people in 516 households. Alternative sources in the Terai were a few shallow wells and irrigation canals.

The scheme uses groundwater pumped to a 250m^3 elevated reinforced-concrete reservoir through 150mm-dia cast-iron pipe. Cast-iron and galvanized-iron pipes are used in the distribution system in the Bazar area, with HDPE pipes elsewhere.

The same supply shifts are used as at Damauli, but in the summer months of March to June, Simara switches to three shifts: 5am to 9am; 12 noon to 2pm; and 4pm to 6pm. Only 19 per cent of Simara's population are served by the 102 private connections, the remainder using 22 public taps.

Both at Simara and at Damauli, maintenance is handled by DWSS, and villagers have no role to play.



Map 2; CASE STUDY AREAS IN RAMECHHAP

1.3 Maidane (MPLD)

The smallest of all the six schemes studied, the Maidane project serves just 19 households with a population of 93. It was the second of four villages in the same village panchayat (Priti) to receive MPLD assistance following approval in 1980. Maidane was given the HDPE pipes left over from construction of the scheme at the first village - Gajechepte.

The scheme, which took six months to build, is a gravity system with a spring source. The intake is directly at the source and no reservoir is provided. HDPE pipe is used for transmission and distribution lines, and the pipes follow the natural gradients, with resulting peaks and troughs.

There are two public tap stands, though at the time of the survey both taps were missing.

1.4 Jorepatal (MPLD)

Frequent changes in the local panchayat leadership meant that the Jorepatal water supply scheme, though requested repeatedly from 1972, was not implemented until 1983. It was then completed in three months. It serves 38 households, or 169 people. Previously, collecting water from the nearest springs took nearly two hours.

The gravity flow system has a spring source diverted to an intake tank along 8m of earth canal. The scheme is similar to Maidane except that the intake is fitted with a strainer and there is a small masonry reservoir (uncovered). There are five water points, but at the time of the survey, no permanent tap stands had been built and there were no taps.

1.5 Nigalpani (MPLD)

Before the water project, Nigalpani had just one spring in the village and it did not provide enough water. Villagers queued from early morning, or walked to the nearest alternative source, two hours away and in the jungle.

The village panchayat submitted a proposal to the district panchayat in 1978. Pipes and cement were delivered in 1981; work began in 1982 and was completed the same year. In all, 243 people in 44 households are served from the spring source. Low-density polyethylene (LDPE) was originally used to connect the source to the intake tank but after it was damaged, an open channel was substituted. LDPE pipe was also used at Nigalpani for the transmission main and some distribution mains.

1.6 Pangchet (MPLD)

Like the other villages, Pangchet had waited a long time for a water supply scheme. The scheme completed in January 1983 had first been requested in 1973. It serves 346 people in 48 households. Before it was built, village women began their journeys at 4am to collect water from the spring.

The spring source feeds a stream on which the scheme intake tank is constructed, and households above the intake use the watercourse for bathing, washing clothes, and watering livestock. The HDPE supply main follows the line of an irrigation canal. There is a masonry reservoir covered with slates.

Pangchet was the only one of the four MPLD schemes fitted with functioning taps - five of the eight were working.

2. Survey Methods

Because the main purpose of the case study was to analyse institutional arrangements, previous study reports and official DWSS and MPLD documents covering scheme selection and design were important references for the study team.

For the field studies, special questionnaires were developed for household surveys, interviews with local leaders and health workers, scheme data collection, village data collection, and general discussions with administrative and other responsible authorities. A census was taken in each case study area and included estimations of age, literacy, sex distribution, landholding and livestock keeping. Enumerators were hired locally for field data collection and interviewing.

2.1 Sample Size

In Damauli and Simara, the two DWSS schemes with comparatively high populations, 20 per cent (200) of the households were interviewed and observations at public and private water points led to further interviews on water use with 66 households.

Because of the smaller populations served by MPLD schemes, higher sampling ratios were used, ranging from 32 per cent (14) in Nigalpani to 79 per cent (15) in Maidane.

2.2 Interviews

Combining household interviews with discussions with local leaders and health workers, the team sought to build up a picture of the community's attitudes towards the water scheme and the degree of involvement in its operation. Questions were designed to assess the value placed on convenience, health benefits and other advantages of the water system, and to identify possible alternative implementation or educational techniques which might lead to improved functioning.

2.3 Field Studies

On each project, the survey team twice inspected all the components of the water system - once independently, and once in the company of a technician or a water committee member or a village leader. Details were recorded of the condition of the water source, intake, pipeline, valves, reservoir, and the distribution system. Maintenance technicians, paid or unpaid, helped to analyse the functioning of each element, and discussed technician training, remuneration and conditions.

At Damauli and Simara, water samples from 10-11 points from source to consumer were sent for analysis in Kathmandu, and pressure measurements, spread over the distribution period, were taken at "in-depth study points". Transport difficulties made it impossible to carry out sample analyses on the MPLD projects, and flow irregularities meant that no pressure measurements were made in the Ramechhap villages.

1. Problems Identified

The Nepalese agencies recognize that their rural water schemes have problems, and the study has found shortcomings in all six schemes. Though the benefits of more convenient water are apparent, there is also clear evidence that the new systems are not functioning as well as they should.

In its simplest terms, evaluation of a water supply project consists of determining whether the system is functioning properly and whether it is being used properly. If both functioning and utilization are satisfactory, an assessment may also be needed of complementary measures designed to achieve maximum health impact.

Though the benefits of more convenient water are apparent, there is also clear evidence that the new systems are not functioning as well as they should.

1.1 Functioning of New Water Systems

Both DWSS schemes were functioning to the extent that water was available at specified times from public and private taps, and individual components were performing their design roles. Coliform counts in some samples show that the quality of the water was not being adequately safeguarded, though this would be rectified to an extent by improved maintenance.

Leakage is a big problem, particularly at Damauli, where most of the valves and fittings in the system are damaged or leaking. Vandalism was blamed for broken valve box covers and damaged air valves. Poor jointing techniques combined with high residual pressures mean that leaks have been there from the start, though switching from HDPE to CI and GI fittings has improved the situation.

In Damauli, public tap stands generally have no proper drainage provision, so that stagnant water surrounds the stands. Of the fourteen public taps, four were leaking and two were damaged at the time of the survey.

Pools of stagnant water around public tap stands are a health hazard.

