For each system, the water is collected either at a treatment plant or reservoir, from where it is distributed to cities. As a result of this investigation, the available capacity of the water source for water supply in the Kathmandu valley can now be assumed to account for 60,540 m3/day from surface water and for 55,620 m3/day from groundwater, amounting to 116,160 m3/day.

For the groundwater, however, because the extreme drawdown caused by mutual interferences due to the closeness between wells, in addition to such factors as facility repairs, electrical fault, etc., the actual available abstraction of the groundwater may be assumed to be much less than the above mentioned value.

Table G-1.1 gives the available capacity of surface water and groundwater for each system.

1.3 Water Supply

Both the surface water and groundwater supplied from each source, either remains untreated or after treatment through the treatment plants of each system, is stored in the distribution reservoirs, from where it is distributed to the cities through the intermittent supply of approximately three hours each in the morning and evening.

Using operation records over a period from August 3 to August 12, 1989 collected during the field investigations of five major reservoirs (Balaju, Bansbari, Maharajganj, Mahankal Chaur and Shaibhu) supplying water to the cities of Kathmandu and Lalitpur, and wells supplying water to each of the above reservoirs, the inflow amount and supply amount of these reservoirs were analyzed.

It was found that the average inflow amount to the five reservoirs accounted for 39,080 m3/day from surface water and for 21,890 m3/day from groundwater, amounting to 60,970 m3/day, and water supply amount from the reservoirs to the cities of Kathmandu and Lalitpur accounted for 61,155 m3/day.

A summary of the analyses for the supply amount is shown in Table G-1.2 and the results of the analyzing each reservoir are given in Table G-1.3.

1.4 Treatment Works

In Kathmandu, there are now five treatment plants: four at Balaju, Maharajganj, Sundarijal and Sundarighat to supply water to the cities of Kathmandu and Lalitpur; and one at Bansbari for the city of Bhaktapur.

Of these, the Sundarighat treatment plant used to take a raw water from the Bagmati, but this has been abandoned, because of heavily contaminated raw

water due to an increasing inflow of urban sewerage in recent years. The following describes both a summary of the facilities and the current status of maintaining and operating each treatment plant.

(1) Balaju treatment plant

The Balaju treatment plant was constructed in 1961 to treat the surface water from the Lambagar Khola and from springs at five locations within the Bisnumati basin. The design capacity is 10,900 m3/day. When the turbidity of raw water is high, there is provision for adding a coagulant to the raw water at the raw water inlet channel, but in practice no coagulant is added and the raw water is sent directly to the sedimentation basin.

Because of imposing an excessive load on the filtration basin and of insufficient coagulation, as well as inadequate washing, the filter media are too contaminated for satisfactory filtration. The results of measuring the contamination from the samples of filter sand both before and after backwashing are given in Table G-1.4.

Into this treatment plant, the groundwater is sent both from the Balaju well and the BB7 well in the Bansbari well field, but this is flowing into the reservoir untreated. For chlorination, bleaching powder is added at the filtered water channel, but as the quality of filtered water is bad, the residual chlorine is found to be about 0.1 ppm or less in the reservoir.

A summary of the system is presented below:

Water Resource	: Lambagar Kh.,Panchmani, Boud, Bhandare, Allye, Chhahare, Balaju well, BB7
Transmission Main	: CI 125 m/m,150 m/m x 12.6 km CI 125 m/m,150 m/m x 6.7 km CI 100 m/m-300 m/m x 11.4 km
Balaju Treatment Plant	
constructed	: 1961(ICM Aid)
design capacity	: 10,900 m3/day
coagulation	: Alum(16% Al2O3 from India)
flocculation	: Three compartment horizontal flow system
rapid sand filter	: 32.8 m2 x 2 basins (backwash with air scour)
chlorination	: Chlorine gas (68kg cylinders from India, Wellace & Tieraman V-notch variable orifice chlorinator)
Balaju Distribution Reservoir	
constructed	: 1930
design capacity	: 4,500 m3 (surface area 765 m2, depth 5.9 m)
capacity operated	: 3,700 m3
inlet pipe	: 400 m/m
outlet pipe	: 200 m/m, 400 m/m

(2) Maharajganj treatment plant

This treatment plant was constructed in 1960, and treats the surface water from two springs at Bisnumati and Shivapuri. The design capacity is 2,400 m3/day.

The sedimentation basin was demolished in 1987 due to a severe water leakage, and the raw water now flows directly into the filter basin. For this reason and because of inadequate washing facilities, as well as an excessive load imposed on the filter basin, the filter media are substantially contaminated (refer to Table G-1.4). Also, because of having only a filter basin, the raw water flows directly into the reservoir during washing.

For chlorination, bleaching powder is added to the filtered water channel, but because of the untreated groundwater entering from the Bansbari reservoir or other wells, as well as the poor quality of the treated water, the residual chlorine is less than 0.1 ppm in the reservoir.

A summary of the system is presented below:

Water Resources	: Bisnumati, Shivapuri, BBO
Transmission main	: SI 150 m/m x 1.4 km CI 125 m/m,200 m/m x 8.7 km
Maharajganj Treatment Plant	
constructed	: 1960
design capacity	: 2,400 m3/day
rapid sand filter	: 24.25 m2 x 1 basin (backwash without air scour)
chlorination	: Bleaching powder
Maharajganj Distribution Reservoir	
constructed	: 1895
capacity	: 1,900 m3 (surface area 1,630 m2, depth 3.0 m)
inlet pipe	: 300 m/m (from the treatment plant) 300 m/m (overflow from Bansbari)
outlet pipe	: 275 m/m

(3) Sundarijal treatment plant

This treatment plant was constructed in 1966, and is one of the major treatment plants for the city of Kathmandu. it treats water from the Sundarijal dam (Bagmati), with a design capacity of 19,600 m3/day.

When the turbidity of raw water is high during the wet season, both a coagulant (alum) and lime are added to the raw water inlet channel to increase alkalinity and to adjust the pH. Although the rate of dosage of both the coagulant and lime is determined by Jar test, the actual dosage rate differs from the result of this test, and is insufficient. The raw water, after

addition of chemicals, is mixed in the channel, and then sent to the sedimentation basin.

There are three filter basins, each being washed daily. Because the chemical dosage is insufficient and because the capacity of the back washing tank is not enough to continue the washing for a sufficient time, the filter media are contaminated (refer to Table G-1.4).

For chlorination, bleaching powder is added to the filtered water channel. After chlorination, water is supplied to villages along the transmission line, and then stored in the Mahankal Chaur reservoir.

A summary of the system is presented below:

Water Resources	: Bagmati (Sundarijal dam), Gokarna W.F., Manohara W.F., Dhobi Khola W.F.
Transmission main	: CI 500 m/m x 8.5 km
Sundarijal Treatment Plant	
constructed	: 1966
design capacity	: 19,600 m3/day
safe yield	: 21,600 m3/day
balancing reservoir	: 4,770 m3 x 2 basins
aeration	: Four steps cascade aerator
coagulation	: Alum and lime
flocculation	: Channel baffle type
sedimentation	: Vertical flow system
rapid sand filter	: 54 m2 x 3 basins (backwash with air scour)
chlorination	: Chlorine gas
Mahankal Chaur Distribution Reservoir	
<Old Reservoir>	
constructed	: 1966
design capacity	: 2,250 m3 x 2 cells (surface area 626 m2, depth 3.66 m)
<New Reservoir>	
constructed	: 1974 (under the 1st Project)
capacity	: 2,250 m3 x 2 tanks (2 circular RC tanks, dia. 29.1 m, depth 3.15m)
chlorination	: Chlorination gas and bleaching powder
inlet pipe	: 150 m/m (from DK1, not used) 150 m/m (from DK5) 300 m/m (from DK3, DK4, DK6) 400 m/m (from Gokarna W.F. and Manohara W.F.) 500 m/m (from Sundarijal T.P.)
outlet pipe	: 600 m/m, 800 m/m

(4) Bansbari treatment plant

This treatment plant treats the surface water from the Mahadev Khola, supplying it to the city of Bhaktapur. The design capacity is 4,900 m3/day. Because this plant is not provided with a chemical feeding facility, the raw

water flows directly into the sedimentation basin without the addition of any coagulant. Especially when the turbidity of the raw water is high during the wet season, therefore, it remains unsettled in the sedimentation basin and is sent into the filter basin.

There are three filter basins. But, for lack of washing equipment, washing of filter materials is performed manually by taking out them from the basins (refer to Table G-1.4). For chlorination, bleaching powder is added to the reservoir. The residual chlorine, however, was found to be about 0.1 ppm in the dry season, but less than 0.1 ppm in the wet season.

A summary of the system is presented below:

Water Resources	: Mahadev Khola
Nagarkot Intake	
constructed	: 1896 (stone masonry intake weir on the Mahadev Kh.)
Conveyance Main	
spun iron pipeline	: 100 m/m (constructed 1896)
spun iron pipeline	: 200 m/m x 3,100 m (constructed 1971, max rate of 4,900 m3/day at C=130)
Bansbari Treatment Plant	
constructed	: 1987
design capacity	: 4,900 m3/day
coagulation	: scheduled to be constructed
flocculation	: scheduled to be constructed
sedimentation	: 225 m3 x 2 basins (detention time 2.2 hr)
rapid sand filter	: 29 m2 x 3 basins (filtration rate 84 m/d)
Bansbari Distribution Reservoir	
constructed	: 1972
capacity	: 2,620 m3 (surface area 537 m2, depth 4.88 m)
outlet pipe	: CI300 m/m x 5,400 m (capacity 5,800 m3/day at C=130)
chlorination	: Bleaching powder

1.5 Other Water Supply Systems

A summary of the water supply systems in the Kathmandu valley other than the above systems is as follows:

(1) Pharping System

Water Resource	: Shesh Narayan, Sat Mul, Kutori Mul, Pharping W.F.
Pharping Pumping Station	
constructed	: 1978
capacity	: 125 m/m x 100 m/m x 1.735 m3/min x 175 m x 125 HP x 2 sets 150 m/m x 125 m/m x 2.78 m3/min x 174 m x 200 HP x 3 sets

Transmission Main : DI 350 m/m x 4.5 km
CI 200 m/m x 2.0 km

Shaibhu Distribution Reservoir
- constructed : 1978 (under the 1st Project)
- capacity : 2,700 m3 (surface area 830 m2, depth 3.0 m)
- chlorination : Bleaching powder (both chlorinators of chlorine gas and bleaching powder are not used)
- measuring equipment : not working
- inlet pipe : 350 m/m (from Pharping)
- outlet pipe : 500 m/m

(2) Bansbari System

Water Resource : Bansbari W.F.

Bansbari Distribution Reservoir
- constructed : 1984 (under the 3rd Project)
- capacity : 2,000 m3 (surface area 655 m2, depth 3.05 m)
- chlorination : Bleaching powder (gas chlorinator constructed in 1987 are not in operation)
- inlet pipe : 500 m/m (from Bansbari W.F.)
- outlet pipe : 600 m/m

(3) Bore-Thimi System

Water Resources : Bhaktapur W.F.
Transmission Main : CI 100 m/m,150 m/m x 21.3 km
Bore Distribution Reservoir
- constructed : 1984 (under the 3rd Project)
- capacity : 500 m3 x 2 cells
- inlet pipe : 300 m/m
- outlet pipe : 350 m/m
- chlorination : Bleaching powder

Katunje Distribution Reservoir
- constructed : 1984 (under the 3rd Project)
- capacity : 1,000 m3 x 2 cells
- inlet pipe : 350 m/m
- outlet pipe : 350 m/m
- chlorination : Bleaching powder

(4) Dood Pokari System

Water Resource	: Dood Phokari
Transmission Main	: CI 175 x 2.8 km
Bhajangal Distribution Reservoir	
constructed	: 1904
capacity	: 900 m3 (surface area 170 m2, depth 4.68 m)
inlet pipe	: 175 m/m
outlet pipe	: 225 m/m
chlorination	: Bleaching powder

(5) Chapagaon System

Water Resource	: Muldole
Transmission Pumping Station	
constructed	: 1974 (WSSB)
capacity	: 0.6 m3/min x 4 pumps (2 pumps are stand by)
Transmission Main	: DI 200 m/m x 5.5 km
Tahakel Distribution Reservoir	
constructed	: 1974
capacity	: 450 m3
inlet pipe	: 200 m/m
outlet pipe	: 200 m/m

(6) Lokhat System

Water Resource	: Lokhat
Transmission Main	: CI 100 m/m x 4.1 km

1.6 Distribution System

Water is now being supplied intermittently to the cities of Kathmandu, Lalitpur and Bhaktapur from the reservoirs of each system for approximately three hours in the morning and evening. Villages around these cities,however, are mostly situated along the transmission lines from which water is supplied to them directly.

The reservoirs were greatly increased in the capacity during the 1st and 2nd projects. The capacities of the reservoirs are now 24,500 m3 and 5,600 m3 to serve Kathmandu-Lalitpur and Bhaktapur respectively.

The reservoirs at Balaju, Maharajganj, etc. are now suffering from water leakage due to deterioration. Both the Bansbari and Shaibhu reservoirs are also insufficient in capacity, causing overflows between the water supply hours.

Since the distribution networks in cities have been expanded in a disorderly way over a long period keeping pace with increasing water demand, both the new and old multiple pipelines have been laid under the same roads thus resulting in a very complex distribution system. The incomplete distribution systems also fail to maintain uniform water pressure, often causing cuts in water supply at the ends of the pipelines. For this reason,

water is supplied in distribution blocks by carefully operating the valves within the systems during the water supply hours.

2 WATER QUALITY

2.1 General

The water quality analysis conducted during the field surveys has confirmed that the groundwater being produced in wells contains very high levels of iron, manganese and ammonia.

The quality of water from the existing treatment plants which treat the surface water is already insufficient, but the supply of untreated groundwater containing high levels of iron and manganese is generating colored water and blockade of pipelines as a direct effect. This makes the problem on waterworks in Kathmandu more serious.

Also, although some of the water is chlorinated, the chlorine is mostly consumed by ammonia. It is, therefore, far from achieving the ultimate object of waterworks which is to supply safe and sanitary water to consumers. The following describes the current status of water quality in Kathmandu.

2.2 Water Quality of Present Supply Resources

The 1st and 2nd field investigations have undertaken water quality analyses on existing water sources during the dry and wet seasons, respectively. Results show that the springs had a stable water quality both in the dry and wet seasons, i.e. there is no problem in regard to water quality. The river water also has no problem in particular as a water resource for water supply, if an appropriate treatment is applied, although its turbidity may increase immediately after rainfall in the wet season.

The groundwater, however, except for that from the Pharping well field, contains a very high level of iron, manganese and ammonia, at levels not permissible as a water source for water supply. Supplying the groundwater without treatment as at present results in additional problems.

Table G-2.1 gives the results of analyzing the water for the existing water supply resources.

2.3 Water Quality of Each Water Treatment Process

In the 1st and 2nd field investigations, water quality of each treatment process for the water treatment plans such as the Balaju, Sundarijal, Maharajganj and Bansbari (Bhaktapur) was surveyed.

Results show that functions of treatment for these plants were insufficient. Table G-2.2 gives the results of analyzing water quality for the each treatment process.

2.4 Water Quality of Distribution Networks

In the 1st and 2nd field investigations, sampling points were selected at six or seven points in each distribution system (refer to Fig.G-2.1), and water was sampled at these points right after starting the water supply and at certain times thereafter to check the variations in the water quality. Results show that the water quality immediately after starting the water supply contains very high levels of contaminating substances, which decrease as time goes on. This is attributable to the flowing-out of such substances from the pipelines due to the sudden change in the flow velocity and is a product of the intermittent supply method.

In this survey, on-site analysis of residual chlorine was made at the time of sampling. No residual chlorine was found, except from samples collected from water in the city of Lalitpur being supplied from the Shaibhu reservoir where the water quality is relatively good.

These results indicate that if the water contains very high levels of ammonia, iron and manganese and few residual chlorine, and if there is only intermittent flow of water in the pipelines, residual chlorine is completely consumed by ammonia and the inside of the distribution system becomes a favorable breeding environment for iron bacteria, nitro bacteria, etc. This results in deterioration of the water quality within the distribution pipes. Therefore, the current water quality can not kill pathogenic bacteria and causes the discharge of the bacteria and colored water from taps.

The level of residual chlorine to be maintained in the tap water must be sufficient to kill such pathogenic bacteria as those causing dysentery, typhoid, etc. Generally, this level is required to be 0.1 ppm or upwards as free residual chlorine, while more than 0.2 ppm is necessary during epidemics or right after reopening the service after supply halt.

Meanwhile, for the anti-corrosion program, the past experience has shown that effective results were obtainable when the pH was 7.5-8.0 and the Rangelier's index -1.0 or upwards. The Rangelier's index was -1.50, -2.65 and 0.08 for the Balaju, Mahankal Chaur and Shaibhu systems, respectively. It is, therefore, assumed that water supplied from the systems other than the Shaibhu system are high corrosive.

Table G-2.3 gives the results of analyzing water quality for the distribution networks.

2.5 Water Quality of Potential Water Resources

The 1st and 2nd field investigations have undertaken analyzing water quality for potential water resources which will be expected of future plan in addition to the existing supply resources. The sampling points of the water are shown in Fig.G-2.2 and Table G-2.4 shows the results of analyzing the water quality.

2.6 Water Quality of Other Water Resources

Table G-2.5 gives the results of analyzing water quality for the other water resources.

TABLES

Table G-1.1 AVAILABLE CAPACITY OF PRESENT WATER SUPPLY RESOURCES

SYSTEM	Surface Water	Ground Water	TOTAL
<KATHMANDU-LALITPUR>			
(1) Balaju	8,230	3,810	12,040
(2) Bansbari		15,770	15,770
(3) Maharajganj	3,120	1,580	4,700
(4) Mahankal Chaur	20,000	21,610	41,610
(5) Shaibhu	19,770	3,090	22,860
(6) Chapagaun	1,700		1,700
(7) Dood Phokari	2,900		2,900
(8) Lokhat	500		500
Sub-Total	56,220	45,860	102,080
<BHAKTAPUR>			
(9) Mahadev Khola	4,320		4,320
(10) Thimi-Bore		9,760	9,760
Sub-Total	4,320	9,760	14,080
TOTAL	60,540	55,620	116,160

Table G-1.2 INFLOW AND WATER SUPPLY AMOUNT OF THE MAIN RESERVOIRS

RESERVOIR	INFLOW AMOUNT (m3/d)			STORAGE VARIATION (m3/d)	SUPPLY AMOUNT (m3/d)
	Surface W	Ground W	Total		
(1) Balaju	7,387	3,163	10,550	-33	10,583
(2) Bansbari	-	8,344	8,344	-87	8,431 (-1,558)*1
(3) Maharajganj	1,992	956	2,948	-21	2,969 (+1,558)*1
(4) Mahankal Chaur	12,222	9,427	21,649	-44	21,693
(5) Shaibhu	17,479	-	17,479	-	17,479 (6,961)*2
TOTAL	39,080	21,890	60,970	-185	61,155

NOTE *1: Overflow from Bansbari reservoir and flow into Maharajganj reservoir
*2: Overflow from Shaibhu reservoir and supplied to the city

Based on the reservoir and well operation records from Aug 3 to Aug 12, 1989.

Table G-1.3 (1/5) INFLOW AND SUPPLY AMOUNT OF EACH RESERVOIR

- BALAJU -

DATE	INFLOW AMOUNT (m3/d)			SUPPLY AMOUNT (m3/d)	STORAGE VARIATION (m3/d)
	Surface W	Ground W	Total		
Aug 03	5,560	3,745	9,305	9,305	0
04	7,904	3,237	11,141	10,844	297
05	7,512	3,342	10,854	11,151	-297
06	7,752	3,637	11,389	11,622	-233
07	8,640	2,832	11,472	11,472	0
08	4,968	2,638	7,606	8,073	-467
09	9,376	2,711	12,087	11,620	467
AVERAGE	7,387	3,163	10,550	10,583	-33

Table G-1.3 (2/5) INFLOW AND SUPPLY AMOUNT OF EACH RESERVOIR

- BANSBARI -

DATE	INFLOW AMOUNT (m3/d)			SUPPLY*1 AMOUNT (m3/d)	OVER*2 FLOW (m3/d)	STORAGE VARIATION (m3/d)
	Surface W	Ground W	Total			
Aug 03	-	8,272	8,272	7,231	1,556	-515
04	-	9,192	9,192	6,721	1,956	515
05	-	9,328	9,328	7,826	1,701	-199
06	-	9,584	9,584	7,170	2,215	199
07	-	8,400	8,400	6,538	2,061	-199
08	-	8,608	8,608	7,073	1,535	0
09	-	7,784	7,784	6,610	1,931	-757
10	-	6,600	6,600	6,334	266	0
11	-	7,984	7,984	6,303	924	757
12	-	7,688	7,688	6,929	1,432	-673
AVERAGE	-	8,344	8,344	6,873	1,558	-87

NOTE *1: Supply to the Kathmandu city
*2: Overflow from Bansbari R. and flow into Maharajganj R.

Table G-1.3 (3/5) INFLOW AND SUPPLY AMOUNT OF EACH RESERVOIR

- MAHARAJGANJ - (UNIT: m3/d)

DATE	INFLOW AMOUNT (m3/d)				SUPPLY AMOUNT (m3/d)	STORAGE VARIATION (m3/d)
	Surface W	Ground W	Overflow*1	Total		
Aug 03	1,992	1,053	1,556	4,601	5,139	-538
04	1,992	1,003	1,956	4,951	4,661	290
05	1,992	999	1,701	4,692	4,858	-166
06	1,992	1,013	2,215	5,220	5,220	0
07	1,992	982	2,061	5,035	5,283	-248
08	1,992	688	1,535	4,215	4,339	-124
09	1,992	988	1,931	4,911	4,208	703
10	1,992	977	266	3,235	3,524	-289
11	1,992	937	924	3,853	3,729	124
12	1,992	924	1,432	4,348	4,307	41
AVERAGE	1,992	956	1,558	4,506	4,527	-21

NOTE *1: Overflow from Bansbari R.

Table G-1.3 (4/5) INFLOW AND SUPPLY AMOUNT OF EACH RESERVOIR

- MAHANKAL CHAUR -

DATE	INFLOW AMOUNT (m3/d)			SUPPLY AMOUNT (m3/d)	STORAGE VARIATION (m3/d)
	Surface W	Ground W	Total		
Aug 03	11,145	10,371	21,516	22,858	-1,342
04	11,037	10,267	21,304	21,461	-157
05	11,982	10,058	22,040	22,477	-437
06	12,951	9,881	22,832	22,676	156
07	11,586	9,654	21,240	21,708	-468
08	10,438	7,450	17,888	18,325	-437
09	11,708	6,588	18,296	16,048	2,248
10	13,077	9,267	22,344	21,750	594
11	13,963	10,293	24,256	24,694	-438
12	14,331	10,445	24,776	24,932	-156
AVERAGE	12,222	9,427	21,649	21,693	-44

Table G-1.3 (5/5) INFLOW AND SUPPLY AMOUNT OF EACH RESERVOIR

- SHAIBHU -

DATE	INFLOW AMOUNT (m3/d)			SUPPLY AMOUNT (m3/d)	OVER*1 FLOW (m3/d)	STORAGE VARIATION (m3/d)
	Surface W	Ground W	Total			
Aug 28	17,792	-	17,792	10,674	7,118	0
29	17,792	-	17,792	10,638	7,154	0
30	17,256	-	17,256	10,371	6,885	0
31	17,256	-	17,256	10,403	6,853	0
Sep 01	17,520	-	17,520	10,519	7,001	0
02	17,256	-	17,256	10,503	6,753	0
AVERAGE	17,479	-	17,479	10,518	6,961	0

NOTE *1: Supply to the Lalitpur city

Table G-1.4 CONTAMINATION OF FILTER MEDIA

TREATMENT PLANT	TURBIDITY (deg.)		REMARKS
	Before backwash	After backwash	
BALAJU			
Depth: 0 - 5 cm	200	340	
5 - 10 cm		290	
10 - 20 cm	540	340	
20 - 30 cm	560	440	
30 - 40 cm	520	410	
MAHARAJGANJ			
Depth: 0 - 10 cm	240	220	
10 - 20 cm	340	170	
20 - 30 cm	280	160	
30 - 40 cm	260	140	
40 - 50 cm	310	160	
50 - 60 cm	350	170	
SUNDARIJAL			
Depth: 0 - 5 cm	260	170	
5 - 10 cm	360	170	
10 - 20 cm	300	120	
20 - 30 cm	210	120	
30 - 40 cm	240	440	
40 - 50 cm	1,040	360	
SUNDARIGHAT			Slow sand filter
Depth: 0 - 20 cm	230	-	not in operation
BANSBARI			
Depth: 0 - 20 cm	840	280	Sand wash is carried out manualy

Analysis method: by JWWA (Japan Water Works Association)

Table G-2.1 (1/3) WATER QUALITY OF PRESENT WATER RESOURCES (1ST FIELD SURVEY)

Name of Resources	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	PO4 mg/l	Colones nos/ml	Coliform nos/ml	SiO2 mg/l	CO3 mg/l	HCO3 mg/l	NO3 mg/l	NO2 mg/l
BIR DHARA SCHEME																								
Surface Water																								
-Bisnumati	6.8	27	11	10	8	2.7	<0.1	0.04	<0.02	2	<1	<1	1	<1	<1	18	0.1	0	0	20	-	-	<1	<0.01
-Shivapri	6.9	35	9	15	11	1.7	<0.1	0.12	<0.02	2	<1	<1	0.8	<1	<1	22	0.1	0	0	22	-	-	<1	<0.01
MAHANKAL CHAUR SYSTEM																								
Surface Water																								
-Sundarijal Dam																								
Depth: Surface	7.4	29	10	18	10	2.2	<0.1	<0.03	<0.02	7	<1	<1	0.5	<1	<1	-	-	0	0	-	-	-	<1	<0.01
H= 1.0m	6.6	29	10.6	15	10	2.2	<0.1	<0.03	<0.02	10	<1	<1	0.8		<1	38	0.2	0	0	-	-	-	<1	<0.01
H= 4.0m	7.0	29	10.1	15	14	2.8	<0.1	<0.03	<0.02	12	<1	<1	1	<1	<1	40	0.2	0	0	-	-	-	<1	<0.01
H= 6.5m	6.4	30	10	15	13	3.1	<0.1	<0.03	<0.02	15	<1	<1	2	1	<1	40	0.2	0	0	-	-	-	<1	<0.01
Bottom	6.8	29	10.2	15	14	6.7	<0.1	<0.03	<0.02	30	2	<1	3	2	<1	48	0.2	5	0	-	-	-	<1	<0.01
Groundwater																								
-GK3	6.9	113	8	52	36	4	0.7	0.81	0.05	16	4	1	2	<1	<1	-	-	2	0	66	<1	9	<1	<0.01
-GK4	6.7	142	8	70	40	6.2	0.7	2.6	0.02	23	5	<1	3	<1	<1	-	-	0	0	71	<1	6	<1	<0.01
-MH2	6.7	138	4	71	89	5.5	1.6	4.9	0.08	30	5	2	2	<1	<1	-	-	0	0	52	<1	6	<1	<0.01
-MH3	6.5	153	4	73	34	8.4	2.5	7.4	0.08	50	8	5	3	<1	<1	-	-	0	0	58	<1	5	<1	<0.01
-MH7	7.0	185	5	97	35	12.5	2.6	2.2	0.08	35	1	<1	5	<1	<1	-	-	0	0	73	<1	7	<1	<0.01
-DK3	6.1	162	6	39	59	4.4	1.2	5.2	0.28	12	1	4	2	<1	<1	-	-	0	0	35	<1	9	<1	<0.01
-DK4	6.0	176	6	55	53	6.3	2	5.5	0.35	26	1	5	2	<1	<1	-	-	0	0	48	<1	9	<1	<0.01
-DK5	6.0	173	6	60	45	6.3	1.8	4.1	0.35	26	2	3	2	<1	<1	-	-	0	0	46	<1	12	<1	<0.01
TRI BHIM DHARA SCHEME																								
Surface Water																								
-Mahadew Khola	7.6	230	0.11	122	128	5.4	<0.1	0.77	0.07	23	4	3	2	1	6	1.52	0.3	120	40	20	-	-	1	0.03
PHARPING SYSTEM																								
Surface Water																								
-Sat Mul	7.4	218	8	109	124	1.1	<0.1	0.17	<0.02	3	3	1	0.6	<1	4	-	-	0	0	-	-	-	-	-
-Head Pond	7.4	195	7	102	118	0.6	<0.1	0.09	<0.02	3	1	1	0.4	<1	<1	-	-	0	0	-	-	-	-	-
-Kutori Mul	7.7	195	9	105	115	<0.3	<0.1	<0.03	<0.02	2	<1	1	0.3	<1	<1	144	<0.1	0	0	8	1	2	3	<0.01

Table G-2.1 (2/3) WATER QUALITY OF PRESENT WATER RESOURCES (1ST FIELD SURVEY)

