connection, types of toilets, etc. The per capita consumption was estimated to be 73.7 lcd, based on the data on water consumption extracted from the above mentioned meter reading records in comparison with the number of consumers per sample.

In these surveys, however, it was difficult to determine whether the meters were functioning or unfunctioning. 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.

2nd consumer 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. The present water consumption in Greater Kathmandu was finally estimated based only on the 2nd consumer suevey.

4.2.1 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:

(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 (m3/month)	22.1	18.0
per capita (lcd)	86.9	72.9
c) Seasonal variation		
dry season (m3/month)	24.0	-
wet season (m3/month)	19.7	-

(2) Questionnaire survey analysis

	Kathmandu	Lalitpur
a) Number of samples	665	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	510 (76.6%)	368 (82.9%)
dry pit / non toilet	5 (0.7%)	0 (-)
e) Per capita consumption	73.7 lcd	-

4.2.2 Results of 2nd consumer survey

The results derived from analyzing the consumer survey conducted in the 2nd field investigation were as follows:

		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%)
unfunctioning		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 with functioning meter			
domestic	(m3/day)	0.670 (87.6 lcd)	0.534 (81.6 lcd)
commercial	(m3/day)	2.139	2.029
industrial	(m3/day)	2.806	1.684
institutional	(m3/day)	4.510	1.545

4.3 Interview Survey on Water Consumption

An interview survey to the people in Greater Kathmandu was conducted on domestic water supplied for the purpose of obtaining all available data for the project evaluation, at the nine revenue stations of NWSC for 40 days from the middle of August to the end of September, 1989. The following questionnaire to interviewees was prepared:

<u>Questionnaire</u>

(A) Do you consider present water price is:
(1) too low (2) low (3) about right (4) high (5) too high

(B) Is present water supply satisfactory?
(1) Yes (2) No

(C) If present water supply is not satisfactory, what is not good:
(1) quantity (2) quality (3) quantity and quality

(D) If water supply is made satisfactory in near future, would you be prepared to pay more for water ?

Effective answers to the above questionnaire amounted to 4,031 in number of which were 2,798 for Kathmandu and 1,233 for Lalitpur. The results may be summarized as follows:

(a) For question (A), approximately 84 % of all interviewees considered to be "about right" for the present water price of NWSC. The breakdown was 85 % for Kathmandu and 80 % for Lalitpur.

(b) Details of answers to questions (B) and (C) are given in Table 4.3.1. Interviewees who answered "not satisfactory" for quantity and/or quality of water supplied at present amounted to 77 % of the whole, consisting of 82 % for Kathmandu and 65 % for Lalitpur. Whereas at the Kopudol station of Lalitpur, it was noticeable that the interviewees dissatisfied were only 25 %.

(c) For all interviewees who answered "not satisfactory", the breakdown of items unsatisfactory were 22 % for the quantity, 28 % for the quality and 50 % for both quantity and quality. In general although the number of interviewees dissatisfied with the quantity was more than that for the quality, the reverse was true for samples at both Kopudol and Tangal stations (See Table 4.3.1).

(d) In reply to question (D), nearly 70 % of the interviewees dissatisfied expressed their willingness to pay more for water, provided that the water supply is made satisfactory. This result will be considered in estimates of benefits in the project evaluation.

4.4 Municipal Water Demand

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 dend are extremely complicated, it is now necessary that the planned daily water supply amount be figured out on the basis of an analysis of actual consumption by use in the past and rational assumptions of future consumption in various uses. The objective area for water demand projection is Greater Kathmandu (urban area of Kathmandu and Lalitpur).

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

4.4.1 Present water consumption

Based on the results of the consumer survey and the numbers of connections in Kathmandu and lalitpur, present water consumption data in both areas such as categories of connection(with meter functioning, unfunctioning, without meter), consumptions by use, number of consumer per connection and consumption per connection were estimated, on an assumption that this survey result represents statistical feature of population of water supply consumption in the area concerned. The result is given in Table 4.4.1.

The original unit of consumption for connections with functioning meters by use can only be estimated by the consumer survey. 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)

the present water consumption by house connections in the village other than the objective area, whose water supply systems are operated by NWSC, is shown in Table 4.4.2. Per capita consumption in these area is assumed to be the same as that of dommestic use in the objective area, that is, Greater Kathmandu (urban area of Kathmandu and Lalitpur).

4.4.2 Prediction of water consumption

For Greater Kathmandu, 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 section 4.1 above 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 the 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 of 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 4.4.1.