Along the 5km supply line from the intake point to Damauli, six leaks were found, and landslides had led to two major sections of pipe being exposed and liable to damage.

Conditions in Simara are generally better than those in Damauli, but with one serious exception. The second pump, intended as a standby, was damaged during installation, and has not been replaced. Although the single pump was performing satisfactorily at the time of the study, it is not an acceptable practice to depend totally on one pumping unit, as, except for the small reservoir storage, all supplies would be lost should it breakdown.

The four MPLD schemes are on a different scale and water is available only from public standposts. Again, the schemes were all providing water, though functional defects were very apparent.

Source pollution is a significant problem. Only in one case - Maidane - is the watershed reasonably safe from contamination, and even there some livestock grazing does take place. On the other three schemes, there is considerable encroachment by livestock, trails, and human settlements. Most serious are Nigalpani and Pangchet, where the source water is used by households above the intakes, before being tapped for the village supplies. At Pangchet, three artificial ponds have been created, where people wash clothes, bathe, and water livestock, before the water reaches the scheme intake. None of the watershed areas is fenced and no measures have been taken to protect them from human or animal pollution. Except for Maidane, there is also a pollution threat between the diversion points and the actual intake tanks, as the open channels are exposed to contamination.

Though all four intake tanks were functioning without leakage, coverings were poor and leaves and other material readily found their way into the supply lines. At Jorepatal and Nigalpani, strainers were provided, but the 10mm screens were too big to keep out leaves.

None of the schemes had the pipe system properly buried, so that damage, vandalism, and illicit connections lead to high leakage, and this is aggravated in Pangchet by poor connections in the GI pipe. Only Maidane and Pangchet had valves installed on the system, and they were either damaged or functioning badly.

Only one tap stand at Maidane and three at Nigalpani were permanent structures. Jorepatal had no tap stands at all, while temporary structures in dry stone masonry had been built at Pangchet and for the remaining points in Maidane and Nigalpani. Only in Pangchet were there functioning taps.

1.2 System Design

The basic concepts of village water supplies in Nepal are simple and appropriate. However, observations on the six case-study schemes suggest some general design principles which might help to overcome operational problems in the future.

DWSS has standard design criteria, which are also given to consultants when schemes are not designed in-house. The case-study experiences offer an opportunity to amend and extend these criteria. In particular, the survey shows that maintenance needs and pollution threats are easier to deal with at the design stage than when the problems arise later.

Intake structures should be sited as close to the water source as possible, and any connecting conduits that prove necessary should avoid trails or other potential sources of pollution (where this is impossible, properly buried and protected pipes will be the best solution). The intake itself needs to be as simple as possible, bearing in mind that in some cases provision may have to be made for sediment removal.

The design should include proper coverage of the intake tank, which will have to allow access for cleaning out. A washout pipe is needed in a position which enables the tank to be emptied completely, and an overflow to cope with blockages. Inlet screens should be provided to keep out leaves and other debris. Stout fencing or other protection is essential if pollution of the source water is to be prevented.

Intake tanks and reservoirs need proper covers to prevent contamination. This ad hoc arrangement is unsatisfactory.

Supply lines from the intake to the village usually run through steep terrain and are vulnerable to damage from landslides and vandalism. DWSS guidelines recommend that steep slopes and ripple-like gradients should be avoided by re-routing wherever possible, but the case-study has shown that this advice was not followed at Damauli, and it does not seem to have been applied on the MPLD projects.

In general, design criteria need to emphasize the need to bury and backfill pipes properly, to provide air valves at high points and sluice valves at low points, to use proper jointing materials and procedures, and to protect valves in secure valve boxes. Pre-cast concrete may offer a solution to protect valve boxes against vandalism, though experiences on the long pipelines suggest that increased vigilance and possibly even stricter legislation to punish offenders may be necessary.

Valves must be better protected

Reservoirs call for the same design criteria as intake tanks, including protection against contamination. There was evidence of a potentially serious pollution risk at Damauli, where the reservoir site was being used for defecation. Though a barbed-wire fence surrounded the site, a leaking supply pipe feeding the reservoir had become an unauthorized supply point.

The most important design defect in the **distribution systems** was the lack of drainage facilities around public tap stands. Stagnant pools provide breeding grounds for mosquitoes and other disease-carrying insects. Simple drainage arrangements would not be expensive, particularly in the hills.

1.3 Project Implementation

Both DWSS and MPLD face manpower problems which hamper the execution of water supply schemes. With few permanent posts, it has been difficult to assign enough technical people to the scheme sites.

Any acceleration of the programme, as implied by the country's IDWSSD Plan, will further stretch the agencies' resources, and suggests the need to create more permanent positions.

Before initiating construction of a new water supply project, DWSS establishes a project office headed by a water supply/sanitary engineer and with technical and administrative support staff. This office supervises construction, following design by the DWSS design cell or local consultants. The Simara project was designed by DWSS and Damauli by a local consultant. Both schemes have been built to a reasonable standard, though the quality at Simara is much better. The time from initial request to project completion was very long and both projects were held up for two years during construction because of shortages of materials and technical manpower.

MPLD projects rely much more on community involvement, and the completed schemes show signs of inadequate technical supervision. Improper alignment and the shallow depth of the pipes have led to damage and leakage, whereas more stable and secure routes could have been chosen with the right guidance. Joints in HDPE pipes and GI fittings were often poorly made or made without the right connectors, no air valves had been provided at high points, and where valves had been fitted no union connection had been used, so that damaged valves could only be removed by cutting the pipe.

Omissions range from valve boxes (missing almost everywhere and resulting in rusting valves and sticking handles) to the supply reservoir itself at Nigalpani. As the Nigalpani source has a minimum flow below the design supply rate from the taps, the reservoir is certainly needed, but it has yet to be built, although the project is recorded as complete in the MPLD books.

All six projects took longer than necessary from request to completion, partly because of procurement and manpower deficiencies already mentioned, and partly because of a lack of coordination between central and local organizations in both agencies.

1.4 Operation and Maintenance

There is a marked contrast between the maintenance standards on the two DWSS schemes and those on the four MPLD projects.

DWSS has assumed responsibility for operation and maintenance of the water supply systems at both Damauli and Simara, and technical teams paid by DWSS have specific responsibilities for each project. Breakdowns and damage do occur but in the main repairs are quick and effective.