Name of Resources	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	PO4 mg/l	Colones nos/ml	Coliform nos/ml	SiO2 mg/l	CO3 mg/l	HCO3 mg/l	NO3 mg/l	NO2 mg/l
PHARPING SYSTEM																								
Groundwater																								
-PH2	7.7	525	6	136	129	0.9	0.1	1.6	0.06	7	16	7	0.4	<1	3	384	<0.1	0	0	29	2	3	<1	<0.01
-PH2	7.7	557	5	144	137	0.9	0.1	0.13	0.06	5	1	12	<0.3	<1	<1	422	<0.1	0	0	29	2	3	<1	<0.01
BANSBARI SYSTEM																								
Groundwater																								
-BB0	6.3	148	4	76	50	6.8	0.7	3	0.27	28	5	<1	2	<1	<1	-	-	0	0	64	<1	9	<1	<0.01
-BB2	6.2	124	3	66	44	2.5	0.4	1.2	0.21	15	2	<1	0.8	<1	<1	-	-	0	0	58	<1	6	<1	<0.01
-BB6	6.8	150	3	81	48	6.6	1.6	1.8	0.03	20	<1	<1	3	<1	<1	-	-	1	1	70	<1	5	<1	<0.01
-BB8	6.8	158	5	81	62	8.2	1.7	2.2	0.08	28	<1	<1	3	<1	<1	-	-	1	1	61	<1	6	<1	<0.01
MAHADEV KHOLA SYSTEM																								
Surface Water																								
-Mahadev Khola	7.2	39	8.7	19	18	2.6	<0.1	<0.03	<2.02	6	<1	<1	0.8	<1	<1	5.8	0.8	5	0	-	-	-	<1	<0.01
DOOD POKHARI SYSTEM																								
Surface Water																								
-Dood Pokhari	7.2	205	9.8	101	225	<0.3	<0.1	<0.03	<2.02	3	<1	1	<0.3	<1	<1	118	<0.1	0	0	-	-	-	-	-
CHAPAGAUN SYSTEM																								
Surface Water																								
-Muldole	7.6	230	7	123	136	0.6	<0.1	<0.03	<2.02	1	<1	1	<0.3	<1	<1	-	-	8	0	-	-	-	-	-

Table G-2.1 (3/3) WATER QUALITY OF PRESENT WATER RESOURCES (2ND FIELD SURVEY)

Name of Resources	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	T-N mg/l	PO4 mg/l	Ca mg/l	HCO3 mg/l
BIR DHARA SCHEME																						
Surface Water																						
-Bisnumati	6.7	20	7.4	13	4	7.5	<0.1	0.21	<0.02	3	1	1	4	2	8	273	40	30	-	0.4	-	-
-Shivapuri	6.8	22	7.4	26	8	6.2	<0.1	0.11	<0.02	3	1	1	1	1	4	58	10	10	-	0.3	-	-
MAHANKAL CHAUR SYSTEM																						
Groundwater																						
-GK1	6.7	97	6.4	51	26	5.0	0.3	1.6	0.18	15	2	<1	2	-	3	82	-	-	0.4	0.6	7	<1
-GK3	7.1	144	7.5	73	36	9.5	1.0	1.3	0.08	20	2	<1	4	-	3	100	-	-	1.2	0.4	8	2
-MH2	6.1	154	3.6	12	38	15	0.7	4.4	0.26	40	3	<1	4	-	4	145	-	-	3.7	<0.1	13	4
-MH3	6.3	147	6.3	14	50	10	2.1	6.7	0.25	40	2	3	3	-	1	128	-	-	3.2	0.7	6	8
-DK4	6.0	198	0.6	11	86	6.8	6.0	3.8	0.22	20	4	12	2	-	1	123	-	-	8.1	0.9	14	8
-DK6	5.9	223	0.5	6	46	13	0.8	2.2	0.33	15	4	8	3	-	4	155	-	-	4.9	<0.1	36	6
TRI BHIM DHARA SCHEME																						
Groundwater																						
-BZ1	6.5	234	6.2	26	88	13	0.7	3.4	0.07	20	5	<1	3	-	4	163	-	-	5.2	0.6	26	9
PHARPING SYSTEM																						
Surface Water																						
-Sat Mul	7.8	201	7.6	98	12	<0.3	0.2	0.13	0.03	1	<1	<1	<0.3	<1	3	130	0	0	-	<0.1	-	-
-Sesh Narayan	7.8	235	7.4	103	20	0.9	<0.1	0.04	0.11	<1	<1	<1	2	1	2	125	15	14	-	<0.1	-	-
Groundwater																						
-PH1	7.3	361	3.2	141	28	0.9	0.1	0.12	0.22	<1	<1	<1	0.3	-	1	250	-	-	0.4	<0.1	52	5
BANSBARI SYSTEM																						
Groundwater																						
-BB0	6.9	144	6.2	77	62	5.3	0.8	1.2	0.05	10	2	1	1	-	2	370	-	-	-	2.0	-	-
-BB5	7.0	177	7.2	96	74	10	3.2	2.1	0.05	15	2	2	3	-	1	298	-	-	4.0	1.9	12	4
-BB6	6.9	164	7.1	86	72	8.7	2.2	2.5	0.03	20	2	<1	2	-	<1	315	-	-	3.1	2.7	10	4
BORE-THIMI SYSTEM																						
Groundwater																						
-BH1	6.5	203	3.0	24	56	12	2.5	3.4	0.32	40	4	5	3	-	1	145	-	-	5.9	1.8	13	7
-BH2	6.2	184	3.9	18	68	6.1	1.4	9.0	0.34	15	8	6	2	-	21	125	-	-	4.6	0.4	22	9
-BH3	6.3	250	5.8	50	110	7.8	4.0	5.9	0.42	40	10	<1	2	-	11	168	-	-	6.7	0.1	26	4
-BH4	6.6	184	3.2	60	74	9.0	2.5	5.1	0.36	30	5	<1	3	-	4	135	-	-	3.9	0.2	14	5
CHAPAGAUN SYSTEM																						
Surface Water																						
-Muldole	7.2	260	7.1	108	130	1.2	0.1	<0.03	<0.02	1	<1	<1	<0.3	<1	<1	125	120	80	-	<0.1	-	-

Table G-2.2 (1/2) WATER QUALITY OF EACH WATER TREATMENT PROCESS (1ST FIELD SURVEY)

Treatment Plant	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	PO4 mg/l	Colones nos/ml	Coliform nos/ml	SiO2 mg/l	CO3 mg/l	HCO3 mg/l	NO3 mg/l	NO2 mg/l
BALAJU																									
-Raw water	7.4	127	10	63	67	3.5	<0.1	0.3	0.05	14	2	-	<1	1	1	3	90	0.2	40	10	21	-	-	<1	0.01
-Sedimented water	7.2	124	11	62	63	2.5	<0.1	0.22	0.06	11	1	-	<1	0.7	<1	1	84	0.2	80	37	23	-	-	<1	0.01
-Filtered water	7.2	120	10	61	59	2.2	<0.1	0.05	0.03	10	<1	-	<1	0.6	<1	<1	88	0.2	40	15	24	-	-	1	<0.01
-Supply water	7.1	122	10	53	60	1.6	<0.1	0.05	0.02	7	<1	2	2	0.6	<1	<1	76	0.2	0	0	26	-	-	2	<0.01
MAHARAJGANJ																									
-Raw water	7.5	40	9	15	15	2.8	<0.1	0.07	0.04	7	<1	<0.1	<1	2	1	<1	54	-	0	0	22	<1	2	<1	<0.01
-Sedimented water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-Filtered water	6.9	64	9	33	20	2.1	<0.1	0.1	0.04	5	<1	<0.1	<1	0.8	<1	<1	84	-	0	0	36	-	-	1	<0.01
-Supply water	6.9	116	8	52	38	4.1	0.5	0.81	0.1	20	1	<0.1	3	2	1	1	126	-	0	0	50	-	-	<1	0.03
SUNDARIJAL																									
-Raw water	6.9	28	9.1	14	7	3.4	<0.1	<0.03	<0.02	1	<1	-	<1	0.9	<1	<1	36	0.1	0	0	-	-	-	<1	0.01
-Sedimented water	6.9	29	9.6	14	7	2.8	<0.1	<0.03	0.02	1	<1	-	1	0.9	<1	<1	32	0.1	0	0	-	-	-	<1	0.01
-Filtered water	6.9	29	10.3	14	7	3.2	<0.1	<0.03	0.03	1	<1	-	<1	0.9	<1	<1	38	0.2	1	0	-	-	-	<1	<0.01
BANSBARI																									
-Raw water	7.4	39	10	19	17	2	<0.1	<0.03	<0.02	6	<1	-	<1	0.8	<1	<1	56	0.8	2	0	-	-	-	<1	<0.01
-Sedimented water	7.4	42	10	19	18	2.3	<0.1	<0.03	<0.02	6	<1	-	<1	0.8	<1	<1	56	0.8	0	0	-	-	-	<1	<0.01
-Filtered water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-Supply water	7.6	44	10	20	24	1.9	<0.1	<0.03	<0.02	6	<1	-	2	0.5	<1	<1	64	0.8	2	0	-	-	-	<1	<0.01

Table G-2.2 (2/2) WATER QUALITY OF EACH TREATMENT PROCESS (2ND FIELD SURVEY)

Treatment Plant	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	PO4 mg/l
BALAJU																			
-Raw water	6.5	31	7.3	9	12	10	0.1	0.52	0.05	4	2	<1	3	2	29	90	160	100	<0.1
-Sedimented water	4.6	72	7.3	<1	16	9.8	<0.1	1.2	0.14	15	5	2	3	2	44	153	100	80	<0.1
-Filtered water	5.0	65	7.4	<1	19	4.5	<0.1	0.33	0.11	6	2	<1	2	1	12	38	80	70	<0.1
-Supply water	6.6	99	7.2	23	28	6.2	0.4	0.87	0.11	6	3	5	2	1	13	85	80	30	0.2
MAHARAJGANJ																			
-Raw water	6.4	21	7.6	14	6	9.5	<0.1	0.22	0.07	1	<1	<1	3	2	8	30	100	100	<0.1
-Sedimented water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-Filtered water	6.5	38	7.2	19	11	6.2	<0.1	0.12	0.06	1	<1	<1	2	2	2	33	80	60	0.4
-Supply water	6.6	106	6.0	54	35	4.7	0.3	0.88	0.07	1	<1	2	2	1	4	98	60	50	1.2
SUNDARIJAL																			
-Raw water	7.0	16	7.7	4	9	25	<0.1	6.9	0.09	400	600	<1	8	6	460	486	3	0	0.2
-Sedimented water	4.4	101	7.7	<1	17	6.2	<0.1	0.27	0.09	3	10	<1	3	2	18	20	51	0	<0.1
-Filtered water	4.5	91	7.6	<1	14	2.0	<0.1	0.16	0.03	3	7	<1	2	1	12	20	18	12	<0.1
-Transmission line *1	4.9	65	7.6	<1	18	5.1	<0.1	1.5	0.03	30	60	<1	2	1	60	78	3	0	0.1
BANSBARI																			
-Raw water	6.7	39	7.5	17	13	11	<0.1	1.7	0.11	50	25	2	3	2	49	163	120	100	<0.1
-Sedimented water	6.9	39	7.4	14	12	11	0.2	1.3	0.07	40	20	1	3	2	31	118	100	80	<0.1
-Filtered water	6.7	36	7.3	15	11	9.3	<0.1	0.86	0.05	15	8	<1	3	2	33	128	80	60	<0.1
-Supply water *2	6.8	28	7.3	13	8	9.0	<0.1	0.81	0.05	20	8	<1	4	2	26	100	50	40	<0.1
-Supply water *3	7.0	30	7.3	14	11	6.7	<0.1	0.52	0.03	8	3	<1	4	2	17	85	80	50	<0.1

Note *1 : Sampled at a tap near Baralgau
*2 : Sampled at a tap in the Bansbari T.P.
*3 : Sampled at a tap in the Bhaktapur city

Table G-2.3 (1/7) WATER QUALITY OF DISTRIBUTION NETWORKS (1ST FIELD SURVEY)

- BALAJU SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml
Reservoir	16:00	7.5	135	10	65	3.9	<0.1	0.19	0.06	10	2	0.5	3	2	<1	88	0	0
	17:10	7.4	136	10	64	3.3	<0.1	0.19	0.05	10	2	0.5	3	2	<1	86	0	0
BJ-1	15:35	-	-	-	65	3	<0.1	0.33	0.03	12	3	<0.1	3	2	2	94	3	0
	15:50	-	-	-	65	2.6	<0.1	0.19	0.02	8	2	0.3	3	2	<1	86	0	0
	17:10	-	-	-	65	2.6	<0.1	0.18	0.02	8	2	0.5	3	2	<1	84	0	0
BJ-2	15:40	-	-	-	65	2.6	<0.1	0.19	0.02	10	2	0.5	3	2	<1	90	2	0
	15:55	-	-	-	65	3	<0.1	0.33	0.03	10	3	0.4	3	2	<1	82	0	0
	17:10	-	-	-	65	2.8	<0.1	0.16	0.02	8	2	0.5	3	2	<1	82	0	0
BJ-3	15:45	-	-	-	65	3	<0.1	0.34	0.03	10	3	<0.1	3	2	<1	94	2	0
	16:00	-	-	-	65	3.9	0.3	0.55	0.04	15	4	<0.1	3	2	3	94	0	0
	17:10	-	-	-	65	4.9	<0.1	0.55	0.02	15	4	<0.1	3	2	4	98	0	0
BJ-4	17:10	7.4	139	12	65	4.4	<0.1	0.52	0.03	12	5	<0.1	3	2	3	92	3	0
	17:25	7.4	138	10	65	3.3	<0.1	0.18	0.03	8	2	0.1	3	2	<1	88	0	0
	18:00	7.5	135	10	65	3.2	<0.1	0.18	0.04	10	2	0.4	3	2	<1	86	0	0
BJ-5	17:10	7.4	141	10	65	3.9	0.1	0.37	0.04	10	3	<0.1	3	2	<1	90	3	0
	17:25	7.4	133	10	65	3.2	<0.1	0.19	0.02	8	2	0.4	3	2	<1	86	0	0
	18:00	7.4	135	10	65	3.2	<0.1	0.19	0.03	8	2	0.4	3	2	<1	84	0	0
BJ-6	17:25	7.1	140	11	68	4.7	<0.1	0.74	0.05	12	4	<0.1	3	2	3	94	2	0
	18:00	7.3	137	11	64	3.4	<0.1	0.19	0.02	8	2	0.1	3	2	<1	86	0	0

Table G-2.3 (2/7) WATER QUALITY OF DISTRIBUTION NETWORKS (1ST FIELD SURVEY)

- MAHANKAL CHAUR SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml
Reservoir	14:50	6.2	86	6.9	20	5.8	0.3	0.6	0.05	3	2	0.1	3	1	<1	46	0	0
	17:30	-	-	-	27	3.6	0.6	0.9	0.08	7	3	0.1	3	1	<1	82	0	0
MK-1	14:10	6.0	112	-	48	14	1.2	7.1	0.22	16	45	<0.05	3	5	27	144	4	0
	14:25	6.1	42	-	15	3.6	0.2	0.4	0.12	7	3	<0.05	2	2	1	54	2	0
	15:55	6.2	138	5.0	62	8.2	1.6	3.1	0.27	16	10	<0.05	4	3	5	132	0	0
	16:10	6.2	131	6.3	56	8.2	1.4	2.7	0.19	16	8	<0.05	5	3	4	130	0	0
	16:45	6.3	125	6.3	54	6.5	1.5	2.5	0.19	16	7	<0.05	4	3	4	118	0	0
	17:10	6.2	127	6.4	53	8.2	1.5	2.8	0.18	20	7	<0.05	8	3	4	132	0	0
MK-2	15:55	6.2	113	8.3	42	7.6	0.7	2.2	0.09	16	14	<0.05	4	3	4	116	1	0
	16:10	6.3	146	7.6	65	11	1.3	3.8	0.19	16	12	<0.05	5	4	9	160	3	0
	16:45	6.4	128	7.4	53	8.2	1.4	2.5	0.16	16	7	<0.05	5	3	4	120	0	0
	17:10	6.3	129	6.7	52	7.6	1.3	2.6	0.16	20	6	<0.05	5	3	4	128	0	0
MK-3	15:55	6.4	124	7.8	55	9.3	1.4	3.6	0.23	16	18	<0.05	6	3	8	128	1	0
	16:10	6.2	135	8.2	38	9.5	0.6	4.8	0.23	16	34	<0.05	3	4	18	112	1	0
	16:45	6.2	131	7.1	54	9.8	1.4	3	0.21	20	8	<0.05	5	3	6	136	0	0
	17:10	6.2	133	7.0	31	7.4	1.4	2.5	0.20	20	7	<0.05	5	3	4	126	0	0
MK-4	15:10	-	-	-	15	2.7	0.3	0.4	<0.02	5	2	<0.1	8	1	<1	46	0	0
	15:25	-	-	-	14	2.5	0.1	0.3	<0.02	3	2	0.1	4	1	<1	52	0	0
	16:00	-	-	-	73	10	1.8	3.8	0.26	15	17	<0.1	4	4	10	172	0	0
	17:10	-	-	-	52	8.4	1.4	3.3	0.25	20	16	<0.1	4	3	8	130	1	0
	17:25	-	-	-	46	7	1.6	2.4	0.18	20	7	<0.1	5	2	4	114	2	0
	18:00	-	-	-	46	5.7	1.6	2.3	0.16	20	7	<0.1	4	2	3	114	0	0
MK-5	17:10	-	-	-	45	14	<0.1	11	0.16	15	45	<0.1	4	8	62	182	4	1
	17:25	-	-	-	46	11	1.1	6.9	0.13	15	35	<0.1	5	5	39	140	0	0
	18:00	-	-	-	46	6.3	1.5	2.4	0.15	20	7	<0.1	5	2	5	120	1	0
MK-6	17:10	-	-	-	63	13	3.0	1.3	0.12	5	7	<0.1	24	6	10	184	40	6
	17:25	-	-	-	50	9.2	1.1	3.4	0.15	20	20	<0.1	5	4	12	138	1	0
	18:00	-	-	-	48	7.9	1.3	2.3	0.13	20	7	<0.1	6	3	5	114	0	0

Table G-2.3 (3/7) WATER QUALITY OF DISTRIBUTION NETWORKS (1ST FIELD SURVEY)

- SHAIBHU SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml
Reservoir	15:40	7.7	204	10	105	0.6	<0.1	<0.03	<0.02	2	4	<0.1	2	<0.3	<1	114	4	0
	18:00	7.8	208	10	102	0.6	<0.1	<0.03	<0.02	3	4	<0.1	2	<0.3	<1	112	4	0
SB-1	15:27	7.4	213	10	105	1.3	<0.1	<0.03	<0.02	8	4	<0.1	3	0.7	2	144	1	0
	15:40	7.6	202	12	103	0.7	<0.1	<0.03	<0.02	2	2	<0.1	2	0.4	<1	138	0	0
	15:55	7.7	203	12	102	0.4	<0.1	<0.03	<0.02	2	2	<0.1	2	0.3	<1	128	3	0
	17:30	7.7	203	12	103	0.8	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	124	3	0
SB-2	15:40	7.6	211	12	103	0.7	<0.1	<0.03	<0.02	4	2	<0.1	2	<0.3	<1	146	0	0
	15:55	7.7	202	13	102	0.4	<0.1	<0.03	<0.02	2	2	<0.1	2	0.3	<1	136	2	0
	17:30	7.7	206	13	103	0.5	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	116	3	0
SB-3	15:40	7.9	200	10	102	0.6	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	148	0	0
	15:55	7.8	204	10	102	0.7	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	144	2	0
	17:30				104	0.5	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	104	3	0
SB-4	15:40	-	-	-	104	0.5	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	102	3	0
	15:55	-	-	-	104	0.5	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	122	5	0
	16:10	-	-	-	104	0.6	<0.1	<0.03	<0.02	2	1	<0.1	2	<0.3	<1	126	3	0
	16:40	-	-	-	104	0.6	<0.1	<0.03	<0.02	2	3	<0.1	2	<0.3	<1	124	3	0
	16:55	-	-	-	104	0.6	<0.1	<0.03	<0.02	2	1	<0.1	2	<0.3	<1	118	1	0
SB-5	15:40	-	-	-	104	0.7	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	108	2	0
	15:55	-	-	-	103	0.7	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	116	2	0
	16:10	-	-	-	104	0.6	<0.1	<0.03	<0.02	2	1	<0.1	2	<0.3	<1	124	1	0
	16:40	-	-	-	104	0.5	<0.1	<0.03	<0.02	2	1	<0.1	2	<0.3	<1	126	1	0
	16:55	-	-	-	101	0.6	<0.1	<0.03	<0.02	2	3	<0.1	2	<0.3	<1	116	3	0
SB-6	15:40	7.8	208	11	104	0.5	<0.1	<0.03	<0.02	2	2	<0.1	2	<0.3	<1	136	1	0
	15:55	7.6	207	10	104	0.7	<0.1	<0.03	<0.02	2	2	<0.1	2	0.4	<1	134	1	0
	16:10	7.7	194	10	103	0.7	<0.1	<0.03	<0.02	2	2	<0.1	2	0.3	<1	140	3	0
	16:40	7.7	200	12	103	0.6	<0.1	<0.03	<0.02	2	2	<0.1	2	0.3	<1	138	0	0
	16:55	7.8	207	12	105	0.7	<0.1	<0.03	<0.02	2	1	<0.1	2	0.3	<1	138	3	0
	17:30	7.8	209	12	105	0.8	<0.1	<0.03	<0.02	2	2	<0.1	2	0.3	<1	118	3	0

Table G-2.3 (4/7) WATER QUALITY OF DISTRIBUTION NETWORKS (2ND FIELD SURVEY)

- BALAJU SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	PO4 mg/l
Reservoir	16:00	7.0	89	6	39	3.8	0.6	0.78	0.04	15	4	0.1	3	2.0	4	108	2	0	1.0
	17:00	6.6	84	6	41	4.4	0.6	1.0	0.12	15	4	0.1	2	1.7	4	140	10	0	1.1
BJ-1	15:35	6.9	93	6	40	4.0	0.5	0.81	0.15	20	5	0.1	4	2.4	3	122	40	20	1.1
	15:50	7.0	95	6	37	3.3	0.4	0.79	0.14	15	4	0.1	3	1.7	2	135	12	5	1.0
	17:10	7.2	89	5	38	3.9	0.5	0.84	0.19	15	4	<0.1	3	2.2	3	130	7	1	0.9
BJ-2	15:40	7.0	94	5	38	4.7	0.4	0.73	0.14	4	3	<0.1	3	2.5	4	90	0	0	1.0
	15:55	7.0	96	4	40	5.0	0.4	0.67	0.14	5	2	<0.1	3	2.5	3	95	10	0	1.1
	17:10	7.1	89	4	38	5.1	0.4	0.77	0.09	10	3	<0.1	3	2.7	4	68	100	80	1.0
BJ-3	15:45	7.0	150	4	74	5.8	0.8	1.2	0.14	15	3	<0.1	2	2.8	2	158	50	50	1.6
	15:55	7.0	103	5	47	8.9	0.8	1.1	0.18	10	4	<0.1	3	5.5	4	128	100	26	0.9
	17:10	7.2	90	4	41	3.7	0.3	0.69	0.09	10	1	<0.1	2	2.1	1	78	8	0	1.0
BJ-4	16:40	7.0	90	6	38	5.3	0.4	0.79	0.14	5	2	<0.1	2	2.7	1	90	100	70	1.1
	16:55	7.0	90	6	39	4.5	0.3	0.85	0.10	10	3	<0.1	2	2.8	2	158	0	0	1.0
	17:10	6.9	90	6	40	3.7	0.4	0.77	0.20	5	1	0.1	2	1.7	1	88	1	0	1.1
	17:30	6.8	90	6	38	4.5	0.2	0.68	0.11	15	3	<0.1	2	2.5	1	98	19	15	1.0
BJ-5	16:40	7.1	91	5	38	9.5	0.6	0.70	0.10	15	4	<0.1	3	6.0	4	92	20	2	1.1
	16:55	7.1	89	5	38	6.8	0.5	0.81	0.07	15	4	<0.1	3	3.0	3	78	0	0	1.1
	17:30	6.7	89	5	40	5.0	0.4	0.83	0.08	15	4	<0.1	4	2.4	2	95	0	0	1.0
BJ-6	16:40	7.0	91	6	38	5.3	0.3	0.77	0.03	15	4	<0.1	3	2.5	2	110	30	6	1.0
	16:55	7.0	90	6	37	5.9	0.4	0.81	0.14	15	4	<0.1	3	2.4	3	92	450	300	1.1
	17:30	6.7	89	5	38	7.6	0.4	0.77	0.05	15	4	<0.1	4	4.0	2	108	80	23	1.0

Table G-2.3 (5/7) WATER QUALITY OF DISTRIBUTION NETWORKS (2ND FIELD SURVEY)

- MAHANKAL CHAUR SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	PO4 mg/l
Reservoir	14:50	6.8	87	7.2	24	4.7	0.5	1.4	0.28	20	6	<0.1	2	0.4	16	88	120	100	0.5
	17:30	6.7	85	7.8	26	1.9	0.4	1.9	0.29	20	7	<0.1	2	0.1	9	95	120	80	0.4
MK-1	13:50	7.1	60	-	21	1.9	0.2	1.0	0.14	15	6	<0.1	2	0.1	5	53	150	120	0.5
	14:10	6.6	60	-	17	1.6	0.3	0.61	0.17	5	3	<0.1	2	0.7	3	128	200	50	0.6
	14:25	6.7	162	-	77	8.4	1.1	2.2	0.36	20	7	<0.1	8	3	10	230	50	40	1.7
	15:55	6.6	151	4.4	66	7.0	1.1	3.2	0.30	30	5	<0.1	5	2	10	215	20	8	2.0
	16:10	6.6	149	-	64	7.0	1.2	1.3	0.41	30	5	<0.1	5	2	11	212	20	15	1.3
	16:45	6.6	146	-	62	7.8	1.2	1.8	0.28	30	7	<0.1	4	3	7	210	80	60	1.7
	17:10	6.6	138	-	62	6.8	1.2	1.9	0.38	20	5	<0.1	7	3	10	225	110	30	1.8
MK-2	15:55	6.6	159	3.8	66	8.4	1.2	2.2	0.35	30	7	<0.1	7	3	19	218	250	70	1.5
	16:10	6.6	160	-	64	7.0	1.2	1.9	0.34	20	5	<0.1	7	2	10	180	70	10	1.1
	16:45	6.6	151	-	62	6.4	1.2	1.4	0.28	20	6	<0.1	3	2	10	95	10	2	1.0
	17:10	6.6	148	-	60	6.5	1.1	1.2	0.32	30	7	<0.1	8	2	15	93	250	200	1.1
MK-3	15:55	6.6	68	6.5	20	8.1	1.2	4.6	0.86	50	10	<0.1	8	4	29	143	120	40	1.0
	16:10	6.6	160	-	75	6.8	1.1	3.3	0.29	20	6	<0.1	7	3	24	140	10	10	0.6
	16:45	6.6	145	-	62	8.1	1.1	1.1	0.21	15	4	<0.1	10	3	22	108	140	120	0.3
	17:10	6.6	145	-	62	7.0	1.1	0.73	0.22	20	6	<0.1	6	3	14	98	80	20	0.3
MK-4	15:10	6.4	64	6.9	19	7.2	<0.1	5.5	0.35	40	10	<0.1	5	3	35	60	120	20	0.4
	15:25	6.5	101	4.1	34	6.7	0.3	1.8	0.20	10	5	<0.1	3	2	6	25	150	80	0.3
	16:00	6.6	177	2.0	73	7.9	1.3	3.1	0.47	30	7	<0.1	10	3	11	133	160	140	0.4
	17:10	6.7	159	3.5	58	7.3	1.0	3.6	0.40	30	15	<0.1	8	3	11	175	50	40	0.4
	17:25	6.6	145	3.3	34	6.1	1.1	2.4	0.40	30	10	<0.1	5	2	13	155	60	50	0.4
	18:00	6.7	151	4.1	56	8.2	1.1	2.6	0.37	40	10	<0.1	5	3	20	143	10	8	0.3
MK-5	17:10	6.8	119	8.4	49	8.2	<0.1	10	0.26	30	7	<0.1	7	3	18	287	180	120	0.7
	17:25	6.7	146	4.8	60	6.4	1.0	2.1	0.29	20	6	<0.1	6	1	13	280	30	10	0.2
	18:00	6.7	142	4.5	60	6.8	1.1	3.0	0.36	15	5	<0.1	6	1	10	213	80	50	0.6
MK-6	17:10	6.8	138	5.7	62	8.2	0.3	4.5	0.34	40	15	<0.1	7	2	19	250	100	70	0.1
	17:25	6.6	143	4.1	62	7.2	1.1	4.0	0.34	30	7	<0.1	6	2	17	168	50	50	1.1
	18:00	6.6	143	3.3	60	7.0	1.0	3.2	0.38	20	6	<0.1	9	2	13	205	120	100	0.8