Based on all the foregoing conditions, the results derived from predicting future water consumption are given in Table 4.4.3 to 4.4.5. Planned daily maximum consumption per capita in various countries applied by recent JICA studies are shown in Table 4.4.6 for reference.

4.4.3 Prediction of water demand

Based on the results of analyzing and predicting water consumption by use, as shown in subsection 4.4.2, the water demand was estimated and the results are given in Table 4.4.7.

The present water leakage in the water distribution system was estimated by means of the following formular based on the survey results of actual water supply amount to the main six reservoirs (Table 2.6.3) and the present water consumption estimated in subsection 4.4.1 as shown in Table 4.4.1.

$$L = (Q_s - Q_c) / Q_s \times 100 \ (\%) = 29.1$$

where, L : water leakage rate (%)

Q_s : water supply amount to the main reservoir (62,755 m^3/day)

Q_c : water consumption (44,509 m^3/day)

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 present rate of about 30%.

5. PLAN FORMULATION

5.1 Principle of Development

Conceivable water sources for water supply in the valley are (i) groundwater, (ii) surface water of the run-of-river type and (iii) the surface water stored in storage reservoirs. As the results of the groundwater evaluation, it will be almost impossible to maintain the present yields of existing wells for the next ten years. On this assumption priority for surface water is given firstly to run-of-river type development because of the quick effect, low cost and the possibility to simplify the improvement of reservoirs and other concerned facilities.

The projection of future demand is prepared based on three main assumptions that (a) the surface water from existing intakes will be kept as at present and more water intakes facilities will be added, (b) pumping from the existing wells will be kept as low as possible and no more wells will be added, (c) the growth of population will be maintained as the plausible case in this report, and (d) losses of water from the system will be reduced at a rate of 0.5 % per year.

Improvement of the existing facilities will have to be made prior to development of the new water source.

Putting the abovementioned factors into account the following works will be undertaken in the near future, so that the water demand up to the target year 2001 will be met and the water quality will be improved to world standards.

5.2 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 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 Chapter 4.

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 amounts are shown in Table 5.2.1 and Fig. 5.2.1.

5.3 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 for newly developed water sources

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

(1) Balaju treatment plant

(a) Provision of a 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 plant

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 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

5.3.2 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 Greater Kathmandu. The survey results confirmed, however, that the groundwater had very high levels of ammonia, iron and manganese, and that it is not suitable as a source of water supply if they remain 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 waterborne disease 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 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 also 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, 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. 5.3.1 . 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 water;

Sample	pH	Ammonia	Iron
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

The variation in ammonia removal rate is shown in Fig. 5.3.2. The results of the 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.

5.3.3 Treatment for newly developed 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 Khola Kh., where potential future water resources can be assumed.

The quality of raw water at intake sites of these new water sources are quite in good conditions in comparison with that of groundwater especially in the dry season. In the rainy season the raw water contains much TDS and organic mater. Test results of water quality are summarized as below;

Intake Site (River)		Season	pH	Alkali	$KMnO_4$	NH_4-N	Color	Turbid	SS
				(mg/l)	(mg/l)	(mg/l)	(deg)	(deg)	(mg/l)
Mahankal Chaur	(Dhobi)	D	7.1	30	7.7	0.2	28	8	<1
		R	6.7	21	42	0.3	30	30	166
Bansbari	(Bisnumati)	R	6.4	12	9.2	<0.1	8	4	3
Balaju	(Bisnumati)	R	6.6	15	15	<0.1	30	15	6
Sundarijal	(Bagmati)	D	7.4	18	3.8	<0.1	8	2	5
		R	7.5	10	3.7	<0.1	2	1	9
Manohara	(Manohara)	D	7.0	25	8.2	0.3	24	16	20
		R	6.8	18	13	<0.1	20	8	8
Balkhu	(Balkhu)	D	8.6	103	10	0.3	40	18	47
		R	8.2	112	8.2	0.2	10	3	4
	(Nakhu)	D	7.7	54	1.7	<0.1	7	2	8
		R	7.5	56	1.9	0.1	2	<1	4
	(Lele)	D	8.4	53	0.8	<0.1	8	44	74
		R	7.5	89	1.9	0.1	1	1	2

R: Rainy season under non-flooding condition D: Dry season

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

5.4 Groundwater Management Plan

5.4.1 Concepts and criteria

The groundwater yield potential of existing NWSC wells (excluding Bhaktapur well field) for groundwater management of the Kathmandu valley is estimated to be about 15,000 m^3/day with selected standard production wells based on groundwater simulation and optimization described in section 3.1. The standard well operation plan is shown in Table 5.4.1. It is recommended that pump yields be controlled to avoid excessive drawdown.