Damauli's supply line presents some problems. More air valves seem to be necessary as the flow is less than it should be and air pockets are a likely cause. Leaking and damaged valves along the supply line were also in need of repair, though Damauli's technical superintendent had made the necessary requests for action to the DWSS regional office.

But Damauli's biggest maintenance headache is damage caused by landslides. The supply pipe route was varied from the original design because of prolonged administrative delays over the plan to run it alongside the highway. The new route has twice been damaged by flooding producing landslides, and the section concerned is still exposed and liable to more damage.

The distribution system is also in need of some attention at Damauli, though initial leakage problems caused by poor quality pipe joints and high residual pressures have largely been put right by switching from HDPE to CI and GI fittings. The situation has also been made easier by the high take-up of house connections and the resulting reduction in residual pressures. Nevertheless, some of the public taps were damaged at the time of the survey, and three were leaking. The valve box was damaged at all the tap stands, and the masonry pillars were in need of repair.

Simara's comparatively sophisticated water supply system, with its elevated reservoir, has fewest maintenance problems

Though its water supply system is more sophisticated, involving an electric pump to lift the groundwater to an elevated reservoir, Simara has fewer maintenance problems. One big advantage is the local source, which means no long supply line. The distribution system suffers fewer breakdowns than Damauli's, and leaks are also fewer despite very high water pressures. Taps, tap stands and valve boxes are generally in good condition.

Simara's big problem has not yet arisen. Failure of the electric pump, calling for repair beyond the capability of the local technicians, would leave the community with only the water stored in its elevated reservoir ($250m^3$ maximum) to supply the 2 777 population and their livestock. A standby pump, to replace the one damaged during installation, is a crucial need.

Both DWSS schemes were equipped with tools and spares when visited by the study team, but it may be important to note that both Damauli and Simara are close to roadheads and within easy bus rides of DWSS regional offices; there were reports in Ramechhap that some DWSS schemes lack repair tools.

MPLD schemes are very poorly maintained. Though the villagers clearly appreciate the benefits of a convenient water supply and worked willingly to construct the projects, there is an attitude of helplessness and apathy when it comes to maintenance.

The results are apparent. Three of the four projects (Pangchet is the exception) have no working taps - the water simply flows continuously from open pipes - and tap stands are either temporary or non-existent. Records show that only Maidane has had uninterrupted supply; there had been five breakdowns at Nigalpani, including one lasting 17 days, and six at Pangchet where the longest was two days. The Jorepatal scheme lacks tap stands, reservoir cover, valves and fittings, and was only being used by part of the community - the rest resorting to traditional sources.

Though the five-member water committees constituted to mobilize local resources and ensure construction progress were still in existence, their effectiveness was much diminished. None of the committee members or local workers had been given any training in system maintenance, and nowhere was there any mechanism for financing spare parts or maintenance items.

While many of the maintenance problems on MPLD schemes can be put down to design or construction defects already mentioned, the fact remains that virtually no routine maintenance work is being carried out, with the possible exception of general cleaning of the reservoirs and intakes. The situation is aggravated by unauthorized connections into supply mains, usually effected by cutting the pipe and introducing a bamboo connector (and a leak!). Exclusion of some parts of the community from the piped water system (e.g. the lower section of the village at Nigalpani) has led to deliberate damage to pipelines, and exposed pipes are tempting targets for thirsty shepherds or travellers, particularly during festivals.

An important outcome of the discussions with villagers, and even with local technicians, is the feeling that maintenance means repairs to restore supply after a breakdown; there was no appreciation that routine maintenance prolongs the life of systems and improves their functioning.

2. Water Use

Within the time constraints of the case study, an attempt was made to establish the consumption pattern in all six villages. In both Damauli and Simara, three "cluster areas" (more than five houses in close proximity) were selected and observations were made on two consecutive days at one public tap stand and four private connections in each area. Two public tap stands were observed for a full day in each of the Ramechhap villages.

Periodic flow measurements were taken at each tap, to give an average for calculation purposes. The method is not very accurate and should only be taken as a general guide to actual consumption. Obviously too, it represents the consumption pattern at the time of the survey - winter - and different results may have been obtained had the measurements been taken during summer.

2.1 Per Capita Consumption

From the observations and measurements, Table 1 was compiled, to illustrate the variation in per capita consumption between private and public taps and between DWSS and MPLD consumers. The numbers of livestock apparently associated with the sample consumer groups are included as a significant factor influencing consumption, but the numbers have not been taken into account in the final column, representing per capita consumption.

The very high consumption estimated for private consumers in Simara (208 litres per head per day) compared with their counterparts in Damauli (119.7 lhd) may be partly explained by the very high flow rates (0.54-0.7 litres/s) and pressures (up to 28m head) recorded in Simara, though it is odd that the same effect does not show in the public consumption figures.

Though accurate estimation is difficult, the observers were also asked to assess the amount of water used for different purposes by the families using the public and private taps. The results are shown in Table 2.

Table 1 Estimated Per Capita Water Consumption

Case study area	Type of supply	Total water used in litres/day	Population People	Population Live-stock	Per capita consumption (lhd)
Damauli	Private	8740	73	16	119.7
	Public	8722	135	2	64
Simara	Private	17897	86	64	208
	Public	14852	254	119	58
Maidane	Public	2434	94	64	26
Jorepatal	Public	735	56	30	13
Nigalpani	Public	3087	132	352	23.4
Pangchet	Public	4796	144	114	33

Table 2 Water Use by Purpose (as % of total water used)

Case study area	Type of supply	Purpose for which water is used: Drinking/ Cooking	Bathing	Washing*	Others
Damauli	Private	36	2	36	26
	Public	46	4	25	25
Simara	Private	38	4	23	35
	Public	42	6	30	22
Maidane	Public	46	5	35	14
Jorepatal	Public	62	-	12	26
Nigalpani	Public	57	-	35	8
Pangchet	Public	33	4	41	22

* Includes washing clothes and washing utensils.

Direct comparison of measured consumption with design assumptions is not possible but the figures on the DWSS schemes do seem high. DWSS allowed for a demand of 65 lhd from private connections and 45 lhd from public taps on both schemes and added 20 lhd for livestock, adjusted to 45 lhd for large animals at Simara only. Though the high consumption from private taps will be a matter of concern, it is not, at this time, presenting a threat to the yield of the scheme because of the low take-up of private connections at Simara.

