5.5.2 Work execution plan

The work to be executed in the Project is roughly classified into civil structures, mechanical and electrical equipment and piping. An outline of the work methods is described as follows:

(1) Civil work (Bio-filter, coagulo-sedimentation basin, Sludge and drainage basin, control room, and electrical room)

Excavation and backfilling is to be carried out manually, but to attain tight compaction tampers will be used in making rolling compaction after backfilling. In replacing soft ground and backfilling an over-excavated part, fine quality soil brought from other places is to be used. Piles for foundation should be made of reinforced concrete, fabricated at the site, and driven in by using a diesel hammer.

Structures should be made of reinforced concrete. Since they require watertightness and high-accuracy finishing, scaffolding, supporting and formwork materials and reinforcing bars are to be imported from Japan, and fabricated and assembled under the proper management of the Japanese contractor. Concrete should be mixed using a concrete mixer at the site before placing.

(2) Mechanical and electrical installation

Mechanical and electrical equipment should be manufactured in Japan and delivered to the site about eight months for the former and eleven months for the later from the commencement of the work, after the finish of shop inspection, ocean and inland transportation. The equipment is to be installed using truck cranes.

After installation, the work should regarded as completed after being subjected to the installation inspection, performance tests, operation checking tests run, adjustment, finally tests witnessed by persons concerned.

(3) Piping work

Since excavation for laying the piping is very long, the excavation should be carried out with a backhoe and the trench bottom making should be performed manually to prevent overexcavation as far as possible.

Hard vinyl chloride pipes with high work facility should be used and ductile cast iron pipes be used to cross rivers and torrents. All these pipes (ϕ150 to ϕ600) should be procured in Japan.

Piping work is to be started when the imported materials are delivered to the site, that is, about five months after the commencement of the work. The hydraulic pressure tests of the piping are to be conducted after the completion of pipe laying in the work sections, and finished before making test runs and adjustment of mechanical and electrical equipment.

5.5.3 Work supervision

The consultant should prepare the detailed design and tender documents, execute the tender and the contract for the Government of Nepal, and supervise the construction work after the contract has been made with the contractor.

(1) Preparation of detailed design and tender documents

The consultant should prepare the detailed design drawings and tender documents according to the topographic survey drawings and the results of soil investigation made during the basic design study and those of more detailed site survey for the detailed design stage, and have discussions with the Government of Nepal about their contents for its approval.

(2) Execution of tender and contract

The tender notice, receipt of application for the tender, oral orientation for the tender, issuance of tender documents, receipt of tender documents, and qualification and examination of them should be carried out by the consultant in place of the Government of Nepal, and the contract for the construction work will be signed by the Government of Nepal.

(3) Work supervision

After concluding the contract, the work supervision stage will start.

In Japan, the consultant should be in charge of the approval of the drawings, documents submitted by the contractor and the specifications for equipment and materials to be procured in Japan, and attend shop inspections, and the likes.

In Nepal, the consultant should supervise and give instructions to the contractors regarding meetings before work commencement, inland transportation of materials and equipment, their work, installation and adjustment, test runs, and on-completion tests, and carry out the control of work progress, quality and cost. The consultant should dispatch its staff members in charge of each work to the site when the work is set about, the work of the treatment facilities, piping and equipment installation starts after the delivery of construction materials (including constructional machinery) and during test runs and adjustment after the finish of work in order to finish its work within the schedule set forth in the Exchange Notes.

(4) Manning plan

In the detailed design stage, engineers in charge of soil matters, civil engineering, the treatment facilities, piping engineering, electrical engineering, estimation and preparation of tender documents shall be assigned under the project manager. In the supervision stage, engineers in charge of the treatment facilities, civil work, piping, and mechanical and electrical installation will be required. Because of the necessity to manage these multiple engineering fields, a class 2 project manager should be assigned and other engineers of classes 2 to 4 in charge of the engineering fields shall be assigned according to the degree of the importance of their tasks.

5.5.4 Procurement plan

As a result of a market survey of Nepal, sand, gravel, brick, cement, and timber can be procured in Nepal. Other materials and equipment have to be imported. In procuring materials and equipment for the Project it will be decided by making comparative consideration of the financial conditions, marketability, economy, quality and other of Nepal, whether they should be imported from Japan or other countries.

(1) Cement, brick, gravel, sand, and timber

These should be procured locally because they are available in Nepal, inexpensive and easily obtainable.

(2) Petrol and light oil

These should be procured locally because they are refined in imported from India and are not in short supply in Nepal.

(3) Reinforcing bars

Although reinforcing bars are imported from India, not only are they inferior in quality but also it is difficult to procure them in bulk because of the poor distribution system in Nepal. They should be procured in Japan because large quantities of reinforcing bars of good quality are required to construct watertight, thin-walled, large-scale important structures.

(4) Form work, scaffolding and supporting

Although plywood panels for formwork are manufactured in Nepal, not only are they inferior in quality, but they become comparatively expensive because the number of times of their use is fewer than those of Japan. Therefore, they should be procured in Japan. Forms, scaffolding and supporting materials should be procured in Japan because it is difficult to obtain them from other countries.

(5) Hard vinyl chloride pipes

Hard vinyl chloride pipes providing good work facility should be used for water conveyance pipes. They should be procured in Japan because it is difficult to obtain large quantities of hard vinyl chloride pipes of uniform quality from other countries within the scheduled delivery time.

(6) Treatment equipment

Equipment of high efficiency and good durability should be imported from Japan because the equipment of the treatment facilities greatly affects the functions of the Project, so that the facilities can be operated and maintained for a long time and efficiently.

(7) Constructional equipment and machines

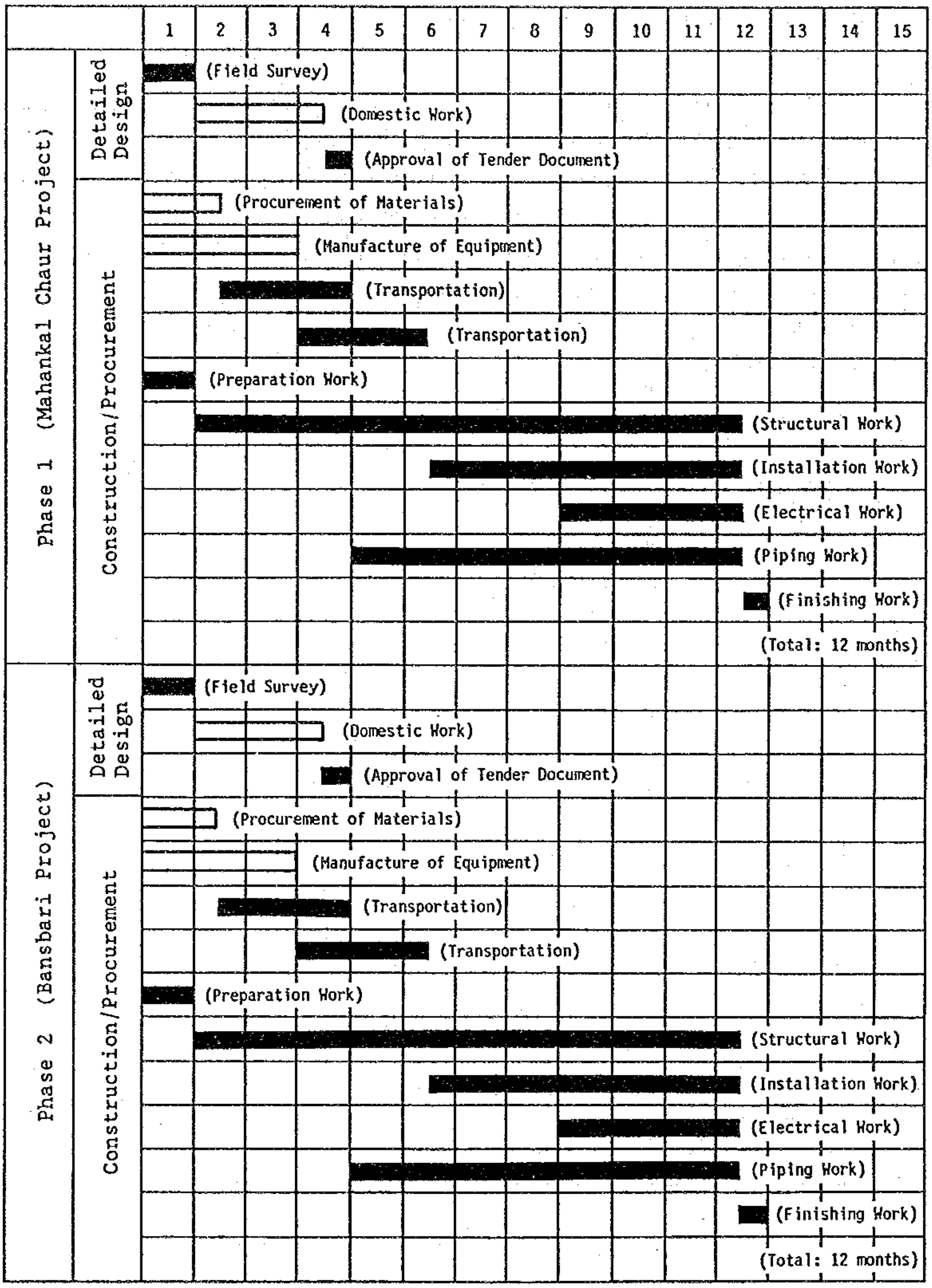
The leasing services for constructional equipment and machines have not developed in Nepal, and it is possible to obtain such services only when local contractors are afforded to lease their own equipment and machines. So it is hardly possible to procure necessary equipment and machines when required. Accordingly, constructional equipment and machines should be procured in Japan by the contractor by lease.

5.5.5 Implementation schedule

This Project should be executed in two phases, the Mahankal Chaur project as Phase 1 and the Bansbari project as Phase 2.

The work period in Phase 1 requires 16 months including procurement of equipment and materials and their transportation, and 22 months when the period for the detailed design after the signing of the Exchange Notes and the tender is counted. The work period in Phase 2 is the same as Phase 1, 16 months but 22 months if the time starts after the Exchange Notes are signed. The implementation schedule of the Project is shown in Table 5.5.1.

Table 5.5.1 IMPLEMENTATION SCHEDULE OF THE PROJECT



CHAPTER 6 PROJECT EVALUATION AND CONCLUSION

CHAPTER 6 PROJECT EVALUATION AND CONCLUSION

6.1 Effects of the Project

In the National Development Plan aiming at the improvement of the economic infrastructure and living standards, the Government of Nepal has the policy of giving priority to the supply of safe and sanitary water to all the nation as one of the important development measures to meet their basic needs.

On the basis of this basic policy, NWSC is promoting water supply development and improvement, to large cities including Greater Kathmandu, DWSS to provincial cities and main villages, and MLD to villages in remote areas.