Table G-2.3 (6/7) WATER QUALITY OF DISTRIBUTION NETWORKS (2ND FIELD SURVEY)

- SHAIBHU SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	PO4 mg/l
Reservoir	15:10	8.1	206	9.9	100	1.4	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	128	0	0	<0.1
	16:30	8.3	204	10.0	100	0.9	<0.1	<0.03	<0.02	<1	<1	>0.2	1	<0.3	<1	130	0	0	<0.1
SB-1	15:10	8.0	192	13.0	106	1.2	0.1	0.05	<0.02	<1	<1	>0.2	2	0.3	<1	83	0	0	0.2
	15:25	8.0	193	15.3	100	2.5	<0.1	0.05	<0.02	<1	<1	0.1	3	0.6	<1	95	0	0	<0.1
	15:40	8.0	198	13.0	102	0.5	<0.1	0.03	<0.02	<1	<1	0.1	3	<0.3	<1	95	0	0	<0.1
	16:10	8.1	202	11.3	102	0.5	<0.1	0.40	<0.02	<1	<1	0.2	1	<0.3	<1	98	0	0	<0.1
	16:25	8.2	217	11.8	102	0.9	0.2	<0.03	<0.02	1	1	>0.2	8	<0.3	<1	108	0	0	0.1
	17:00	8.4	200	10.8	98	0.6	<0.1	<0.03	<0.02	<1	<1	>0.2	6	<0.3	<1	135	0	0	0.1
SB-2	16:10	7.9	207	13.0	98	1.1	0.1	0.04	<0.02	<1	<1	0.2	5	0.3	<1	118	0	0	0.3
	16:25	7.9	204	13.6	102	1.6	<0.1	0.03	<0.02	<1	<1	0.1	3	0.4	<1	105	0	0	0.2
	17:00	8.1	225	12.6	98	0.5	<0.1	<0.03	<0.02	<1	<1	>0.2	7	<0.3	<1	108	0	0	0.3
SB-3	16:10	8.1	202	10.0	100	0.6	<0.1	<0.03	<0.02	<1	<1	>0.2	4	<0.3	<1	115	0	0	<0.1
	16:25	8.1	200	10.0	98	0.3	<0.1	<0.03	<0.02	<1	<1	>0.2	4	<0.3	<1	105	0	0	0.2
	17:00	8.1	206	10.0	100	0.3	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	115	0	0	<0.1
SB-4	14:15	-	-	-	104	0.3	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	130	0	0	0.2
	15:10	8.1	192	-	104	0.3	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	125	0	0	0.2
	15:25	8.1	191	-	100	0.3	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	113	0	0	0.2
	15:40	8.1	190	-	104	0.5	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	113	0	0	0.2
	16:10	8.0	194	-	102	0.6	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	120	0	0	0.1
	16:25	7.9	189	-	102	0.5	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	110	0	0	0.2
SB-5	14:20	-	-	-	100	1.1	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	113	0	0	0.2
	15:10	8.1	191	-	104	1.6	<0.1	<0.03	<0.02	<1	<1	>0.2	2	0.4	<1	138	0	0	0.2
	15:25	8.1	189	-	102	1.6	<0.1	<0.03	<0.02	<1	<1	>0.2	2	0.3	<1	113	1	1	<0.1
	15:40	7.8	179	-	102	1.1	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	98	0	0	<0.1
	16:10	8.1	186	-	100	1.5	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	105	0	0	<0.1
	16:25	7.9	190	-	102	1.4	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	95	0	0	<0.1
SB-6	15:10	8.0	192	11.4	100	0.8	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	125	0	0	<0.1
	15:25	8.1	198	10.0	100	1.4	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	123	0	0	<0.1
	15:40	8.0	186	12.1	100	0.8	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	133	0	0	<0.1
	16:10	8.0	201	15.0	104	0.9	<0.1	<0.03	<0.02	<1	<1	>0.2	1	<0.3	<1	125	0	0	<0.1
	16:25	7.9	195	13.3	102	0.6	<0.1	<0.03	<0.02	<1	<1	>0.2	1	<0.3	<1	123	0	0	<0.1
	17:00	8.2	205	15.3	100	0.8	<0.1	<0.03	<0.02	<1	<1	>0.2	2	<0.3	<1	135	0	0	<0.1

Table G-2.3 (7/7) WATER QUALITY OF DISTRIBUTION NETWORKS (2ND FIELD SURVEY)

- BANSBARI SYSTEM -

Sampling Point	Sampling Time	pH	EC ms/cm	DO mg/l	Alkali mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	PO4 mg/l
Reservoir	16:00	6.9	182	6.0	78	5.1	0.9	1.5	0.06	20	6	<0.1	5	2	5	95	5	3	0.3
	17:30	6.9	171	6.0	78	5.1	1.0	1.7	0.03	12	4	<0.1	2	2	3	55	4	2	0.5
BB-1	17:40	6.8	180	6.2	71	8.4	0.2	1.5	0.09	20	6	<0.1	6	2	<1	295	7	4	0.3
	17:55	6.8	178	6.1	75	10	0.4	1.4	0.11	15	5	<0.1	5	3	1	275	5	2	0.4
	18:30	6.8	166	5.8	76	11	0.9	1.7	0.14	20	6	<0.1	5	3	6	235	0	0	0.5
BB-2	17:40	6.8	169	5.9	72	7.3	0.1	1.6	0.09	15	5	<0.1	2	2	5	228	15	10	0.5
	17:55	6.7	172	5.6	73	6.1	0.1	1.2	0.07	10	4	<0.1	4	2	2	293	10	6	0.2
	18:30	7.0	176	5.0	72	9.8	0.4	1.6	0.07	20	5	<0.1	6	4	4	250	12	7	0.1
BB-3	16:25	6.5	176	1.8	71	8.2	<0.1	0.83	0.07	20	6	<0.1	3	2	1	268	10	6	0.4
	16:40	6.6	171	1.9	72	6.7	<0.1	0.83	0.07	20	6	<0.1	1	2	1	273	7	4	0.1
	17:15	6.8	162	4.6	69	6.5	0.2	0.78	0.07	20	5	<0.1	2	2	2	293	8	4	0.1
	17:55	6.6	174	4.6	71	7.5	0.1	1.3	0.07	20	6	<0.1	4	3	4	278	7	4	0.1
	18:10	6.8	175	5.2	74	7.8	<0.1	1.2	0.07	12	4	<0.1	6	3	3	260	2	0	0.4
	18:45	6.8	172	4.5	72	7.6	0.1	1.5	0.11	20	6	<0.1	4	3	4	278	0	0	0.3
BB-4	17:40	-	-	-	71	5.8	0.2	0.52	0.05	12	4	<0.1	2	2	1	163	6	3	0.5
	17:55	-	-	-	72	4.8	0.1	0.53	0.07	15	4	<0.1	3	2	2	170	4	2	0.5
	18:30	-	-	-	71	6.4	<0.1	0.53	0.06	15	3	<0.1	<1	2	2	180	2	1	0.5
BB-5	16:10	7.0	169	-	65	5.8	0.1	0.64	0.09	20	6	<0.1	1	2	5	185	14	8	0.4
	16:25	6.8	174	-	74	6.2	0.1	0.62	0.08	10	3	<0.1	3	2	7	205	11	6	0.6
	17:00	6.7	173	-	71	5.8	<0.1	0.57	0.03	10	4	<0.1	2	2	9	188	12	5	0.4
	17:40	6.8	171	-	73	6.2	0.1	1.2	0.02	15	5	<0.1	2	2	2	188	10	5	0.7
	17:55	6.9	170	-	64	6.7	<0.1	1.2	0.04	20	5	<0.1	1	2	9	188	8	4	0.5
	18:30	6.8	171	-	73	7.0	<0.1	1.0	0.03	10	3	<0.1	2	2	<1	148	6	3	0.5
BB-6	16:10	6.7	167	-	68	5.8	0.1	1.3	0.08	15	4	<0.1	4	2	2	158	8	4	0.3
	16:25	6.7	174	-	71	6.7	0.1	2.4	0.15	15	5	<0.1	8	2	10	183	7	3	0.6
	17:00	6.6	172	-	75	5.1	0.1	1.1	0.08	15	4	<0.1	4	2	2	183	4	2	0.5
	17:40	6.7	173	-	72	5.8	<0.1	1.0	0.02	10	3	<0.1	4	2	2	63	6	4	0.4
	17:55	6.6	170	-	72	6.1	<0.1	1.0	0.04	10	3	<0.1	2	2	1	98	3	2	0.3
	18:30	6.7	170	-	68	6.7	<0.1	1.0	0.03	15	4	<0.1	2	2	<1	85	5	3	0.4

Table G-2.4 (1/2) WATER QUALITY OF POTENTIAL WATER RESOURCES (1ST FIELD SURVEY)

Name of River	Sampling Point	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	PO4 mg/l	Colones nos/ml	Coliform nos/ml	SiO2 mg/l	CO3 mg/l	HCO3 mg/l	NO3 mg/l	NO2 mg/l
Bisnumati	BS-1	-	-	-	77	95	21	0.2	1.0	0.1	25	41	5	6	4	46	208	0.2	-	-	23	-	-	<1	0.02
Dhobi Kh.	DK-1	7.1	77	6	30	24	7.7	0.2	1.8	<0.02	28	8	3	5	3	<1	-	-	160	100	21	-	-	<1	<0.01
Nagmati	NG-1	7.7	22	12	12	8	1.9	<0.1	0.09	<0.02	2	<1	<1	0.4	<1	<1	22	0.1	0	0	21	-	-	<1	<0.01
Bagmati	BG-1	7.6	26	12	14	9	1.4	<0.1	0.05	<0.02	2	<1	<1	0.7	<1	<1	24	0.1	0	0	22	-	-	<1	<0.01
	BG-2	7.4	29	10	18	10	2.2	<0.1	<0.03	<0.02	9	<1	<1	0.5	<1	<1	-	-	0	0	-	-	-	<1	<0.01
	BG-3	7.4	37	9	18	10	3.8	<0.1	0.1	6.04	8	2	<1	2	1	5	-	-	35	15	-	-	-	-	-
	BG-4	7.0	36	7	16	11	5.8	<0.1	0.43	<0.02	14	4	5	2	1	3	-	-	10	6	-	-	-	<1	<0.01
	BG-5	7.3	40	8	16	11	5.5	<0.1	0.56	0.04	20	10	1	3	1	16	-	-	20	20	-	-	-	-	-
	BG-6	7.0	23	7	17	15	6.2	<0.1	2.47	0.05	20	32	2	3	1	36	-	-	6	5	-	-	-	-	-
	BG-7	7.1	37	7	19	23	6.5	0.4	2.49	0.05	12	27	4	3	2	30	-	-	20	15	-	-	-	-	-
Manohara	MH-1	7.4	53	10	20	31	4.0	<0.1	0.76	<0.02	20	6	2	2	1	<1	-	-	-	-	-	-	-	-	-
	MH-2	7.0	71	9	25	37	8.2	0.3	1.7	0.02	24	16	2	3	2	20	-	-	-	-	-	-	-	-	-
Godawari Kh.	GD-1	7.8	257	9	136	150	0.6	<0.1	<0.03	<0.02	<1	<1	<1	<0.3	<1	<1	-	-	0	0	-	-	-	<1	<0.01
	GD-2	8.2	207	9	101	114	1.9	<0.1	0.06	0.02	7	1	1	1	1	<1	-	-	110	10	-	-	-	<1	<0.01
	GD-3	8.4	245	10	129	124	4.4	<0.1	0.3	0.1	13	4	1	2	1	1	-	-	20	3	-	-	-	3	0.03
Khodu Kh.	KD-1	8.2	205	9	105	120	1.1	<0.1	<0.03	<0.02	3	<1	<1	0.6	1	<1	-	-	23	5	-	-	-	1	<0.01
	KD-2	8.7	163	9	80	100	4.9	<0.1	1.0	<0.02	20	4	3	3	2	<1	-	-	10	2	-	-	-	-	-
Nakhu Kh.	NK-1	7.7	108	9.7	54	54	1.7	<0.1	0.07	<0.02	7	2	1	0.5	<1	8	98	0.1	2	2	-	-	-	-	-
	NK-2	8.6	135	10.7	68	68	3.6	<0.1	0.17	0.05	10	20	2	2	2	15	124	<0.1	20	5	-	-	-	-	-
	NK-3	9.1	137	-	65	68	4.9	<0.1	0.41	0.09	16	28	3	2	2	53	158	<0.1	30	8	-	-	-	-	-
Lele Kh.	LL-1	8.4	150	12.5	53	60	0.8	<0.1	0.15	0.05	8	44	1	0.5	<1	74	122	<0.1	10	7	-	-	-	-	-
Bosan Kh.	BS-1	7.6	222	7	106	124	2.1	<0.1	0.23	<0.02	0.5	4	1	0.9	<1	10	-	-	30	8	-	-	-	-	-
Balkhu Kh.	BL-1	7.7	237	-	113	232	7.9	0.2	2.1	0.07	0.25	17	2	5	3	37	176	0.1	220	10	-	-	-	-	-
	BL-2	8.6	220	-	103	228	10	0.3	0.76	0.06	40	18	7	6	5	47	178	0.5	180	10	-	-	-	-	-

Table G-2.4 (2/2) WATER QUALITY OF POTENTIAL WATER RESOURCES (2ND FIELD SURVEY)

Name of River	Sampling Point	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	T-N mg/l	PO4 mg/l
Bisnumati	BN-1	6.4	20	6.4	12	5	7.2	<0.1	0.52	<0.02	3	2	<1	5	3	5	58	120	40	-	<0.1
	BN-1*	6.8	23	7.2	9	5	9.0	<0.1	0.41	0.05	4	2	<1	3	2	25	48	800	700	-	0.2
	BN-2	6.4	31	6.6	12	11	9.2	<0.1	1.4	<0.02	8	4	<1	5	3	3	45	80	30	-	<0.1
	BN-3	6.6	43	6.8	15	14	15	<0.1	3.5	0.02	30	15	<1	6	4	6	95	120	100	-	<0.1
	BN-3*	6.9	75	6.0	30	34	52	<0.1	8.2	0.13	150	150	<1	18	13	562	600	200	140	-	0.1
Dhobi Kh.	DK-1	6.7	60	6.9	21	38	42	0.3	6.0	0.10	30	30	2	10	5	166	445	50	40	-	0.3
Bagmati	BG-3	7.5	21	7.5	10	6	3.7	<0.1	0.26	0.03	2	1	<1	1	1	9	38	350	300	3.1	<0.1
	BG-3*	6.6	18	7.7	9	8	18	<0.1	8.1	0.06	100	150	<1	7	5	395	416	190	140	0.6	0.6
	BG-4*	6.5	19	7.8	5	8	18	<0.1	6.0	0.10	100	170	<1	6	3	387	424	290	160	0.5	0.4
	BG-6	7.0	25	6.8	10	7	21	0.1	2.9	0.02	30	15	<1	7	5	66	75	150	120	3.6	<0.1
	BG-6*	7.3	26	6.5	12	50	40	0.4	9.1	0.22	100	50	9	12	9	609	625	500	400	3.3	<0.1
	BG-7	7.0	24	8.0	6	11	21	0.1	4.9	0.18	150	250	<1	9	4	461	584	240	110	1.2	0.6
	BG-7*	7.2	24	5.9	10	52	133	0.3	9.0	0.18	500	500	8	24	15	1930	2280	800	700	5.6	<0.1
	BG-8	6.8	340	<0.1	122	110	56	8.1	8.5	0.38	25	15	28	23	13	378	673	1000	900	19	0.2
	BG-8*	7.0	144	4.6	49	62	43	0.2	9.6	0.16	50	50	11	17	12	758	855	600	550	5.1	<0.1
Manohara	MH-0	6.7	42	7.0	18	10	6.2	<0.1	1.3	<0.02	12	5	<1	3	2	2	68	70	50	-	<0.1
	MH-1	6.8	46	6.9	16	12	8.7	<0.1	2.0	0.02	20	8	<1	4	3	6	40	40	30	-	<0.1
	MH-2	6.8	41	6.6	18	14	13	<0.1	1.4	0.02	20	8	<1	5	3	8	68	0	50	-	<0.1
	MH-2*	6.5	32	4.9	3	23	212	<0.1	16	0.11	250	200	1	47	22	1940	3570	280	140	-	<0.1
Godawari Kh.	GD-1	7.5	245	4.6	30	134	<0.3	<0.1	0.05	0.03	3	<1	<1	<0.3	<1	<1	150	50	30	-	0.2
	GD-3	8.1	202	4.4	100	108	11	0.1	<0.03	<0.02	800	300	<1	10	4	1530	1710	110	1000	-	<0.1
Khodu Kh.	KD-1	8.0	180	4.8	86	88	1.2	<0.1	0.32	0.05	5	5	<1	1	<1	9	135	120	100	-	0.5
	KD-2	8.0	201	4.6	90	93	5.0	0.1	0.97	0.11	20	10	<1	3	1	7	125	160	120	-	<0.1
	KD-2*	7.5	175	7.0	81	94	15	<0.1	4.0	0.07	35	20	2	5	3	133	208	280	250	-	<0.1
Nakhu Kh.	NK-1	7.5	126	7.0	56	98	1.9	0.1	<0.03	0.03	2	<1	<1	1	<1	4	88	120	100	-	<0.1
	NK-2	8.3	162	5.6	75	73	3.4	<0.1	0.37	0.05	10	4	<1	3	1	10	132	150	50	-	0.8
	NK-3	8.6	160	4.5	76	73	2.8	<0.1	0.63	0.09	10	5	<1	3	1	22	128	160	100	-	1.2
	NK-3*	7.5	158	6.6	72	116	13	0.2	3.7	0.24	20	20	<1	4	2	256	263	200	130	-	<0.1
Leie Kh.	LL-1	7.5	200	7.0	89	100	1.9	0.1	0.03	0.02	1	1	<1	0.4	<1	2	95	120	100	-	<0.1
Bosan Kh.	BS-1	7.9	246	6.9	103	22	3.7	0.1	0.15	0.19	10	5	<1	2	1	39	140	40	30	-	0.1
Balkhu Kh.	BL-2	8.2	228	6.6	112	114	8.2	0.2	3.6	0.06	10	3	<1	4	3	4	158	300	200	-	<0.1
	BL-2*	7.3	137	6.2	40	80	34	0.2	9.1	0.27	50	30	5	13	10	549	580	250	200	-	<0.1

Note *: Data on flooding condition.

Table G-2.5 (1/2) WATER QUALITY OF OTHER WATER RESOURCES (1ST FIELD SURVEY)

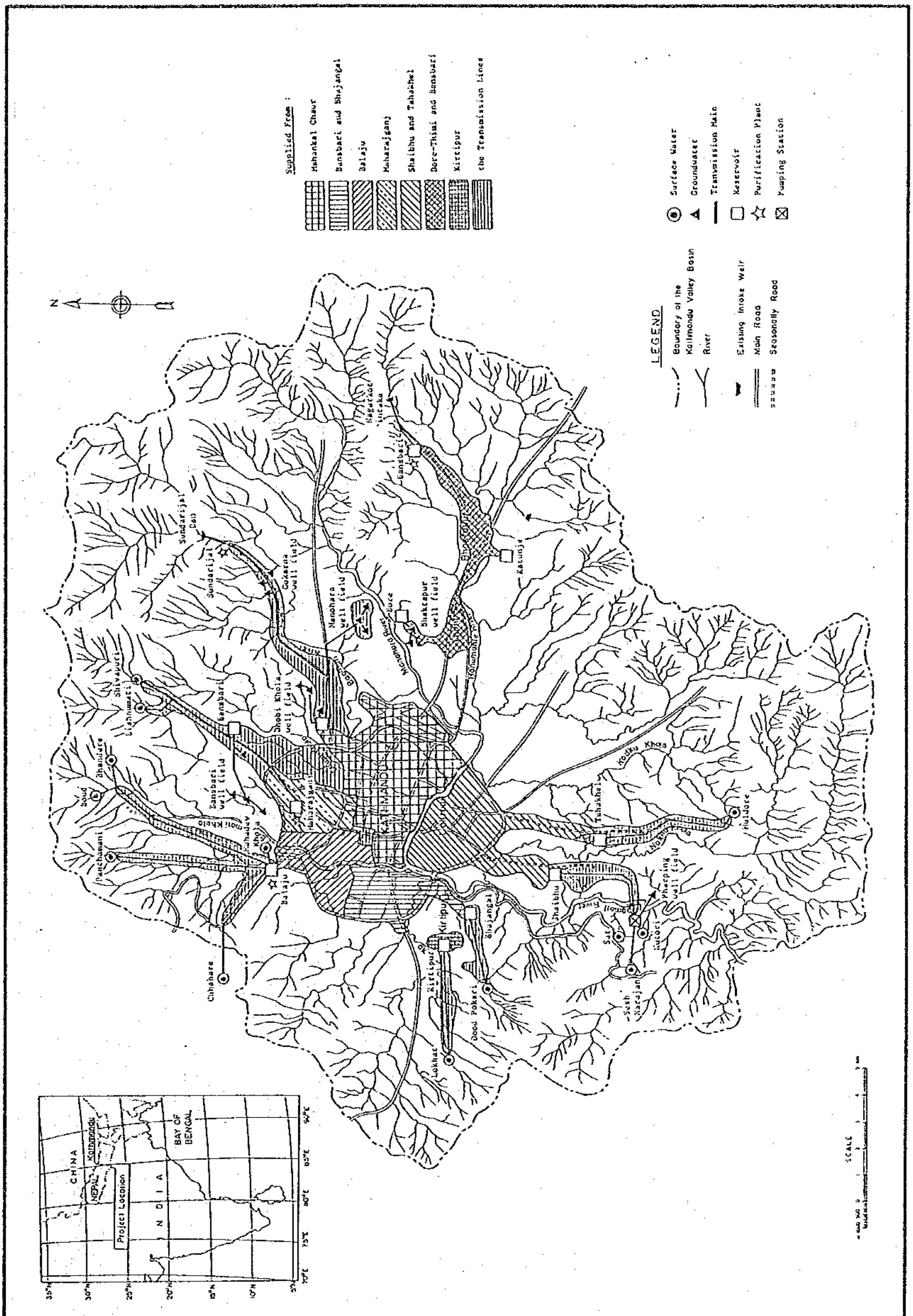
Name of Resources	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Res.Cl mg/l	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	PO4 mg/l	Colones nos/ml	Coliform nos/ml	SiO2 mg/l	CO3 mg/l	HCO3 mg/l	NO3 mg/l	NO2 mg/l	Ca mg/l	O/M mg/l
DEEP WELL																											
-Coca Cola	6.6	1320	3	755	353	51	95	13	0.91	40	80	-	30	16	<1	56	-	-	0	0	92	<1	102	<1	<0.01	86	25
-Pepsi Cola	6.6	447	2	245	120	22	11	5.1	0.71	32	8	-	<1	9	<1	16	-	-	2	3	51	<1	31	<1	<0.01	26	7
-Everest Sheraton	6.6	642	2	355	173	27	22	6.6	0.95	28	30	-	2	10	<1	21	-	-	0	37	80	<1	37	<1	<0.01	34	8
-Gas Well	6.6	1140	4	606	310	47	64	6.5	0.63	40	90	-	14	9	<1	30	556	18	0	0	82	<1	54	<1	<0.01	91	10
-Himal Cement	7.2	626	1	253	130	14.5	30	3.4	0.05	40	16	-	<1	6	<1	<1	-	-	0	0	47	<1	5	<1	<0.01	39	-
SHALLOW WELL																											
-kathmandu	6.7	228	8	116	99	6.7	1.7	7.5	0.31	80	69	<0.1	4	3	-	17	182	0.9	0	0	-	-	-	<1	<0.01	-	-
-Lalitpur	-	-	-	89	-	2.3	0.2	1.1	0.12	15	16	-	41	10	-	<1	312	-	16	5	-	-	-	-	-	-	-
SPOUT																											
-Kathmandu(1)	6.4	518	5	119	80	5.4	2.1	<0.03	0.07	20	2	-	53	3	-	<1	366	8.9	20	0	-	-	-	41	0.13	-	-
-Kathmandu(2)	6.4	441	3	171	180	4.8	1.2	0.15	0.20	20	1	-	21	2	-	<1	228	15	1000	400	-	-	-	11	0.18	-	-
-Lalitpur	6.0	359	5	72	105	2	0.2	<0.03	0.09	7	<1	-	31	1	-	<1	254	2.3	20	0	-	-	-	3.5	0.07	-	-
BAGMATI																											
-BG-8 (Jan 23)	7.3	300	4	99	91	28	4.3	0.3	0.29	33	45	-	25	14	9	57	-	-	1000	150	-	-	-	-	-	-	20
-BG-8 (Mar 2)	-	-	-	205	120	123	19	0.3	0.52	90	57	-	52	52	40	86	392	8	2000	1500	-	-	-	<1	<0.01	-	-
SUNDARIGHAT INTAKE WELL	-	-	-	201	125	14	16	0.2	1.90	22	25	-	30	5	4	8	262	0.2	5	0	29	9.2	-	2	0.17	35	-
HANUMANTE																											
-HN-1	-	-	-	189	312	62	15	3.6	0.15	80	38	-	27	24	18	41	308	1.5	540	200	-	-	-	-	-	-	-
-HN-2	-	-	-	136	248	17	4.2	3.1	0.10	40	27	-	18	8	5	22	210	0.4	120	50	-	-	-	-	-	-	-

Note O/M : Organic matter

Table G-2.5 (2/2) WATER QUALITY OF OTHER WATER RESOURCES (2ND FIELD SURVEY)