Compared with DWSS's allowance of 60 per cent of the population served from private connections, the survey found that less than 20 per cent were connected. At Damauli, on the other hand, 45 per cent of the population had private connections, still below the 75 per cent DWSS estimate.

2.2 Hourly Variations in Consumption

Some interesting results emerged from the observations of water use hour-by-hour, particularly on the MPLD schemes, where water is available at all times. The shift system operated at Damauli and Simara obviously dictates when people can draw water, though the basis of it may be called into question following the measurements at Maidane, Nigalpani and Pangchet (Jorepatal is omitted from the analysis because the results were incomplete).

DWSS guidelines suggest that when water is continuously available, 30 per cent of the daily demand occurs between 6 and 8am, and 30 per cent between 4 and 6pm, with the remaining 40 per cent spread over eight hours from 8am to 4pm. However, the survey found that in the Ramechhap villages, those eight hours accounted for between 69 per cent (Pangchet) and 79 per cent (Maidane) of consumption, and that roughly 60 per cent of daily demand occurs between 10am and 2pm.

Though Simara operates a 12 to 2pm shift for the three summer months, for the rest of the year supplies on both DWSS schemes are restricted to 5am to 10am and 4pm to 7pm. The survey showed that the Simara consumers generally draw their water about one hour later than those in Damauli, peaking in the 8-9am period, when 31 per cent of the daily demand occurs.

2.3 Water Collectors

Women and children are the main water collectors, generally accounting for more than 70 per cent of the journeys in all the study areas, and with women making about three times as many journeys as the children. Though three schemes - Damauli, Pangchet and Maidane - showed some correlation between the number of journeys to collect water and the proximity of the taps, there was no evidence from the other schemes that distance influenced the number of visits.

2.4 Water Quality

Chemical analyses of water samples from Damauli and Simara showed that water at the source, in the reservoir and in public and private taps met WHO quality standards. From the bacteriological point of view however, it was a different story.

The analyses are shown separately in Appendix 1 for Damauli and for Simara. Damauli is the more serious, with coliform bacteria present at all points, and the faecal bacteria E. coli identified in the source water and at the public taps. Simara was relatively free of E. coli, but coliforms were present everywhere except in the borehole source.

Better source protection and prevention of stagnant pools around leaking pipe joints would have a big impact on water quality at Damauli, but the results suggest that the water should really be chlorinated before use. Development of a simple chlorination device, appropriate for village water supplies in Nepal would be a major advance.

Evaluation of water quality on the MPLD schemes is based only on visual examination, as laboratory tests were not practical, because of transport difficulties. Visually, the water was unobjectionable except for some small traces of suspended solids detected in samples at Jorepatal and Pangchet. However, the vulnerability of sources and pipelines to contamination means that bacteriological quality is likely to be poor, and again simple disinfection would be sensible.

3. Community Attitudes

The views of villagers about their new projects are very important. Unless the community appreciates the value of the services provided, there is little hope that the system will be properly looked after. Interviews established that there is a widespread belief that the water projects have brought benefits to each village, with convenience outweighing health improvements as the most appreciated advantage.

3.1 Perceived Benefits

Across the six villages, there was a 4:1 majority believing that the schemes had brought about change. Asked to specify the most important changes resulting from the new water systems, 60 per cent said that life was now easier for the women, a similar number saw the fact that the household had more water available as a benefit, and about a third of the respondents recognized the advantage of extra water for the animals and water for the kitchen garden. By comparison, only 13 per cent thought greater cleanliness worth mentioning.

Asked if villagers had become more healthy because of the scheme water, many householders replied that nutrition was more important than water availability. Some said that skin diseases were gradually disappearing but could not be sure that it was due to the new water supplies.

It is not hard to see why time-savings for the women have registered as the main benefit. Villagers were asked to compare the time taken to collect a gagro (12-20 litre pot) of water before and after the scheme was built. These are the results:

	Before	After
Damauli	30 - 75 mins	1 - 10 mins
Simara	5 - 50 mins	1 - 8 mins
Maidane	90 mins	1 - 15 mins
Jorepatal	60 -120 mins	5 - 30 mins
Nigalpani	90 -120 mins	3 - 30 mins
Pangchet	150 mins	3 - 20 mins

The time saved was mainly being used for household work, with a high proportion of the respondents in Simara and Nigalpani also mentioning agriculture and cattle activities as outlets. Some households (about 10 per cent) had started kitchen gardens, though slightly more indicated that the saved time was spent resting.

3.2 Water Adequacy

Most people told the interviewers that the water scheme provided adequate water for all their household needs. The exceptions were Jorepatal and Nigalpani, where people were still using old sources because the new scheme was not seen as completed, and about 30 per cent of the respondents on the two DWSS schemes. In Damauli, households using the public taps preferred to use spring or river water for bathing and washing clothes while in Simara shallow tubewells serve the same purpose.

A few households in the scheme areas said that the taps were too distant and in Damauli there was some evidence of caste discrimination.

3.3 Operation and Maintenance

As has already been noted, villagers contribute little or nothing towards the operation and maintenance of the new water schemes. However, the survey revealed that, with proper direction, they are very willing to contribute labour and, to a lesser degree, cash towards maintenance.

First though, some education and training is needed. Asked whether there was anyone in the village responsible for looking after the scheme, most of the Ramechhap villagers rightly said that there was not. On the DWSS schemes, there are maintenance technicians operating in the villages, but 60 per cent of the Simara residents questioned did not know, and another 15 per cent thought there was no-one in the village responsible for maintenance. Damauli households were better informed - 60 per cent of them knew that local technicians were assigned to the water scheme.