NWSC has been improving networks and sewerage with the assistance of the IBRD and UNDP. The UWSSRP, which centers on the improvement of the existing facilities such as water distribution facilities and service installations is now in progress with the aid of 66 million dollars from IBRD and UNDP. However, this plan pays no attention at all to measures for the increase of water supply amount and improvement of water quality which are most important for the waterworks of Greater Kathmandu.

Under these situations, when the Project is implemented with Grant Aid Assistance from the Government of Japan, the following effects can be expected.

(1) Water supply amount

The maximum water supply amount in 1989 was 62,800 m^3/d, out of which groundwater was 22,500 m^3/d accounted for 35.8%. The JICA Master Plan Study proposed that the pumpage for groundwater should be limited to 15,600 m^3/d if it is to be used permanently; this rate equals to 14,500 m^3/d in terms of water supply amount. Therefore, this indicates that, if the groundwater pumpage had been limited according to the above-mentioned proposal, about 8,000 m^3/d would have been short even in 1989 as the maximum water supply capacity would have been 54,800 m^3/d. Without the development of new water sources in the future, the amount of 30,900 m^3/d and 71,400 m^3/d will be in short supply in 1995 and in 2001, respectively.

The water supply capacity in 1989 was 9,500 m^3/d from the Mahankal Chaur system and 13,600 m^3/d from the Bansbari system, and 23,100 m^3/d in total. After implementing the Project, the capacity would total 48,600 m^3/d, 26,500 m^3/d and 22,100 m^3/d, respectively. Finally, the maximum capacity for Greater Kathmandu would be 89,300 m^3/d, with addition of the existing capacity of 40,700 m^3/d of the Sundarijal, Balaju and Shaibhu systems. This figure can meet the water demand in 1995. The water supply amount and the service population of the Project will be as set forth in the following table, 72.4% of Kathmandu citizens having the benefit.

	1995			2001		
	Mahankal Chaur	Bansbari	Total	Mahankal Chaur	Bansbari	Total
Annual water supply amount (1,000 m^3)	7,667	6,243	13,910	8,136	6,405	14,541
Average daily water supply amount (1,000 m^3/d)	21.0	17.1	38.1	22.3	17.5	39.8
Annual paid water (1,000 m^3/d)	5,597	4,557	10,154	6,102	4,804	10,906
Beneficiaries (1,000 persons)	182.3	148.5	330.8	191,7	150.5	342.2
(House connection) (1,000 persons)	(172.3)	(140.3)	(312.6)	(184.8)	(145.1)	(329.9)
(Standpost) (1,000 persons)	(10.0)	(8.2)	(18.2)	(6.9)	(5.4)	(12.3)

(2) Water quality

According to the actual water supply records in 1989, the water supply amount related to the groundwater in the northern part of the valley was 32,300 m^3/d, accounting for 51.4% of the total. The rate of occurrences of water-borne diseases afflicting the citizens, who cannot obtain sanitary and safe water despite the payment of equal water rates, is over 2.1 times that for other citizens. Many complaints about turbid and colored water have been raised.

After the completion of the Project, the planned water supply amount under the Project will reach 52.5% of the total supply amount, which means that more than half the citizens will have the benefits of improved water quality from the Project.

(3) Health and hygiene

At present, the rate of occurrences of water-borne diseases (patients treated at hospitals, exhibit cholera-like symptoms) is 77 persons on an average per 10,000 population in Kathmandu city and 47 persons on an average per 10,000 population of Lalitpur city. Compared with Lalitpur city, which has a better quality of supplied water, the records of Kathmandu city show a rate of occurrence more than 1.6 times that for Lalitpur. More particularly, in the distribution areas related to the Project where groundwater is supplied without any treatment, the rate of occurrences comes up to as many as 100 to 340 persons per 10,000 population.

When the Project is implemented and safe, sanitary water is supplied, the hygiene conditions will improve greatly, reducing the incidence of water-borne diseases. This will not only contribute to improved hygiene environment, but will also have a great effect on the stability of people's lives.

For reference, the rate of occurrence of water-borne diseases (per 10,000 population) after the construction of waterworks in Hiroshima and Kofu cities in Japan was as below, suggesting that a safe and sanitary water supply improves the situation to great extent.

	Before construction of waterworks	After construction of waterworks
Hiroshima City	54 persons	16 persons
Kofu City	21.5 persons	14.4 persons

(4) Management of water supply works

18.6 million NRs for land acquisition cost and costs of administrative facilities will be borne by the Government of Nepal.

Operation and maintenance cost will be 22.2 million NRs in 1995 and 22.8 million NRs in 2001. Assuming an annual redemption rate of 0.75% and the number of years for redemption of 30 years, the annual expenses, which are the cost of redemption borne by the Government of Nepal plus operation and maintenance cost, will amount to 22.9 million NRs, the unit price of water coming up to 1.65 NRs/m^3.

On the other hand, assuming a water rate for house connections to be 4 NRs/m^3, a paid water ratio of 55%, and the water rate for standposts to be 6.2 NRs/m^3, revenues from water charge will be as shown below:

(Unite: Thousand NRs)

	Year 1995			Year 2001		
	Mahankal Chaur	Bansbari	Total	Mahankal Chaur	Bansbari	Total
Revenues from water charge	17,332	14,114	31,446	18,288	14,350	32,638
Household connections	16,611	13,527	30,138	17,725	13,909	31,634
Standposts	721	587	1,308	563	441	1,004

These revenues from the water charge will equal to 1.43 times of the annual expenses to be borne by the Nepalese Government, so that the annual expenses can be covered by the revenues.

If the paid water ratio is improved through improving the distribution facilities and service installations, arranging the collecting system, training of the technical personnel, and enlightening the citizens, the increase in revenue will be appropriated to the costs of improving these existing facilities.

The improvement and rehabilitation costs of the UWSSRP related to the Mahankal Chaur and Bansbari systems are estimated to be 307.8 million NRs (Refer to Table 4.3.3), the annual expenses being 11.3 million NRs, so that the balance of the revenue and expenditure will be covered if the paid water ratio could be increased to 60%.

6.2 Conclusion

As groundwater with inferior quality being supplied without treatment, the deterioration of existing water supply facilities, a shortage of water supply amount and unplanned expansion of the water distribution system, the waterworks of Greater Kathmandu is suffered from problems in terms of both water quality and quantity.

However, the implementation of the Project will achieve the following:

1) Improvement of quality of groundwater supplied without treatment
2) Securing of maximum water supply capacity of 48,600 m^3/d by developing new surface water sources for the conjunctive use with its groundwater, and by improving water quality,

Coupled with the implementation of the UWSSRP with the assistance of IBRD/UNDP, a safe, sanitary water supply for the population of about 342,000 will be attained.

The water supply amount, including water from the existing water supply systems which are expected to be improved in future, will meet water demand by 1995. This will contribute greatly to improving the health and hygiene conditions of the people of Greater Kathmandu, activating the economy, and will, as a result, better people's lives.

In consideration of the remarkable contribution the Project will be able to make to improving the basic living conditions, it is judged that Grant Aid Assistance of the Government of Japan will have great significance.

6.3 Recommendation

For the effects of the Project to be thoroughly played, it is necessary to pay full attention to the following matters:

(1) Proper operation and maintenance of facilities

a) Procurement of chemicals for water treatment
It is necessary that the essential chemicals needed for water treatment, such as PAC, lime, sodium hydroxide, raw salt, bleaching powder be procured properly. In particular, a proper measure for the procurement of PAC, which must be obtained in Japan, should be taken.

b) Improvement of paid water ratio
The operation and management expenses of facilities are met mainly by revenues from water charge. Since the water rates were increased recently from 1.2 NRs/m^3 to 4 NRs/m^3, which means the limit bearable by citizens in view of the area's living standards, an increase in the revenues from the water charge can only be achieved by improving the paid water ratio. The present paid water ratio of 35% should be increased through improving the distribution facilities and service installations, arranging the collection system, training of the related personnel and enlightening the citizens, to secure the necessary operation and management expenses.

c) Technical cooperation
To carry out the operation and maintenance adequately, it is necessary to strengthen the management organization and train the technical personnel. In addition to the training courses concerning water supply by JICA, it is necessary to train the technical personnel in concrete matters using actual facilities and improve their level by dispatching experts from Japan.

(2) Early implementation of UWSSRP

The UWSSRP and the JICA Water Supply Development Plan, on which the Project is based, compete and overlap with each other in the water supply development target up to 2001, the target year of the Melamchi project.

Accordingly, it is necessary to clarify the components which can be shared between the UWSSRP and the JICA Water Supply Development Plan, and the effects of the plans should be made manifest even if partially, as soon as possible.

This is also necessary to secure the operation and maintenance expense through improving the paid water ratio in (1)-b) above.

(3) Coordination with Melamchi project in the long-term water supply development target

To have the greatest possible effect of the long-term water supply development of Greater Kathmandu using the limited funds to the best advantage, it is necessary for the Melamchi project to avoid overlapping investments by making full use of the facilities under the Project and the UWSSRP after their realization.

(4) Proper pumping management of groundwater resources

Even though the groundwater source is limited, it is a precious water source for Greater Kathmandu waterworks. The groundwater source help allow maximum water supply capacity of 35,100 m3/d in the Project by the permanent use of it, enabling the implementation of the Melamchi project to delay by about five year.

Accordingly, it is necessary to make the permanent use of the groundwater source possible through the pertinent improvement of the wells and their proper operation and maintenance and making every effort to conserve groundwater source by a proper pumping management.

APPENDICES

1. Member List of Survey Team
2. Survey Schedule
3. List of People Concerned of the Recipient Country
4. Minutes of Discussion
5. Outline of JICA Water Supply Development Plan
6. Improvement Plans for Groundwater Quality
7. Breakdown of Operation and Maintenance Cost
8. Scope of Work for the Government of Nepal

APPENDIX 1 Member List of Survey Team

1. Basic Design Study Team

Mr. Yutaka HOSONO	Leader Managing Director, Grant Aid Study and Design Department, Japan International Cooperation Agency
Mr. Tetsuhiko TAKANASHI	Waterworks Planner Chief, Construction Department, City of Sendai Waterworks Bureau
Mr. Yuji MARUO	Waterworks Planner Development Specialist, Japan International Cooperation Agency
Ms. Noriko SUZUKI	Project Coordinator Japan International Cooperation Agency
Mr. Munetaka MORIO	Water Supply Planner Japan Engineering Consultants Co., Ltd.
Mr. Kazumi MATSUDA	Facilities Designer Japan Engineering Consultants Co., Ltd.
Mr. Akira KADOYA	Machinery Planner Japan Engineering Consultants Co., Ltd.
Mr. Masari HOSAKA	Electrical Facilities Designer Japan Engineering Consultants Co., Ltd.

2. Draft Final Report Explanation Team

Mr. Kenichi SHISHIDO	Leader Grant Aid Study and Design Department, Japan International Cooperation Agency
Mr. Munetaka MORIO	Water Supply Planner Japan Engineering Consultants Co., Ltd.
Mr. Kazumi MATSUDA	Facilities Designer Japan Engineering Consultants Co., Ltd.