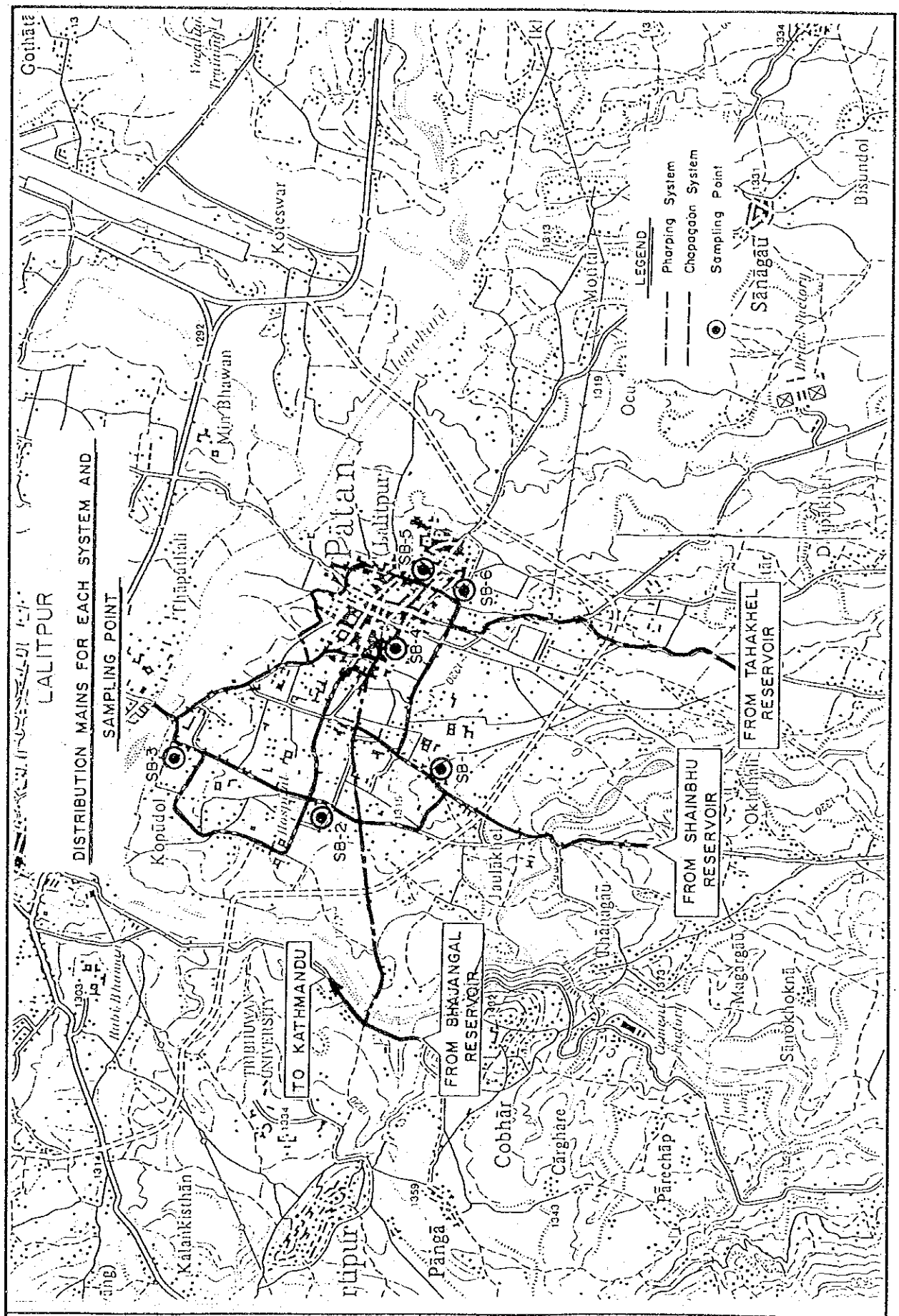
Name of Resources	pH	EC ms/cm	DO mg/l	Alkali mg/l	Hard mg/l	KMnO4 mg/l	NH4-N mg/l	Fe mg/l	Mn mg/l	Color deg.	Turbid deg.	Cl mg/l	COD mg/l	BOD mg/l	SS mg/l	TDS mg/l	Colones nos/ml	Coliform nos/ml	T-N mg/l	PO4 mg/l	Ca mg/l	HCO3 mg/l
DEEP WELL																						
-Malla Hotel	6.1	614	2.2	296	132	42	26	13	0.32	50	120	<1	12	-	19	368	-	-	40	13	43	19
-JW1	6.5	208	7.0	101	56	16	2.9	2.1	0.26	30	1	<1	5	-	4	185	-	-	3.2	0.9	20	3
-JW2	7.0	159	8.0	75	74	3.1	0.6	2.2	0.03	15	1	1	0.4	-	<1	338	-	-	0.7	1.1	12	3
SHALLOW WELL																						
-Lalitpur	6.5	1030	6.2	248	183	7.2	2.9	<0.03	0.09	2	2	126	3	-	6	695	-	-	6.6	6.4	35	15
-Sinamagal	6.3	947	5.3	263	318	13	0.2	<0.03	0.45	5	3	117	5	-	4	652	-	-	4.1	0.5	95	13
-Pasupatinath (1)	5.7	92	7.0	31	24	1.5	0.9	1.0	0.11	24	<1	2	0.5	-	<1	78	-	-	1.2	0.8	7	6
-Pasupatinath (2)	5.5	64	7.0	21	25	1.9	<0.1	0.56	0.11	20	2	3	0.7	-	<1	58	-	-	0.4	0.2	5	3
SPOUT																						
Kathmandu																						
-No. 3	5.6	440	7.1	19	106	1.7	<0.1	<0.03	0.09	2	<1	55	1	1	<1	378	200	150	-	0.4	-	-
-No. 4	6.3	397	4.2	82	112	7.5	<0.1	<0.03	0.08	<1	<1	92	1	1	<1	345	250	200	-	0.7	-	-
-No. 8	6.2	1020	5.8	162	260	9.4	3.0	<0.03	0.59	5	2	112	4	2	2	725	200	150	-	8.1	-	-
-No. 11	6.5	550	4.2	119	85	13	<0.1	<0.03	<0.02	<1	<1	54	6	4	<1	502	120	100	-	0.9	-	-
-No. 16	6.3	194	6.6	53	81	1.6	<0.1	0.08	<0.02	<1	<1	18	0.5	-	<1	-	-	-	-	0.3	-	-
Lalitpur																						
-No. 1	6.5	571	6.4	144	172	3.3	3.3	0.04	0.11	<1	<1	50	2	-	<1	-	-	-	-	2.9	-	-
-No. 2	6.3	436	5.8	84	124	6.7	<0.1	<0.03	0.07	<1	<1	43	3	2	<1	295	60	50	-	<0.1	-	-
-No. 10	6.5	414	6.2	95	164	4.2	<0.1	<0.03	<0.02	<1	<1	63	2	1	<1	608	100	50	-	0.6	-	-
SHAIBHU RESERVOIR																						
-Before filtration	7.4	220	7.7	100	20	1.7	<0.1	<0.03	0.03	1	<1	<1	<0.3	<1	<1	127	2	2	-	<0.1	-	-
-After filtration	7.8	213	7.8	94	32	<0.3	<0.1	0.06	0.02	1	<1	<1	<0.3	<1	2	118	0	0	-	<0.1	-	-

FIGURES

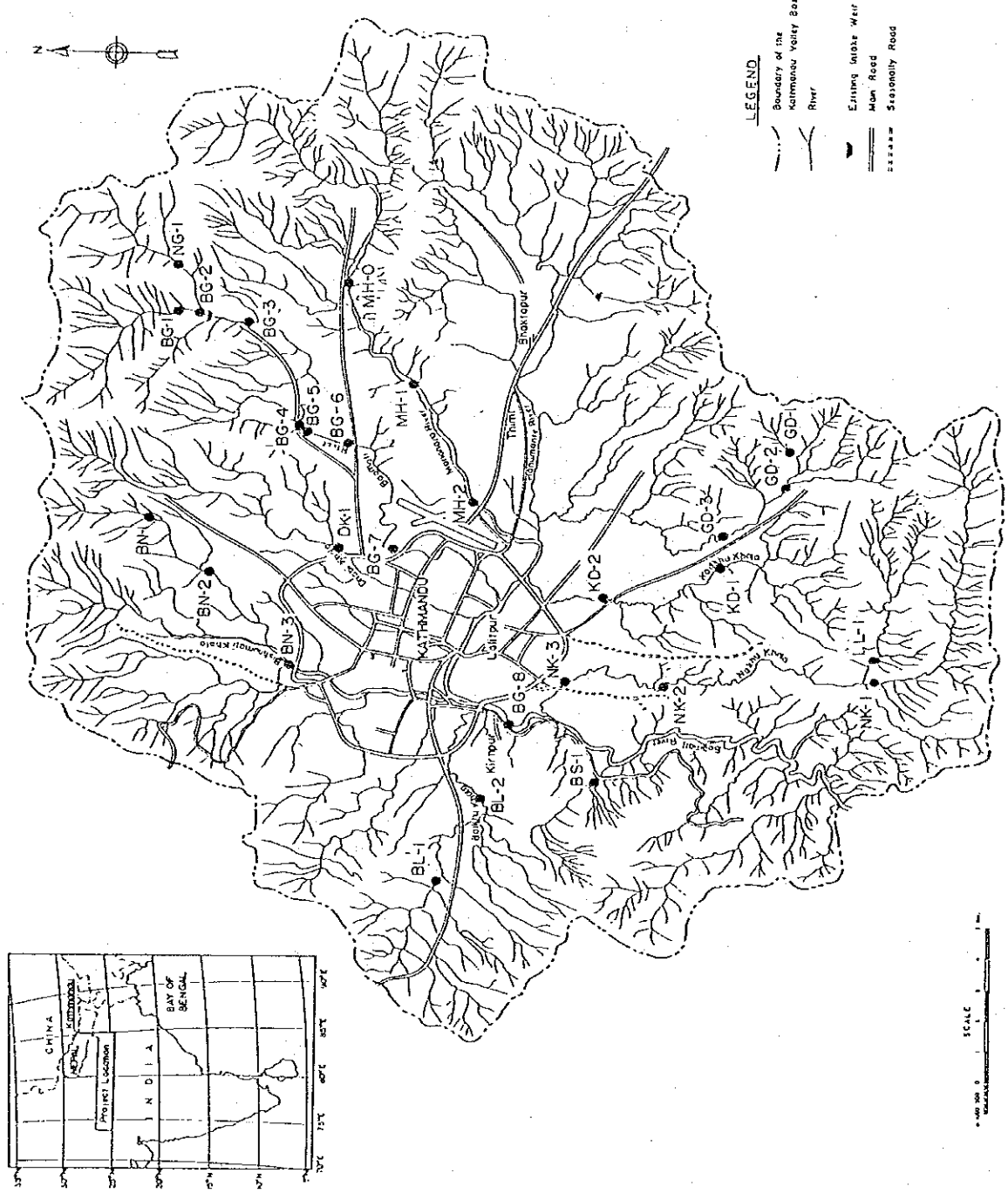


HIS MAJESTY'S GOVERNMENT OF NEPAL GROUND WATER MANAGEMENT PROJECT IN THE KATHMANDU VALLEY	Fig. G-1.1	EXISTING WATER SUPPLY SYSTEM
JAPAN INTERNATIONAL COOPERATION AGENCY		

HIS MAJESTY'S GOVERNMENT OF NEPAL GROUND WATER MANAGEMENT PROJECT IN THE KATHMANDU VALLEY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. G-2.1 (1/2)	SAMPLING POINTS IN DISTRIBUTION NETWORKS (KATHMANDU)



HIS MAJESTY'S GOVERNMENT OF NEPAL GROUND WATER MANAGEMENT PROJECT IN THE KATHMANDU VALLEY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. G-2.2 (2/2)	SAMPLING POINTS IN DISTRIBUTION NETWORKS (LALITPUR)



HIS MAJESTY'S GOVERNMENT OF NEPAL GROUND WATER MANAGEMENT PROJECT IN THE KATHMANDU VALLEY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. G-2.2	SAMPLING POINTS OF POTENTIAL WATER RESOURCES

APPENDIX H
POPULATION PROJECTIONS

APPENDIX H

POPULATION PROJECTIONS

LIST OF TABLES

1. INTRODUCTION

Future population of urban areas in the Kathmandu and Lalitpur Districts have been projected by many investigators throughout various projects since 1973, so the primary objective of the present study is to review the previous studies and to select the most appropriate projection for estimating future water demand.

Table H-1 shows results of main previous studies on population projections of the Kathmandu and Lalitpur urban areas. As seen in the table these results vary widely, for example, the forecast 2001 population ranges from 384 thousand to 958 thousand. In general these forecasts indicate larger figures in later studies, especially the forecast figures in the 1980's are far larger than those in the 1970's. The forecast may be influenced from population growth at the point of time studied. Actually the intercensal growth rate between 1971 and 1981 is fairly high compared with those up to the 1971 census.

Although there are some projections as mentioned above, at present the projection on the basis of the 1981 census population seems to be realistic. From such point of view, the projected population is chiefly reviewed on two reports in the 1980's; Proctor and Redfern, " Water Supply and Sewerage Studies, Nepal 1984 ", Appendix 'D'- Population Projections (Ref.1) and Binnie and Partners," Water Supply for Kathmandu-Lalitpur, from outside the Valley 1988 ", Appendix 'N'- Population (Ref.2).

Para. 2 gives outlines of methods and results of the population projections shown in the said two reports. Since there is a great difference between both results, a different projection is carried out in Para. 3 in order to check the forecasts in previous studies, and finally results and considerations are given in Para. 4.

2. Review of Previous Studies

2.1 Study of Proctor and Redfern, 1984

This study (Ref.1) was carried out with the objective of forecasting the future population of 23 towns in the whole country including Kathmandu, Lalitpur and Bhaktapur urban areas, as a part in "Water Supply and Sewerage

Studies 1984 (the 4th Project)". According to Ref.1, references which were used for the forecast are as follows:

(1) The Sixth Development Plan of Nepal.
(2) The World Bank: Nepal-Policies and Prospects for Accelerated Growth, October 1981.
(3) The World Bank: Urban Sector Memorandum, October 1982.
(4) National Planning Commission: Proceedings of the Janakpur Seminar on Population and the Social Service Sector, September 1981.
(5) Department of Housing and Physical Planning: Three papers presented at a "Seminar on Urbanization and National Development", September 1983.

Based on the above references and the 1961, 1971 and 1981 censuses, the future population of the Kathmandu and Lalitpur urban areas was projected through three stages; at the 1st stage the projections of population and its growth rate for Nepal and urban areas in the Hill Zone, at the 2nd stage for urban areas in the Central Region, and finally for the Kathmandu and Lalitpur urban areas. The population projections were made up to the year 2001 by using a mathematical model (compound interest formula)based on the 1981 census population and the expected population growth rates in areas concerned.

At the 1st stage the future population and the growth rates of Nepal and urban areas in the Hill Zone were estimated on the detailed examination of historic trends of population parameters such as total fertility rate, life expectancy at birth, crude birth and death rates, land use in each zone, internal migration, and prospective impacts of power supply and transport. The results are as follows:

Areas	Population('000) 2001	Average Annual Growth Rate(%)* 1981-2001
Nepal	25,195	2.62
Urban Areas in Hill Zone	1,384 - 1,522	5.0 - 6.0

*Compound interest rate

Next, the future population and growth rates for urban areas in the Central Region in the Hill Zone were estimated on the basis of the above results, taking account of the censuses' population, intercensal growth rates,

historic trends of migration for each region in the Hill Zone, and prospective impacts of power supply and transport. As the result, the urban population in the Central Region was projected to be 1,043 thousand in 2001 at an average annual growth rate of 4.59 % for the 1981-2001 period.

Finally, the population and population growth rates for the Kathmandu and Lalitpur urban areas were estimated on the basis of the 1981 census population and the above results, taking account of historical population growth rates of Kathmandu and Lalitpur. The results are as follows:

Urban Areas	Urban Population('000) 1981	1991	2001	Average Annual Growth Rate(%)* 1981-2001
Kathmandu	235	368	577	4.60
Lalitpur	81	111	152	3.20
Kathmandu/Lalitpur	316	479	729	4.27

---

*Compound interest rate

The above-estimated growth rates for the period 1981-2001 for urban areas of Kathmandu and Lalitpur are very close to the respective intercensal growth rates (4.57 % and 3.20 %) between 1971 and 1981, i.e. the 2001 population estimated by extrapolating the intercensal trend from 1971 to 1981 becomes nearly equal to the estimations of Proctor and Redfern.

2.2 Study of Binnie and Partners, 1988

This study (Ref.2) was conducted with the objective of forecasting the population of the Kathmandu and Lalitpur urban areas as a part of "Feasibility Study of Water Supply for Kathmandu-Lalitpur from outside the Valley, 1988". Major references used for the forecast amounted to 15 kinds of data including "Population Monograph of Nepal, 1987" (Ref.3) and "Population Projection of Nepal 1981-2001, 1986" (Ref.4), published by the Central Bureau of Statistics.

For estimating the future population growth, authors adopted a semi-component model; combination of both component and mathematical models. Regarding the component model, life expectancy at birth up to 2021 was first estimated for urban areas of Kathmandu and Lalitpur by using historical life expectancy of Nepal and other concerned data, and next applying a functional relationship between life expectancy and crude death rate (CDR), CDR for each projection year was estimated by giving the life expectancy and CDR for the base year.

On the other hand, the crude birth rate (CBR) for urban areas of Kathmandu and Lalitpur was assumed for each projection year in consideration of the effect of family planning based on historical CBR of Nepal, and the natural growth rate (r_1) for each projection year was given as a difference between CBR and CDR, r_1 = CBR - CDR. Following the natural growth rate 'r_1', the migration growth rate (r_2) for the Kathmandu and Lalitpur urban areas was assumed for each projection year in consideration of the results of earlier studies and the population densities in urban areas for each projection year, and finally the population growth rate (r) for each projection year was calculated as $r = r_1 + r_2$.

Besides the foregoing growth rates estimated from the component model, the population growth rates in 1986 for urban areas of Kathmandu and Lalitpur were estimated by using the 1981 population and number of voters in 1981 and 1986, and the results were estimated to be the rate between 3.46 % (Low) and 9.51 % (High) for the Kathmandu urban area and the rate between 4.18 % (Low) and 8.56 % (High) for the Lalitpur urban area.

Based on the above estimates, concerning the population growth rates for both urban areas, authors prepared three kinds of scenarios; Model-I(Medium), Model-II(High) and Model-III(Low), and the growth rates on Model-I were assumed as follows;

- for the year 1981, the census growth rate;
- for the year 1986, the growth rate of the medium scenario given by calculation;
- the average growth rate for the period from 1981 to 1986 was assumed to be continued up to 1991 as constant; and
- for years after 1991, the growth rate (r) was given as the sum of components 'r_1' and 'r_2', i.e. $r = r_1 + r_2$.

Model-II and Model-III were designed in order to obtain the extreme minimum and maximum growth pattern with different values and assumptions for the population parameters.

Given the population in the base year and the assumed average growth rates between projection years, population for each projection year up to 2021 was calculated using the exponential formula; $P_t = P_0 e^{rt}$, where P_t = population in t-year, P_0 = population in the base year, r = growth rate and t = projection year. The results of three model are given in Table N.4.1 of Ref.2, and authors recommended the result of Model-I as the most preferable one. The projection up to 2001 of Model-I is summarized below:

	Urban Population('000)				Average Annual Growth Rate(%)*		
Urban Areas	1981	1991	2001	2011	1981-1991	1991-2001	2001-2011
Kathmandu	235	445	722	938	6.38	4.83	2.62
Lalitpur	81	148	236	309	6.02	4.68	2.70
Kathmandu/Lalitpur	316	593	958	1,247	6.29	4.79	2.64

*Exponential model

The above-estimated population in 2001 for Kathmandu/Lalitpur is large by about 230 thousand (or 30 %) compared with the 2001 population (729 thousand) which was projected by Proctor and Redfern. On the other hand, the estimated population in 2011 by Model-I is very close to that obtained by extrapolating the intercensal trend between 1971 and 1981.

3. STUDY APPROACH

3.1 General

Population projections for the Kathmandu and Lalitpur urban areas are made in a different way from previous studies to examine the large difference between two population projections by Proctor and Redfern, 1984 (Ref.1) and Binnie and Partners, 1988 (Ref.2). The main references used for this study are "Population Monograph of Nepal, 1987" (Ref.3) and "Population Projection of Nepal 1981-2001, 1986" (Ref.4), published by the Central Bureau of Statistics.

3.2 Methodology of Population Projection

The population projections applied in this study are made in two stages; (A) initial estimates of population and (B) adjustment of initial estimates. Although this study aims at projecting the urban population of Kathmandu/Lalitpur, the rural and whole population of the Valley and three districts also are estimated for making an adjustment to initial estimates of the urban population.

(A) Initial Estimates of Population

(1) Initial estimates of population are made for each of the Kathmandu Valley as a whole and three districts of Kathmandu, Lalitpur and Bhaktapur.

(2) At the same time, the initial estimates are also made for each of urban and rural areas in the Valley as a whole and three districts.

As a result, twelve kinds of initial estimates of population are obtained for each projection year. Method of estimates is concretely given in the following Section 3.3.

(B) Adjustment of Initial Estimates

Twelve kinds of estimates given in (A) above are revised by the following method:

(1) First Adjustment

For each of the whole valley and three districts, the sum of urban and rural population estimated in (2) of (A) above should be equal to the total population estimated in (1) of (A). If they are not equal, the difference, as an estimation error, is distributed to respective initial estimates of urban, rural and the population as a whole in proportion to respective population sizes. The revised values for respective population are again given as initial estimates for the next adjustment. The above-mentioned description can be expressed using condition equations as follows:

1st Adjustment of Initial Estimates		Revised Values	
$(K_{u0} + K_{r0}) - K_{w0} = dK_0$		K_{u1} , K_{r1} , K_{w1}	
$(L_{u0} + L_{r0}) - L_{w0} = dL_0$	----->	L_{u1} , L_{r1} , L_{w1}	.....[1]
$(B_{u0} + B_{r0}) - B_{w0} = dB_0$		B_{u1} , B_{r1} , B_{w1}	
$(V_{u0} + V_{r0}) - V_{w0} = dV_0$		V_{u1} , V_{r1} , V_{w1}	

where, K, L & B : population of Kathmandu, Lalitpur & Bhaktapur Districts, respectively

V : Population of Kathmandu Valley

suffixes u, r & w : mean urban, rural & whole (urban + rural) areas, respectively

suffixes 0 & 1 : mean initial estimate & 1st revised value of population, respectively

dK, dL, dB & dV : estimation errors of K, L, B & V, respectively

(2) Second Adjustment

Following the 1st adjustment (1), the 2nd adjustment is made using the values revised by the 1st adjustment, under the condition which each sum of urban, rural and total population in three districts should be equal respectively to the urban, rural and total population of the Kathmandu Valley. If they are not equal, the results obtained by the 1st adjustment are again revised in proportion to the population sizes of three districts and the Valley. Condition equations for the 2nd adjustment can be expressed as follows:

2nd Adjustment		Revised Values	
$(K_{u1} + L_{u1} + B_{u1}) - V_{u1} = dU_1$		K_{u2} , L_{u2} , B_{u2} , V_{u2}	
$(K_{r1} + L_{r1} + B_{r1}) - V_{r1} = dR_1$	----->	K_{r2} , L_{r2} , B_{r2} , V_{r2}	....[2]
$(K_{w1} + L_{w1} + B_{w1}) - V_{w1} = dW_1$		K_{w2} , L_{w2} , B_{w2} , V_{w2}	

where, dU, dR and dW mean estimation errors of urban, rural and whole population, respectively, and suffixes '1' and '2' mean results of 1st and 2nd adjustments, respectively. Other symbols have the same mean as those in the

equations [1].

Results obtained from the equations [2] are again given as the initial values in the equations [1], in case that they have not attained to an accuracy required, judging from the estimation errors of dK, dL and dW, and the calculation is repeated using the equations [1] and [2] till the results attain to a necessary accuracy.

3.3 Initial Estimates of Population

The initial estimates of population to be input data of the above iteration calculation are obtained under the following assumptions and conditions:

(1) The initial estimates of population are made using both mathematical and component models for each projection year up to 2001.

(2) Population growth rate (r) is regarded as the sum of the natural growth rate (r_1) and the migration growth rate (r_2); $r = r_1 + r_2$.

(3) The natural growth rate (r_1) applies an average rate of the country as a whole for the entire Kathmandu Valley, assuming that there is no difference between both natural growth rates of the country and Valley , since it is difficult to obtain reasonable regional data as regards the effect of family planning and the natural population growth in the valley.

(4) The projection of natural growth rate is quoted from "Population Projection of Nepal 1981-2001, 1986" (Ref.4), which gives the most reliable information at present. The projection in Ref.4 was made by five years up to 2001 on the national population using a component model which analyzes population parameters such as fertility, mortality, life expectancy at birth, etc., and it was composed of four different scenarios; high, plausible, medium and low variants. Finally the population growth rates for the four periods, 1981-1986, 1986-1991, 1991-1996 and 1996-2001, were estimated based on the population projected (See Table H-2).

(5) Of the above growth rates, three kinds of rates corresponding to high, plausible and low scenarios (except medium scenario) are adopted as initial estimates of the natural growth rate (r_1) for the Kathmandu Valley as

a whole, and the population projections in the present study are made based on the growth rates of scenarios.

(6) Initial estimates of the migration growth rate (r_2) up to 2001 are estimated using three intercensal growth rates for the period 1952/54-1981 for Nepal, the Valley, three Districts, and urban and rural areas of each the Valley and three Districts (See Table H-3). In accordance with assumptions in (2) and (3) above, the growth in the country as a whole represents a natural growth, and the growth in other areas consists of two factors of migration and natural growths. Hence the migration growth rate for each area (r_2) is obtained by subtracting the growth rate for the country (r_1) from the growth rate of each area (r), i.e. $r_2 = r - r_1$. Three rates of intercensal migration growth for each area can be estimated by using this method by each period of four censuses from 1952/54 to 1981. The initial estimates of the future migration growth rates are obtained by an extrapolation using the intercensal migration growth rates (See Table H-4).

(7) The population for each projection year up to 2001 is estimated using the 1981 census population and the growth rates obtained by making the sum of the natural growth rates and migration growth rates. The estimated population is given as the initial values (input data) of the equations [1] of Section 3.2 (B).

3.4 Results

The population in each projection year for the Kathmandu/Lalitpur urban areas is estimated using the foregoing iteration method for each of three scenarios; high, plausible and low variants. Final results of the population projection and the estimated growth rates estimated are given in Table H-5.

In 2001 the urban population of Kathmandu/Lalitpur is forecasted to be 781 thousand, 734 thousand and 628 thousand for each of three scenarios. The difference between both population projected for the high and low scenarios amounts to 153 thousand, i.e. the high scenario population is more by 24 % than the low one, and the population of plausible scenario is somewhat less than that of the high scenario.

The differences of population between three scenarios may be due mainly to different three rates of natural population growth which have been quoted from Ref.4. Accordingly the forecasts obtained from the plausible scenario which applies the plausible rate of natural population growth seem to be

preferable to results of other two scenarios. The population forecasts by the plausible scenario for the Kathmandu and Lalitpur urban areas are summarized below:

Urban Areas	Urban Population('000)					Average Annual Growth Rate(%)*			
	1981	1986	1991	1996	2001	1981-1986	1986-1991	1991-1996	1996-2001
Kathmandu	235	301	379	479	595	4.95	4.61	4.68	4.34
Lalitpur	80	92	107	122	139	2.80	3.02	2.62	2.61
Kathmandu/Lalitpur	315	393	486	601	734	4.42	4.25	4.25	4.00

*Exponential model

As seen in the above table, the urban population of Kathmandu and Lalitpur in 2001 will amount to 2.5 times and 1.7 times of the census population in 1981 respectively.

4. Considerations and Conclusion

4.1 Considerations

Concerning the total urban population of Kathmandu and Lalitpur, the results of three kinds of projection shown in Sections 2 and 3 are summarized below:

Studies	Urban Population ('000)			Average Annual Growth Rate (%)*		
	1981	1991	2001	1971-1981	1981-1991	1991-2001
(A) P & R, 1984	316	479	729	4.08	4.16	4.20
(B) B & P, 1988	316	593	958	4.08	6.29	4.80
(C) Present Study (Plausible)	315	486	734	4.08	4.34	4.12

*Exponential model

P & R: Proctor and Redfern

B & P: Binnie and Partners

Some comments on the above three projections are given below:

(A) P & R, 1984

(1) This projection was made up to 2001 using other available data than "Population Projection of Nepal 1981-2001", 1986 (Ref.2).

(2) The average annual growth rate estimated for the period 1981-2001 is very close to the intercensal annual growth rate between 1971 and 1981.

(3) Based on this projection, the population up to 2011 is forecasted by the NWSC.

(B) B & P, 1988

(1) The population up to 2021 was projected by applying both mathematical and component models.

(2) Voter's lists produced for the 1981 and 1986 elections were used for estimating the 1986 population and the population growth between 1981 and 1986, and the estimated growth rate was assumed to continue to 1991 as constant.

(3) The Report states that the voter's lists might not represent the actual population with age of 21 years or above, so an adjustment was made.

(C) Present Study

(1) The population projections up to 2001 in the present study have been forecasted on the basis of the natural growth rate in "Population Projection of Nepal 1981-2001" (Ref.4), and using the future migration growth rate estimated from the intercensal growth rate in the Valley.

(2) For a reference of the future study, an attempt is made on a provisional population projection for years after 2001. The projections are carried out using the 2001 population and the future population growth rate which is obtained by applying a mathematical (exponential) model to the above-forecasted growth rate for the period 1981-2001. As a result, for the period 2001-2011 the population and its growth rate for the Kathmandu and Lalitpur urban areas are forecasted as follows:

Urban Areas	Urban Population ('000) 2001	2006	2011	Average Annual Growth Rate (%)* 2001-2006	2006-2011
Kathmandu	595	734	899	4.21	4.04
Lalitpur	139	158	178	2.54	2.45
Kathmandu/Lalitpur	734	892	1,077	3.91	3.77

---

* Exponential model

According to this projection, the total urban population of Kathmandu/Lalitpur appears to exceed one million in 2011 at the average annual growth rates of 3.91 % and 3.77 % for two periods 2001-2006 and 2006- 2011, respectively.

4.2 Conclusion

- For urban areas of Kathmandu/Lalitpur, the forecast population of 734 thousand in 2001 in the present study (C) is close to that (729 thousand) by Proctor & Redfern (A) in the same year.

- The forecast population in 2001 by Binnie and Partners (B) is fairly large compared with those of other two forecast (A) and (C). This may be due mainly to the high growth rate which was estimated from the voter's lists for the period 1981-1986. If this growth rate (6.29 % per annum) is realistic, the population forecast by Binnie and Partners seems to be preferable to the other forecasts.

- However, since it is difficult to examine the reality of the Binnie and Partnre's growth rate in course of the present study, water demand for urban areas of Kathmandu/Lalitpur is discussed on the basis of the population forecast in the present study.

REFERENCES

[1] Proctor and Redfern: Water Supply and Sewerage Studies, Nepal 1984, Appendix-D Population Projections.

[2] Binnie & Partners: Feasibility Study on Water supply for Kathmandu-Lalitpur from outside the Valley, 1988, Appendix-N Population.

[3] Population Monograph of Nepal, 1987, Central Bureau of Statistics.

[4] Population Projection of Nepal 1981-2001, 1986, Central Bureau of Statistics.