Groundwater management is to be carried out by a combination of well operation with due regard to conjunctive use together with surface water, which involves the coordinated and planned operation of both surface water and groundwater resources. The well operation plan is to be limited to standard production wells and total abstraction amount is also to be kept below 5,500,000 m^3 (15,000 m^3/day x 365 days).

However, the operation of additional production wells will be required to supplement the water supply in the dry season, because the groundwater yield of the standard production wells and potential of surface water resources during the dry season are not enough for water demand of dry season. This will form an exception to the general operation rule. Therefore careful groundwater management will be required to conserve the aquifer.

5.4.2 Well operation plan

In order to perform the conjunctive use, the existing 26 NWSC production wells (excluding Bhaktapur well field) have been classified into three groups namely standard production wells, extra production wells and monitoring wells as shown in Table 5.4.1. Twelve production wells have been selected as standard production wells for optimum groundwater management, namely, Balaju, BB2, BB3, BB5, BB6, BB8, GK2, GK3, MH3, MH5, MH7 and PH2. Twelve extra production wells have been chosen to meet the shortage of surface water during the dry season on after 1995. The remaining three wells of GK5,MH6,DK1 should be adopted as a monitoring wells for each well field.

Well operation should follow a standard pumping system, and peak pumping system.

1) Standard pumping operation

If the daily proposed discharge rate is to be less than twice the standard yield of each well field, the standard pumping operation is to be followed with standard production wells. The standard production wells should be operated at a discharge rate preferably below twice the standard yield.

2) Peak pumping operation

If the daily proposed discharge rate is required to be more than twice the standard yield, peak pumping operation is to be followed with all production wells except the monitoring wells, However, the maximum discharge rate of each well must be limited to 80 % of the full capacity of these wells for safety of the wells.

3) Control of annual discharge amounts

Annual discharge amounts in each well field should be controlled to be less than the annual total amount at the standard daily discharge rate. The proposed daily yields of each well field for every month from 1990 to 2001 are shown in Table 5.4.2. This proposed amounts are based on the plan of water supply amounts and optimum groundwater simulation.

5.4.3 Monitoring plan

To protect a groundwater resource against depletion, a groundwater monitoring program is necessary. Monitoring methods may include not only groundwater level monitoring, but also production well monitoring, water quality monitoring, and subsidence monitoring. The data obtained by water level monitoring and production well monitoring will indicate whether the groundwater development condition is serious or not. If the groundwater level reaches the critical groundwater level, the groundwater management plan should be revised. Information from the monitoring system will indicate the time for improvement of future predictions before depletion of the aquifer. Also, subsidence monitoring is of importance to preserve the Kathmandu valley from subsidence.

1) Water level monitoring

The proposed water level monitoring well locations are shown in Fig.2.4.5 and are as follows:

a. Existing NWSC wells with automatic recorder; DK1
b. Existing NWSC wells without automatic recorder; MH6, GK5
c. JICA observation wells with automatic recorder;JW1,JW2,JW4
d. JICA observation well with water pressure gauge ; JW3 (self flowing)

Measurements of water level in the NWSC monitoring wells without automatic recorder should be made every day by portable water level meter. Automatic water level recorders are provided in the JICA observation wells and NWSC wells to provide a continuous record of water level changes.

2) Production well monitoring

Engineering Science (1987) recommended and Binnie & Partners (1988) confirmed daily monitoring for each well of the following:

a) Voltage and amperage(at the control panel)
b) Power factor(at the control panel)
c) Delivery head
d) Number of hours run (at the control panel) or by reading all times at which the pump is started and stopped each day
e) Pumping rate and total volume pumped
f) Static water level
g) Dynamic water level

In accordance with these recommendation, NWSC has been carrying out monitoring of production wells, but at several wells there is no pressure gauge, no meter, and also no dip tube to measure water level. Moreover, records of production wells have not been summarized by NWSC. It is very important to maintain records of the production wells because without summary and analysis of monitoring records, the wells and pumps cannot operate properly. The monthly summary and analysis of the monitoring record should be indicate the trend of groundwater development.

3) Water quality monitoring

Water quality monitoring is also required by normal WHO guidelines. At the very least, seasonal monitoring of iron, ammonium and nitrogen of production wells are needed for biochemical filtration methods.