APPENDIX 2 Survey Schedule

1. Basic Design Study Team

Date	Activities
Feb. 13 (Wed)	Arrive to Kathmandu. Meeting with JICA office.
14 (Thu)	Courtesy call on Ministry of Housing and Physical Planning (MHPP), Nepal Water Supply Corporation (NWSC) and Embassy of Japan (EOJ).
15 (Fri)	Field Survey (Sundarijal, Shivapuri, Balaju, Sundarighat, Shaibhu).
16 (Sat)	Inner meeting.
17 (Sun)	Submission and explanation of Inception Report and discussion with NWSC.
18 (Mon)	Courtesy call on World Bank and Minister of MHPP. Meeting with JICA office. Field survey (water sampling in the city).
19 (Tue)	Inner meeting.
20 (Wed)	Discussion with NWSC.
21 (Thu)	Field survey. Inner meeting.
22 (Fri)	Signing of Minutes. Report to EOJ and JICA office. Setting up equipment of bio-filtration experiment.
23 (Sat)	Holiday. Mr. Hosono, Maruo, Takanashi and Ms. Suzuki leave Kathmandu.
24 (Sun)	Discussion with NWSC. Explanation of Questionnaire prepared by the Study Team.
25 (Mon)	Geological survey at Mahankal Chaur and Bansbari.
26 (Tue)	Geological survey at proposed intake sites. Discussion with Nepal Electric Authority (NEA).
27 (Wed)	Supervision of topographic survey work. Field survey at proposed intake sites (Sundarijal, Dhobi Khola and Bisnumati)
28 (Thu)	Inner meeting.

Date	Activities
Mar. 1 (Fri)	Discussion with NWSC.
2 (Sat)	Holiday.
3 (Sun)	Flow measurement in Dhobi Khola well field.
4 (Mon)	Flow measurement at Sundarijal power plant and Sundarijal treatment plant.
5 (Tue)	Discussion with NWSC. Supervision of topographic survey work.
6 (Wed)	Flow measurement in Bansbari well field.
7 (Thu)	Discussion with NWSC. Flow measurement in Bansbari well field.
8 (Fri)	Supervision of topographic survey work. Report to EOJ and JICA office.
9 (Sat)	Mr. Hosaka leave Kathmandu. Flow measurement in Manohara and Gokarna well field.
10 (Sun)	Discussion with NWSC. Flow measurement in Dhobi Khola well field.
11 (Mon)	Discussion with German Water Engineering (GWE, Consultant of UWSSRP). Discussion with Snowy Mountains Engineering Corporation (SMEC, Consultant of Melamchi Project). Flow measurement at Bagmati river, Dhobi Khola and Bisnumati Khola.
12 (Tue)	Data collection. Flow measurement at existing spring (Shivapuri).
13 (Wed)	Report to EOJ.
14 (Thu)	Joint meeting with NWSC, World Bank, SMEC and EOJ.
15 (Fri)	Discussion with SMEC. Flow measurement at existing spring (Bisnumati).
16 (Sat)	Holiday.
17 (Sun)	Data collection.
18 (Mon)	Data collection. Field survey at proposed intake sites.
19 (Tue)	Discussion with NWSC and World Bank. Report to EOJ.
20 (Wed)	Report to JICA office. Mr. Morio, Matsuda and Kadoya leave Kathmandu.

2. Draft Final Report Explanation Team

Date	Activities
Jul. 11 (Thu)	Arrive to Kathmandu.
12 (Fri)	Meeting with JICA office. Courtesy call on Ministry of Housing and Physical Planning (MHPP) and Embassy of Japan (EOJ).
13 (Sat)	Field Survey (Sundarijal, Mahankal Chaur, Shivapuri, Bansbari).
14 (Sun)	Discussion with Nepal Water Supply Corporation (NWSC).
15 (Mon)	Discussion with World Bank and Snowy Mountains Engineering Corporation (SMEC). Discussion with NWSC.
16 (Tue)	Discussion with MHPP and NWSC, and finalization of Minutes. Signing of Minutes. Report to EOJ and JICA office.
17 (Wed)	Leave Kathmandu.

APPENDIX 3 List of People Concerned of the Recipient Country

1. Nepalese Side

    1) Ministry of Housing and Physical Planning (MHPP)

Mr. Achyut Raj REGMI	Minister
Mr. Sant Bahadur RAI	Secretary

    2) Nepal Water Supply Corporation (NWSC)

Mr. G.R.Sharma KHAREL	General Manager
Mr. Dhurba Raj SHARMA	Senior Manager, Planning and Management
Mr. Narendra Man PRADHAN	Senior Manager, Operation and Maintenance
Mr. Gautam B. AMATYA	Project Manager, Urban Water Supply and Sanitation Rehabilitation Project (UWSSRP)
Mr. Madan S. SHRESTHA	Project Manager, Greater Kathmandu Water Supply Project (Melamchi Project)
Mr. Noor Kumar TAMRAKAR	Manager, Greater Kathmandu Service Department
Mr. Kaushal Nath BHATTARAI	Chief, Finance Department
Mr. Binod S. PALIKHE	Senior Divisional Engineer, Mechanical Branch
Mr. Himesh A. BAIDYA	Assistant Engineer

2. Japanese Side

    1) Embassy of Japan in Nepal

Mr. Chuichi ITOH	Ambassador
Mr. Takao NISHINA	Acting Ambassador
Mr. Kenzo HIROKI	Second Secretary
Mr. Mikio ISHIWATARI	Third Secretary

2) JICA Nepal Office

Mr. Hidekazu KUMANO	Resident Representative
Mr. Masatoshi NAGATOMO	Deputy Representative
Mr. Masami OHYAMA	Officer
Mr. Takashi YAMANAKA	Officer

3. Party related to the Project

1) World Bank

Mr. Nigel ROBERTS	Resident Representative in Nepal
Mr. Tashi TENZING	National Country Officer, Water Supply and Sanitation Sector Development Team in Asia

2) Snowy Mountains Engineering Corporation Limited (SMEC)

Mr. Simon J. ALLEN	Project Manager, Greater Kathmandu Water Supply Project (Melamchi Project)
Mr. Les FABIAN	Technical Manager, Greater Kathmandu Water Supply Project (Melamchi Project)

3) German Water Engineering GmbH (GWE)

Mr. Kurt RIPPINGER	Project Manager, Urban Water Supply and Sanitation Rehabilitation Project (UWSSRP)

APPENDIX 4 Minutes of Discussion

MINUTES OF DISCUSSIONS

THE BASIC DESIGN STUDY
ON
THE KATHMANDU WATER SUPPLY FACILITY IMPROVEMENT PROJECT
IN
THE KINGDOM OF NEPAL

In response to the request of His Majesty's Government of the Kingdom of Nepal, the Government of Japan decided to conduct a Basic Design Study on the Kathmandu Water Supply Facility Improvement Project (hereinafter referred to as "the Project"), and the Japan International Cooperation Agency (JICA) sent the study team, headed by Mr. Yutaka Hosono, Managing Director, Grant Aid Study and Design Department, JICA, from February 12th to 24th, 1991. The team had a series of discussions with the authorities concerned of the Government of Nepal and conducted a field survey in the Project areas.

As a result of the discussions and field survey, both parties confirmed the main items described on the attached sheets. The team will proceed to the works and prepare the Basic Design Study Report.

Kathmandu, February 22nd, 1991

Mr. Yutaka HOSONO	Mr. Sant Bahadur RAI
Leader	Chairman
Basic Design Study Team	Nepal Water Supply Corporation
JICA	

ATTACHMENT

1. Objective

The objective of the Project is to improve water supply situation at Kathmandu city in order to promote public health and to upgrade living standards of inhabitant, through improvement and construction of Mahankal Chaur and Bansbari water supply systems.

2. Project sites

The Project sites are located at Mahankal Chaur, Bansbari and related areas in the Kathmandu valley.

3. Executing agency

Nepal Water Supply Corporation (NWSC) is responsible for the administration and execution of the Project.

4. The Project requested by the Government of Nepal

The Project requested by the Government of Nepal includes the following items.

(1) Mahankal Chaur System

a) Construction of a treatment plant, including a biological filtration facility for groundwater (excluding rehabilitation of existing wells)

b) Construction of a run-of-river intake and a conveyance system in the Dhobi Khola

c) Construction of a new intake in the penstock line of the Sundarijal power plant

d) Construction of a conveyance system between the intake in Sundarijal and the treatment plant

e) Installation of booster pump for transmission of treated water into the reservoir

f) Provision of instruments and equipment necessary for water quality monitoring

(2) Bansbari System

a) Construction of a treatment plant, including a biological filtration facility for groundwater (excluding rehabilitation of existing wells)

b) Construction of a run-of-river intake and a conveyance system in the Bisnumati Khola

c) Expansion of a conveyance system from Shivapuri

d) Installation of booster pump for transmission of treated water into the reservoir

e) Reconstruction of Maharajganj reservoir

f) Provision of instruments and equipment necessary for water quality monitoring

However, the final components of the Project may differ from the above items, if it is considered necessary after further studies in Japan.

5. Other important issues related to the Project

(1) Nepalese side explained the outline of related projects financed by the World Bank/UNDP as follows;

a) Urban Water Supply and Sanitation Rehabilitation Project including Management Support to NWSC

b) Water Supply for Kathmandu-Lalitpur from Outside the Valley

Nepalese side promised that all facilities covered by the Project would be utilized effectively after completion of the above-mentioned World Bank/UNDP projects.

(2) Nepalese side will improve the distribution systems related to the Project at the first priority with the assistance of the World Bank.

(3) Nepalese side requested the Japanese side to improve and/or construct the remaining four water supply systems namely Shaibhu, Balaju, Sundarijal and Chapagaun by Japanese Grant Aid. The team answered that the above-mentioned requests would be carefully examined without any actual commitments for this matter.

(4) Nepalese side assured that the costs of operation and maintenance concerning the Project would be preferentially covered from their revenue.

(5) Nepalese side will be responsible to coordinate the consultants from the World Bank/UNDP and the consultant from Japan for the purpose of maintaining consistency between the respective project.

6. Grant Aid system extended by the Government of Japan

   (1) Nepalese side has understood the system of Japanese Grant Aid explained by the team.

   (2) Nepalese side will take necessary measures, described in Annex-1 for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan will be extended to the Project.

7. Schedule of the Study

   (1) JICA will prepare the draft report in English and dispatch a mission in order to explain to the Nepalese side its contents around June 1991.

   (2) In case that the contents of the report is accepted in principle by the Nepalese side, JICA will complete the final report and send it to the Government of Nepal by July 1991.

8. Technical cooperation

Nepalese side strongly requested for the dispatch of Japanese expert to train local staffs for operating and maintaining treatment plants. Similarly NWSC staffs of different level shall be trained in Japan for the same purpose.