TABLES

Table H-1 PREVIOUS STUDIES ON POPULATION PROJECTIONS OF KATHMANDU AND LALITPUR TOWN PANCHAYATS

Report		Population Projections ('000)			Annual Population Growth Rate (%) *1	
Name	Date	1981	1991	2001	1981-1991	1991-2001
Kathmandu						
(1) B&P	1973	187	225	271	1.85	1.86
(2) E.S.	1979	245	330	443	2.98	2.94
(3) P&R	1985	235(census)	368	577	4.48	4.50
(4) B&P	1988	235(census)	445	722	6.38	4.84
Lalitpur						
(1) B&P	1973	73	91	113	2.20	2.16
(2) E.S.	1979	87	116	157	2.88	3.03
(3) P&R	1985	81(census)	111	152	3.15	3.14
(4) B&P	1988	81(census)	148	236	5.89	4.80
Kathmandu/Lalitpur						
(1) B&P	1973	260	316	384	1.95	1.95
(2) E.S.	1979	332	446	600	2.95	2.97
(3) P&R	1985	316(census)	479	729	4.16	4.20
(4) B&P	1988	316(census)	593	958	6.30	4.80

Note: B&P : Binnie and Partners
E.S.: Engineering Service
P&R : Proctor and Redfern

*1 : Growth rate is based on an exponential model, 'e^{rt}'.

Table H-2 ESTIMATES OF POPULATION GROWTH RATES OF NEPAL

Unit : %

Variant	Historical Growth Rate*1			Projected Growth Rate *1			
	1952/54 -1961	1961- 1971	1971- 1981	1981- 1986	1986- 1991	1991- 1996	1996- 2001
High variant	1.64	2.05	2.62	2.71	2.76	2.76	2.85
Plausible variant	1.64	2.05	2.62	2.64	2.57	2.39	2.25
Medium variant	1.64	2.05	2.62	2.62	2.46	2.12	1.82
Low variant	1.64	2.05	2.62	2.53	1.92	1.28	1.00

Source: Population projection of Nepal 1981-2001, Central Bureau of Statistics
*1: Exponential model

Table H-3 POPULATION AND POPULATION GROWTH RATE BY URBAN AND RURAL AREAS IN NEPAL AND KATHMANDU VALLEY

Location	Population				Average Annual Growth Rate(%) *1		
	1952/1954	1961	1971	1981	1952/54-1961	1961-1971	1971-1981
Nepal	8,256,625	9,412,986	11,555,983	15,022,839	1.64	2.05	2.62
urban	235,892	336,222	461,938	956,721	4.43	3.18	7.28
rural	8,020,733	9,076,774	11,094,045	14,066,118	1.55	2.01	2.37
Kathmandu Valley	410,995	459,990	618,811	766,345	1.41	2.97	2.14
urban	178,699	202,609	249,563	363,507	1.57	2.08	3.76
rural	232,296	257,381	369,348	402,838	1.28	3.61	0.87
Kathmandu District	193,782	224,867	353,756	422,237	1.86	4.53	1.77
urban	105,247	121,019	150,402	235,160	1.75	2.17	4.47
rural	88,535	103,848	203,354	187,077	1.99	6.72	-0.83
Lalitpur District	133,753	145,301	154,998	184,341	1.03	0.65	1.73
urban	41,334	47,713	59,048	79,875	1.79	2.13	3.02
rural	92,419	97,588	95,949	104,466	0.68	-0.17	0.85
Bhaktapur District	83,460	89,822	110,157	159,767	0.92	2.04	3.72
urban	32,118	33,877	40,112	48,472	0.67	1.69	2.10
rural	51,342	55,945	70,045	111,295	1.07	2.25	4.63

Source: Population Monograph of Nepal, Central Bureau of Statistics, 1987
Note: Urban area is defined as comunity with 5,000 population or more.
*1: Exponential model

Table H-4 INITIAL ESTIMATES OF ANNUAL MIGRATION RATES IN KATHMANDU VALLEY

Unit: %

Location	1981-1991	1991-2001
Urban		
Kathmandu Valley	1.67	2.33
Kathmandu District	2.48	3.40
Lalitpur District	0.46	0.56
Bhaktapur District	-0.10	0.14
Rural		
Kathmandu Valley	-1.52	-2.23
Kathmandu District	-3.14	-4.98
Lalitpur District	-2.49	-2.91
Bhaktapur District	3.22	4.59
Urban/Rural		
Kathmandu Valley	-0.10	-0.21
Kathmandu District	-0.44	-1.02
Lalitpur District	-1.23	-1.36
Bhaktapur District	2.00	2.95

Table H-5 POPURATION PROJECTIONS FOR URBAN AREAS IN KATHMANDU/LALITPUR DISTRICTS

Classification	Population('000)					Annual Population Growth Rate(%) *1			
	1981 (census)	1986	1991	1996	2001	1981-1986	1986-1991	1991-1996	1996-2001
High variant									
Kathmandu	235	302	384	494	633	5.02	4.80	5.04	4.96
Lalitpur	80	93	108	126	148	3.01	2.99	3.08	3.22
Kathmandu/Lalitpur	315	395	492	620	781	4.53	4.39	4.62	4.62
Plausible variant									
Kathmandu	235	301	379	479	595	4.95	4.61	4.68	4.34
Lalitpur	80	92	107	122	139	2.80	3.02	2.62	2.61
Kathmandu/Lalitpur	315	393	486	601	734	4.42	4.25	4.25	4.00
Law variant									
Kathmandu	235	299	365	436	509	4.82	3.99	3.55	3.10
Lalitpur	80	92	103	111	119	2.80	2.26	1.50	1.39
Kathmandu/Lalitpur	315	391	468	547	628	4.32	3.60	3.12	2.76

*1: Exponential model

APPENDIX I
WATER DEMAND

APPENDIX I
WATER DEMAND

LIST OF TABLES

LIST OF FIGURE

1 CONSUMER SURVEY

1.1 General

In order to understand how the water supply is actually being used and to contribute to future planning, a consumer survey was conducted during the 1st and 2nd field investigations.

The 1st investigation collected both the meter reading records and the consumer's ledger data over a period of eight months from July 1988 up to February 1989, both from the Tripureswar (Kathmandu) and Jawalakhel (Lalitpur) offices of the NWSC, from which both the average consumption per connection and the per capita consumption were assessed.

Furthermore, 20 households per ward were surveyed by questionnaire to assess the status of installing water meters, the number of consumers per connection, types of toilets, etc. The per capita consumption was estimated based on the data on water consumption extracted from the above mentioned meter reading records in comparison with the numbers of consumers per sample.

In these surveys, however, it was difficult to determine whether the meters were functioning or nonfunctioning meters. It was also difficult to categorize the consumption by use (domestic, commercial, industrial and institutional uses). There was also a defect in that the number of consumers per connection used to estimate the per capita consumption was based on the average of insufficient data from the above mentioned questionnaire survey.

In the 2nd field investigation, in order to solve these problems and to supplement the 1st consumer survey, an interview type consumer survey was conducted at nine revenue offices of the NWSC, six in Kathmandu and three in Lalitpur since NWSC re-organization June, 1989. In this survey, approximately 24,700 records were collected representing 44% of the total number of connections managed by the NWSC.

1.2 Results of 1st Consumer Survey

The results derived from analyzing the meter reading records and consumer's ledger data, from analysis of the questionnaire survey conducted in the 1st field investigation are as follows. And the results of each item are shown in Table I-1.1 through I-1.6.

(1) Meter reading records and consumer's ledger analysis

	Kathmandu	Lalitpur
a) Number of samples	38,181	14,065
Meter reading record	30,476	11,963
Consumer's ledger	7,705	2,102
b) Water consumption		
per connection (m^3/month)	22.1	18.0
per capita (lcd)	86.9	72.9

c) Seasonal variation		
dry season (m^3/month)	24.0	-
wet season (m^3/month)	19.7	-

(2) Questionnaire survey analysis

	Kathmandu	Lalitpur
a) Number of samples	664	444
b) Category of connection		
metered connection	557 (86.5%)	392 (88.3%)
non-metered connection	90 (13.5%)	52 (11.7%)
c) Consumer per connection	8.34	8.09
adult	5.97	5.80
child	2.37	2.29
d) Type of toilet		
cistern flush toilet	150 (22.6%)	76 (17.1%)
hand flush toilet	509 (76.6%)	368 (82.9%)
dry pit / non toilet	5 (0.8%)	0 (-)
e) Per capita consumption	73.7 lcd	-

1.3 Results of 2nd consumer survey

The results derived from analyzing consumer survey conducted in the 2nd field investigation are as follows. And the results of each item are shown in Table I-1.7 through I-1.9.

	Kathmandu	Lalitpur
a) Number of samples	17,980	6,713
b) Category of connection		
Metered connection	15,763 (87.7%)	5,936 (88.4%)
functioning	12,266 (77.8%)	5,317 (89.6%)
nonfunctioning	3,497 (22.2%)	619 (10.4%)
Non-metered connection	2,217 (12.3%)	777 (11.6%)
c) Category of use		
domestic	16,899 (94.0%)	6,406 (95.4%)
commercial	788 (4.4%)	230 (3.4%)
industrial	129 (0.7%)	31 (0.5%)
institutional	164 (0.9%)	46 (0.7%)
d) Consumer per connection	7.65	6.54
adult	5.79	4.51
child	1.86	2.63
e) Water consumption per connection		
domestic (m^3/month)	20.8	16.6
(per capita)	(87.6 lcd)	(81.6 lcd)
commercial (m^3/month)	66.3	62.9
industrial (m^3/month)	87.0	52.7
institutional (m^3/month)	139.8	47.9

2 MUNICIPAL WATER DEMAND

2.1 General

Estimates of future demand in water supply have been hitherto based on the past results and on very macroscopic procedures. Although the factors for water demand are extremely complicated, it is now necessary that the planned daily water supply amount be figured out on the basis of an analysis of the actual consumption by use in the past and rational assumptions of future consumption in various uses.

In the following section, analysis of consumption by use, and prediction of the consumption by use and the water demand are carried out.

2.2 Present Water Consumption

Based on the results of the consumer survey described in section 1 and the population in 1989 estimated, the present water consumption in Kathmandu and Lalitpur were estimated, and the results are given in Table I-2.1.

Here, the original unit of consumption by use from the consumer survey in section 1 above is only calculated from the connections with functioning meters. For the connections with nonfunctioning meters and non-metered connections, the original unit of consumption by use was estimated with reference to the survey results of "Leak Detection and Repair - Kathmandu/Patan Water Supply System 1988, GTZ".

From this survey, the original unit of consumption by connection with nonfunctioning meters and non-metered connections was determined to be respectively 1.10 and 1.77 times that of the connections with functioning meter.

The monthly consumption pattern was estimated based on both the actual monthly consumption of functioning metered connections from July 1988 to February 1989 and the variation of average monthly temperature.

Monthly consumption pattern

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
84.4	87.8	96.0	102.8	107.3	110.2	110.9	110.5	108.1	102.4	93.2	85.9

Mean air temperature (°C)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9.5	11.2	15.6	19.2	21.6	23.2	23.5	23.4	22.0	19.0	14.1	10.2

(Kathmandu airport 1968 - 1975)

2.3 Prediction of Water Consumption

For Kathmandu and Lalitpur, future water consumption was predicted by considering the following conditions and based on the actual situation of water consumption.

(a) For the population, the future plausible population predicted in Appendix H was used.

(b) Both the nonfunctioning metered connections and non-metered connections, both with higher consumption than that of functioning metered connections, shall be assumed to be improved at the rates of 40% in 1991, 20% in 1992 and 1993 and 10% in 1994 and 1995 in accordance with "the meter rehabilitation and supply plan" to be implemented under the IDA.

(c) The per capita consumption in domestic use should take into account of an increase both due to the popularization of cistern flush toilet and the livelihood level advancement.

The increase in per capita consumption due to the former factor (the popularization of cistern flush toilets), q1 = 0.37 lcd can be calculated from the following formula:

$$q1 = (A - B) \times C/100 = (28.2 - 3.5) \times 1.5/100 = 0.37 \text{ lcd}$$

where,

A: the per capita consumption by a cistern flush toilet, 28.1 lcd

B: the per capita consumption by a hand flush toilet, 3.5 lcd

C: the annual increase rate in the popularization of cistern flush toilets, 1.5%. (based on the 1.47% figure obtained from a survey of increase in popularization between 1984 and 1988 in the ten cities of Japan which are at same scale and same level in its popularization as Kathmandu and Lalitpur)

The increase due to the latter factor (the livelihood level advancement), q2 = 2.2 lcd, can be given by the following formula.

$$q2 = 0.7 + 0.47\ D = 2.18 \text{ lcd}$$

where,

D: the annual increase rate in the net production, 3.15%, 1.5 times 2.1% in the growth rate of per capita GNP of Nepal over a period of six years from 1983/84 to 1988/89.

Therefore, the annual increase rate becomes 2.5% (q2/86.0 lcd).

(d) An increase in the original unit of consumption by commercial, industrial and institutional use and standpost should only result from a livelihood level advancement. Therefore, the growth rate becomes 2.5%.

(e) The monthly consumption pattern is as per subsection 2.2.

Based on all the foregoing conditions, the results derived from predicting future water consumption are given in Table I-2.2 through I-2.4.

2.4 Prediction of Water Demand

Based on the results of analyzing and predicting water consumption by use, as shown in subsection 2.3, the annual maximum and monthly water demand were estimated and the results are given in Table I-2.5 and Table I-2.6 respectively. The annual maximum and average water demands are shown in Fig.I-2.1.

Here, the rate of water leakage is to be improved in accordance with the implementation plan for rehabilitating the distribution system under the IDA (20% in 1991, 15% in 1992 and 1993, and 10% in 1994 to 1998). The ultimate objective is an improvement of the water leakage rate up to 25% from about 30% in 1989.

TABLES

Table I-1.1 (1/2) RESULTS OF METER READING RECORDS ANALYSIS (KATHMANDU)

Ward	Number of Metered Tap			Water Consumption (m3 / month)								
No.	Funct	Unfunct	Total	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
1	617	374	991	11,847	8,219	11,823	12,409	9,477	8,659	10,633	3,548	76,615
				(560)	(552)	(565)	(561)	(561)	(554)	(555)	(126)	(4034)
2	646	209	855	12,198	4,225	21,099	22,641	12,598	13,451	12,545	9,436	108,193
				(550)	(291)	(585)	(573)	(580)	(582)	(596)	(431)	(4188)
3	879	381	1,260	17,172	8,724	21,018	18,081	16,004	16,686	15,140	7,390	120,215
				(675)	(463)	(737)	(735)	(736)	(718)	(710)	(372)	(5146)
4	735	475	1,210	12,282	7,243	17,154	15,176	14,519	12,822	11,925	5,192	96,313
				(545)	(271)	(572)	(585)	(607)	(603)	(602)	(263)	(4048)
5	436	80	516	6,882	1,240	15,121	10,820	7,347	7,497	8,280	6,892	64,079
				(384)	(78)	(353)	(369)	(342)	(357)	(364)	(361)	(2608)
6	1,031	537	1,568	19,026	13,414	25,516	28,541	22,611	22,138	19,953	4,114	155,313
				(866)	(451)	(877)	(703)	(845)	(903)	(935)	(209)	(5789)
7	1,123	148	1,271	23,595	13,805	20,403	16,730	16,729	15,726	14,523	9,349	130,860
				(1030)	(956)	(875)	(885)	(893)	(905)	(906)	(581)	(7031)
8	484	16	500	8,757	28,351	4,498	47,135	6,991	6,669	5,628	-	108,029
				(468)	(360)	(354)	(357)	(366)	(368)	(381)	(-)	(2654)
9	1,086	227	1,313	19,677	13,932	25,401	20,336	18,323	17,569	16,569	14,927	146,734
				(1081)	(925)	(922)	(941)	(948)	(957)	(955)	(827)	(7556)
10	2,233	912	3,145	37,769	25,722	42,574	36,593	29,810	37,987	34,807	29,558	274,820
				(1922)	(1740)	(1837)	(1869)	(1883)	(1955)	(2004)	(1783)	(14993)
11	668	278	946	12,427	8,109	17,868	15,217	12,246	12,473	11,698	4,835	94,873
				(531)	(495)	(547)	(532)	(538)	(565)	(546)	(218)	(3972)
12	406	111	517	5,912	20	8,885	5,742	6,726	6,520	6,686	5,381	45,872
				(285)	(1)	(295)	(282)	(329)	(346)	(345)	(330)	(2213)
13	699	719	1,418	9,770	4,934	15,432	12,322	11,527	10,830	10,573	4,583	79,971
				(473)	(220)	(540)	(547)	(558)	(556)	(572)	(253)	(3719)
14	1,077	382	1,459	14,062	3,859	30,816	18,555	15,420	15,762	15,296	8,064	121,834
				(690)	(208)	(777)	(863)	(918)	(951)	(970)	(435)	(5812)
15	542	288	830	8,658	4,973	12,504	9,557	9,618	8,594	8,507	4,730	67,141
				(411)	(361)	(436)	(460)	(458)	(470)	(456)	(264)	(3316)
16	1,813	412	2,225	40,974	30,987	53,996	41,077	36,355	34,195	32,480	14,717	284,781
				(1501)	(1511)	(1583)	(1620)	(1633)	(1652)	(1648)	(779)	(11927)
17	507	352	859	8,443	5,250	11,185	7,803	7,021	6,752	5,845	2,697	54,996
				(379)	(375)	(421)	(415)	(432)	(424)	(407)	(225)	(3078)
18	201	183	384	2,645	691	3,005	1,876	2,412	1,817	1,979	962	15,387
				(151)	(47)	(157)	(158)	(170)	(161)	(164)	(84)	(1092)
19	182	190	372	2,017	497	1,817	1,489	1,711	1,406	1,212	816	10,965
				(148)	(49)	(140)	(137)	(137)	(138)	(127)	(86)	(962)
20	390	52	442	5,794	3,623	6,974	5,983	5,572	5,073	4,800	2,964	40,783
				(270)	(167)	(339)	(381)	(346)	(330)	(335)	(218)	(2386)
21	392	68	460	5,271	3,162	7,293	6,268	5,825	5,358	5,165	2,473	40,815
				(261)	(167)	(308)	(333)	(343)	(342)	(361)	(187)	(2302)
22	70	450	520	1,463	1,110	1,673	1,121	1,341	1,195	1,248	863	10,014
				(59)	(22)	(59)	(50)	(55)	(56)	(54)	(45)	(400)
23	402	155	557	6,697	4,078	6,855	5,888	6,163	5,493	6,114	2,504	43,792
				(332)	(216)	(350)	(342)	(364)	(365)	(368)	(170)	(2507)
24	55	154	209	324	281	341	440	374	445	357	154	2,716
				(30)	(20)	(34)	(31)	(35)	(38)	(37)	(25)	(250)
25	66	180	246	495	578	539	532	544	567	506	88	3,849
				(48)	(50)	(51)	(52)	(53)	(53)	(55)	(10)	(372)
26	83	146	229	1,070	10	833	719	680	567	548	526	4,953
				(49)	(1)	(56)	(60)	(65)	(61)	(60)	(63)	(415)
27	93	270	363	586	324	843	783	699	674	679	471	5,059
				(48)	(29)	(51)	(66)	(65)	(73)	(74)	(43)	(449)
28	168	154	322	1,647	469	2,789	1,626	1,791	1,536	1,653	841	12,352
				(116)	(21)	(121)	(124)	(122)	(124)	(124)	(81)	(833)
29	786	456	1,242	10,254	3,070	15,348	11,733	12,434	11,618	77,438	4,190	146,085
				(540)	(159)	(600)	(609)	(623)	(614)	(611)	(272)	(4028)
30	111	303	414	1,758	1,341	1,615	1,834	1,544	1,273	1,304	505	11,174
				(84)	(32)	(80)	(83)	(81)	(84)	(73)	(49)	(566)
31	847	182	1,029	19,066	8,971	25,342	17,921	17,601	15,822	15,418	12,484	132,625
				(658)	(292)	(714)	(689)	(698)	(686)	(585)	(575)	(4997)
32	838	405	1,243	15,397	6,239	19,054	14,747	12,632	13,590	13,023	7,591	102,273
				(628)	(252)	(661)	(662)	(669)	(682)	(680)	(367)	(4601)
33	1,022	539	1,561	17,413	8,460	21,808	17,527	15,074	13,973	15,476	10,745	120,476
				(740)	(358)	(761)	(801)	(813)	(793)	(817)	(577)	(5660)
TOTAL	20,688	9,788	30,476	361,348	225,911	471,422	429,222	339,719	334,737	388,008	183,590	2,733,957
				(16513)	(11140)	(16758)	(16875)	(17266)	(17466)	(17577)	(10309)	(123904)

Note ( ): Number of sample available

Table 1-1.1 (2/2) RESULTS OF METER READING RECORDS ANALYSIS (LALITPUR)

Area	Number of Metered Tap			Water Consumption (m3 / month)								
No.	Funct	Unfunct	Total	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
1	1,385	767	2,152	26,153	24,695	22,094	21,337	26,356	25,607	23,945	10,372	180,559
				(1235)	(948)	(903)	(905)	(899)	(882)	(934)	(429)	(7135)
2	910	1,429	2,339	8,372	5,715	4,692	4,850	4,622	4,379	4,111	2,304	39,045
				(729)	(433)	(368)	(376)	(334)	(351)	(354)	(213)	(3158)
3	1,242	786	2,028	10,431	7,835	7,251	6,878	8,004	7,273	6,203	3,415	57,290
				(1081)	(1017)	(842)	(878)	(997)	(1060)	(874)	(423)	(7072)
4	1,128	1,207	2,335	17,445	26,023	7,635	15,868	29,763	19,448	14,439	14,632	145,253
				(855)	(554)	(473)	(476)	(513)	(543)	(572)	(601)	(4587)
5	2,124	985	3,109	23,988	20,647	25,895	18,802	25,713	22,648	15,640	10,494	163,827
				(1759)	(1335)	(1338)	(1373)	(1350)	(1373)	(1225)	(802)	(10555)
Total	6,789	5,174	11,963	86,389	84,915	67,567	67,735	94,458	79,355	64,338	41,217	585,974
				(5659)	(4287)	(3924)	(4008)	(4093)	(4209)	(3959)	(2468)	(32607)

Note ( ): Number of sample available

Table I-1.2 (1/6) WATER CONSUMPTION OF METERED TAP (SUMMARY - KATHMANDU)

Part	Water Consumption (m3 / month)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
(1)	28,009	14,823	32,962	26,725	27,112	24,131	24,261	12,662	190,685
	(1512)	(789)	(1666)	(1734)	(1755)	(1741)	(1759)	(1012)	(11968)
(2)	125,247	74,236	168,673	151,634	120,282	125,437	119,555	80,864	965,928
	(6088)	(4114)	(5907)	(5841)	(6018)	(6150)	(6273)	(4451)	(44842)
(3)	75,909	40,262	95,105	78,375	67,960	67,230	65,912	35,848	526,601
	(3052)	(2054)	(3224)	(3179)	(3202)	(3205)	(3176)	(1658)	(22750)
(4)	40,974	30,987	53,996	41,077	36,355	34,195	32,480	14,717	284,781
	(1501)	(1511)	(1583)	(1620)	(1633)	(1652)	(1648)	(779)	(11927)
(5)	91,209	65,603	120,686	131,411	88,010	83,744	145,800	39,499	765,962
	(4360)	(2672)	(4378)	(4501)	(4658)	(4718)	(4721)	(2409)	(32417)
TOTAL	361,348	225,911	471,422	429,222	339,719	334,737	388,008	183,590	2,733,957
	(16513)	(11140)	(16758)	(16875)	(17266)	(17466)	(17577)	(10309)	(123904)

Note 1. ( ): Number of sample available
2. (1): Core Part (Ward No. 18-28)
(2): Residental Part (Ward No. 2, 4, 5, 6, 9, 10, 33)
(3): Institutional Part (Ward No. 1, 3, 11, 31, 32)
(4): Industrial Part (Ward No. 16)
(5): Other Part (Ward No. 7, 8, 12, 13, 14, 15, 17, 29, 30)

Table I-1.2 (2/6) WATER CONSUMPTION OF METERED TAP (CORE PART)

Ward	Water Consumption (m3 / month)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
18	2,645	691	3,005	1,876	2,412	1,817	1,979	962	15,387
	(151)	(47)	(157)	(158)	(170)	(161)	(164)	(84)	(1092)
19	2,017	497	1,817	1,489	1,711	1,406	1,212	816	10,965
	(148)	(49)	(140)	(137)	(137)	(138)	(127)	(86)	(962)
20	5,794	3,623	6,974	5,983	5,572	5,073	4,800	2,964	40,783
	(270)	(167)	(339)	(381)	(346)	(330)	(335)	(218)	(2386)
21	5,271	3,162	7,293	6,268	5,825	5,358	5,165	2,473	40,815
	(261)	(167)	(308)	(333)	(343)	(342)	(361)	(187)	(2302)
22	1,463	1,110	1,673	1,121	1,341	1,195	1,248	863	10,014
	(59)	(22)	(59)	(50)	(55)	(56)	(54)	(45)	(400)
23	6,697	4,078	6,855	5,888	6,163	5,493	6,114	2,504	43,792
	(332)	(216)	(350)	(342)	(364)	(365)	(368)	(170)	(2507)
24	324	281	341	440	374	445	357	154	2,716
	(30)	(20)	(34)	(31)	(35)	(38)	(37)	(25)	(250)
25	495	578	539	532	544	567	506	88	3,849
	(48)	(50)	(51)	(52)	(53)	(53)	(55)	(10)	(372)
26	1,070	10	833	719	680	567	548	526	4,953
	(49)	(1)	(56)	(60)	(65)	(61)	(60)	(63)	(415)
27	586	324	843	783	699	674	679	471	5,059
	(48)	(29)	(51)	(66)	(65)	(73)	(74)	(43)	(449)
28	1,647	469	2,789	1,626	1,791	1,536	1,653	841	12,352
	(116)	(21)	(121)	(124)	(122)	(124)	(124)	(81)	(833)
TOTAL	28,009	14,823	32,962	26,725	27,112	24,131	24,261	12,662	190,685
	(1512)	(789)	(1666)	(1734)	(1755)	(1741)	(1759)	(1012)	(11968)

Note ( ): Number of sample available

Table I-1.2 (3/6) WATER CONSUMPTION OF METERED TAP (RESIDENTIAL PART)

Ward	Water Consumption (m3 / month)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
2	12,198	4,225	21,099	22,641	12,598	13,451	12,545	9,436	108,193
	(550)	(291)	(585)	(573)	(580)	(582)	(596)	(431)	(4188)
4	12,282	7,243	17,154	15,176	14,519	12,822	11,925	5,192	96,313
	(545)	(271)	(572)	(585)	(607)	(603)	(602)	(263)	(4048)
5	6,882	1,240	15,121	10,820	7,347	7,497	8,280	6,892	64,079
	(384)	(78)	(353)	(369)	(342)	(357)	(364)	(361)	(2608)
6	19,026	13,414	25,516	28,541	22,611	22,138	19,953	4,114	155,313
	(866)	(451)	(877)	(703)	(845)	(903)	(935)	(209)	(5789)
9	19,677	13,932	25,401	20,336	18,323	17,569	16,569	14,927	146,734
	(1081)	(925)	(922)	(941)	(948)	(957)	(955)	(827)	(7556)
10	37,769	25,722	42,574	36,593	29,810	37,987	34,807	29,558	274,820
	(1922)	(1740)	(1837)	(1869)	(1883)	(1955)	(2004)	(1783)	(14993)
33	17,413	8,460	21,808	17,527	15,074	13,973	15,476	10,745	120,476
	(740)	(358)	(761)	(801)	(813)	(793)	(817)	(577)	(5660)
TOTAL	125,247	74,236	168,673	151,634	120,282	125,437	119,555	80,864	965,928
	(6088)	(4114)	(5907)	(5841)	(6018)	(6150)	(6273)	(4451)	(44842)

Note ( ): Number of sample available

Table I-1.2 (4/6) WATER CONSUMPTION OF METERED TAP (INSTITUTIONAL PART)

Ward	Water Consumption (m3 / month)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
1	11,847	8,219	11,823	12,409	9,477	8,659	10,633	3,548	76,615
	(560)	(552)	(565)	(561)	(561)	(554)	(555)	(126)	(4034)
3	17,172	8,724	21,018	18,081	16,004	16,686	15,140	7,390	120,215
	(675)	(463)	(737)	(735)	(736)	(718)	(710)	(372)	(5146)
11	12,427	8,109	17,868	15,217	12,246	12,473	11,698	4,835	94,873
	(531)	(495)	(547)	(532)	(538)	(565)	(546)	(218)	(3972)
31	19,066	8,971	25,342	17,921	17,601	15,822	15,418	12,484	132,625
	(658)	(292)	(714)	(689)	(698)	(686)	(585)	(575)	(4997)
32	15,397	6,239	19,054	14,747	12,632	13,590	13,023	7,591	102,273
	(628)	(252)	(661)	(662)	(669)	(682)	(680)	(367)	(4601)
TOTAL	75,909	40,262	95,105	78,375	67,960	67,230	65,912	35,848	526,601
	(3052)	(2054)	(3224)	(3179)	(3202)	(3205)	(3176)	(1658)	(22750)

Note ( ): Number of sample available

Table I-1.2 (5/6) WATER CONSUMPTION OF METERED TAP (INDUSTRIAL PART)