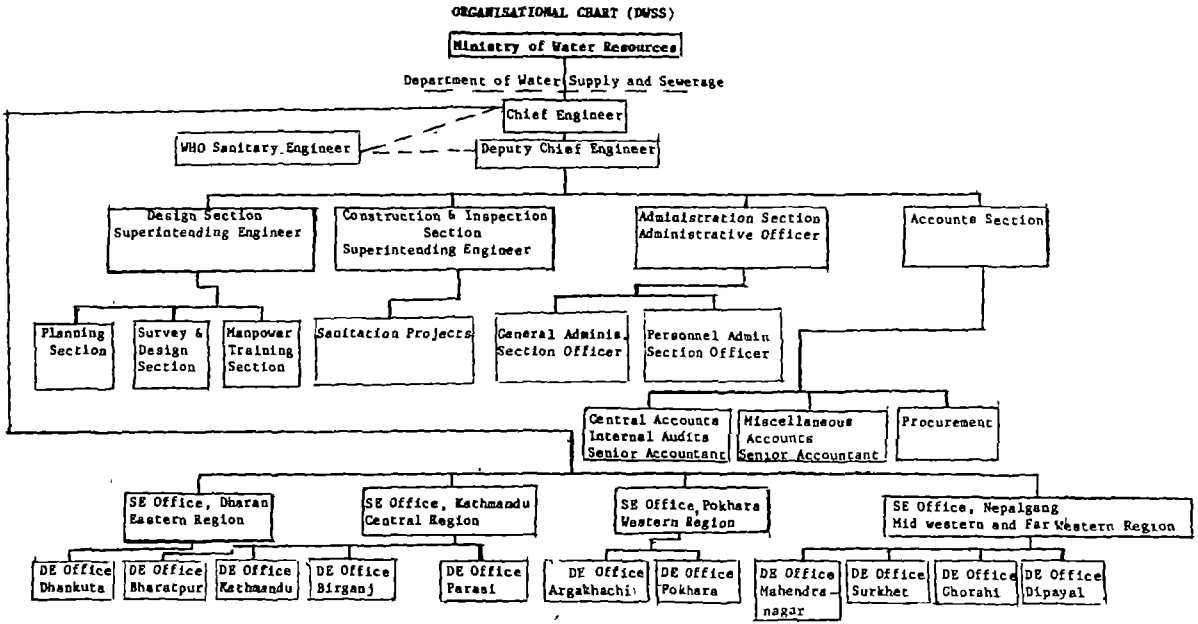
Who should be responsible for the upkeep of completed water systems? Of 62 households interviewed in the Ramechhap villages, only one felt that the water committee should retain responsibility. Most - 38 - said that the local panchayat should take over. Only in Pangchet was there any significant departure from the majority view, with eight people feeling that the Government should be responsible for MPLD schemes.

In the two DWSS villages, opinions were much more evenly divided, with a slight majority favouring government responsibilty for maintenance, almost as many feeling that the local panchayat should be in charge, and a few households in Simara wanting responsibility to be with the district panchayat.

DWSS estimates that water charges (Rs5.0/month for each private connection) account for 14 per cent of maintenance costs in Simara and 7 per cent in Damauli. The MPLD water committees have no mechanisms (and no powers) to collect funds for the maintenance of schemes. The survey asked whether villagers contributed cash or labour now towards scheme upkeep, and whether they would be willing to contribute towards better maintenance. The answers are revealing:

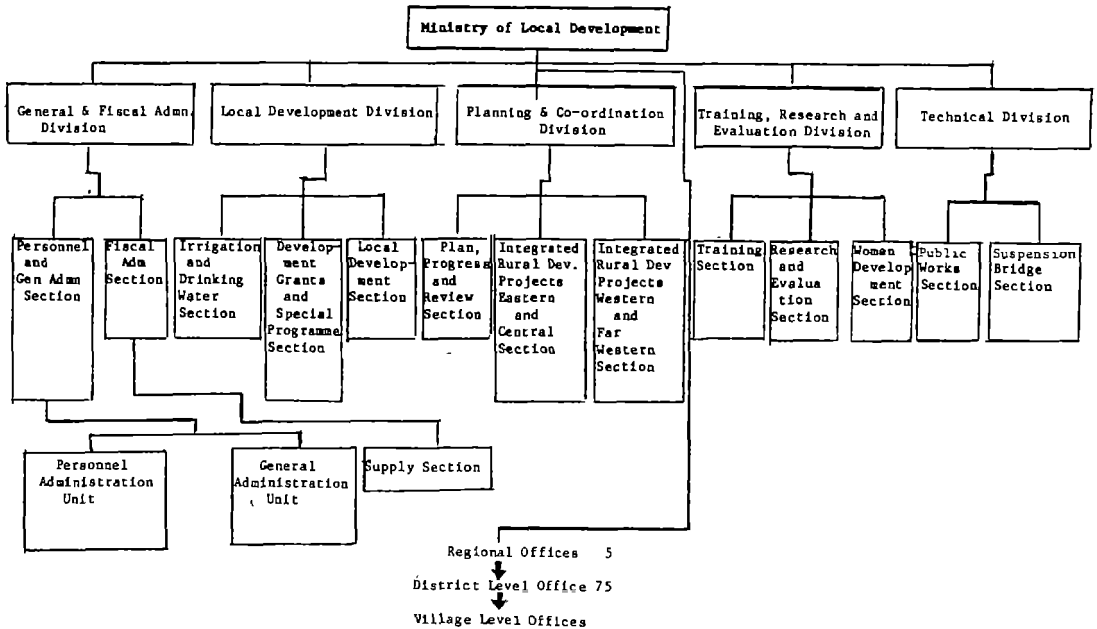
	Contributing now				Willing to contribute			
	Cash	Labour	Cash and Labour	No	Cash	Labour	Cash and Labour	No
Damauli	12	3	6	75	-	42	30	24
Simara	17	-	6	81	-	52	14	38
Maidane	-	2	4	9	-	12	3	-
Jorepatal	-	-	7	7	-	11	3	-
Nigalpani	-	-	7	7	-	7	7	-
Pangchet	-	3	8	8	-	14	5	-

Every one of the Ramechhap households indicated a willingness to make some form of contribution to scheme maintenance, with an obvious preference for it to be labour rather than cash. Though 30 per cent of the DWSS consumers did not want to make any contribution, the number of willing contributors is well up on those actually making a contribution now.



SE = Superintending Engineer
DE = Divisional Engineer

ORGANISATIONAL CHART OF MLD



Nepal has ambitious plans for the International Drinking Water Supply and Sanitation Decade (IDWSSD). The schemes studied for this report show that the will exists among villagers to give top priority to water supply; a simple technological solution is available for rural supplies; and existing institutions are aware of the needs.

Schemes have been delayed in the past because of a lack of proper coordination and management in regional and district offices of MPLD and DWSS, and because of manpower shortages, procurement difficulties, and other constraints within the agencies. The first set of recommendations, therefore, deals with ways of improving the **planning and implementation** of new water projects within the institutions.