The team pointed out that new official requests through proper channel was necessary.

ANNEX-1

The following measures are requested to be taken by the Government of Nepal.

(1) To secure necessary lands for the Project, and to clear,fill and level the sites as needed before the start of the works.

(2) To provide facilities for distribution of electricity, and other incidental facilities outside of the site if necessary.

(3) To construct access roads to the sites when necessary.

(4) To provide respective data and information to the Japanese consultant and the contractor necessary for the detailed engineering services and construction.

(5) To ensure prompt unloading, tax payment, customs clearance, and prompt internal transportation therein of the products purchased under the grant.

(6) To exempt Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed in Nepal with respect to the supply of the products and services under the verified contracts of the Project.

(7) To provide and accord necessary permissions, licences and other authorization required for execution of the Project.

(8) To maintain and use properly and effectively the facilities constructed under the grant, and to arrange the budget for maintenance and operation.

(9) To bear all the expenses, other than those to be borne by the grant, necessary for the Project.

(10) To have discussion among NWSC, Ministry of Agriculture and Ministry of Water Resources on the problems such as water contamination, water rights, etc., which will be expected through execution of the Project.

MINUTES OF DISCUSSIONS

THE BASIC DESIGN STUDY

ON THE KATHMANDU WATER SUPPLY FACILITY

IMPROVEMENT PROJECT

IN THE KINGDOM OF NEPAL

(CONSULTATION ON DRAFT REPORT)

In February 1991, the Japan International Cooperation Agency (hereinafter referred to as JICA) dispatched the Basic Design Study Team on the Kathmandu Water Supply Facility Improvement Project in the Kingdom of Nepal (hereinafter referred to as the Project), and through a series of discussions, field survey in the Project area, and technical examination of the results in Japan, has designed the appropriate plan for the Project and prepared the Draft Report of the Basic Design Study.

In order to explain and to consult on the components of the Draft Report, JICA sent a team, headed by Mr.Ken-ichi Shishido, Project Officer, First Basic Design Study Div., Grant Aid Study and Design Dept., JICA from July 10th to 18th, 1991.

As a result of the discussions, both parties confirmed the main items described on the attached document.

Kathmandu, July 16th, 1991

Mr. Ken-ichi Shishido
Leader,
Draft Report Explanation Team,
JICA

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ATTACHMENT

1. Components of Draft Report

The Nepalese side has agreed and accepted in principle the components of the Draft Report proposed by the team, while the following comments have been made by the Nepalese side;

a) the Nepalese side has requested that the power lead-in work should be covered under the Japan's grant aid assistance,

b) the Nepalese side has requested that the drainage pipe-lines for the sludge removal to the nearest disposal point not causing environmental pollution should be designed and also be covered under the Japan's grant aid assistance.

However, the team has explained that the final scope to be covered under the Japan's grant aid assistance would be shown in the Final Report.

2. Land Aquisition

The Nepalese side has explained that Ministry of Housing and Physical Planning will bear all responsibility for the land aquisition, which is being processed. The team has pointed out that Nepalese side should report its progress to Japanese side because the land aquisition is an indispensable work for the implementation of the Project. This work should be completed before Exchange of Notes(E/N).

3. Japan's Grant Aid System

(1) The Nepalese side has understood the system of Japan's Grant Aid explained by the team.

(2) The Nepalese side will take the necessary measures, described in Annex-1 of Minutes of Discussions signed on February 22nd, 1991 for smooth implementation of the Project on condition that the Grant Aid assistance by the Government of Japan is extended to the Project.

4. Other important issue related to the Project

Both sides have reconfirmed Item-5. of Minutes of Discussions signed on February 22nd, 1991. Furthermore, Nepalese side requested for grant aid of other remaining treatment plants at Shaibhu, Balaju, Lambagar, Sundarijal, Manohara, Bulkhu, as mentioned in the JICA Water Supply Development Plan.

5. Further schedule

JICA will complete the Final Report in accordance with the confirmed items, and send it to His Majesty's Government of Nepal by September, 1991.

6. Technical Cooperation

The Nepal side has requested for the Japanese expert who will be assigned in NWSC to facilitate NWSC's activities and coordination acivities between agencies concerned. As for the dispatch of Japanese expert, the team has suggested that the Nepalese side should submit an official request (form A-1) as soon as possible for its realization.

APPENDIX 5 Outline of JICA Water Supply Development Plan

1. Optimum Water Management Plan

1) Criteria

Establishment of the plan for water supply facilities up to the year 2001 will be based on the following conditions:

a) The development plan for the water supply facilities will consist of developing water sources to meet future water demand, constructing new facilities, and rehabilitating existing facilities to supply safe and potable water.

b) The additional water resource from outside of the Kathmandu valley will become available after the year 2001 following completion of the water conveyance facilities from outside of the valley.

c) In order to conserve groundwater resources, abstraction of groundwater will be reduced from the current production amount,and the level of the groundwater shall not be allowed to be lower than the yield computed by simulation.

d) The increasing water demand up to 2001 shall be supplied from water resources within the valley. The groundwater resources are limited, so development of water resource must depend solely on surface water.

e) In regard to the surface water development plan, all available surface water sources within the valley shall be examined and then determined.

f) The available capacity of the surface water, which will be the sole source,will have a high level of monthly variation so the water supply facilities to be established shall coordinated with the planned monthly water supply.

g) The groundwater shall, without exception,be treated with bio-filters to remove ammonia andiron.

h) Disinfection equipment shall be expanded and established at all water treatment plants.

i) The water supply area per system shall be established to minimize the effects upon the quality of water supplied at connections due to variation in the flow rate through the distribution system.

j) The order of precedence of established schemes shall be decided through comparative examination of the many available implementation plans for improving both quality and quantity.

2) Mathematical model simulation on the main aquifer
The FEM mathematical model simulation reveals that

a) The recharge source of the main aquifer is leakage water through aquitard deposit or squeezed from the aquitard deposit:

b) The present rate of groundwater abstraction is twice as much as the available capacity. The abstraction should not exceed the critical abstraction amount of 15,000 m^3/d which is linked with conditions such as pump capacity, upper rim of the main aquifer, depth of strainers and well loss.

c) Artificial groundwater abstraction will cause leakage (or squeeze) of water from upper layers, which may result in stable, or steady condition. But if the abstraction volume reaches or exceeds the critical capacity of 15,000 m^3/d, the pump efficiency will fall and several social problems such as subsidence will occur.

3) Optimum operation

Optimum pump operation have been established by the Modified Simplex Method. The contribution of each well field will be:

a)	Bansbari well field	6,936 m^3/d (44%)
b)	Balaju well field	1,000 m^3/d (6%)
c)	Gokarna/Manohara well field	6,093 m^3/d (39%)
d)	Pharping well field	1,600 m^3/d (10%)
	Total	15,629 m^3/d (100%)
		(15,000 m^3/d)

4) Surface water development

A development plan for surface water in the valley has been formulated to meet the future water demand in Greater Kathmandu up to the year 2001 through exploitability study of all conceivable schemes. In the valley, there are some sixty Government-aided and local farmers' irrigation intakes and nine (9) NWSC's municipal water intakes, where river water is mostly used in the dry season. Therefore, the development plan has been made so as not to interfere with the present arrangement for water abstraction.

5) River water development

For effective use of net surplus river water, additional run-of-river type intake schemes are proposed on six rivers. In this study, two types of intake facilities are envisaged in consideration of site conditions and for ease of operation and maintenance: One is aground-sill type for the three rivers Manohara, Dhobi Khola, and Lambagar Khola,and the other is a concrete weir type for the Balkhu Khola and Bisnumati river. In the Bagmati river, the existing low intake dam of the Sundarijal hydro-power plant could be used also for further water intake. Their planning rate of abstraction will vary seasonally up to 0.15 m^3/s at a maximum according to natural variations in available river water with proper reliability, say more than 80% dependability on average.

6) Storage reservoir schemes

Storage reservoir schemes have also been studied as the valley's own water source development. The Balkhu Khola, reservoir scheme, located to the west of Kirtipur, has the highest reservoir yield potential of 0.8 m^3/s and the highest storage efficiency (effective storage volume divided by dam volume) and appears to be economically superior. However, Bishnu Devi Temple which would be submerged after reservoir impounding is religiously important to local people. Unless this social problem can be solved in advance, this scheme's implementation would be impossible. The Nakhu Khola dam scheme (at Tikabhairau, Q=6.6 m^3/s) and Kodhu Khola,dam scheme (at Baregau, Q=0.3 m^3/s) with the Nakhu Khola, water transfer are expected to be attractive in view of their economical superiority and the absence of great technical constraints to their implementation, though compensation would have to be paid for agricultural land to be inundated.

7) Water quality improvement plan

The groundwater has very high levels of ammonia, iron and manganese, and is not suitable as a source of water supply, if it remains untreated. Ammonia, iron and manganese are not necessarily directly injurious to the health, but they consume a great deal of the chlorine added for chlorination, and this creates the problem of reducing the residual chlorine enough so that it is sufficient for preventing the growth of water-borne disease organisms in the distribution system.

Although both iron and manganese can be treated by normal methods, such a high level of ammonia has never been treated in the field of waterworks. There are several methods of treating ammonia, however, most of which are very expensive and some may generate harmful byproducts such as triphenylmethane gas. Among these methods, an unprecedented experimental biological filtration method was tried out during the field investigation and resulted in excellent treatment effects and without the defers mentioned above. It is recommended, therefore, that groundwater in the valley be treated by this method.

A water quality improvement plan was therefore determined on the basis of a comprehensive treatment system for the groundwater consisting of bio-filtration, coagula-sedimentation and filtration for iron removal, and of a conventional treatment system for the surface water. The following describes the proposed water treatment plan for each system.

a) Balaju system

The water resource for this system consists of the existing surface water source (8,700 m^3/d) and a groundwater source in the Balaju well (600 m^3/d).

The existing Balaju treatment plant, where almost no output is assumed due to deterioration, is to be reconstructed to have a treatment capacity of 9,300 m^3/d. The existing distribution reservoir which has serious leakage shall also be rehabilitated. Treated water shall be stored in this distribution reservoir and then supplied (9,000 m^3/d) to consumers by gravity flow. The treated water of 4,300 m^3/d from the Lambagar treatment plant will also be sent to this distribution reservoir and then into this system.

b) Lambagar system

The water source for this system will be the surface water to be taken in through a new run-of-river intake (14,300 m^3/d) from the Lambagar Khola (W105). A conventional water treatment plant (13,000 m^3/d) will be newly constructed for this system.