4) Subsidence monitoring

Subsidence is the most serious environmental effect of groundwater development. If the water level monitoring shows a remarkable decline in water level over a short period, it will cause some subsidence in the Kathmandu valley. To preserve the land of the Kathmandu valley against ground subsidence, a ground level survey between reliable bench marks on the basement rock and other bench marks on the alluvial plain should be carried out periodically.

5.5 Surface Water Development Plan

It was revealed, through the surface water balance study in section 3.2, that river water could be further developed at several sites in the Kathmandu valley in addition to 9 existing NWSC's water supply intakes.

In this study, ROR type intake schemes are proposed for implementation on 5 tributaries of the Bagmati river; that is, the Lambagar Khola, Dhobi Khola, Manohara river, Balkhu Khola and Bisnumati river for future water supply increase in Greater Kathmandu up to 2001.

Furthermore, storage reservoir schemes have also been preliminarily studied for water supply source development in the valley as mid or long-term countermeasure.

5.5.1 ROR type intake schemes

(1) Exploitable water

For ROR type of development scheme, 15 alternative intake sites were examined and selected. These would all be ROR type intakes from topographical and geological standpoints, in addition to the 8 existing NWSC intake sites operated for water supply to Greater Kathmandu. Their development concepts would be:

- The river water would be abstracted in both dry and wet seasons.
- Planned abstraction will vary seasonally and flexibly according to natural variations in available river water with proper reliability: say, more than 80 % volumetric dependability on an average with the supply support of ground water sources to supplement the lack of surface water sources.

Of all sites above, the following five sites are selected as promising ROR type intakes especially from the standpoint of water availability in both dry and rainy seasons, as shown in Table 3.2.3.

River name	Location*1	Available Water (m^3/s)	
		Q30*3	Q80
Lambagar	W105*2	0.72	0.08
Dhobi	W202	0.67	0.07
Bagmati	W301*2	1.94	0.12
Manohara	W403	2.30	0.22
Balkhu	D801	1.17	0.12

Note, *1 corresponding to site number in Fig. 3.2.4
*2 existing intake sites
*3 discharge with 30% dependability in time

The monthly abstraction rates of the above sites which have 80% dependability in abstraction amount are shown in Table 5.5.1. The abstraction rates were incorporated as monthly exploitable maximums of surface water sources so that the groundwater abstraction can be saved as much as possible in formulation of the future water supply plan for Greater Kathmandu.

(2) Intake facility planning

Intake facility plans were made at 4 of the sites selected above excluding W301. As for W301,the existing low intake dam of the Sundarijal hydropower plant can also be functioned as the W301 intake. The W106 sites on the Bisnumati river were additionally selected only for rainy season water abstraction, as discussed in detail in Chapter 6.

There is no large scale irrigation system downstream of the 5 intakes above. However, small private irrigation systems of 30 ha and 17 ha are operated on the Bisnumati and Manohara rivers by local farmers respectively. Thus, 2 intakes on these rivers will abstract only excess river water beyond the irrigation offtake requirements and river maintenance flows, while the other 3 intakes will divert river waters except for river maintenance flow to be preferentially released.

In this study, two types of intake structures were envisaged based mainly on topographical and geological site conditions and easiness of operation and maintenance: one is a ground-sill type for 3 intake sites of W105, W202 and W403. The other is a concrete weir type for D801 and W106, as shown in Figs. 5.5.1 (1/2) and (2/2).

5.5.2 Storage reservoir schemes

(1) Reservoir yield potential

Reservoir yield potentials of 5 alternatives; that is, Balkhu Kh., Sundarijal, Kodku Kh., Lele Kh. and Nakhu Kh. dam schemes selected through map study and field reconnaissance are examined, as summarized below, through a reservoir operation study assuming a single purpose dam for Greater Kathmandu water supply. Their locations are shown in Fig. 3.2.4.

Dam	Reservoir			Dam		Index	
	Max. Yield (m^3/s)	Volume (mcm) Effect.	Volume (mcm) Gross	Crest EL. (m)	Height (m)	SE*1	WC*2
Balkhu kh.	0.8	16	18.3	1,350	38	76	1.0
Sundarijal	0.3	6	7.8	1,643	73	4	2.8
Kodku Kh.	0.3	7	8.0	1,395	40	29	1.4
Lele Kh.	0.3	7	7.9	1,507	34	29	2.1
Nakhu Kh.	0.6	17	19.6	1,510	61	25	1.3

Note: *1 effective storage volume/dam volume
*2 ratio of water cost at damsite to that of Balkhu Kh. scheme

In the case of the Kodku Kh. and Lele Kh. schemes, inter-basin water transfer plans from the Nakhu Kh. and Naldu Kh., respectively were incorporated in terms of effective use of their available reservoir capacities, since their capacities are not fully used owing to the small amount of available river water in their drainage basins.