Recommendation 1: Targets

DWSS and MPLD should commit themselves to realistic targets in each region. A central planning department must be responsible for reviewing progress regularly, analysing the reasons for any delays or slippage, and correcting programmes accordingly.

Introducing specific responsibility for the planning process should help to overcome the long administrative delays which have frequently been associated with project implementation in both agencies. Planners should recognize too that in the long term it is better to have less schemes fully completed and well maintained than more schemes only part complete and poorly maintained. Targets for the number of schemes to be implemented year by year, should take account of design needs, potential for local participation, and maintenance demands.

Recommendation 2: Institutional Responsibilities

Villagers must be made aware of the agency that is responsible for the construction and upkeep of village water supply and sanitation schemes. If all rural water supply is to be the responsibility of local panchayats and MPLD, the panchayats should be instructed on upward referral routes for work beyond their capabilities.

There is confusion among villagers about which agency to contact when they wish to propose a scheme for consideration or when a completed scheme needs repair. Requests have been sent to both DWSS and MPLD offices for the same scheme, and sometimes WSSB is even asked to approve small village systems. The present division of responsibility between DWSS and MPLD is soundly based, but is not sufficiently well publicized. Duplicate or multiple requests create unnecessary work and can add to delays in processing bona fide applications.

Even within the agencies themselves, the division of responsibility is not always clear, particularly when the local technicians or water committee members come across problems which they cannot handle. A simple organization chart incorporating referral procedures for procurement, technical

advice, financial matters, and administrative business should be one of the "tools" distributed widely on all schemes. Preparation of such a chart would in itself be instructive, and might well highlight shortcomings or missing links which are responsible for present difficulties.

Recommendation 3: Role of Local Panchayats

When assessing project proposals, the district panchayat, as a political and administrative unit, must be consulted about the potential use of local materials and village labour. Village training programmes and mobile units based in agency district offices should be used to raise the competence of local panchayats during project implementation.

Schemes are generally simple to build and require no machine work, making them ideally suited for local labour to construct. The task of listing available materials and matching them with project needs would help to focus district panchayat attention on the demands of the project, and provide useful guidance for the implementing agency in categorizing schemes under consideration. It would also be of use to the technicians carrying out a detailed feasibility study later.

Experiences from the field have shown that local panchayats do not have the skills to run schemes properly, and that closer supervision is needed during construction. The construction phase provides a good opportunity for motivating and training local people, including panchayat members, in the skills necessary for future maintenance. DWSS has developed a simple operation and maintenance manual for technicians, and this could form the basis of instruction for villagers.

Mobile teams of technicians, based in district offices would provide regular monitoring of completed projects, and offer the opportunity to encourage community responsibility. During construction, they could fulfil the supervisory role which seems to be lacking now, without taking away the villagers' own motivation and commitment. In particular, the teams could guide the local labour in essential design elements like the burying of pipes and protection of sources.

Recommendation 4: Manpower Development

Better career structures must be provided in both DWSS and MPLD, with opportunities for local technicians to progress into permanent posts, and with enough skilled people at the district level to provide training and back-up. More engineering posts are needed in both organizations, including at central offices.

The survey confirmed DWSS and MPLD claims that manpower shortages were hampering project implementation. The biggest problem is at the local level, where staff are unhappy about their temporary status and lack of promotion possibilities. Although both agencies have provision for promoting experienced overseers to assistant engineer positions, the rate of promotion has been very low. This may well be a contributing factor to MPLD's observation that when local maintenance workers are trained, rather than stay working on the water system they seek job opportunities elsewhere.

In fact, though training of local technicians is a stated policy of both DWSS and MPLD, it is evidently not practised satisfactorily. The study showed that technicians generally lacked technical knowledge of crucial elements. Increased numbers, more training, and incentives to lower-level technical manpower would solve many of the problems identified by the survey team.

Regular in-service refresher courses for local and district technicians would also provide the chance to exchange ideas and build up knowledge through others' experiences. Inclusion of village workers in meetings increases motivation. There is a need for periodic training in central and regional offices also, and for mobility of staff between headquarters, regions and districts.

Especially in the smaller villages which come under the auspices of MPLD, the level of health knowledge and appreciation of the need for proper sanitation practices is very low. Local technicians should be seen as a convenient route to improving this situation too. This means that training should include health education and instruction in ways of imparting such knowledge to villagers.

Table - 17 DWSS Staff Situation

Categories	Central Level			Regional Level			District Level			Project Level			Total	
	Sanction number	Post filled Permanent	Post filled Temporary	Sanction number	Post filled Permanent	Post filled Temporary	Sanction number	Post filled Permanent	Post filled Temporary	Sanction number	Post filled Permanent	Post filled Temporary	Sanction No	Post filled
1 Chief Engineer	1	1	-	-	-	-	-	-	-	-	-	-	1	1
2 Deputy Chief Engineer	1	1	-	-	-	-	-	-	-	-	-	-	1	1
3. Superintending Engineer	2	2	-	-	-	-	-	-	-	4		4	6	6
4. Divisional Engineer	3	2	-	4	4	-	-	-	-	12	-	12	19	18
5 Engineer	-	-	-	-	-		10	10	-	-	-	-	10	10
6. Assistant Engineer	4	4	-	6	6		38	37		79		79	127	126
7. Overseer	8	8	-	7	7	-	58	58	-	203	-	203	276	276
8 Artist	1	1	-	-	-	-	-	-	-	-	-	-	1	1
9 Draftman	2	2		3	2		8	2	1	2	-	2	15	9
10 Driller	1	1	-	-	-	-	-	-	-	6	-	6	7	7
11. Sanitarian	2	2	-	-	-	-	-	-	-	-	-	-	2	2
12 Tracer	2	-	2	-	-	-	1	-	-	-	-	-	3	2
13 Driver	6	6	-	3	1	1	-	-	-	4	-	4	13	12
14 Telephone Operator	1	1	-	-	-	-	-	-	-	-	-	-	1	1
15. Administrator	20	16	4	16	12	2	56	41	4	337	-	337	429	416
16. Typist	4	4	-	4	4	-	4	3	-	10	-	10	22	21
17 Watchman	5	5	-	13	10	2	13	10	2	785	-	785	816	814
18 Sweeper	-	-	-	-	-	-	-	-	-	1	-	1	1	1
19 Plumber		-	-	-	-	-	-	-	-	354	-	354	354	354
20. Helper		-	-	-	-	-	-	-	-	5		5	5	5
21 Tap Inspector	-	-	-	-	-	-	-	-	-	21	-	21	21	21
22. Supervisor	-	-	-	-	-	-	-	-	-	121	-	121	121	121
23 Pump Operator		-	-	-	-	-	-	-	-	56	-	56	56	56
24 Meter Reader	-	-	-	-	-	-	-	-	-	8	-	8	8	8
25 Line Man	-	-	-	-	-	-	-	-	-	2	-	2	2	2
Total	63	56	6	56	46	5	188	161	7	2010	-	2010	2317	2291
													2318	2292

*Included pool level staff

**Included superintending office staff

SOURCE DWSS, Panipokhari, Kathmandu.