The treated water will be sent in part to the Balaju system and the remainder of some 8,300 m^3/d shall be sent to anew distribution reservoir (2,400 m^3/d) through a new transmission pipeline. The water shall be supplied to consumers either by booster pumping system or by gravity flow.

c) Bansbari system

The water resource for this system will consist of the existing surface water source (2,100 m^3/d) of the existing Maharajganj treatment plant, surface water to be taken in through a new run-of-river intake ($14,300\ m^3/d$) from the Bisnumati (W106), and the groundwater source of the Bansbari well field. The groundwater will first be pre-treated through bio-filters and then be treated through a new conventional water treatment plant ($21,500\ m^3/d$) together with the surface water. Of the treated water, $6,900\ m^3/d$ will be supplied to the north area of the city of Kathmandu via the existing Bansbari reservoir ($2,000\ m^3$) by gravity. The remaining water of $13,900\ m^3/d$ will be sent into the Maharajganj system.

d) Maharajganj system

The existing water treatment plant will be demolished and the existing distribution reservoir ($3,750\ m^3$) will be reconstructed to be supplied via a new water transmission pipeline from the new Bansbari treatment plant. $13,900\ m^3/d$ will be supplied from the reservoir by gravity.

e) Mahankal Chaur system

The water source for this system consists of groundwater in the well fields of Gokarna, Manohara and Dhobi Khola, surface water in the Bagmati (W301) from the penstock of the Sundarijal hydroelectric power plant, and the surface water to be taken through a new run-of-river intake from the Dhobi Khola (W202).

The groundwater will first be pre-treated by bio-filters ($18,600\ m^3/d$) to remove the high concentration of both ammonia and iron and then will be treated in a new conventional water treatment plant ($32,900\ m^3/d$) together with the surface water.

The treated water will be sent by pumps into the existing distribution reservoirs ($9,000\ m^3$) and then be supplied to the central area of the city of Kathmandu.

f) Sundarijal system

The water treated in the existing water treatment plant is currently sent into the Mahankal Chaur reservoir but this will be diverted into the new Sundarijal system.

The existing Sundarijal water treatment plant will be reconstructed with a capacity of 20,600 m^3/d. The treated water will be sent to three water distribution reservoirs (1,850 m^3 x 2 basins and 1,550 m^3 x 1 basin) to be newly constructed in the water supply area to the east of the city of kathmandu through the existing transmission pipeline into the Mahankal Chaur reservoir and a new transmission pipeline by which the water will then be supplied at a rate of 6,400 m^3/d, 6,400 m^3/d and 5,200 m^3/d.

g) Shaibhu system

The water source for this system consists of existing spring water and groundwater in the Pharping well field. The water supply area is the city of Lalitpur. To ensure that water of 24,500 m^3/d shall be reliably supplied to consumers for 5 hours each in the morning and evening supply, a 4,500 m^3 distribution reservoir together with a distribution main shall be newly constructed,in addition to the existing distribution reservoir (2,70 m^3) and distribution main. Disinfection equipment shall also be newly constructed.

h) Manohara system

The water supply area is the southeast part of the city of Kathmandu. A conventional water treatment plant shall be newly constructed with the surface water source taken by a new run-of-river intake from Manohara (W406). The treated water will be sent int two new water distribution reservoirs (1,850 m^3 each) within the water supply area from which 6,300 m^3/d will be supplied to consumers by a booster pump system.

i) Balkhu system

The water supply area will be the southwest area of the city of Kathmandu. A conventional water treatment plant will be newly constructed for the surface water resource taken in through a new run-of-river intake from the Balkhu Khola (W802). The treated water will be sent into two new water distribution reservoirs (1,850 m^3 each) within the water supply area and 6,300 m^3/d will be supplied to consumers from one reservoir by gravity and the same quantity from the other reservoir by booster pump type.

8) Concept on implementation plan

In order to meet the water demand up to the year 2001 on both aspects of quality and quantity, the priority for establishment of each scheme of water supply facilities should be determined by the following condition.

a) The water supply to be increased by implementing the schemes shall balance the increase in water demand.

b) No existing supply capacity will be distributed.

c) A scheme with a groundwater source that causes problems in terms of both water quality and quantity, shall in principle take precedence over all other systems, including the expansion of a new surface water source in the systems concerned.

d) A scheme which will include refurbishment of an existing water treatment plant shall be quickly completed, including expansion with a new resource of surface water in the systems concerned.

e) A new scheme with a completely new resource of surface water shall be implemented last.

f) Through consideration shall be given to the workability and economy of the foregoing.

g) Among the afore-mentioned surface water schemes, the storage dam schemes will not be needed before 2001. Hence these schemes are not taken up in this study, but proposed as an element to be considered when the plan after 2001 is studied.

9) Implementation plan

As the result of comparative examination for many available implementation plans,the following implementation order is recommended.

Precedence	Scheme	Main Objectives
1	Mahankal Chaur	Quality improvement of groundwater New treatment plant Development of surface water
2	Bansbari, Maharajganj	Quality improvement of groundwater New treatment plant Development of surface water Improvement of reservoir (Ban. only)
3	Shaibhu	Expansion of transmission pipeline and reservoir
4	Balaju	Renewal of existing treatment plant and reservoir
5	Lambagar	Development of surface water New reservoir, treatment plant and transmission pipeline
6	Sundarijal	Renewal of existing treatment plant New reservoir and transmission pipeline
7	Manohara	Development of surface water Newt treatment plant New transmission pipeline
8	Balkhu	Development of surface water New treatment plant New transmission pipeline

2. Groundwater Management Plan

1) Criteria

a) Groundwater resources in the valley should not be exhausted.

b) The critical groundwater yield shall be obtained by the optimization simulation, and abstraction of groundwater shall not be allowed to exceed the critical level.

c) During the dry season the potential of surface water sources of the valley does not satisfy the demand of water supply. Hence groundwater management will have to be carried out by a combination of well operation by standard production wells with due regard to conjunctive use.

d) Groundwater monitoring and subsidence monitoring is required to manage the groundwater.

2) Groundwater management plan

The critical groundwater yield potential of existing NWSC wells (excluding Bhaktapur well field) for the groundwater management of the Kathmandu Valley is estimated at about 15,000 m^3/d with selected standard wells based on groundwater simulation methods. It is recommended that pump yield be controlled to avoid excessive drawdown.

3) Well operation

Because, during the dry season the potential of surface water resources of the Kathmandu Valley does not satisfy the demand of water supply, groundwater management should be carried out by combination of well operation by standard production wells with due regard to conjunctive use. However, if the total amount of groundwater yield of the standard production wells does not meet the peak demand in the dry season (mainly April and May) then, supplementary groundwater pumping will be required not only from the standard wells but also from other production well during the dry season.

4) Conjunctive use

In order to achieve conjunctive use, the existing NWSC production wells (excluding Bhaktapur well field) have been classified into three groups, namely standard production wells, extra production wells and monitoring wells by a groundwater model simulation method. Twelve production wells have been selected as standard production wells for optimum groundwater management. Other production wells have been chosen as stand-by or extra wells to meet the shortage of surface water during the dry season. Therefore, the rainy season standard operation pumping is to be carried out with the standard production wells. In the dry season peak pumping operations after 1994 will be carried out by all production wells except monitoring wells, on condition that the annual discharge amounts of all NWSC production wells (excluding Bhaktapur well field) shall be controlled to be less than 15,000 m^3/d on a yearly average.

Peak operation forms an exception to the general operation rule. Therefore, careful groundwater monitoring is required to conserve the aquifer. In order to observe the groundwater level, three wells have been selected from NWSC wells and four JICA observation wells as a monitoring well for each well field.

5) Groundwater monitoring

Monitoring methods include not only groundwater level monitoring, but also production monitoring, water quality monitoring, and subsidence monitoring. The information from these monitoring systems will indicate the time for improvement of future predictions before depletion of the aquifer. Also, the subsidence monitoring is important to preserve the Kathmandu Valley from subsidence.

3. Project Cost and Evaluation

1) Cost of projects

For the purpose of determining the priority and for the provisional project evaluation, the projects' costs are estimated provisionally. The results are as follows; namely

Precedence	Project	Foreign Currency Portion	Local Currency Portion	Total
1	Mahankal Chaur	14,030	4,300	18,330
2	Bansbari, Maharajganj	11,599	3,816	15,417
3	Shaibhu	3,579	1,346	4,925
4	Balaju	4,271	973	5,244
5	Lambagar	11,118	4,452	15,570
6	Sundarijal	11,118	4,452	15,570
7	Manohara	12,746	5,988	18,734
8	Balkhu	11,230	5,790	17,020
	Total	76.774	29,717	106,491

2) Project evaluation, economic analysis

The economic analysis has been made on the assumption that all the above mentioned eight schemes (projects) will be implemented so that the benefits and the costs of the eight projects may be treated together.

Tangible benefits will be: (1) those caused by the quantitative increase in the amount of water to be supplied and (2) those caused by the decrease in illness and epidemics owing to the improvement of water quality. The benefits will commence in the year following completion of the first projects and will grow to full benefits of US$4,115 million per year in year following full completion of the eight projects, namely in 2001. These full benefits will occur every year until 2023, and will disappear as the economic lives of the projects expire. The benefits will thus all disappear in 2031. In comparison of these benefits with the costs of the projects (construction cost and the OMR costs),the economic internal rate of return (EIRR) is estimated at 3.4%.

3) Project evaluation, financial analysis

On the assumption that all of the construction costs of the project will depend upon loans,the following model is assumed. Namely,(1) the rate of interest is 1%, (2) the grace period is ten years, and (3) the repayment period is 30 years including the grace period. As to the income, two models are assumed, namely (1) 1.5% of the household income and (2) about four times of the current tariff. In either case, the financial rate of internal rate of return (FIRR) is estimated at less than 2%. However, the loan will be fully refunded during the projects lives of 30 years until 2030, and the income will at all times be more than the relevant operation expenses.

4) Judgement

A municipal water supply project is normally accompanied by low value of internal rate of return (IRR). Nevertheless, implementation of this project provide safe and suitable drinking water to the inhabitants as a basic human needs. Moreover, Nepal is one of the countries whose gross domestic product (GDP) per capita is the lowest in the world. For these reasons, it is judged that these projects are viable.

4. Conclusion and Recommendation

1) Conclusion

At present, groundwater in the valley is being pumped excessively. New water sources from surface water are available by the run-of-river method of 0.15 m^3/s (or 12,600 m^3/d). In the initial stages of developing the surface water, an occasional shortage of water will occur.

As a new development, it is necessary to implement the eight projects proposed herewith one after the other so that all of them may be completed by 2001. The fundamental purpose of municipal water supply is to supply the quantities needed of safe and hygienic water containing the necessary amount of residual chlorine at the users' taps. So long as the groundwater of the valley is used, the obstacle to quality will be the high content of ammonia. In purifying the ammonia contained water, ammonia consumes about ten times the amount of chlorine as compared with purifying the same amount of ferrous and manganese contents. Moreover, it can originate matters which are harmful to the human body. Therefore, removal of ammonia is indispensable. Groundwater from which ammonia has been removed as well as surface water has then to be treated by the normal procedures of sterilization. To supply the water quantities only is not the way to achieve the fundamental requirements of supplying municipal water.

The eight projects proposed in this report are all needed, are technically possibly, and are economically and financially viable. Therefore, all eight of the projects are worthy of implementation.