Ward	Water Consumption (m3 / month)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
16	40,974	30,987	53,996	41,077	36,355	34,195	32,480	14,717	284,781
	(1501)	(1511)	(1583)	(1620)	(1633)	(1652)	(1648)	(779)	(11927)

Note ( ): Number of sample available

Table I-1.2 (6/6) WATER CONSUMPTION OF METERED TAP (OTHER PART)

Ward	Water Consumption (m3 / month)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
7	23,595	13,805	20,403	16,730	16,729	15,726	14,523	9,349	130,860
	(1030)	(956)	(875)	(885)	(893)	(905)	(906)	(581)	(7031)
8	8,757	28,351	4,498	47,135	6,991	6,669	5,628	-	108,029
	(468)	(360)	(354)	(357)	(366)	(368)	(381)	(-)	(2654)
12	5,912	20	8,885	5,742	6,726	6,520	6,686	5,381	45,872
	(285)	(1)	(295)	(282)	(329)	(346)	(345)	(330)	(2213)
13	9,770	4,934	15,432	12,322	11,527	10,830	10,573	4,583	79,971
	(473)	(220)	(540)	(547)	(558)	(556)	(572)	(253)	(3719)
14	14,062	3,859	30,816	18,555	15,420	15,762	15,296	8,064	121,834
	(690)	(208)	(777)	(863)	(918)	(951)	(970)	(435)	(5812)
15	8,658	4,973	12,504	9,557	9,618	8,594	8,507	4,730	67,141
	(411)	(361)	(436)	(460)	(458)	(470)	(456)	(264)	(3316)
17	8,443	5,250	11,185	7,803	7,021	6,752	5,845	2,697	54,996
	(379)	(375)	(421)	(415)	(432)	(424)	(407)	(225)	(3078)
29	10,254	3,070	15,348	11,733	12,434	11,618	77,438	4,190	146,085
	(540)	(159)	(600)	(609)	(623)	(614)	(611)	(272)	(4028)
30	1,758	1,341	1,615	1,834	1,544	1,273	1,304	505	11,174
	(84)	(32)	(80)	(83)	(81)	(84)	(73)	(49)	(566)
TOTAL	91,209	65,603	120,686	131,411	88,010	83,744	145,800	39,499	765,962
	(4360)	(2672)	(4378)	(4501)	(4658)	(4718)	(4721)	(2409)	(32417)

Note ( ): Number of sample available

Table I-1.3 (1/3) RESULTS OF CONSUMER TO CONSUMER SURVEY (KATHMANDU)

Ward No.	Consumer No.	No. of Consumer	Water Consumption (m3 / month) Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
1	10893	10	14	12	10	13	8	13	12	-	82
1	4582	9	25	22	20	20	11	12	5	-	115
1	3205	4	18	14	11	24	10	15	13	-	105
1	15245	2	34	10	10	7	25	1	10	-	97
1	3102	3	43	10	15	10	10	10	10	-	108
1	27593	2	53	10	58	28	21	5	10	58	243
1	10771	7	16	10	12	27	12	20	10	6	113
1	15144	4	13	10	3	3	3	10	10	-	52
1	12693	6	-	-	15	20	15	10	10	-	70
3	9290	5	-	-	15	8	-	-	-	-	23
3	17642	6	9	10	8	9	9	8	6	8	67
3	26162	10	6	10	16	2	-	-	-	-	34
3	35442	10	32	10	39	15	15	17	7	-	135
3	26912	10	-	-	9	8	-	-	10	-	27
3	5688	4	3	-	1	1	10	5	4	-	24
4	36937	14	39	-	57	55	43	36	39	42	311
4	22987	5	10	-	22	16	13	10	10	10	91
4	22267	10	40	-	66	49	40	34	24	44	297
4	7309	6	-	-	24	1	-	2	8	-	35
4	21573	10	17	10	6	-	-	-	-	-	33
6	29686	7	31	10	93	76	40	50	51	-	351
6	17441	6	10	10	27	15	10	34	20	14	140
6	35527	5	11	10	15	53	10	21	12	-	132
6	38079	6	5	10	14	9	6	8	9	-	61
6	17592	5	3	10	3	16	10	16	8	-	66
7	11327	4	-	10	37	10	-	-	-	19	76
7	4427	9	-		76	57	49	28	23	43	276
7	9008	9	10	10	10	-	47	55	84	43	259
7	37060	10	10	15	15	-	10	20	-	33	103
7	15811	8	35	10	19	12	12	10	2	10	110
7	13112	4	29	10	59	28	37	43	41	31	278
7	3763	7	28	15	15	15	15	15	15	-	118
7	5250	5	15	15	15	15	15	15	15	15	120
7	17291	7	15	10	16	3	11	10	9	10	84
7	29337	2	8	5	4	10	8	10	1	10	56
7	14804	9	7	10	18	10	13	9	9	8	84
8	24569	7	15	-	-	-	-	-	8	-	23
8	35410	7	15	15	17	24	10	37	15	-	133
8	15263	6	15	15	15	15	15	15	3	-	93
8	24864	8	15	-	-	-	1	-	1	-	17
8	20562	8	7	6	10	5	5	9	10	-	52
8	19433	10	9	31	10	53	23	25	15	-	166
8	15374	6	20	22	10	23	15	15	10	-	115
8	4415	8	10	5	2	2	3	10	5	-	37
8	11927	12	2	-	15	-	-	-	-	-	17
8	19116	5	10	-	-	-	-	-	-	-	10
8	15189	6	37	35	10	37	21	15	12	-	167
9	16153	5	11	10	11	16	16	20	9	12	105
9	28364	4	4	10	7	14	13	10	7	13	78
9	25341	5	6	10	12	15	26	5	3	27	104
9	8949	8	14	10	19	18	6	16	4	5	92
9	28461	9	17	10	19	26	13	14	13	11	123
9	5932	10	25	10	32	23	16	19	20	18	163
9	23202	5	15	-	-	-	15	16	10	8	64
9	35454	10	9	10	10	10	30	5	4	10	88
9	8734	17	37	10	59	37	33	32	34	30	272
9	35382	5	25	10	14	17	20	11	8	11	116
9	16832	5	11	10	33	31	18	19	17	14	153
9	3578	11	36	10	100	59	55	49	57	-	366
9	5890	8	24	-	-	-	-	11	10	18	63
9	37436	11	15	-	-	-	-	-	-	3	18
9	18882	6	6	10	12	12	16	19	12	12	99
Sub Total			999 (402)	547 (317)	1,270 (398)	1,082 (357)	908 (354)	924 (360)	784 (375)	596 (225)	7,110 (2788)

Note ( ): Total number of consumers

Table I-1.3 (2/3) RESULTS OF CONSUMER TO CONSUMER SURVEY (KATHMANDU)

Ward No.	Consumer No.	No. of Consumer	Water Consumption (m3 / month) Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
11	10650	7	20	10	18	17	14	14	14	10	117
11	24435	4	10	10	15	10	10	10	10	10	85
11	24398	7	15	10	15	18	17	20	20	15	130
11	28	7	25	10	40	30	25	25	25	30	210
11	33489	5	20	10	17	11	10	12	20	5	105
11	4914	17	30	10	100	49	40	40	50	52	371
11	28574	8	-	-	17	6	-	2	5	7	37
11	20074	16	12	10	60	25	30	35	20	60	252
11	36883	10	60	10	10	100	30	25	20	30	285
12	28914	13	-	-	-	-	24	46	-	-	70
12	35453	10	-	-	30	-	-	40	71	47	188
12	22610	10	-	-	91	25	-	-	25	-	141
12	28917	7	11	-	13	9	9	6	8	8	64
12	28662	8	16	-	30	17	19	14	13	15	124
12	28677	13	10	-	12	12	15	12	15	15	91
12	28712	6	11	-	13	9	12	8	11	8	72
12	28902	8	14	-	25	15	16	11	15	13	109
12	28901	9	18	-	18	11	16	14	12	-	89
12	39403	4	-	-	64	-	-	-	-	-	64
12	8758	15	100	-	-	-	-	42	-	-	142
12	22537	9	-	-	-	-	2	-	-	-	2
12	34819	8	25	-	39	20	19	17	16	14	150
12	28922	13	-	-	13	-	20	25	19	12	89
12	28595	12	8	-	4	7	11	6	5	6	47
13	41156	7	-	-	-	14	14	15	13	12	68
13	26652	6	25	-	51	17	21	16	22	19	171
13	10965	7	28	-	35	31	25	24	20	23	186
13	39588	2	16	20	21	13	9	12	10	-	101
13	10960	6	7	-	6	11	9	7	8	7	55
13	7068	4	11	13	16	12	9	7	6	-	74
14	25713	8	19	-	25	22	16	1	-	-	83
14	24184	6	22	-	28	16	12	10	9	6	103
14	42279	4	-	-	-	-	-	-	-	16	16
14	27039	6	21	-	48	33	29	28	26	25	210
14	24926	8	21	-	15	17	17	12	18	19	119
14	23570	7	18	-	26	14	10	9	9	10	96
14	23590	24	21	-	19	18	14	12	12	13	109
14	23754	8	-	-	38	19	18	21	10	4	110
14	21415	7	28	-	30	16	12	13	21	9	129
14	11447	6	16	-	18	21	12	13	12	15	107
15	22728	7	6	-	1	9	1	-	6	10	33
15	36980	9	27	10	43	30	16	18	18	26	188
15	7335	14	-	-	10	1	1	-	-	-	12
15	8418	10	2	-	2	1	1	2	2	-	10
15	17157	10	19	25	21	21	10	24	22	-	142
16	3325	3	6	11	10	9	1	5	6	-	48
16	16722	6	10	51	146	45	41	32	40	-	365
16	34401	6	18	18	20	30	23	20	22	-	151
16	31692	5	24	10	48	17	22	23	24	30	198
16	31694	10	47	10	30	15	17	14	13	15	161
16	31693	13	-	10	50	23	20	35	33	25	196
16	31679	4	28	10	51	26	30	27	25	25	222
17	18967	2	15	9	16	12	10	12	8	-	82
17	39058	9	-	4	10	18	7	8	4	-	51
17	23316	15	8	-	-	-	-	-	-	-	8
17	6988	7	19	10	30	24	22	16	16	18	155
17	1558	13	23	10	28	17	16	1	1	1	97
18	4144	10	32	-	20	38	18	16	16	18	158
18	14795	15	-	-	-	-	12	-	10	-	22
Sub Total			942 (373)	301 (176)	1,556 (432)	1,001 (412)	834 (444)	877 (432)	856 (428)	703 (346)	7,070 (3043)

Note ( ): Total number of consumers

Table I-1.3 (3/3) RESULTS OF CONSUMER TO CONSUMER SURVEY (KATHMANDU)

Ward No.	Consumer No.	No. of Consumer	Water Consumption (m3 / month) Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
20	32888	15	12	-	39	12	15	-	-	-	78
20	38128	7	30	-	32	18	26	10	6	-	122
20	27721	15	-	48	55	50	40	52	40	47	332
20	32630	7	7	4	6	7	5	2	3	5	39
20	32631	5	10	9	10	10	12	13	9	9	82
20	27720	7	20	17	15	12	10	10	11	7	102
20	38800	10	14	19	19	20	9	8	-	-	89
20	38803	15	14	14	20	25	22	9	5	-	109
20	32889	11	25	19	17	18	16	12	8	9	124
20	32428	7	25	15	1	-	14	35	25	-	115
21	36583	3	9	-	10	9	4	7	8	6	53
21	36731	7	-	-	55	20	20	22	15	15	147
21	37184	5	-	-	7	-	-	-	2	3	12
21	36786	7	13	-	30	16	14	12	12	10	107
21	36975	7	10	-	15	10	10	8	7	9	69
21	37320	12	30	-	40	12	18	14	20	18	152
21	41050	8	-	-	-	27	13	20	20	14	94
21	36673	9	8	-	7	10	6	8	9	8	56
21	5442	9	11	-	10	9	-	-	10	-	40
21	20822	10	17	-	-	20	30	8	4	5	84
23	39996	3	-	-	2	-	5	6	9	6	28
25	9971	13	3	9	5	6	7	10	3	-	43
25	12834	7	10	10	6	2	6	9	-	-	43
25	19607	3	10	9	4	3	4	10	10	-	50
27	40997	10	-	-	-	15	15	20	8	13	71
28	19770	12	16	-	22	12	16	25	9	4	104
28	7563	8	5	-	3	5	5	2	3	3	26
28	3230	9	14	-	19	-	13	14	9	10	79
28	24650	4	-	-	8	10	12	-	-	-	30
28	17306	7	9	-	-	10	10	-	4	-	33
30	15010	4	8	15	6	13	10	6	5	-	63
31	34644	8	2	-	11	7	-	12	24	23	79
31	12141	11	14	-	12	2	8	8	10	7	61
31	29225	6	12	-	11	11	12	10	3	17	76
31	29223	3	13	-	12	12	9	10	9	4	69
31	29222	7	24	-	28	15	14	11	11	9	112
31	15621	7	23	-	8	-	-	-	-	-	31
31	20574	7	13	-	10	19	21	22	22	19	126
31	12215	12	-	-	43	26	-	15	41	8	133
31	23210	7	33	-	33	23	26	27	24	25	191
31	7437	4	28	-	49	26	21	16	-	7	147
31	25555	14	-	-	6	27	23	31	26	15	128
31	12394	12	42	-	90	17	20	14	7	8	198
31	23583	8	1	-	10	1	26	8	11	11	68
Sub Total			535 (284)	188 (104)	786 (327)	567 (331)	567 (321)	536 (315)	462 (315)	354 (254)	3,995 (2251)
TOTAL			2,476 (1059)	1,036 (597)	3,612 (1157)	2,650 (1100)	2,309 (1119)	2,337 (1107)	2,102 (1118)	1,653 (825)	18,175 (8082)

Note ( ): Total number of consumers

Table I-1.4 (1/2) WATER CONSUMPTION AND SEASONAL PATTERN (KATHMANDU)

Ward	Water Consumption (m3/month/connection)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Average
1	21.16	14.89	20.93	22.12	16.89	15.63	19.16	28.16	18.99
2	22.18	14.52	36.07	39.51	21.72	23.11	21.05	21.89	25.83
3	25.44	18.84	28.52	24.60	21.74	23.23	21.32	19.87	23.36
4	22.54	26.73	29.99	25.94	23.92	21.26	19.81	19.74	23.79
5	17.92	15.90	42.84	29.32	21.48	21.00	22.75	19.09	24.57
6	21.97	29.74	29.09	40.60	26.76	24.52	21.34	19.68	26.83
7	22.91	14.44	23.32	18.90	18.73	17.38	16.03	16.09	18.61
8	18.71	78.75	12.71	132.03	19.10	18.12	14.77	-	40.70
9	18.20	15.06	27.55	21.61	19.33	18.36	17.35	18.05	19.42
10	19.65	14.78	23.18	19.58	15.83	19.43	17.37	16.58	18.33
11	23.40	16.38	32.67	28.60	22.76	22.08	21.42	22.18	23.89
12	20.74	20.00	30.12	20.36	20.44	18.84	19.38	16.31	20.73
13	20.66	22.43	28.58	22.53	20.66	19.48	18.48	18.11	21.50
14	20.38	18.55	39.66	21.50	16.80	16.57	15.77	18.54	20.96
15	21.07	13.78	28.68	20.78	21.00	18.29	18.66	17.92	20.25
16	27.29	20.51	34.11	25.36	22.26	20.70	19.71	18.89	23.88
17	22.28	14.00	26.57	18.80	16.25	15.92	14.36	11.99	17.87
18	17.52	14.70	19.14	11.87	14.19	11.29	12.07	11.45	14.09
19	13.63	10.14	12.98	10.87	12.49	10.19	9.54	9.49	11.40
20	21.46	21.69	20.57	15.70	16.10	15.37	14.33	13.60	17.09
21	20.20	18.93	23.68	18.82	16.98	15.67	14.31	13.22	17.73
22	24.80	50.45	28.36	22.42	24.38	21.34	23.11	19.18	25.04
23	20.17	18.88	19.59	17.22	16.93	15.05	16.61	14.73	17.47
24	10.80	14.05	10.03	14.19	10.69	11.71	9.65	6.16	10.86
25	10.31	11.56	10.57	10.23	10.26	10.70	9.20	8.80	10.35
26	21.84	10.00	14.88	11.98	10.46	9.30	9.13	8.35	11.93
27	12.21	11.17	16.53	11.86	10.75	9.23	9.18	10.95	11.27
28	14.20	22.33	23.05	13.11	14.68	12.39	13.33	10.38	14.83
29	18.99	19.31	25.58	19.27	19.96	18.92	126.74	15.40	36.27
30	20.93	41.91	20.19	22.10	19.06	15.15	17.86	10.31	19.74
31	28.98	30.72	35.49	26.01	25.22	23.06	26.36	21.71	26.54
32	24.52	24.76	28.83	22.28	18.88	19.93	19.15	20.68	22.23
33	23.53	23.63	28.66	21.88	18.54	17.62	18.94	18.62	21.29
Average	21.88	20.28	28.13	25.44	19.68	19.17	22.07	17.81	22.07
Ratio	0.99	0.92	1.27	1.15	0.89	0.87	1.00	0.81	1.00

Table I-1.4 (2/2) WATER CONSUMPTION AND SEASONAL PATTERN (LALITPUR)

Area	Water Consumption (m3/month/connection)								
No.	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Average
1	21.18	26.05	24.47	23.58	29.32	29.03	25.64	24.18	25.31
2	11.48	13.20	12.75	12.90	13.84	12.48	11.61	10.82	12.36
3	9.65	7.70	8.61	7.83	8.03	6.86	7.10	8.07	8.10
4	20.40	46.97	16.14	33.34	58.02	35.82	25.24	24.35	31.67
5	13.64	15.47	19.35	13.69	19.05	16.50	12.77	13.08	15.52
Average	15.27	19.81	17.22	16.90	23.08	18.85	16.25	16.70	17.97
Ratio	0.85	1.10	0.96	0.94	1.28	1.05	0.90	0.93	1.00

Table I-1.5 (1/2) NUMBER OF CONSUMER PER CONNECTION (KATHMANDU)

Ward No.	No. of Sample	Total No. of Consumer			People per Connection		
		Adult	Child	Total	Adult	Child	Total
1	20	93	27	120	4.65	1.35	6.00
2	20	86	23	109	4.30	1.15	5.45
3	19	125	64	189	6.58	3.37	9.95
4	21	103	54	157	4.90	2.57	7.48
5	20	86	42	128	4.30	2.10	6.40
6	20	112	39	151	5.60	1.95	7.55
7	20	105	39	144	5.25	1.95	7.20
8	21	119	59	178	5.67	2.81	8.48
9	20	115	45	160	5.75	2.25	8.00
10	20	115	48	163	5.75	2.40	8.15
11	20	133	45	178	6.65	2.25	8.90
12	20	144	46	190	7.20	2.30	9.50
13	22	101	36	137	4.59	1.64	6.23
14	20	142	45	187	7.10	2.25	9.35
15	20	154	48	202	7.70	2.40	10.10
16	19	125	38	163	6.58	2.00	8.58
17	19	89	49	138	4.68	2.58	7.26
18	20	100	64	164	5.00	3.20	8.20
19	20	155	48	203	7.75	2.40	10.15
20	20	106	90	196	5.30	4.50	9.80
21	20	116	53	169	5.80	2.65	8.45
22	20	171	44	215	8.55	2.20	10.75
23	23	145	44	189	6.30	1.91	8.22
24	20	138	46	184	6.90	2.30	9.20
25	20	126	50	176	6.30	2.50	8.80
26	20	133	30	163	6.65	1.50	8.15
27	20	109	68	177	5.45	3.40	8.85
28	20	118	58	176	5.90	2.90	8.80
29	20	134	53	187	6.70	2.65	9.35
30	20	116	34	150	5.80	1.70	7.50
31	20	128	52	180	6.40	2.60	9.00
32	20	117	59	176	5.85	2.95	8.80
33	20	107	32	139	5.35	1.60	6.95
TOTAL	664	3,966	1,572	5,538	5.97	2.37	8.34

Table I-1.5 (2/2) NUMBER OF CONSUMER PER CONNECTION (LALITPUR)

Ward No.	No. of Sample	Total No. of Consumer			People per Connection		
		Adult	Child	Total	Adult	Child	Total
1	21	95	31	126	4.52	1.48	6.00
2	20	78	25	103	3.90	1.25	5.15
3	20	124	74	198	6.20	3.70	9.90
4	20	110	50	160	5.50	2.50	8.00
5	20	101	37	138	5.05	1.85	6.90
6	20	105	35	140	5.25	1.75	7.00
7	20	108	50	158	5.40	2.50	7.90
8	20	103	41	144	5.15	2.05	7.20
9	20	145	57	202	7.25	2.85	10.10
10	20	122	41	163	6.10	2.05	8.15
11	20	131	46	177	6.55	2.30	8.85
12	21	116	40	156	5.52	1.90	7.43
13	20	86	42	128	4.30	2.10	6.40
14	19	155	36	191	8.16	1.89	10.05
15	22	122	51	173	5.55	2.32	7.86
16	20	137	47	184	6.85	2.35	9.20
17	20	150	52	202	7.50	2.60	10.10
18	21	98	38	136	4.67	1.81	6.48
19	20	122	41	163	6.10	2.05	8.15
20	20	123	60	183	6.15	3.00	9.15
21	20	111	57	168	5.55	2.85	8.40
22	20	134	65	199	6.70	3.25	9.95
TOTAL	444	2,576	1,016	3,592	5.80	2.29	8.09

Table I-1.6 (1/2) TYPE OF TOILET (KATHMANDU)

- KATHMANDU AREA -

WARD NO.	NUMBER OF SAMPLE	TYPE OF TOILET		
		Cistern	Hand	Dry pit
1	20	3	17	0
2	20	12	8	0
3	19	3	16	0
4	21	5	16	0
5	20	12	8	0
6	20	5	15	0
7	20	1	19	0
8	21	3	14	4
9	20	8	11	1
10	20	10	10	0
11	20	4	16	0
12	20	7	13	0
13	22	4	18	0
14	20	0	20	0
15	20	1	19	0
16	19	6	13	0
17	19	3	16	0
18	20	1	19	0
19	20	1	19	0
20	20	0	20	0
21	20	2	18	0
22	20	2	18	0
23	23	2	21	0
24	20	4	16	0
25	20	3	17	0
26	20	0	20	0
27	20	5	15	0
28	20	2	18	0
29	20	8	12	0
30	20	8	12	0
31	20	3	17	0
32	20	6	14	0
33	20	16	4	0
TOTAL	664	150	509	5

Table I-1.6 (2/2) TYPE OF TOILET (LALITPUR)

- LALITPUR AREA -

WARD NO.	NUMBER OF SAMPLE	TYPE OF TOILET		
		Cistern	Hand	Dry pit
1	21	18	3	0
2	20	17	3	0
3	20	4	16	0
4	20	7	13	0
5	20	16	4	0
6	20	4	16	0
7	20	0	20	0
8	20	0	20	0
9	20	2	18	0
10	20	0	20	0
11	20	0	20	0
12	21	3	18	0
13	20	0	20	0
14	19	0	19	0
15	22	1	21	0
16	20	0	20	0
17	20	0	20	0
18	21	0	21	0
19	20	2	18	0
20	20	1	19	0
21	20	0	20	0
22	20	1	19	0
TOTAL	444	76	368	0

Table I-1.7 (1/2) NUMBER OF SAMPLES FOR EACH CATEGORY OF USE (KATHMANDU)

OFFICE	CATEGORY OF USE				
	Domestic	Commercial	Industrial	Institutional	TOTAL
KATHMANDU AREA					
(1) MAHARAJGANJ	2,725	190	8	17	2,940
functioning	2,097	152	5	7	2,261
unfunctioning	453	23	1	7	484
non-meter	175	15	2	3	195
(2) CHHETRAPATI	2,074	47	1	2	2,124
functioning	1,547	43	1	1	1,592
unfunctioning	527	4	0	1	532
non-meter	0	0	0	0	0
(3) TRIPURESWAR	4,526	304	26	113	4,969
functioning	1,868	121	11	23	2,023
unfunctioning	1,003	88	10	44	1,145
non-meter	1,655	95	5	46	1,801
(4) MAHAMKAL CHAUR	2,379	64	71	11	2,525
functioning	1,689	47	63	8	1,807
unfunctioning	626	15	6	3	650
non-meter	64	2	2	0	68
(5) KAMALADI	1,646	74	3	20	1,743
functioning	1,287	59	2	10	1,358
unfunctioning	294	13	1	5	313
non-meter	65	2	0	5	72
(6) BANESWAR	3,549	109	20	1	3,679
functioning	3,112	94	18	1	3,225
unfunctioning	356	15	2	0	373
non-meter	81	0	0	0	81
Sub-total	16,899	788	129	164	17,980
functioning	11,600	516	100	50	12,266
unfunctioning	3,259	158	20	60	3,497
non-meter	2,040	114	9	54	2,217
Ratio (%)	94	4	1	1	100

Table I-1.7 (2/2) NUMBER OF SAMPLES FOR EACH CATEGORY OF USE (LALITPUR)

OFFICE	CATEGORY OF USE				
	Domestic	Commercial	Industrial	Institutional	TOTAL
LALITPUR AREA					
(7) JAWALAKHEL	3,031	75	12	35	3,153
functioning	2,376	58	10	26	2,470
unfunctioning	248	4	0	3	255
non-meter	407	13	2	6	428
(8) KUPONDOL	1,686	117	3	0	1,806
functioning	1,673	114	3	0	1,790
unfunctioning	11	3	0	0	14
non-meter	2	0	0	0	2
(9) TANGAL	1,689	38	16	11	1,754
functioning	1,012	24	13	8	1,057
unfunctioning	342	7	1	0	350
non-meter	335	7	2	3	347
Sub-total	6,406	230	31	46	6,713
functioning	5,061	196	26	34	5,317
unfunctioning	601	14	1	3	619
non-meter	744	20	4	9	777
Ratio (%)	95	3	0	1	100
TOTAL	23,305	1,018	160	210	24,693
functioning	16,661	712	126	84	17,583
unfunctioning	3,860	172	21	63	4,116
non-meter	2,784	134	13	63	2,994
Ratio (%)	94	4	1	1	100

Table I-1.8 PER CAPITA CONSUMPTION FOR DOMESTIC USE (2ND FIELD SURVEY)

OFFICE	NUMBER OF SAMPLES	WATER USED (m3)	NUMBER OF CONSUMER				PER CAPITA CONSUMPTION (lcd)
			Adult	Child	Total	Per tap	
KATHMANDU AREA							
(1) MAHARAJGANJ	2,097	44,089	12,095	4,210	16,305	7.78	87.2
(2) CHHETRAPATI	1,547	23,369	8,257	2,797	11,054	7.15	68.2
(3) TRIPURESWAR	1,868	38,129	10,732	3,314	14,046	7.52	87.6
(4) MAHANKAL CHAUR	1,689	39,856	10,801	3,036	13,837	8.19	92.9
(5) KAMALADI	1,287	29,419	8,318	2,713	11,031	8.57	86.0
(6) BANESWAR	3,112	66,288	16,931	5,559	22,490	7.23	95.1
Sub-total	11,600	241,150	67,134	21,629	88,763	7.65	87.6
LALITPUR AREA							
(7) JAWALAKHEL	2,376	41,331	9,963	5,673	15,636	6.58	85.3
(8) KUPONDOL	1,673	31,383	7,998	2,621	10,619	6.35	95.3
(9) TANGAL	1,012	11,121	4,880	1,990	6,870	6.79	52.2
Sub-total	5,061	83,835	22,841	10,284	33,125	6.55	81.6
TOTAL	16,661	324,985	89,975	31,913	121,888	7.32	86.0

Table I-1.9 WATER CONSUMPTION FOR EACH CATEGORY OF USE (2ND FIELD SURVEY)

(UNIT: m3/month)

OFFICE	DOMESTIC			COMMERCIAL			INDUSTRIAL			INSTITUTIONAL		
	No. of sample	Total consump	Per tap	No. of sample	Total consump	Per tap	No. of sample	Total consump	Per tap	No. of sample	Total consump	Per tap
KATHMANDU AREA												
(1) MAHARAJGANJ	2,097	44,089	21.0	152	6,500	42.8	5	322	64.4	7	393	56.1
(2) CHHETRAPATI	1,547	23,369	15.1	43	2,964	68.9	1	30	30.0	1	62	62.0
(3) TRIPURESWAR	1,868	38,129	20.4	121	15,437	127.6	11	2,531	230.1	23	5,645	245.4
(4) MAHANKAL CHAUR	1,689	39,856	23.6	47	2,951	62.8	63	4,997	79.3	8	180	22.5
(5) KAMALADI	1,287	29,419	22.9	59	2,672	45.3	2	170	85.0	10	689	68.9
(6) BANESWAR	3,112	66,288	21.3	94	3,686	39.2	18	652	36.2	1	20	20.0
Sub-total	11,600	241,150	20.8	516	34,210	66.3	100	8,702	87.0	50	6,989	139.8
LALITPUR AREA												
(7) JAWALAKHEL	2,376	41,331	17.4	58	3,553	61.3	10	654	65.4	26	1,506	57.9
(8) KUPONDOL	1,673	31,383	18.8	114	8,353	73.3	3	71	23.7	-	-	-
(9) TANGAL	1,012	11,121	11.0	24	426	17.8	13	631	48.5	8	124	15.5
Sub-total	5,061	83,835	16.6	196	12,332	62.9	26	1,356	52.2	34	1,630	47.9
TOTAL	16,661	324,985	19.5	712	46,542	65.4	126	10,058	79.8	84	8,619	102.6