Table - 15 MPLD Staff Situation

Categories	Central Level*			Regional Level			District Level			Town Panchayat Level			Total	
	Sanction Number	Post filled		Sanction number	Post filled		Sanction number	Post filled		Sanction number	Post filled		Sanction No	Post filled
		Permanent	Temporary		Permanent	Temporary		Permanent	Temporary		Permanent	Temporary		
1 Superintending Engineer	1	1	-	-	-	-	-	-	-	-	-	-	1	1
2. Divisional Engineer	1	1	-	5	4	-	-	-	-	-	-	-	6	5
3 Engineer	29	29	-	15	15	-	-	-	-	-	-	-	44	44
4 Non-graduate eng	-	-	-	-	-	-	75	34	41 **	-	-	-	75	75
5 Overseer	54	-	-	85	74	11	412	262	150	-	-	-	551	497
6 Regional Director	-	-	-	5		-	-	-	-	-	-	-	5	5
7 Local Development Officer	-	-	-	-	-	-	75	75	-	-	-	-	75	75
8 Administrator	-	-	-	68	68	-	503	503	-	30	30	-	601	601
Total	85	31	-	178	166	11	1065	874	191	30	30		1358	1302

* Not included administrative staff of Central Level

** All the temporary non-graduate engineers are permanent overseer
Source MPLD, Pulchowk, Kathmandu

Recommendation 5: Design

The design guidelines produced by DWSS should be updated, taking account of the experiences revealed by the case study, and similar guidelines should be developed and distributed for use on MPLD projects.

Project design has been discussed in detail in the previous chapter of this report, and it is clear that some new emphasis is needed to correct deficiencies identified by the study. In general, however, the DWSS guidelines provide a good basis for water supply system design in Nepal. They would be equally applicable on MPLD projects, and the team commends their use by MPLD and its advisers.

Guidelines are also needed for feasibility studies of MPLD projects; none of the schemes studied had proper estimates or outline designs completed before implementation began. Wherever possible, the local community should be involved in design discussions, and feel that they are able to influence decisions being taken on their behalf.

Recommendation 6: Procurement

A central coordinating section should be set up to handle procurement of materials for schemes in each agency's programme. The procurement section should handle external supplies through the different aid agencies and coordinate the procurement activities of regions and districts for local materials. More study is needed of the feasibility of producing essential pipes and fittings in Nepal.

Most of the schemes were held up during the construction phase by lack of materials. Though both DWSS and MPLD have programmes for securing supplies through the aid agencies, lack of coordination has led to duplication of effort and other inefficiencies. There are two units producing HDPE pipe in Nepal, but all fittings and GI pipes have to be imported. Cement production does not meet domestic requirements.

Stagnation of waste water over leaking valves can contaminate the whole system by sucking water into the system during low pressure periods.

High residual pressure can cause frequent wear and tear of fittings.

As will be clear from the rest of this report, the most serious deficiency of rural water systems in Nepal is the lack of maintenance. Even the relatively new systems studied here are suffering from neglect of routine maintenance and simple repairs. The problem is more acute on the smaller schemes implemented by MPLD and handed over to local panchayats for operation and maintenance, but even the larger DWSS schemes could be better maintained.

The next series of recommendations, therefore, covers ways in which the agencies might seek to improve **operation and maintenance.**

Recommendation 7: Community Motivation

More instruction and encouragement must be given to villagers during the construction phase of projects, to equip them to carry out routine maintenance later. The water committees formed to supervise MPLD scheme construction are a good model for maintenance too, but need better instruction.

Nepalese villagers see water as a top priority and respond enthusiastically to requests to participate in scheme construction. This enthusiasm has not so far been carried forward into operation and maintenance. DWSS has responded by taking over the running of completed projects itself, with reasonable success in Simara and Damauli. However, MPLD has not yet managed to find a successful formula for the upkeep of systems. The survey team also doubted whether Simara and Damauli were fully representative of DWSS projects. Their proximity to DWSS district offices and good communications make supervision comparatively easy.

In general, the team concluded that community involvement in operation and maintenance was the best way of achieving success on all rural schemes, though the degree of technical support needed will vary according to the size and complexity of the system. Recommendations 3 and 4 include measures for motivating villagers through training programmes during construction and refresher courses subsequently.

It is also necessary to ensure that there is specific responsibility for O&M matters assigned to one individual, or collectively to the water committee, and that technical support is readily available to cope with more difficult situations. A simple list of regular maintenance tasks, to be checked off as completed and monitored periodically by district technicians, would be a worthwhile introduction.

Villagers greatly appreciate the benefits of new water schemes and have every incentive to see that they are well maintained, provided that they recognize that there is a way of improving things. Community education programmes and the integrated rural development projects offer other opportunities for bringing better awareness.

Recommendation 8: Technical Support

Regular supervision by trained technicians should extend beyond construction, at least until villagers are seen to develop an effective maintenance programme.

The mobile teams of technicians described in Recommendation 3 as a means of supervising construction of small schemes, should also be used to assist during the learning time for villagers as the scheme comes into operation. Even when a good village-based system has been developed, periodic supervision should continue, both to encourage and to identify any shortcomings. The technicians should check the maintenance routines of the local caretakers, anticipate demands for spare parts and materials, and provide the link with procurement and technical sections at district and regional offices.

Recommendation 9: Incentives

Local caretakers should receive some recognition of the important role that they perform on behalf of the community. The agencies should draw up rules governing the appointment of scheme caretakers, which may include remuneration for regular service.