2) Recommendation 1

It is recommended that there be thorough management of groundwater. Without such management, it would be possible to exhaust the precious aquifer, and give rise social hazards associated with ground subsidence.

a) Of the existing NWSC's wells, twelve wells have been selected as standard production wells and three wells as observation wells. The rest of the wells are to be reserved.

b) In normal cases, pumping of groundwater will be made from the standard production wells only.

c) At the end of the dry season, especially in April and May, when surface water runs short, the reserve wells may have to be operated. However, the pumped amount should not exceed 15,000 m^3/d on a yearly average.

d) When water from outside the valley becomes available,d certain water source will have to be found in place of the reserve wells in order to preserve the groundwater.

e) Monitoring of the groundwater has to be made in order to preserve groundwater and to prevent ground subsidence.

f) Legal feature of groundwater of the Kathmandu Valley should be defined in the near future as public water. Based on this, general legislation management/preservation including regulation of exploitation should be established.

3) Recommendation 2

The eight (8) projects proposed in this report,

a) Mahankal Chaur Project,
b) Bansbari and Maharajganj Project,
c) Shaibhu Project,
d) Balaju project,
e) Lambagar Project,
f) Sundarijal Project,
g) Manohara Project,
h) Balkhu Project

are to be implemented. It is, therefore, recommended that the necessary steps are taken for their implementations. The priority of implementation will follow the above-given precedence for technical reasons.

4) Recommendation 3

It may happen, even after water from outside the valley becomes available, that the surface water in the valley will run short by the end of the dry season, especially in April and May, and this may cause difficulty ion maintaining the peak supplies. Accordingly, plans for storage dams for the valley are worthy of further studies.

APPENDIX 6 Improvement Plans for Groundwater Quality

1. Water Quality Improvement Plan 1

1) Quality improvement target

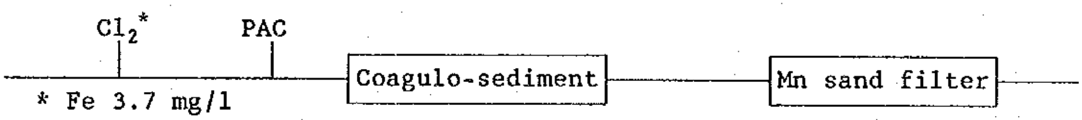
a) Free chlorine : none

b) Iron : removed

c) Manganese: not treated

d) Ammonia : not treated

2) Treatment flow and effect, problems, etc.



a) As manganese is difficult to be oxidized, it cannot be removed by the methods other than using oxidation by means of free chlorine and in condition where there is residual free chlorine. In this treatment method, the water supply will be made without removing the manganese. However, if there is no reaction with free chlorine thereafter, there would be no problem in this case.

b) Ammonia nitrogen cannot be treated by this method, either. In the case in the distribution piping where there is no residual chlorine, organic matters deposit in the piping due to breeding of bacteria and extinction, etc., of bacteria concerning ammonia nitrogen, which will be connected to increased muddy color matter and aggravation of water quality.

c) As pH and alkalinity are low and the corrosive quality of treated water containing much dissolved matters is high and due to increase in undissolved matter due to breeding and extinction of bacteria in the piping, the corrosion and deterioration of distribution piping are accelerated. In addition the problem of colored water, etc., due to iron rust as a result of corrosion of piping.

d) The bacilli system including pathogenic bacilli in the treatment process and raw water cannot be eradicated, thus the bacilli system is sent to and breeds in the distribution piping.

e) This system dose not allow to eradication of pathogenic bacilli and other bacilli in the case of an emergency in the distribution piping

2. Water Quality Improvement Plan 2

1) Quality improvement target

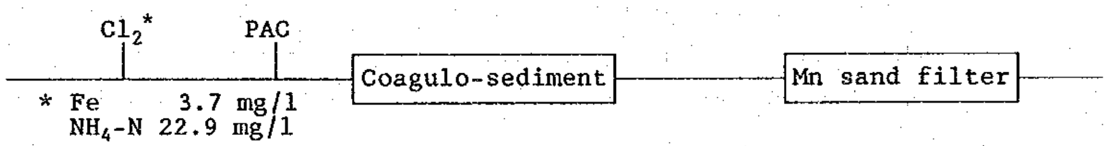
a) Free chlorine : none

b) Iron : removed

c) Manganese : not treated

d) Ammonia : chloramine

2) Treatment flow and effect, problems, etc.



a) With regard to manganese there are problems similar to those of Improvement Plan 1.

b) Ammonia nitrogen becomes monochlamine (NH_2Cl) or di-chloramine ($NHCl_2$). It has the sterilizing power of about 1/25 of free chlorine, ensuring the required sterilizing capability in the distribution piping. However, this substance has the following problems:

- Di-chloramine causes an offensive odor.
- As the feeding of chlorine about the degree of B.P. is required corresponding to the concentration of ammonia nitrogen in the raw water, it is necessary to measure the concentration and feeding control of chlorine coping therewith. As the technological level of proper feeding is very high, the proper control is difficult.
- Excessive chlorine may cause the water to blacken due to oxidation of manganese, and may change the flow rate as it deposits in the piping. If there is oxygen shortage problems similar to those of Improvement Plan 1 would arise.

c) Bacilli including pathogenic bacilli will be same as Improvement Plan 1.

d) The sterilizing capacity in the distribution piping will be the same as Improvement Plan 1.

3. Water Quality Improvement Plan 3

1) Quality improvement target

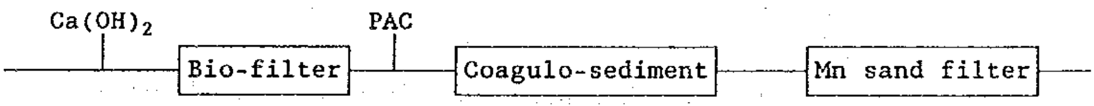
a) Free chlorine : none

b) Iron : removed

c) Manganese : not treated

d) Ammonia : nitrification

2) Treatment flow and effect, problems, etc.



a) There will be problems similar to Improvement Plan 1 with regard to manganese.

b) The ammonia nitrogen is nitrified. The treated water becomes high both in alkalinity and pH due to feeding of alkali agent for treatment of ammonia nitrogen, thereby increasing corrosive nature of water and in turn contribute to further deteriorate the water quality in the distribution piping.

c) Bacilli including pathogenic bacilli will be the same as water quality Improvement Plan 1.

d) The sterilizing capacity in the distribution piping will be the same as Water Quality Improvement Plan 1.

4. Water Quality Improvement Plan 4

1) Quality improvement target

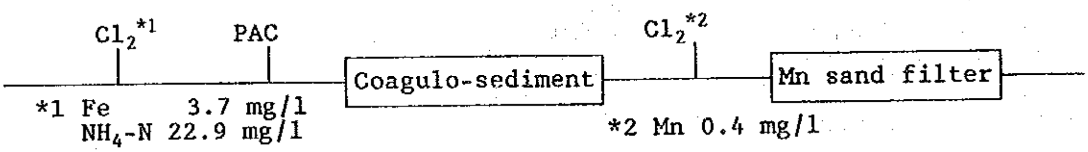
a) Free chlorine : none

b) Iron : removed

c) Manganese : removed

d) Ammonia : chloramine

2) Treatment flow and effect, problems, etc.



a) The manganese is oxidized by free chlorine and remove in the manganese sand filtration.

b) The problem of manganese for connection with other water supply systems with existing excess chlorine and free chlorine due to chloramine of ammonia nitrogen will be eliminated.

c) The ammonia nitrogen will be the same as Water Quality Improvement Plan 2.

5. Water Quality Improvement Plan 5

1) Quality improvement target

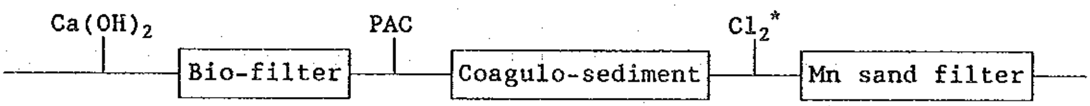
a) Free chlorine : none

b) Iron : removed

c) Manganese : not treated

d) Ammonia : nitrification

2) Treatment flow and effect, problems, etc.



* Mn 0.4 mg/l

a) The manganese, after reducing its load by means of nitrified matters and coagulo-sedimentation treatment of oxides of iron, is oxidized by free chlorine and removed by sand filtration.

b) The ammonia nitrogen is nitrified by means of biological filtration similar to Water Quality Improvement Plan 3.

c) The treated water is sterilized.

d) The sterilizing capacity in the distribution piping will be the sane as Water Quality Improvement Plan 1.

6. Water Quality Improvement Plan 6

1) Quality improvement target

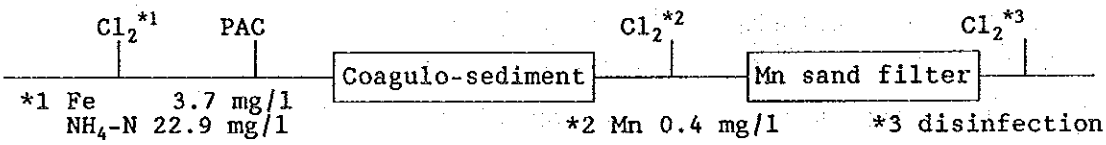
a) Free chlorine : exists

b) Iron : removed

c) Manganese : removed

d) Ammonia : chloramine

2) Treatment flow and effect, problems, etc.



a) The manganese will be the same as Water Quality Improvement Plan 4.

b) The ammonia nitrogen will be the same as Water Quality Improvement Plan 2.

c) Bacilli including pathogenic bacilli of treated water are eradicated.

d) There is sterilizing capacity in the distribution piping.

7. Water Quality Improvement Plan 7

1) Quality improvement target

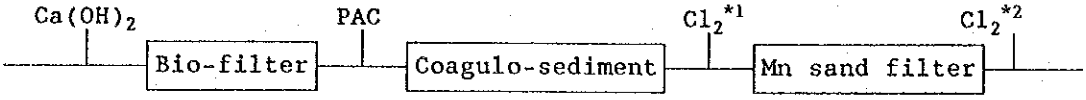
a) Free chlorine : exists

b) Iron : removed

c) Manganese : removed

d) Ammonia : nitrification

2) Treatment flow and effect, problems, etc.



*1 Mn 0.4 mg/l *2 disinfection

a) The manganese will be the same as Water Quality Improvement Plan 5.

b) The ammonia nitrogen will be the same as Water Quality Improvement Plan 3.

c) The bacilli including pathogenic bacilli of treated water are eradicated.

d) There is sterilizing capacity in the distribution piping.