Table I-2.1 PRESENT WATER CONSUMPTION

(UNIT: m3/d)

Category of Use	Number of Connection	Original Unit	Water Consumption
<KATHMANDU>			
Domestic			
funct	26,619	0.670	17,838
unfunct	7,479	0.737	5,513
non-meter	4,681	1.186	5,552
Commercial			
funct	1,184	2.139	2,533
unfunct	363	2.353	854
non-meter	261	3.786	988
Industrial			
funct	229	2.806	643
unfunct	46	3.087	142
non-meter	21	4.967	104
Institutional			
funct	115	4.510	519
unfunct	137	4.961	680
non-meter	124	7.983	990
Standpost	448	1.120	502
Sub-Total	41,707	0.884	36,858
<LALITPUR>			
Domestic			
funct	8,581	0.534	4,586
unfunct	1,019	0.588	599
non-meter	1,261	0.946	1,193
Commercial			
funct	332	2.029	674
unfunct	24	2.232	54
non-meter	34	3.591	122
Industrial			
funct	44	1.684	74
unfunct	2	1.852	4
non-meter	7	2.981	21
Institutional			
funct	58	1.545	90
unfunct	5	1.700	8
non-meter	15	2.735	41
Standpost	166	1.120	186
Sub-Total	11,548	0.663	7,651
TOTAL	53,255	0.836	44,509

Table I-2.2 NUMBER OF CONNECTIONS BY USE

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<KATHMANDU>												
Domestic	40,763	42,844	45,034	47,333	49,729	52,234	54,859	57,448	60,147	62,966	65,894	68,967
funct	28,603	30,684	37,738	42,469	47,297	51,019	54,859	57,448	60,147	62,966	65,894	68,967
unfunct	7,479	7,479	4,487	2,991	1,495	747	0	0	0	0	0	0
non-meter	4,681	4,681	2,809	1,873	937	468	0	0	0	0	0	0
Commercial	1,900	1,997	2,099	2,206	2,321	2,438	2,560	2,681	2,807	2,938	3,075	3,218
funct	1,276	1,373	1,724	1,956	2,197	2,376	2,560	2,681	2,807	2,938	3,075	3,218
unfunct	363	363	218	145	72	36	0	0	0	0	0	0
non-meter	261	261	157	105	52	26	0	0	0	0	0	0
Industrial	311	327	344	361	379	398	418	438	458	479	501	524
funct	244	260	303	334	365	391	418	438	458	479	501	524
unfunct	46	46	28	19	10	5	0	0	0	0	0	0
non-meter	21	21	13	8	4	2	0	0	0	0	0	0
Institutional	395	415	436	458	481	505	530	555	581	608	636	666
funct	134	154	280	354	429	479	530	555	581	608	636	666
unfunct	137	137	82	55	28	14	0	0	0	0	0	0
non-meter	124	124	74	49	24	12	0	0	0	0	0	0
Standpost	448	448	448	448	448	448	448	448	448	448	448	448
Sub-total	43,817	46,031	48,361	50,806	53,358	56,023	58,815	61,570	64,441	67,439	70,554	73,823
<LALITPUR>												
Domestic	11,205	11,561	11,917	12,274	12,653	13,033	13,425	13,805	14,196	14,588	15,003	15,420
funct	8,925	9,281	10,549	11,363	12,198	12,806	13,425	13,805	14,196	14,588	15,003	15,420
unfunct	1,019	1,019	611	407	203	101	0	0	0	0	0	0
non-meter	1,261	1,261	757	504	252	126	0	0	0	0	0	0
Commercial	402	415	428	441	455	469	483	497	511	525	540	555
funct	344	357	394	419	445	464	483	497	511	525	540	555
unfunct	24	24	14	9	4	2	0	0	0	0	0	0
non-meter	34	34	20	13	6	3	0	0	0	0	0	0
Industrial	55	57	59	61	63	65	67	69	71	73	75	77
funct	46	48	54	59	62	65	67	69	71	73	75	77
unfunct	2	2	1	0	0	0	0	0	0	0	0	0
non-meter	7	7	4	2	1	0	0	0	0	0	0	0
Institutional	80	82	84	86	89	92	95	98	101	104	107	110
funct	60	62	72	76	85	91	95	98	101	104	107	110
unfunct	5	5	3	2	1	0	0	0	0	0	0	0
non-meter	15	15	9	6	3	1	0	0	0	0	0	0
Standpost	166	166	166	166	166	166	166	166	166	166	166	166
Sub-total	11,908	12,281	12,654	13,028	13,426	13,825	14,236	14,635	15,045	15,456	15,891	16,328
TOTAL	55,725	58,312	61,015	63,834	66,784	69,848	73,051	76,205	79,486	82,895	86,445	90,151

Table 1-2.3 ORIGINAL UNIT OF CONSUMPTION BY USE

(UNIT: m3/d/connection)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<KATHMANDU>												
Domestic												
funct	0.690	0.710	0.731	0.752	0.773	0.796	0.819	0.842	0.865	0.890	0.915	0.941
unfunct	0.759	0.781	0.804	0.827	0.850	0.876	0.901	0.926	0.952	0.979	1.007	1.035
non-meter	1.221	1.257	1.294	1.331	1.368	1.409	1.450	1.490	1.531	1.575	1.620	1.666
Commercial												
funct	2.192	2.247	2.303	2.361	2.420	2.481	2.543	2.606	2.671	2.738	2.807	2.877
unfunct	2.411	2.472	2.533	2.597	2.662	2.729	2.797	2.867	2.938	3.012	3.088	3.165
non-meter	3.880	3.977	4.076	4.179	4.283	4.391	4.501	4.613	4.728	4.846	4.968	5.092
Industrial												
funct	2.876	2.948	3.022	3.097	3.175	3.254	3.335	3.419	3.504	3.592	3.682	3.774
unfunct	3.164	3.243	3.324	3.407	3.493	3.579	3.669	3.761	3.854	3.951	4.050	4.151
non-meter	5.091	5.218	5.349	5.482	5.620	5.760	5.903	6.052	6.202	6.358	6.517	6.680
Institutional												
funct	4.623	4.738	4.857	4.978	5.103	5.230	5.361	5.495	5.632	5.773	5.918	6.065
unfunct	5.085	5.212	5.343	5.476	5.613	5.753	5.897	6.045	6.195	6.350	6.510	6.672
non-meter	8.183	8.386	8.597	8.811	9.032	9.257	9.489	9.726	9.969	10.218	10.475	10.735
Standpost	1.148	1.177	1.206	1.236	1.267	1.299	1.331	1.365	1.399	1.434	1.470	1.506
<LALITPUR>												
Domestic												
funct	0.550	0.567	0.583	0.600	0.618	0.635	0.654	0.673	0.692	0.711	0.732	0.753
unfunct	0.605	0.624	0.641	0.660	0.680	0.699	0.719	0.740	0.761	0.782	0.805	0.828
non-meter	0.974	1.004	1.032	1.062	1.094	1.124	1.158	1.191	1.225	1.258	1.296	1.333
Commercial												
funct	2.080	2.132	2.185	2.240	2.296	2.353	2.412	2.472	2.534	2.597	2.662	2.729
unfunct	2.288	2.345	2.404	2.464	2.526	2.588	2.653	2.719	2.787	2.857	2.928	3.002
non-meter	3.682	3.774	3.867	3.965	4.064	4.165	4.269	4.375	4.485	4.597	4.712	4.830
Industrial												
funct	1.726	1.769	1.813	1.859	1.905	1.953	2.002	2.052	2.103	2.156	2.210	2.265
unfunct	1.899	1.946	1.994	2.045	2.096	2.148	2.202	2.257	2.313	2.372	2.431	2.492
non-meter	3.055	3.131	3.209	3.290	3.372	3.457	3.544	3.632	3.722	3.816	3.912	4.009
Institutional												
funct	1.584	1.623	1.664	1.705	1.748	1.792	1.837	1.882	1.929	1.978	2.027	2.078
unfunct	1.742	1.785	1.830	1.876	1.923	1.971	2.021	2.070	2.122	2.176	2.230	2.286
non-meter	2.804	2.873	2.945	3.018	3.094	3.172	3.251	3.331	3.414	3.501	3.588	3.678
Standpost	1.148	1.177	1.206	1.236	1.267	1.299	1.331	1.365	1.399	1.434	1.470	1.506

NOTE : Original unit mentioned is annual maximum.

Table I-2.4 PREDICTION OF WATER CONSUMPTION

(UNIT: m3/d)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<KATHMANDU>												
Domestic	31,130	33,510	34,828	36,904	39,114	41,924	44,930	48,371	52,027	56,040	60,293	64,898
funct	19,736	21,786	27,586	31,937	36,561	40,611	44,930	48,371	52,027	56,040	60,293	64,898
unfunct	5,677	5,841	3,608	2,474	1,271	654	0	0	0	0	0	0
non-meter	5,717	5,883	3,634	2,493	1,282	659	0	0	0	0	0	0
Commercial	4,685	5,020	5,162	5,434	5,732	6,107	6,510	6,987	7,497	8,044	8,632	9,258
funct	2,797	3,085	3,970	4,618	5,317	5,895	6,510	6,987	7,497	8,044	8,632	9,258
unfunct	875	897	552	377	192	98	0	0	0	0	0	0
non-meter	1,013	1,038	640	439	223	114	0	0	0	0	0	0
Industrial	955	1,025	1,079	1,143	1,216	1,302	1,394	1,498	1,605	1,721	1,845	1,978
funct	702	766	916	1,034	1,159	1,272	1,394	1,498	1,605	1,721	1,845	1,978
unfunct	146	149	93	65	35	18	0	0	0	0	0	0
non-meter	107	110	70	44	22	12	0	0	0	0	0	0
Institutional	2,331	2,484	2,434	2,495	2,563	2,697	2,841	3,050	3,272	3,510	3,764	4,039
funct	619	730	1,360	1,762	2,189	2,505	2,841	3,050	3,272	3,510	3,764	4,039
unfunct	697	714	438	301	157	81	0	0	0	0	0	0
non-meter	1,015	1,040	636	432	217	111	0	0	0	0	0	0
Standpost	514	527	540	554	568	582	596	612	627	642	659	675
Sub-total	39,615	42,566	44,043	46,530	49,193	52,612	56,271	60,518	65,028	69,957	75,193	80,848
<LALITPUR>												
Domestic	6,753	7,164	7,323	7,622	7,952	8,345	8,780	9,291	9,824	10,372	10,982	11,611
funct	4,909	5,262	6,150	6,818	7,538	8,132	8,780	9,291	9,824	10,372	10,982	11,611
unfunct	616	636	392	269	138	71	0	0	0	0	0	0
non-meter	1,228	1,266	781	535	276	142	0	0	0	0	0	0
Commercial	896	945	972	1,013	1,056	1,109	1,165	1,229	1,295	1,363	1,437	1,515
funct	716	761	861	939	1,022	1,092	1,165	1,229	1,295	1,363	1,437	1,515
unfunct	55	56	34	22	10	5	0	0	0	0	0	0
non-meter	125	128	77	52	24	12	0	0	0	0	0	0
Industrial	104	111	113	117	121	127	134	142	149	157	166	174
funct	79	85	98	110	118	127	134	142	149	157	166	174
unfunct	4	4	2	0	0	0	0	0	0	0	0	0
non-meter	21	22	13	7	3	0	0	0	0	0	0	0
Institutional	146	153	152	155	160	166	175	184	195	206	217	229
funct	95	101	120	133	149	163	175	184	195	206	217	229
unfunct	9	9	5	4	2	0	0	0	0	0	0	0
non-meter	42	43	27	18	9	3	0	0	0	0	0	0
Standpost	191	195	200	205	210	216	221	227	232	238	244	250
Sub-total	8,090	8,568	8,760	9,112	9,499	9,963	10,475	11,073	11,695	12,336	13,046	13,779
TOTAL	47,705	51,134	52,803	55,642	58,692	62,575	66,746	71,591	76,723	82,293	88,239	94,627

NOTE : Consumptions mentioned are annual maximum.

Table I-2.5 ANNUAL MAXIMUM WATER DEMAND

(UNIT: m3/d)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<KATHMANDU>												
Domestic	44,471	47,871	49,054	51,434	53,950	57,430	61,129	65,366	69,835	74,720	80,391	86,531
Commercial	6,693	7,171	7,270	7,574	7,906	8,366	8,857	9,442	10,063	10,725	11,509	12,344
Industrial	1,364	1,464	1,520	1,593	1,677	1,784	1,897	2,024	2,154	2,295	2,460	2,637
Institutional	3,330	3,549	3,428	3,477	3,535	3,695	3,865	4,122	4,392	4,680	5,019	5,385
Standpost	734	753	761	772	783	797	811	827	842	856	879	900
Sub-Total	56,592	60,808	62,033	64,850	67,851	72,072	76,559	81,781	87,286	93,276	100,258	107,797
<LALITPUR>												
Domestic	9,647	10,234	10,314	10,623	10,968	11,432	11,946	12,555	13,187	13,829	14,643	15,481
Commercial	1,280	1,350	1,369	1,412	1,457	1,519	1,585	1,661	1,738	1,817	1,916	2,020
Industrial	149	159	159	163	167	174	182	192	200	209	221	232
Institutional	209	219	214	216	221	227	238	249	262	275	289	305
Standpost	273	279	282	286	290	296	301	307	311	317	325	333
Sub-Total	11,558	12,241	12,338	12,700	13,103	13,648	14,252	14,964	15,698	16,447	17,394	18,371
TOTAL	68,150	73,049	74,371	77,550	80,954	85,720	90,811	96,745	102,984	109,723	117,652	126,168
LEAKAGE RATIO(%)	30.0	30.0	29.0	28.3	27.5	27.0	26.5	26.0	25.5	25.0	25.0	25.0

NOTE : Water demand mentioned is annual maximum.

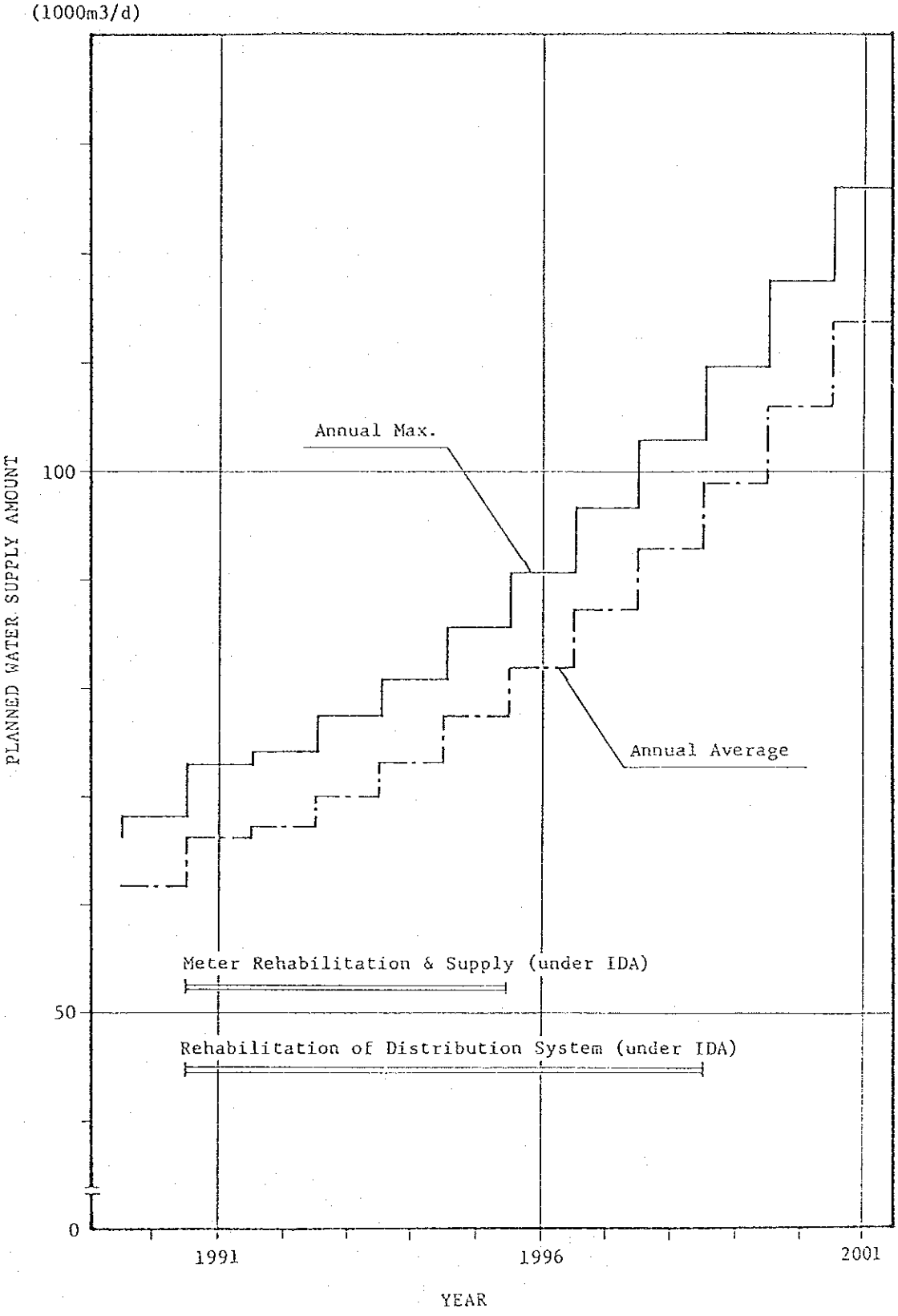
Table I-2.6 MONTHLY WATER DEMAND

(UNIT: m3/d)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1990	51,865	53,955	58,994	63,172	65,938	67,720	68,150	67,904	66,429	62,927	57,273	52,787	61,466
1991	55,594	57,833	63,234	67,714	70,678	72,588	73,049	72,786	71,205	67,450	61,390	56,582	65,879
1992	56,600	58,880	64,379	68,939	71,957	73,902	74,371	74,103	72,493	68,671	62,501	57,606	67,079
1993	59,019	61,397	67,131	71,886	75,033	77,061	77,550	77,270	75,592	71,606	65,173	60,068	69,942
1994	61,610	64,092	70,077	75,041	78,326	80,443	80,954	80,662	78,910	74,749	68,033	62,705	73,011
1995	65,237	67,865	74,203	79,459	82,937	85,179	85,720	85,411	83,556	79,150	72,039	66,396	77,315
1996	69,111	71,895	78,610	84,178	87,863	90,238	90,811	90,483	88,518	83,851	76,317	70,340	81,907
1997	73,627	76,593	83,747	89,679	93,604	96,134	96,745	96,396	94,302	89,330	81,304	74,936	87,252
1998	78,376	81,533	89,148	95,462	99,641	102,334	102,984	102,613	100,384	95,091	86,547	79,768	92,888
1999	83,504	86,868	94,981	101,709	106,161	109,030	109,723	109,327	106,953	101,313	92,211	84,988	98,964
2000	89,539	93,146	101,845	109,059	113,833	116,909	117,652	117,228	114,682	108,634	98,874	91,130	106,112
2001	96,020	99,888	109,217	116,953	122,072	125,372	126,168	125,713	122,983	116,498	106,031	97,726	113,792
RATIO	84.4	87.8	96.0	102.8	107.3	110.2	110.9	110.5	108.1	102.4	93.2	85.9	100.0

NOTE : Supply amount on July is annual maximum.

FIGURES



HIS MAJESTY'S GOVERNMENT OF NEPAL GROUND WATER MANAGEMENT PROJECT IN THE KATHMANDU VALLEY JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. I-2.1	WATER DEMAND

APPENDIX J
WATER SUPPLY PLAN AND COST ESTIMATE

APPENDIX J

WATER SUPPLY PLAN AND COST ESTIMATES

LIST OF TABLES

LIST OF FIGURES

1. PLANNED WATER SUPPLY AMOUNT

The monthly water demand was estimated with allowance both for reduction of wastage through "The Meter Rehabilitation and Supply Plan" and the improvement of the water leakage rate through "The Rehabilitating Plan of Distribution Systems" to be implemented under IDA, and to satisfy the predictions of the growing population and water consumption based on past actual records and consumer survey results derived in Appendix I.

This monthly water demand shall become the basis of establishing the water supply plan up to the year 2001 as the planned water supply amount. The planned water supply amount (annual maximum and average) is shown in Table J-1.1 and Fig.J-1.1.

2. WATER QUALITY IMPROVEMENT PLAN

According to the analysis results of existing and potential water sources in the 1st and 2nd field investigations, the following three water quality improvement plans were studied.

(a) Water quality improvement of existing treatment plants
(b) Water quality improvement of existing groundwater now being supplied without treatment
(c) Water treatment of potential water sources

2.1 Quality Improvement of Existing Treatment Plants

Jar and filter tests on the raw water were conducted and the actual conditions of the existing facilities were examined in Sundarijal, Balaju and Maharajganj treatment plants. The results are given in Table J-2.1.

The improvement and operating plans necessary to improve the water quality were established using these results. The following describes measures to maintain or recover the function of existing water treatment plants.

(1) Balaju treatment plant

(a) Provision of chemical feeding facility
(b) Reconstruction of coagulo-sedimentation basin
(c) Reconstruction of filter
(d) Provision of disinfection facility
(e) Rehabilitation of existing reservoir
(f) Upgrading of operation and maintenance through staff training

(2) Maharajganj treatment plan

It is not advisable to restore the functions of the plant through rehabilitation. Reconstruction is recommendable rather than rehabilitation, if water treatment is to continue treatment at this site.

(3) Sundarijal treatment plant

(a) Provision of chemical feeding facility
(b) Reconstruction of coagulo-sedimentation basin
(c) Reconstruction of filter and provision of a back washing tank with sufficient capacity
(d) Provision of disinfection facility

(4) Bansbari treatment plant (Bhaktapur)

(a) Provision of chemical feeding facility
(b) Provision of flush mixer and flocculator
(c) Reconstruction of filter
(d) Provision of disinfection facility
(e) Rehabilitation of existing reservoir

2.2 Quality Improvement of Existing Groundwater Sources

The yield of the existing groundwater in Kathmandu and Lalitpur is now 38,960 m^3/day or 38% of the total yield. Therefore, groundwater is a very important source in establishing the future water supply plan for Kathmandu and Lalitpur. The survey results confirmed, however, that the groundwater had a very high levels of ammonia, iron and manganese, and that it 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. However, they consume a great deal of the chlorine added for chlorination, e.g., 1 ppm each of ammonia, iron and manganese each consumes 10 to 13, 0.63, 1.29 ppm of chlorine respectively, and the reduction of residual chlorine to a level that is insufficient for preventing the growth of water-borne diseases organisms in the distribution system.

Although both iron and manganese can be treated by normal methods, such high levels of ammonia have never been treated in the field of waterworks. Generally, there are the following methods of treating ammonia.

(a) Breakpoint chlorination (combined Cl Chlorination)
(b) Ammonia stripping
(c) Ion exchange
(d) Zeolite treatment
(e) Biological treatment

In the treatment method (a), it is possible that triphenylmethane gas may be generated from combination with the great amount of chlorine dosed with organic matter in the water. Method (a) is very expensive. Methods (b), (C) and (d) are all very expensive and very difficult in operation and maintenance.

Method (e) includes a biological filtration method, a rotating disk method and a honeycomb tubing method, of which the biological filtration method is the easiest method in terms of the operation and maintenance and excellent treatment effects can be expected.

During the field investigations, the biological filtration experiments were conducted on representative samples of existing groundwater from DK5 and the Bansbari reservoir. The equipment used in this experiment is shown in Fig. J-2.1. In this experiment, three columns were filled with such filter media as porous ceramic, quartz sand and pumice sand respectively. The filtration rate is at 120 m/day. Air was blown from the bottom of column.

This experiment covered the following range of raw water;

Sample	pH	Ammonia (mg/l)	Iron (mg/l)
Well DK5	6.0 - 6.2	3.0 - 7.0	1.7 - 9.0
Bansbari Reservoir	6.4 - 6.6	0.7 - 1.8	0.9 - 1.8

Results of the biological filtration experiment are given in Table J-2.2 and the variation in ammonia removal rate is shown in Fig.J-2.2. The results derived from this experiment showed that ammonia can be removed efficiently by the filter media of porous ceramic and pumice sand.

Based on this result, a groundwater quality improvement plan was established by means of a standard treatment system including biological filtration, coagulo-sedimentation with an oxidation process and filtration for iron removal.

2.3 Treatment of Potential Water Sources

Water quality analysis, Jar/filter tests were conducted to assess the treatability of river water from the Bagmati, Manohara, Bisnumati, Nakhu, Lele and Balkhu Kh., where potential future water resources can be assumed. The results are given in Table J-2.3.

Since the Bagmati is expected to suffer increased contamination due to organic matter in the future, such a similar biological filtration experiment as described in subsection 2.2 above was conducted at the point of Gauri Ghat (upstream of Pasupatinath).

The quality of the raw water at this point has a high daily and hourly variation in pH value and temperature. During the winter season, the water temperature drops to a level too low to conduct biological treatment. Furthermore, because of the high content of organic matter other than ammonia, intensive operation control is necessary to achieve satisfactory results. The intake of raw water from a location where contamination can be expected, therefore, should be avoided as much as possible.

Based on the above mentioned results, conventional water treatment plants with easy operation and maintenance are recommendable for newly developed surface water resources.

3 OPTIMUM WATER SUPPLY MANAGEMENT PLAN

3.1 Concept and Criteria

It is clear that the groundwater in the Kathmandu basin is mostly not recharged and is a limited water resource. It also contains a high concentration of ammonia and iron thus requiring special treatment prior to use as water resource of water supply.

The surface water resources varies greatly from year to year and month to month. The available capacity for water resources is also limited because the dry season overlaps with the period of high irrigation water requirements. If the quantitative balance between water supply and demand is considered the surface water becomes the main water resource for waterworks but the limited resource of groundwater is also an important source of supplementary water during the dry season.

In the future water supply plan, the groundwater resource should be used only as a supplement when the surface water resource is restricted low during the dry season, after using the surface water to the maximum. It is desirable to preserve the groundwater resource so that it can be used as a supplement over a long period.

In addition, the following considerations have to be taken when establishing a water quality plan.

(1) The groundwater needs to be treated with bio-filters to remove ammonia and iron.

(2) The surface water, other than the Pharping system which has relatively good water quality, needs to be treated in a conventional water treatment plant.

(3) Disinfection equipment needs to be expanded and established at all water treatment plants.

(4) The water supply area per system must be established to minimize the effects on quality of water supplied at connections due to variation in the flow rate through the distribution system.

3.2 Alternative Water Supply Systems

The monthly available quantity of surface water and groundwater abstraction under the optimum groundwater management were incorporated to meet the demands by month under conditions as described in section 3.1. Each water supply facilities is composed in order to fit these conjunctive water sources. The proposed water supply systems mentioned below are diagrammed in Fig.J-3.1 and Fig.J-3.2. The layout and structural design of the proposed water supply facilities are shown in Fig.J-3.3.

3.2.1 Balaju system

The water resource for this system consists of 1) the existing surface water resource (8,700 m^3/day) and 2) a groundwater resource in the Balaju well (600 m^3/day). The existing Balaju treatment plant which is on the verge of collapse, shall be reconstructed to have a treatment capacity of 9,300 m^3/day. The existing distribution reservoir which suffers severe leakage shall also be rehabilitated.