Even when a villager is willing to undertake maintenance work voluntarily, as was the case on all the MPLD schemes studied, the arrangement is difficult to keep going for long. Things go wrong rapidly when, for personal or other reasons, the volunteer loses interest. Replacing the caretaker is very difficult, unless some financial or other inducement is available.

The opportunity to attend periodic meetings at the district office, visits from supervising technicians, and the provision of sets of tools and spares are all forms of encouragement. If the individual concerned can, at the same time, be assigned some semi-governmental status, this too will add to the sense of responsibility. As part of the caretaker's job may be to combat vandalism, thought should be given to vesting some sort of local judicial authority as well, which may mean introducing legislation.

Recommendation 10: Spare Parts

A set of repair tools, spare parts and materials for routine maintenance should be made available to each local caretaker, through the water committee where one exists. A designated storage area should be provided in each village, preferably with a lockable store under the control of the caretaker. District offices of MPLD and DWSS should be equipped with bigger spares, and with reasonable stocks of ordinary supplies to replenish village stores.

Few of the village schemes had any tools or equipment for maintenance, and the procurement process for spares causes severe delays. The need for local maintenance facilities is clear; without them many of the other recommendations will be wasted.

Recommendation 11: Cost Recovery

A model system should be implemented for collecting money from scheme beneficiaries to pay for the upkeep of water systems.

There is presently no mechanism for collecting any kind of contributions from villagers on MPLD projects, although a majority told the study team that they would be willing to contribute at least labour. On the DWSS schemes, charges for private connections yield only a small proportion of system maintenance costs, and a tariff system for households using public taps is under consideration.

Cash contributions, however small, increase the community's feelings of ownership and, therefore, encourage better maintenance. If funds can be controlled locally, there is also a better chance of spares and routine maintenance materials being obtained in a more timely manner than at present.

A lesson from the electricity sector in Nepal is that charges may have to jump dramatically once aid agencies start putting maintenance conditions on loan agreements.

The main objective of MPLD nad DWSS has been to provide villages with easy access to water. Less attention has been paid to guaranteeing the quality of the water when it reaches the consumer, there being an implicit assumption that using clean water sources will be enough, as the community will protect the source from contamination and safeguard the quality in tanks and reservoirs.

With the low level of basic health knowledge in many villages, protection of water quality is rarely seen as a priority once convenient supplies have been provided. There is also the very difficult question of water rights, which can make it impossible to prevent contamination upstream of intake points.

The final series of recommendations, therefore, address the issue of **water quality and health.**

Recommendation 12: Role of the Health Department

Health education programmes need to emphasize the crucial links between contaminated water, gastroenteric disease and infant or child mortality. The water agencies must work closely with health workers to bring home this message and to stress the need for proper sanitation practices.

Villagers have demonstrated little knowledge of the health benefits of clean water, and there is a corresponding disregard of water quality protection and of basic sanitation. There is a limit to the amount of health education which can be expected to spread from technicians whose prime role is project construction or maintenance. Close collaboration is, therefore, needed between the water agencies and health authorities, in order to see that the water and sanitation message is included in health education programmes.

Recommendation 13: Water Quality Analyses

Water quality analyses should be introduced on all village schemes. This will call for collaboration between DWSS, which has some facilities for testing, and MPLD, which does not. It would also be helped by involving the Health Department and the Water Supply and Sewerage Board, both of which have both laboratory facilities and trained staff for sampling and testing.

The study was able to carry out tests only on the two DWSS schemes, both of which showed the presence of harmful faecal bacteria in drinking water supplies. Though no tests were possible, the circumstances on MPLD projects make it pretty certain that water is contaminated.

Protection is needed at various points, as the next recommendation says, but it will be important to monitor water quality regularly on all schemes if full health benefits are to be obtained. Health workers may be the best people to carry out quality tests in their villages, reporting their findings to DWSS or MPLD district offices for corrective action where needed.

Periodic detailed analyses should be carried out by central laboratories, which will mean MPLD making arrangements with DWSS, WSSB, or Health Department laboratories.

Recommendation 14: Quality Protection

More attention must be paid to protecting water sources, intakes, pipelines and reservoirs from pollution. Where necessary, the agencies must face water rights issues before implementing schemes, to ensure that contamination of sources can be prevented.

A great deal of improvement can be made by better housekeeping. On future schemes, intakes should be sited close to sources, or connected via closed conduits; tanks should be properly covered and protected by screens, pipes should be properly jointed and buried; and pools of stagnant water can be prevented by drainage. Existing schemes may need better fencing, new covers, repairs to leaking mains, and drainage.

A basic requirement is for the message about the dangers of drinking contaminated water (or the benefits of drinking uncontaminated water) to get home to villagers. One successful way of establishing the sanctity of water sources has been to build a temple nearby.

Recommendation 15: Disinfection

Further study is needed to develop a simple village disinfection device, and field trials should be undertaken on iron-based purification devices already developed.

However much protection is introduced, village water supplies will be in continuous danger of contamination. Chlorination devices may add to the maintenance commitments, but if a simple village device can be developed, the extra job of keeping it working may not be too much. There is reference in an earlier report to research on an iodine dispenser, and to an existing technology for installing iron-based purifiers in small rural water schemes. This is worth pursuing.

Recommendation 16: Sanitation

A programme of demonstration latrines at health posts, panchayat buildings, schools and houses of local leaders should be implemented to encourage villagers to develop new sanitation habits. A joint programme of the Health Department, Ministry of Education, and the water agencies should be developed and instituted to promote safe sanitation and solid waste disposal.

Field visits revealed that only 15 per cent of Damauli and Simara villagers used latrines, and use of latrines was virtually unknown in the Ramechhap study villages. Questionnaire responses showed that there was little appreciation of the hygiene benefits of access to clean water. Much more health education is clearly a prerequisite but local actions may be prompted by demonstration projects at key centres.

Recommendation 17: Future Evaluations

Periodic evaluations similar to this case study should be used to monitor improvements as recommended actions are implemented. Future studies should include a measure of health impacts.

Evaluation of the way that water systems function is the best way of diagnosing problems and identifying successful techniques for dealing with them. Future studies may well reveal further suggestions for changes; certainly they will provide some evidence for the validity or otherwise of our proposed actions. As functioning and utilization of water systems improves, so the health benefits can be expected to materialize.