APPENDIX 7 Breakdown of Operation and Maintenance Cost

1. Personnel Expenses

(1) Mahankal Chaur project

	person		NRs/person		NRs/month
Plant Manager	1	x	3,500	=	3,500
Asst. Plant Manager	1	x	3,000	=	3,000
Section Chief	4	x	2,750	=	11,000
Asst. Chief	9	x	2,250	=	20,250
Engineer/Officer	21	x	1,750	=	36,750
Technician	76	x	1,350	=	102,600
Asst. Officer	2	x	1,350	=	2,700
Janitor	5	x	750	=	3,750
Watchman	23	x	1,000	=	23,000
Total	142				206,550

206,550 x 12 = 2,478,600 NRs/year

(2) Bansbari project

	person		NRs/person		NRs/month
Plant Manager	1	x	3,500	=	3,500
Asst. Plant Manager	1	x	3,000	=	3,000
Section Chief	4	x	2,750	=	11,000
Asst. Chief	10	x	2,250	=	22,500
Engineer/Officer	21	x	1,750	=	36,750
Technician	61	x	1,350	=	82,350
Asst. Officer	2	x	1,350	=	2,700
Janitor	5	x	750	=	3,750
Watchman	20	x	1,000	=	20,000
Total	125				185,550

185,550 x 12 = 2,226,600 NRs/year

2. Fuel Cost

(1) Mahankal Chaur Project

	lit/month		months		NRs/lit		NRs/year
Administrative use vehicle	300	x	12	x	10	=	36,000

(2) Bansbari Project

	lit/month		months		NRs/lit		NRs/year
Administrative use vehicle vehicle	300	x	12	x	10	=	36,000
Transportation vehicle	200	x	12	x	10	=	24,000
Total							60,000

3. Equipment Maintenance Cost

(1) Maintenance plan

1) General purpose pump & blower

Two and half years maintenance	Replacement of seal & packing
Five years maintenance	Replacement of shaft sleeve & bearing

2) Chemical feeding pump & agitator

Two and half years maintenance	Replacement of seal & packing
Five years maintenance	Replacement of diaphragm

3) Water softener

Two and half years maintenance	Replacement of resin

4) Water quality measuring instrument

One year maintenance	Replacement of battery & lamp

5) Well pump

Five years maintenance	Replacement of shaft fittings, propeller, sleeve, ring, bushings
Seven and half years maintenance	Submersible pump

(2) Equipment list

1) Mahankal Chaur project

a)	Pump & blower	Blower (3), Surface washing pump (3), Make-up water pump (2), Transfer pump (3), Drain pump (2)
b)	Pump & agitator	Agitator (10), Transfer pump (8), Chemical feeding pump (18), Other pumps (4)
c)	Water softener	Water softener (1)
d)	Instruments	pH meter (3), Turbidity meter (3), Residual chlorine meter (1)
e)	Well pump	Pump (14)

2) Bansbari project

a)	Pump & blower	Blower (3), Surface washing pump (3), Make-up water pump (2), Transfer pump (4), Drain pump (2)
b)	Pump & agitator	Agitator (10), Transfer pump (8), Chemical feeding pump (18), Other pumps (4)
c)	Instruments	pH meter (3), Turbidity meter (3), Residual chlorine meter (1)
d)	Well pump	Pump (8)

(3) Maintenance cost

1) Mahankal Chaur project

a) Pump & blower

Two and half years maintenance

	NRs/set/time		times		NRs
Blower	20,300	x	2	=	40,600
Surface washing pump	33,900	x	2/3	=	22,600
Make-up water pump	24,800	x	1	=	24,800
Transfer pump	33,900	x	3	=	101,700
Drain pump	27,000	x	2/3	=	18,000
Total					207,700

Five years maintenance

	NRs/set/time		times		NRs
Blower	97,000	x	2	=	194,000
Surface washing pump	174,000	x	2/3	=	116,000
Make-up water pump	151,000	x	1	=	151,000
Transfer pump	174,000	x	3	=	522,000
Drain pump	78,000	x	2/3	=	52,000
Total					1,035,000

207,700 + 1,035,000 = 1,242,700 NRs
1,242,700 ÷ 5 = 249,000 NRs/year

b) Pump & agitator

Two and half years maintenance

	NRs/set/time		times		NRs
Agitator	11,200	x	5	=	56,000
Transfer pump	4,500	x	4	=	18,000
Chemical feeding pump	4,500	x	7	=	31,500
Other pump	4,500	x	2	=	9,000
Sub-total					114,500

Five years maintenance

	NRs/set/time		times		NRs
Agitator	22,600	x	5	=	113,000
Transfer pump	33,800	x	4	=	135,200
Chemical feeding pump	11,200	x	7	=	78,400
Other pump	11,200	x	2	=	22,400
Sub-total					349,000

114,500 + 349,000 = 463,500 NRs
463,500 ÷ 5 = 93,000 NRs/year

c) Water softener

Two and half years maintenance

	NRs/set/time		times		NRs
Water softener	60,000	x	1	=	60,000

60,000 ÷ 2.5 = 24,000 NRs/year

d) Water quality measuring instruments

	NRs/set/time		times		NRs
pH meter	2,200	x	3	=	6,600
Turbidity meter	500	x	3	=	1,500
Residual chlorine meter	10,800	x	1	=	10,800
Sub-total					18,900

19,000 NRs/year

e) Well pump

Five years maintenance

	NRs/set/time		times		NRs
Well pump	52,000	x	7	=	364,000

364,000 ÷ 5 = 72,800 NRs/year

Seven and half years maintenance

	NRs/set/time		times		NRs
Well pump	248,300	x	7	=	1,738,100

1,738,100 ÷ 7.5 = 231,700 NRs/year

Sub-total 305,000 NRs/year

Total 690,000 NRs/year

1) Bansbari project

a) Pump & blower

Two and half years maintenance

	NRs/set/time		times		NRs
Blower	20,300	x	2	=	40,600
Surface washing pump	33,900	x	2/3	=	22,600
Make-up water pump	24,800	x	1	=	24,800
Transfer pump	33,900	x	2	=	144,000
Drain pump	27,000	x	2/3	=	18,000
Total					250,000

Five years maintenance

	NRs/set/time		times		NRs
Blower	97,000	x	2	=	194,000
Surface washing pump	174,000	x	2/3	=	116,000
Make-up water pump	151,000	x	1	=	151,000
Transfer pump	113,000	x	2	=	226,000
Drain pump	78,000	x	2/3	=	52,000
Total					739,000

(250,000 + 739,000) ÷ 5 = 198,000 NRs/year

b) Chemical feeding pump & agitator

Two and half years maintenance

	NRs/set/time		times		NRs
Agitator	11,200	x	5	=	56,000
Transfer pump	4,500	x	4	=	18,000
Chemical feeding pump	4,500	x	7	=	31,500
Other pump	4,500	x	2	=	9,000
Sub-total					114,500

Five years maintenance

	NRs/set/time		times		NRs
Agitator	22,600	x	5	=	113,000
Transfer pump	33,800	x	4	=	135,200
Chemical feeding pump	11,200	x	7	=	78,400
Other pump	11,200	x	2	=	22,400
Sub-total					349,000

(114,500 + 349,000) ÷ 5 = 93,000 NRs/year

c) Water quality measuring instrument

	NRs/set/time		times		NRs
pH meter	2,200	x	3	=	6,600
Turbidity meter	500	x	3	=	1,500
Residual chlorine meter	10,800	x	1	=	10,800
Sub-total					18,900

19,000 NRs/year

e) Well pump

Five years maintenance

	NRs/set/time		times		NRs
Well pump	52,000	x	4	=	208,000

208,000 ÷ 5 = 41,600 NRs/year

Seven and half years maintenance

	NRs/set/time		times		NRs
Well pump	248,300	x	4	=	993,200

993,200 ÷ 7.5 = 132,400 NRs/year

Sub-total 174,000 NRs/year

Total 484,000 NRs/year

4. Chemical Cost for Treatment

(1) Water quantity to be treated

1) Mahankal Chaur project

Year 1995

	Bio-filter	Treatment	Water supply
Groundwater	1,425,321	1,378,140	1,338,000
Surface water (in wet season)	-	3,679,160	3,572,000
Surface water (in dry season)	-	2,839,401	2,756,700
Total	1,425,000 m^3	7,897,000 m^3	7,667,000 m^3

Year 2001

	Bio-filter	Treatment	Water supply
Groundwater	1,879,750	1,839,477	1,785,900
Surface water (in wet season)	-	3,700,893	3,593,100
Surface water (in dry season)	-	2,839,401	2,756,700
Total	1,880,000 m^3	8,380,000 m^3	8,136,000 m^3

2) Bansbari Project

Year 1995

	Bio-filter	Treatment	Water supply
Groundwater	1,985,600	1,929,808	1,873,600
Surface water (in wet season)	-	2,847,744	2,764,800
Surface water (in dry season)	-	1,652,841	1,604,700
Total	1,986,000 m^3	6,430,000 m^3	6,243,000 m^3

Year 2001

	Bio-filter	Treatment	Water supply
Groundwater	2,120,650	2,075,038	2,014,600
Surface water (in wet season)	-	2,866,387	2,782,900
Surface water (in dry season)	-	1,655,931	1,607,700
Total	2,121,000 m^3	6,597,000 m^3	6,405,000 m^3

(2) Chemical cost for treatment (Breakdown in 1995)

1) Mahankal Chaur project

PAC

				t/year
Surface water (in wet season)	3.7×10^{-6}	x 3,679,000	=	13.6
Surface water (in dry season)	2.6×10^{-6}	x 2,839,000	=	7.4
Groundwater	2.6×10^{-6}	x 1,378,000	=	3.6
Total				24.6

24.6 t/year x 74,200 NRs/t = 1,825,000 NRs/year

NaOH

				t/year
Groundwater	10×10^{-6}	x 1,425,000	=	14.3

14.3 t/year x 22,200 NRs/t = 317,000 NRs/year

$Ca(OH)_2$

				t/year
Surface water (in wet season)	$16/0.8 \times 10^{-6}$	x 3,679,000	=	73.6
Surface water (in dry season)	$4/0.8 \times 10^{-6}$	x 2,839,000	=	14.2
Total				87.8

87.8 t/year x 2,000 NRs/t = 176,000 NRs/year

Brine

				t/year
Surface water (in wet season)	2.5×10^{-6}	x 2.6 x 3,679,000	=	23.9
Surface water (in dry season)	1.5×10^{-6}	x 2.6 x 2,839,000	=	11.1
Groundwater	1.8×10^{-6}	x 2.6 x 1,378,000	=	6.4
Total				41.4

41.4 t/year x 1,650 NRs/t = 68,000 NRs/year

Total chemical cost 2,386,000 NRs/year

2) Bansbari project

PAC

			t/year
Surface water (in wet season)	3.7×10^{-6}	x 2,848,000 =	10.5
Surface water (in dry season)	2.6×10^{-6}	x 1,653,000 =	4.3
Groundwater	2.6×10^{-6}	x 1,930,000 =	5.0
Total			19.8