The treated water of 9,000 m^3/day shall be held in this distribution reservoir and then supplied to consumers by gravity flow. Treated water of 4,300 m^3/day from the Lambagar treatment plant is also to be sent to this distribution reservoir and then into this system. The water supply area of this system is the northwest of the city of Kathmandu.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

Existing surface water Capacity : 8,700 m^3/day

Existing groundwater
Balaju well : 600 m^3/day (0.8 m^3/day, 11kw)

(2) Water treatment plant

a) Coagulo-sedimentation basin (reconstruction)

Capacity : 9,300 m^3/day

Mixing basin
volume : 18.8 m^3 x 1 basin
detention time : 3 min
type : fall gravity type
Flocculation basin
volume : 102 m^3/basin x 2 basins
detention time : 31 min
type : vertical baffling type

Sedimentation basin

volume	: 200 m^3/basin x 2 basins
detention time	: 1 hr
type	: plane-shape of latitudinal-flow type with inclined parallel plates
inclined parallel plates	: 2.5 stages x 5 lines (75 sets per line)

Sludge removal equipment

type	: hopper type
sludge valve	: 250 m/m
number of hopper	: 12 pits/basin
volume	: 2.2 m^3/pit

b) Rapid sand filter (reconstruction)

Rapid sand filter

filtration area	: 12 m^2/basin x 6 basins
filtration rate	: max 150 m/day
type	: self-washing type (by valve)

Raw water distribution equipment

: 0.8 m wide square weir and 200 m/m valve

Backwashing equipment

backwashing rate	: 0.6 m/min x 8 min
drainage device	: 350 m/m x 350 m/m gate
make-up pump	: 2.5 m^3/min x 7 m x 7.5 kw x 1 set
drain trough	: l= 1.8 m, 5 sets/basin

Surface washing equipment

type	: fixed type
surface washing rate	: 0.2 m/min x 5 min
surface washing pump	: 2.5 m^3/min x 20 m x 18.5 kw x 3 sets
surface washing pipe	: 200 m/m
surface washing valve	: 200 m/m

Filter control equipment

1.5 m wide square weir 4 sets

Filter layer (silica sand)

effective diameter	: 0.6 m/m
uniformity coefficient	: 1.8
depth of layer	: 0.6 m

Supporting layer (gravel)

grain size	: 2 - 20 m/m
depth of layer	: 0.2 m

Underdrain system

type	: porous block type

c) Chemical feeding facilities

PAC (Poly aluminum chloride)

solution tank	: 0.5 m^3 x 2 tanks
transport pump	: 20 l/min x 2 sets
storage tank	: 0.5 m^3 x 2 tanks
feeding pump	: 0.26 l/min x 3 sets with constant feeding device

Ca(OH)2

solution tank	: 0.5 m^3 x 2 tanks
transport pump	: 20 l/min x 2 sets
storage tank	: 0.2 m^3 x 2 tanks
feeding pump	: 0.07 l/min x 3 set with constant feeding device

d) Disinfection facilities

NaClO generation equipment

capacity	: 24 kg Cl2/day x 2 sets
storage tank	: 2 m^3 x 2 tanks
feeding pump	: 1.4 l/min x 3 sets with constant feeding device

(3) Distribution facilities

Balaju reservoir (reconstruction)

number of basin	: 1 basin
volume	: 3,700 m^3

3.2.2 Lambagar system

The water resource of this system is the surface water to be taken in through the run-off-river intake (14,300 m^3/day) located in the existing water intake on the Lambagar Khola (W105), which is to be expanded and reconstructed. A conventional water treatment plant (13,000 m^3/day) shall be newly constructed for this system.

The treated water of 4,300 m^3/day is to be sent to the Balaju system and the remainder of 8,300 m^3/day is to be sent to a new distribution reservoir (2,400 m^3/day) via a new 300 m/m x 4,000 m water transmission pipeline. The water should then be supplied to consumers either by a booster pumping system or gravity flow. The water supply area of this system is west of the city of Kathmandu.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

Run-off-river intake on the Lambagar Khola (W105)

Capacity	: 14,300 m^3/day
Intake pipe	: 400 m/m
Grit chamber	: 2 basins
volume	: 130 m^3/basin
detention time	: 13 min
Intake pump	: 5 m^3/min x 10 m x 15 kw x 3 sets
Conveyance pipe	: 400 m/m x 20 m

(2) Water treatment plant

a) Coagulo-sedimentation basin

Capacity	: 13,000 m^3/day

Receiving well and mixing basin
- volume : 34 m^3 x 1 basin
- detention time : 3.8 min
- mixing type : fall gravity type

Flocculation basin
- volume : 145 m^3/basin x 2 basins
- detention time : 32 min
- type : vertical baffling type

Sedimentation basin
- volume : 813 m^3/basin x 2 basins
- detention time : 3 hr
- flow rate : 0.38 m/min
- type : plane-shape of latitudinal flow type

Sludge removing hopper
- number of hopper : 15 pits/basin
- volume : 4.4 m^3/pit
- sludge valve : 300 m/m

b) Rapid sand filter

Capacity : 13,000 m^3/day

Rapid sand filter
- filtration area : 17.4 m^2/basin x 6 basins
- filtration rate : max 150 m/day
- type : self-washing type (by valve)

Raw water distribution equipment : 0.9 m wide square weir and 250 m/m valve

Backwashing equipment
- backwashing rate : 0.6 m/min x 8 min
- drainage device : 450 m/m x 450 m/m gate
- make-up pump : 3.5 m^3/min x 7 m x 7.5 kw x 1 set
  3.5 m^3/min x 20 m x 11 kw x 1 set
- drain trough : l= 3.2 m, 3 sets/basin

Surface washing equipment
- type : fixed type
- surface washing rate : 0.2 m/min x 5 min
- surface washing pump : 3.5 m^3/min x 20 m x 11 kw x 2 sets
- surface washing pipe : 200 m/m
- surface washing valve : 200 m/m

Filter control equipment : 1.5 m wide square weir 5 sets

Filter layer (silica sand)
- effective diameter : 0.6 m/m
- uniformity coefficient : 1.8
- depth of layer : 0.6 m

Supporting layer (gravel)
- grain size : 2 - 20 m/m
- depth of layer : 0.2 m

Underdrain system
- type : porous block type

c) Chemical feeding facilities

PAC (Poly aluminum chloride)
- solution tank : 0.5 m^3 x 2 tanks
- transport pump : 20 l/min x 2 sets
- storage tank : 0.8 m^3 x 2 tanks
- feeding pump : 0.36 l/min x 3 sets with constant feeding device

Ca(OH)2

solution tank	: 0.6 m^3 x 2 tanks
transport pump	: 30 l/min x 2 sets
storage tank	: 0.7 m^3 x 2 tanks
feeding pump	: 0.45 l/min x 3 sets with constant feeding device

d) Disinfection facilities

NaClO generation equipment

capacity	: 36 kg Cl2/day x 2 sets
storage tank	: 2.7 m^3 x 2 tanks
feeding pump	: 1.9 l/min x 3 sets with constant feeding device

e) Clear water reservoir

volume	: 294 m^3/basin x 2 basins
detention time	: 1 hr

(3) Transmission facilities

(for Balaju reservoir)

Transmission pump	: 1.6 m^3/min x 67 m x 30 x 3 sets
Transmission pipe	: 200 m/m x 300 m

(for Lambagar reservoir)

Transmission pump	: 3.9 m^3/min x 60 m x 75 kw x 3 sets
Transmission pipe	: 300 m/m x 4,000 m

(4) Distribution facilities

Lambagar reservoir

capacity	: 8,300 m^3/day
volume	: 2,400 m^3
detention time	: 7 hr
distribution pump	: 1.3 m^3/min x 75 m x 30 kw x 3 sets
distribution pipe	: 150 m/m x 500 m 250 m/m x 1,000 m

3.2.3 Bansbari system

The water resource of this system consists of 1) 2,100 m^3/day of the existing surface water resource of the existing Maharajganj treatment plant, 2) the surface water of 14,300 m^3/day from the Bisnumati river at W106 through a new run-off-river intake and 3) the groundwater resource of the Bansbari well field. The groundwater should first be pre-treated by bio-filters and then by a new conventional water treatment plant (21,500 m^3/day) together with the surface water.

Of the treated water, 6,900 m^3/day should be supplied to the northern part of the city of Kathmandu via the existing Bansbari reservoir (2,000 m^3) by gravity flow. The remainder of 13,900 m^3/day should be sent into the Maharajganj system. The water supply area of this system is northern part of the city of Kathmandu.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

(Groundwater)

Bansbari well field (existing)

BB0 (1.26 m^3/min, 30 kw)	BB2 (1.26 m^3/min, 30 kw)
BB3 (3.00 m^3/min, 80 kw)	BB4 (3.00 m^3/min, 80 kw)
BB5 (3.00 m^3/min, 80 kw)	BB6 (3.00 m^3/min, 80 kw)
BB7 (3.50 m^3/min, 75 kw)	BB8 (3.00 m^3/min, 80 kw)

(Surface water)

Shivapuri and Bisnumati
Existing water resources for the Maharajganj water treatment plant

Run-off-river intake on the Bisnumati (W106)

Capacity	: 14,300 m^3/day
Intake pipe	: 400 m/m
Grit chamber	: 2 basins
volume	: 130 m^3/basin
detention time	: 13 min
Intake pump	: 5 m^3/min x 60 m x 90 kw x 3 sets
Conveyance pipe	: 400 m/m x 3,000 m

(2) Water treatment plant

a) Bio-filter

Capacity	: 17,700 m^3/day
Receiving well and mixing basin	
volume	: 34 m^3/basin x 1 basin
detention time	: 2.8 min
mixing type	: fall gravity type
Bio-filter	
filtration area	: 16.4 m^2/basin x 10 basins
filtration rate	: max 120 m/day
type	: self-washing type (by valve)
Raw water distribution equipment	: 0.9 m wide square weir and 200 m/m valve
Backwashing equipment	
backwashing rate	: 1.0 m/min x 10 min
drainage device	: 450 m/m x 450 m/m gate
make-up pump	: pump for rapid sand filter
drain trough	: l= 3.2 m, 3 sets/basin
Air blowing equipment	
air blowing device	: fixed type
blower	: 12.5 m^3Air/min x 6mSq x 30 kw x 2 sets
Filter control equipment	: 1.5 m wide square weir 7 sets
Filter layer (pumice sand)	
size	: 5 - 10 m/m
depth of layer	: 1.5 m

Supporting layer (gravel)
size : 5 - 40 m/m
depth of layer : 0.4 m

Underdrain system
type : porous block type

b) Coagulo-sedimentation basin

Capacity : 21,500 m^3/day

Receiving well and mixing basin
volume : 29 m^3/basin x 2 basins
detention time : 4.0 min
mixing type : fall gravity type

Flocculation basin
volume : 105 m^3/basin x 4 basins
detention time : 30 min
type : vertical baffling type

Sedimentation basin
volume : 627 m^3/basin x 4 basins
detention time : max 3 hr
flow rate : 0.24 m/min
type : plane-shape of latitudinal-flow type

Sludge removal equipment
type : hopper type
number of hopper : 10 pits/basin
volume : 3.6 m^3/pit
sludge valve : 250 m/m

c) Rapid sand filter

Capacity : 21,500 m^3/day

Rapid sand filter
filtration area : 15.5 m^2/basin x 8 basins
filtration rate : max 300 m/day for groundwater
max 150 m/day for surface water
type : self-washing type (by valve)

Raw water distribution equipment
: 0.9 m wide square weir and 250 m/m valve

Backwashing equipment
backwashing rate : 0.6 m/min x 8 min
drainage device : 450 m/m x 450 m/m gate
make-up pump : 3.5 m^3/min x 7 m x 7.5 kw x 1 set
3.5 m^3/min x 20 m x 11 kw x 1 set
drain trough : l= 3.2 m, 3 sets/basin

Surface washing equipment
type : fixed type
surface washing rate : 0.2 m/min x 5 min
surface washing pump : 3.5 m^3/min x 20 m x 11 kw x 2 sets
surface washing pipe : 200 m/m
surface washing valve : 200 m/m

Filter control equipment : 1.5 m wide square weir 8 sets

Filter layer (silica sand)
effective diameter : 0.6 m/m
uniformity coefficient : 1.8
depth of layer : 0.6 m

Supporting layer (gravel)
grain size : 2 - 20 m/m
depth of layer : 0.2 m

Underdrain system
type : porous block type

c) Chemical feeding facilities

PAC (Poly aluminum chloride)
solution tank : 0.6 m^3 x 2 tanks
transport pump : 30 l/min x 2 sets
storage tank : 1.0 m^3 x 2 tanks
0.6 m^3 x 2 tanks
feeding pump : 0.25 l/min x 4 sets
0.30 l/min x 3 sets
with constant feeding device

Ca(OH)2
solution tank : 0.6 m^3 x 2 tanks
transport pump : 30 l/min x 2 sets
storage tank : 0.7 m^3 x 2 tanks
feeding pump : 1.2 l/min x 3 sets with constant feeding device

d) Disinfection facilities

NaClO generation equipment
capacity : 100 kg Cl2/day x 2 sets
storage tank : 6.6 m^3 x 2 tanks
feeding pump : 0.5 l/min x 5 sets
0.27 l/min x 2 sets
with constant feeding device

e) Clear water reservoir
volume : 357 m^3/basin x 2 basins
detention time : 50 min

(3) Transmission facilities

(for Bansbari reservoir)
Transmission pump : 2.7 m^3/min x 7 m x 7.5 kw x 3 sets
Transmission pipe : 300 m/m x 100 m

(for Maharajganj reservoir)
Transmission pipe : 300 m/m x 2,700 m

(4) Distribution facilities

Bansbari reservoir (existing)
capacity : 6,900 m^3/day
volume : 2,000 m^3
detention time : 7 hr

Maharajganj reservoir (reconstruction)

capacity	: 13,900 m^3/day
volume	: 3,750 m^3
detention time	: 7 hr

3.2.4 Maharajganj system

The existing water treatment plant should be demolished and the existing distribution reservoir of 3,750 m^3 should be reconstructed, into which water will be received via a new 300 m/m x 2,700 m water transmission pipeline from the new Bansbari treatment plant. 13,900 m^3/day will be supplied from the reservoir by gravity flow. The water supply area of this system is northwestern part of the city of Kathmandu.

3.2.5 Mahankal Chaur system

The water resource of this system consists of groundwater in the Gokarna, Manohara and Dhobi Khola well fields and the surface water at W301 in the Bagmati river and at W202 in the Dhobi Khola. Water from W301 is to be abstracted from the penstock of the Sundarijal hydroelectric power plant, and water from W202 is to be taken through a new run-off-river intake.

The groundwater of 18,600 m^3/day should first be pre-treated by bio-filters to remove the high concentrations of both ammonia and iron and then by a new conventional water treatment plant whose capacity is 32,900 m^3/day together with the surface water.

The treated water is to be sent by pumps into the existing distribution reservoirs of 9,000 m^3 and then be supplied to the central part of the city of Kathmandu.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

(Groundwater)

Manohara well field (existing)

MH2 (2.8 m^3/min, 42 kw)	MH3 (2.8 m^3/min, 42 kw)
MH4 (2.8 m^3/min, 42 kw)	MH5 (2.8 m^3/min, 42 kw)
MH7 (2.8 m^3/min, 42 kw)	

Gokarna well field (existing)

GK1 (2.0 m^3/min, 28 kw)	GK2 (2.0 m^3/min, 28 kw)
GK3 (2.0 m^3/min, 28 kw)	GK4 (2.0 m^3/min, 28 kw)

Dhobi Khola well field (existing)

DK3 (1.5 m^3/min, 18 kw)	DK4 (1.5 m^3/min, 18 kw)
DK5 (1.5 m^3/min, 18 kw)	DK6 (0.8 m^3/min, 11 kw)

(Surface water)

Run-off-river intake on the Dhobi Khola (W202)

Capacity	: 14,300 m^3/day
Intake pipe	: 400 m/m
Grit chamber	: 2 basins
volume	: 130 m^3/basin
detention time	: 13 min
Intake pump	: 5 m^3/min x 33 m x 45 kw x 3 sets
Conveyance pipe	: 350 m/m x 2,000 m

Intake at the penstock of the Sundarijal power station

Capacity	: 14,300 m^3/day
Pressure reducing equipment	: 300 m/m reducing valve
Conveyance pipe	: 350 m/m x 9,000 m

(2) Water treatment plant

a) Bio-filter

Capacity	: 18,600 m^3/day
Receiving well and mixing basin	
volume	: 46 m^3/basin x 1 basin
detention time	: 3.6 min
mixing type	: fall gravity type
Bio-filter	
filtration area	: 17.7 m^2/basin x 10 basins
filtration rate	: max 120 m/day
type	: self-washing type (by valve)
Raw water distribution equipment	: 0.9 m wide square weir and 200 m/m valve
Backwashing equipment	
backwashing rate	: 1.0 m/min x 10 min
drainage device	: 450 m/m x 450 m/m gate
make-up pump	: pump for rapid sand filter
drainage trough	: l= 3.2 m, 4 sets/basin
Air blowing equipment	
blower	: 12.5 m^3Air/min x 6mSq x 30 kw x 2 sets
Filter control equipment	: 1.5 m wide square weir 8 sets
Filter layer (pumice sand)	
size	: 5 - 10 m/m
depth of layer	: 1.5 m
Supporting layer (gravel)	
size	: 5 - 40 m/m
depth of layer	: 0.4 m
Underdrain system	
type	: porous block type

b) Coagulo-sedimentation basin

Capacity	: 32,900 m^3/day
Receiving well and mixing basin	
volume	: 52 m^3/basin x 2 basins
detention time	: 4.2 min
mixing type	: fall gravity type
Flocculation basin	
volume	: 180 m^3/basin x 4 basins
detention time	: 29 min
type	: vertical baffling type
Sedimentation basin	
volume	: 952 m^3/basin x 4 basins
detention time	: 2.5 hr
flow rate	: 0.26 m/min
type	: plane-shape of latitudinal-flow type
Sludge removal equipment	
type	: hopper type
number of hopper	: 15 pits/basin
volume	: 4.4 m^3/pit
sludge valve	: 300 m/m

c) Rapid sand filter

Capacity	: 32,900 m^3/day
Rapid sand filter	
filtration area	: 17.3 m^2/basin x 12 basins
filtration rate	: max 300 m/day for groundwater max 150 m/day for surface water
type	: self-washing type (by valve)
Raw water distribution equipment	: 0.9 m wide square weir and 300 m/m valve
Backwashing equipment	
backwashing rate	: 0.6 m/min x 8 min
drainage device	: 450 m/m x 450 m/m gate
make-up pump	: 5.1 m^3/min x 7 m x 11 kw x 1 set 5.1 m^3/min x 20 m x 30 kw x 1 set
drain trough	: 1= 2.4 m, 5 sets/basin
Surface washing equipment	
type	: fixed type
surface washing rate	: 0.2 m/min x 5 min
surface washing pump	: 3.5 m^3/min x 20 m x 11 kw x 2 sets
surface washing pipe	: 250 m/m
surface washing valve	: 250 m/m
Filter control equipment	: 1.5 m wide square weir 12 sets
Filter layer (silica sand)	
effective diameter	: 0.6 m/m
uniformity coefficient	: 1.8
depth of layer	: 0.6 m
Supporting layer (gravel)	
grain size	: 2 - 20 m/m
depth of layer	: 0.2 m
Underdrain system	
type	: porous block type

c) Chemical feeding facilities

PAC (Poly aluminum chloride)

solution tank	: 0.6 m^3 x 2 tanks
transport pump	: 30 l/min x 2 sets
storage tank	: 1.4 m^3 x 2 tanks
	0.6 m^3 x 2 tanks
feeding pump	: 0.7 l/min x 3 sets
	0.35 l/min x 3 sets
	with constant feeding device

Ca(OH)2

solution tank	: 0.6 m^3 x 2 tanks
transport pump	: 30 l/min x 2 sets
storage tank	: 1.75 m^3 x 3 tanks
feeding pump	: 1.2 l/min x 3 sets
	with constant feeding device

d) Disinfection facilities

NaClO generation equipment

capacity	: 130 kg Cl2/day x 2 sets
storage tank	: 10 m^3 x 2 tanks
feeding pump	: 2.5 l/min x 3 sets
	4.4 l/min x 3 sets
	1.5 l/min x 2 sets
	with constant feeding device

e) Clear water reservoir

volume	: 630 m^3/basin x 2 basins
detention time	: 50 min

(3) Transmission facilities

Transmission pump	: 9 m^3/min x 7 m x 15 kw x 4 sets
Transmission pipe	: 500 m/m x 80 m

(4) Distribution facilities

Mahankal Chaur reservoir (existing)

capacity	: 31,900 m^3/day
volume	: 9,000 m^3
detention time	: 6.24 hr

3.2.6 Sundarijal system

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

The existing Sundarijal treatment plant should be reconstructed to have a capacity of 20,600 m^3/day. The treated water should 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 in the eastern part of the city of Kathmandu via the existing water transmission pipeline into the Mahankal Chaur reservoir and a new water transmission pipeline (400 m/m x 2,000 m, 350 m/m x 1,000 m and 300 m/m x 2,000 m) from where the water should then be supplied to consumers at a rate of 6,400 m^3/day, 6,400 m^3/day and 5,200 m^3/day. The water supply area of this system is eastern part of the city of kathmandu.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

Water resources	: existing
Capacity	: 20,600 m^3/day
Intake pump	: 7.9 m^3/min x 7 m x 15 kw x 3 sets

(2) Water treatment plant

a) Coagulo-sedimentation basin

Capacity : 20,600 m^3/day

Receiving well and mixing basin

volume	: 50 m^3/basin x 1 basin
detention time	: 3.5 min
mixing type	: fall gravity type

Flocculation basin

volume	: 214 m^3/basin x 2 basins
detention time	: 30 min
type	: vertical baffling type

Sedimentation basin

volume	: 431 m^3/basin x 2 basins
detention time	: 1 hr
type	: plane-shape of latitudinal-flow type with inclined parallel plates

Sludge removal equipment

type	: hopper type
number of hopper	: 15 pits/basin
volume	: 4.4 m^3/pit
sludge valve	: 300 m/m

Inclined parallel plates : 3.5 stages x 6 lines (85 sets per line)

b) Rapid sand filter

Capacity : 20,600 m^3/day

Rapid sand filter

filtration area	: 20.65 m^2/basin x 8 basins
filtration rate	: max 143 m/day
type	: self-washing type (by valve)

Raw water distribution equipment : 0.9 m wide square weir and 250 m/m valve

Backwashing equipment

backwashing rate	: 0.6 m/min x 8 min
drainage device	: 500 m/m x 500 m/m gate
make-up pump	: 4.2 m^3/min x 7 m x 7.5 kw x 1 set 4.2 m^3/min x 20 m x 22 kw x 1 set
drain trough	: l= 3.2 m, 4 sets/basin

Surface washing equipment

type	: fixed type
surface washing rate	: 0.2 m/min x 5 min
surface washing pump	: 4.2 m^3/min x 20 m x 22 kw x 2 sets
surface washing pipe	: 250 m/m
surface washing valve	: 250 m/m

Filter control equipment : 1.5 m wide square weir 9 sets

Filter layer (silica sand)
effective diameter : 0.6 m/m
uniformity coefficient : 1.8
depth of layer : 0.6 m

Supporting layer (gravel)
grain size : 2 - 20 m/m
depth of layer : 0.2 m

Underdrain system
type : porous block type

c) Chemical feeding facilities

PAC (Poly aluminum chloride)
solution tank : 0.6 m^3 x 2 tanks
transport pump : 30 l/min x 2 sets
storage tank : 1.0 m^3 x 2 tanks
feeding pump : 0.6 l/min x 3 sets
with constant feeding device

Ca(OH)2
solution tank : 0.6 m^3 x 2 tanks
transport pump : 30 l/min x 2 sets
storage tank : 0.5 m^3 x 2 tanks
feeding pump : 0.15 l/min x 3 sets
with constant feeding device

d) Disinfection facilities

NaClO generation equipment
capacity : 60 kg Cl2/day x 2 sets
storage tank : 4.3 m^3 x 2 tanks
feeding pump : 3.0 l/min x 3 sets
with constant feeding device

e) Clear water reservoir
volume : 288 m^3
detention time : 20 min

(3) Transmission facilities

Transmission pipe : 500 m/m x 8,500 m (existing)
400 m/m x 2,000 m
350 m/m x 1,000 m
300 m/m x 2,000 m

(4) Distribution facilities

Sundarijal (A) reservoir
capacity : 6,400 m^3/day
volume : 1,850 m^3
detention time : 7 hr
distribution pump : 8.8 m^3/min x 20 m x 45 kw x 3 sets
booster pump : 2.5 m^3/min x 10 m x 7.5 kw x 3 sets

Sundarijal (B) reservoir

capacity	: 6,400 m^3/day
volume	: 1,850 m^3
detention time	: 7 hr
distribution pump	: 8.8 m^3/min x 20 m x 45 kw x 3 sets
booster pump	: 2.5 m^3/min x 10 m x 7.5 kw x 3 sets

Sundarijal (C) reservoir

capacity	: 5,200 m^3/day
volume	: 1,550 m^3
detention time	: 7 hr
distribution pump	: 7 m^3/min x 20 m x 37 kw x 3 sets
booster pump	: 2.0 m^3/min x 10 m x 5.5 kw x 3 sets

3.2.7 Shaibhu system

The water resources of this system consist 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/day will be reliably supplied to consumers for 5 hours each in the morning and evening, a 4,500 m^3 distribution reservoir together with a distribution main (350 m/m x 3,500 m) should be constructed, in addition to the existing distribution reservoir (2,700 m^3) and distribution main (500 m/m x 3,500 m). Disinfection equipment should also be newly provided.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

(Groundwater)
Pharping well field (existing)
PH1 (2.0 m^3/min, 28 kw) PH2 (2.8 m^3/min, 42 kw)

(Surface water)
Spring water (existing)
Shesh Narayan, Sat Mul, Kutori Mul
capacity : 21,600 m^3/day

(2) Shaibhu distribution facilities

a) Capacity : 24,500 m^3/day

b) Filtration : simple filter

c) Disinfection facilities

NaClO generation equipment

capacity	: 60 kg Cl2/day x 2 sets
storage tank	: 5.1 m^3 x 2 tanks
feeding pump	: 3.5 l/min x 3 sets with constant feeding device

d) Shaibhu reservoir (existing)

volume	: 2,700 m^3
detention time	: 2.6 hr

e) Shaibhu reservoir (proposed)

volume	: 4,500 m^3
detention time	: 4.4 hr

(3) Distribution pipeline

Distribution pipe	: 500 m/m x 3,000 m (existing) 350 m/m x 3,500 m

3.2.8 Manohara system

The water supply area is the southeast of the city of Kathmandu. A conventional water treatment plant should be constructed with the surface water resource taken in through a new run-off-river intake at W406 in the Manohara river. The treated water should be sent into two new water distribution reservoir of 1,850 m^3, each of which serves 6,300 m^3/day by a booster pump system.

Contents of the facilities for the system are shown as follows:

(1) Intake facility

Run-off-river intake on the Manohara (W406)

Capacity	: 14,300 m^3/day
Intake pipe	: 400 m/m
Grit chamber	
volume	: 130 m^3/basin x 2 basins
detention time	: 13 min
Intake pump	: 5 m^3/min x 10 m x 15 kw x 3 sets

(2) Water treatment plant

a) Coagulo-sedimentation basin

Capacity	: 13,000 m^3/day

Receiving well and mixing basin

volume	: 34 m^3/basin x 1 basin
detention time	: 3.8 min
mixing type	: fall gravity type

Flocculation basin

volume	: 145 m^3/basin x 2 basins
detention time	: 32 min
type	: vertical baffling type

Sedimentation basin

volume	: 813 m^3/basin x 2 basins
detention time	: 3 hr
flow rate	: 0.38 m/min
type	: plane-shape of latitudinal-flow type

Sludge removal equipment
type : hopper type
number of hopper : 15 pits/basin
volume : 4.4 m^3/pit
sludge valve : 300 m/m

c) Rapid sand filter

Capacity : 13,000 m^3/day

Rapid sand filter
filtration area : 17.4 m^2/basin x 6 basins
filtration rate : max 150 m/day
type : self-washing type (by valve)

Raw water distribution equipment
: 0.9 m wide square weir and
250 m/m valve

Backwashing equipment
backwashing rate : 0.6 m/min x 8 min
drainage device : 450 m/m x 450 m/m gate
make-up pump : 3.5 m^3/min x 7 m x 7.5 kw x 1 set
3.5 m^3/min x 20 m x 11 kw x 1 set
drain trough : l= 3.2 m, 3 sets/basin

Surface washing equipment
type : fixed type
surface washing rate : 0.2 m/min x 5 min
surface washing pump : 3.5 m^3/min x 20 m x 11 kw x 2 sets
surface washing pipe : 200 m/m
surface washing valve : 200 m/m

Filter control equipment : 1.5 m wide square weir 5 sets

Filter layer (silica sand)
effective diameter : 0.6 m/m
uniformity coefficient : 1.8
depth of layer : 0.6 m

Supporting layer (gravel)
grain size : 2 - 20 m/m
depth of layer : 0.2 m

Underdrain system
type : porous block type

c) Chemical feeding facilities
PAC (Poly aluminum chloride)
solution tank : 0.5 m^3 x 2 tanks
transport pump : 20 l/min x 2 sets
storage tank : 0.8 m^3 x 2 tanks
feeding pump : 0.36 l/min x 3 sets
with constant feeding device

Ca(OH)2
solution tank : 0.6 m^3 x 2 tanks
transport pump : 30 l/min x 2 sets
storage tank : 0.7 m^3 x 2 tanks
feeding pump : 0.45 l/min x 3 sets
with constant feeding device