19.8 t/year x 74,200 NRs/t = 1,469,000 NRs/year

NaOH

			t/year
Groundwater	10×10^{-6}	x 1,986,000 =	19.9

19.9 t/year x 22,200 NRs/t = 442,000 NRs/year

$Ca(OH)_2$

			t/year
Surface water (in wet season)	$16/0.8 \times 10^{-6}$	x 2,848,000 =	57.0
Surface water (in dry season)	$4/0.8 \times 10^{-6}$	x 1,653,000 =	8.3
Total			65.3

65.3 t/year x 2,000 NRs/t = 131,000 NRs/year

Brine

			t/year
Surface water (in wet season)	2.5×10^{-6}	x 2.6 x 2,848,000 =	18.5
Surface water (in dry season)	1.5×10^{-6}	x 2.6 x 1,653,000 =	6.4
Groundwater	1.8×10^{-6}	x 2.6 x 1,930,000 =	9.1
Total			34.0

34.0 t/year x 1,660 NRs/t = 56,000 NRs/year

Total chemical cost 2,098,000 NRs/year

(3) Chemical cost for treatment (Breakdown in 2001)

1) Mahankal Chaur project

PAC

			t/year
Surface water (in wet season)	$3.7 \times 10^{-6} \times 3{,}701{,}000$	=	13.7
Surface water (in dry season)	$2.6 \times 10^{-6} \times 2{,}839{,}000$	=	7.4
Groundwater	$2.6 \times 10^{-6} \times 1{,}839{,}000$	=	4.8
Total			25.9

25.9 t/year x 74,200 NRs/t = 1,922,000 NRs/year

NaOH

			t/year
Groundwater	$10 \times 10^{-6} \times 2{,}121{,}000$	=	21.2

21.2 t/year x 22,200 NRs/t = 471,000 NRs/year

$Ca(OH)_2$

			t/year
Surface water (in wet season)	$20 \times 10^{-6} \times 3{,}701{,}000$	=	74.0
Surface water (in dry season)	$5 \times 10^{-6} \times 2{,}839{,}000$	=	14.2
Total			88.2

88.2 t/year x 2,000 NRs/t = 176,000 NRs/year

Brine

			t/year
Surface water (in wet season)	$2.5 \times 10^{-6} \times 2.6 \times 3{,}701{,}000$	=	24.1
Surface water (in dry season)	$1.5 \times 10^{-6} \times 2.6 \times 2{,}839{,}000$	=	11.1
Groundwater	$1.8 \times 10^{-6} \times 2.6 \times 1{,}839{,}000$	=	8.6
Total			43.8

43.8 t/year x 1,650 NRs/t = 72,000 NRs/year

Total chemical cost 2,641,000 NRs/year

2) Bansbari project

PAC

			t/year
Surface water (in wet season)	$3.7 \times 10^{-6} \times 2,866,000$	=	10.6
Surface water (in dry season)	$2.6 \times 10^{-6} \times 1,656,000$	=	4.3
Groundwater	$2.6 \times 10^{-6} \times 2,075,000$	=	5.4
Total			20.3

20.3 t/year x 74,200 NRs/t = 1,506,000 NRs/year

NaOH

			t/year
Groundwater	$10 \times 10^{-6} \times 2,121,000$	=	21.2

21.2 t/year x 22,200 NRs/t = 471,000 NRs/year

$Ca(OH)_2$

			t/year
Surface water (in wet season)	$20 \times 10^{-6} \times 2,866,000$	=	57.3
Surface water (in dry season)	$5 \times 10^{-6} \times 1,656,000$	=	8.3
Total			65.6

65.6 t/year x 2,000 NRs/t = 131,000 NRs/year

Brine

			t/year
Surface water (in wet season)	$2.5 \times 10^{-6} \times 2.6 \times 2,866,000$	=	18.6
Surface water (in dry season)	$1.5 \times 10^{-6} \times 2.6 \times 1,656,000$	=	6.5
Groundwater	$1.8 \times 10^{-6} \times 2.6 \times 2,075,000$	=	9.7
Total			34.8

34.8 t/year x 1,650 NRs/t = 57,000 NRs/year

Total chemical cost 2,165,000 NRs/year

5. Electrical Costs

(1) Mahankal Chaur project (Year 1995)

1) Deep well pump

		NRs/year
Basic charge	32,561.25 NRs/month x 12 month =	390,735
Usage fee	398,494/0.8 KWH/year x 0.75 NRs/KWH =	373,588
Sub-total		764,323

2) Treatment plant

		NRs/year
Basic charge	284.35/0.8 KW/month x 50 NRs/KW x 12 months	
	=	213,264
Usage charge	415,964/0.8 KWH/year x 0.65 NRs/KWH =	337,971
Sub-total		551,235

Total 1,315,558 NRs/year

(2) Bansbari project (Year 1995)

1) Deep well pump

		NRs/year
Basic charge	38,902.50 NRs/month x 12 months =	466,830
Usage fee	997,100/0.8 KWH/year x 0.75 NRs/KWH =	934,781
Sub-total		1,401,611

2) Treatment plant

		NRs/year
Basic charge	245.95/0.8 KW/month x 50 NRs/KW x 12 months	
	=	184,464
Usage fee	323,980 KWH/year x 0.65 NRs/KWH =	263,234
Sub-total		447,700

Total 1,849,311 NRs/year

(3) Mahankal Chaur project (Year 2001)

1) Deep well pump

		NRs/year
Basic charge	32,561.25 NRs/month x 12 months =	390,735
Usage fee	524,518/0.8 KWH/year x 0.75 NRs/KWH=	491,735
Sub-total		882,471

2) Treatment plant

		NRs/year
Basic charge	284.35/0.8 KW/month x 50 NRs/KW x 12 months =	213,264
Usage fee	471,811/0.8 KWH/year x 0.65 NRs/KWH =	383,346
Sub-total		596,610

Total 1,479,081 NRs/year

(4) Bansbari project (Year 2001)

1) Deep well pump

		NRs/year
Basic charge	38,902.5 NRs/month x 12 months =	466,830
Usage fee	1,067,810/0.8 KWH/year x 0.75 NRs/KWH=	1,001,072
Sub-total		1,468,369

2) Treatment plant

		NRs/year
Basic charge	245.95/0.8 KW/month x 50 NRs/KW x 12 months =	184,464
Usage fee	337,249/0.8 KWH/year x 0.65 NRs/KWH=	274,015
Sub-total		458,479

Total 1,926,848 NRs/year

MOTOR CAPACITY AND BASIC POWER CHARGE FOR DEEP WELL PUMPS

Mahankal Chaur project

Well Name	Output	Input (Output/0.8) KW	Basic Charge (Input X 57 KW/Month)
GK 1	28	35	1,995
2	"	"	"
3	"	"	"
4	"	"	"
6 (none)	"	"	"
MH 2	42	5.25	2,992.5
3	"	"	"
4	"	"	"
5	"	"	"
6 (none)	"	"	"
7	"	"	"
DK 3	18	22.5	1,282.5
4	"	"	"
5	"	"	"
6	11 KW	13.75	783.75
Total	475 KW	471.25	32,561.25 NRs/month

Bansbari project

Well Name	Output	Input (Output/0.8) KW	Basic Charge (Input X 57 KW/Month)
Balaju	11	13.75	783.75
BB 7	75	93.75	5,343.75
0	30	37.5	2,137.5
2	30	37.5	"
3	80	100	5,700
4	80	100	"
5	80	100	"
6	80	100	"
Total	546 KW	682.5 KW	38,902.5 NRs/month

6. Replacement of Electrode for Hypochlorite Generator

Year 1995

Electrode 24,600,000 yen/set (130 kgCl/d) = 5,553,000 NRs

Replacement period $\frac{25,000}{365 \times 24}$ year x $\frac{130 \text{ kg} \times 2}{79.5 \text{ kg}}$ = 9.33 years

Annual cost $\frac{5,553,000 \times 2}{9.33}$ = 1,190,000 NRs/year

Mahankal Chaur	1,190,000 x 0.549	=	653,000 NRs/year
Bansbari	1,190,000 x 0.451	=	537,000 NRs/year

Year 2001

Replacement period $\frac{25,000}{365 \times 24}$ year x $\frac{130 \text{ kg} \times 2}{82.8 \text{ kg}}$ = 9.00 years

Annual cost $\frac{5,553,000 \times 2}{9}$ = 1,234,000 NRs/year

Mahankal Chaur	1,234,000 x 0.557	=	687,000 NRs/year
Bansbari	1,234,000 x 0.443	=	547,000 NRs/year

7. Distribution Costs

	person		NRs/person		NRs/month
Sweeper	1	x	750	=	750
Helper	2	x	1,000	=	2,000
Chief	1	x	2,750	=	2,750
Technician	2	x	1,350	=	2,700
Operation					
Asst. Chief	5	x	2,250	=	11,250
Engineer	10	x	1,750	=	175,000
Technician	20	x	1,350	=	27,000
Maintenance					
Asst. Chief	2	x	2,250	=	4,500
Engineer	5	x	1,750	=	8,750
Technician	10	x	1,350	=	13,500
Total					248,200

248,200 x 12 = 2,978,400 NRs/year
2,978,400 x 0.567 (Proportion of the Project)
= 1,689,000 NRs/year

8. Water Charge Collection

Per revenue office

	person		NRs/person		NRs/month
Ass Chief	1	x	750	=	750
Clerk	3	x	1,750	=	5,250
Ass Clerk	3	x	1,350	=	4,050
Helper	3	x	1,000	=	3,000
Sweeper	1	x	750	=	750
Total					15,300

15,300 x 12 = 183,600 NRs/year
183,600 x 9 offices = 1,652,400 NRs/year

Meter reader

	person		NRs/month		NRs/month
Assistant clerk	45	x	1,000	=	45,000

45,000 x 12 = 540,000 NRs/year

Total 2,192,400 NRs/year

2,192,400 x 0.567 (Proportion of the Project)
= 1,243,000 NRs/year

APPENDIX 8 Scope of Work for the Government of Nepal

(1) Land Acquisition Costs

1) Mahankal Chaur Treatment Plant	
Area to be Purchased	8,048m^2 (15 Ropanis 13 anna)
Cost per m^2	1,600 NRs
Total Cost	1,287,600 NRs
2) Bansbari Treatment Plant	
Area to be Purchase	4,294m^2 (8 Ropanis 7 anna)
Cost per m^2	1,200 NRs
Total Cost	5,153,000 NRs
Total	18,029,000 NRs

(2) Costs for Administrative Facilities

Mahankal Chaur Treatment Plant	
Fence (Brick, h = 2m)	254m x 1,800 NRs/m = 457,200 NRs
Bansbari Treatment Plant	
Fence (Brick, h = 2m)	30m x 1,800 NRs/m = 54,000 NRs
Fence (Barbed Wire)	75m x 510 NRs/m = 38,250 NRs
Sundarijal Intake	
Fence (Barbed Line)	30m x 510 NRs/m = 15,300 NRs
Total	564,750 NRs

JICA