(2) Storage reservoir development

Five alternative storage reservoir schemes are considered as follows from technical, economical and environment viewpoints. Table 5.5.2 lists present land use, building and other major property in the reservoir areas of the above dam plans, surveyed on the basis of topographic maps (1:10,000 and 1:50,000), land utilization maps (1:50,000; published by the Topographical Survey Branch of the Survey Development in 1984) and from field reconnaissance.

<u>Balkhu Kh. scheme</u>

Since this scheme has the highest reservoir yield potential of 0.8 (m^3/s) in a constant draft rate with 90 % supply firmness on a yearly base out of the 5 alternative schemes and the highest storage efficiency(≈effective storage volume/dam volume): 3 times or more than those of other schemes, the scheme is expected to be superior to others from an economical standpoint. However, Bishnu Devi Temple located 1 km upstream from the damsite will be submerged after reservoir impounding and local people will be strongly against the temple's resettlement to other site because of its religious importance to them. Unless this social problem is solved in advance, this schemes implementation would be impossible.

Sundarijal scheme

This scheme seems to be much inferior to other schemes economically because of its small storage efficiency owing to its topographical disadvantage in the dam and reservoir areas:namely, relatively wide valley shape and small reservoir space.

Kodkhu Kh. scheme

Its maximum yield potential is as small as 0.2 (m^3/s). However, this scheme has the second highest storage efficiency after the Balkhu Kh. scheme. If Nakhu Kh. water from the adjacent basin is conveyed from Tikabhairav to the reservoir, the yield potential will be raised to 0.3 (m^3/s) and the economical attractiveness of the scheme will become higher.

Lele Kh. scheme

Its maximum yield potential is 0.3 m3/s, incorporating inter-basin water transfer from the Naldu Kh..

A small saddle behind the left abutment, composed predominantly of gravel deposits of which the exact extent is unknown so far, is so narrow that water leakage will inevitably occur through this part after impounding water into the reservoir and high cost countermeasure work will be required for this pervious deposit zone, possibly accompanied by technical difficulties.

Since this site is located 0.7 km upstream from the Nakhu Kh. dam site, the Nakhu Kh. reservoir impoundment would cause the Lele Kh. dam to be submerged into the reservoir.

Nakhu Kh. scheme

This scheme can exploit its own basin's river water up to the yield potential of 0.6 (m^3/s) which is the second highest and inherently more economical and superior to the Kodkhu Kh. scheme.

Based on the considerations above, Nakhu Kh. dam scheme and Kodku Kh. dam scheme with the Nakhu Kh. water transfer appear to be attractive as storage reservoir schemes in the Kathmandu valley in view of their economical superiority and absence of great technical constraints to their implementation. Most of the reservoir areas of both schemes are, however, used as agricultural lands at present and reasonable compensation will have to be made for the submerged agricultural land and other property. The yield potentials of the two are very different from one another. Therefore, further study on these reservoir development schemes should be made, taking into consideration the projected increase in water demand after the year 2001 and also the necessity for staged development.

The general dam layouts at the two schemes described above are preliminarily envisaged as illustrated in Figs. 5.5.2 and 5.5.3, adopting a rock fill type dam based on the findings from field reconnaissance, though the preferable types will have to be selected based on the results of the further investigation.

6. OPTIMUM WATER MANAGEMENT PLAN

6.1 Concepts and Criteria

It is clear that the groundwater in the Kathmandu valley 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 a water resource of water supply.

The surface water resource 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 resources of groundwater are 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 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 into account when establishing the 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 Pharphing system, is of relatively good quality and can 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.

6.2 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 6.1. Each water supply facility is composed in order to fit these conjunctive water sources. The proposed water supply systems mentioned below are diagrammed in Fig. 6.2.1 and Fig. 6.2.2 .

(1) Balaju system

The water resource of 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 water 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 water 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.

(2) Lambagar system

The water resource of this system is the surface water from Lambagar Khola(W105) through a reconstructed run-of-river intake (14,300 m^3/day) which presently supplies raw water to Balaju treatment plant. A conventional water treatment plant (13,000 m3/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 the 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 by gravity flow. The water supply area of this system is west of the city of Kathmandu.

(3) Bansbari system

The water of this system consist of 1) 2,100 m^3/day of the existing Maharajganj water treatment plant, 2) the surface water of 14,300 m^3/day from the Bisnumati river at W106 through a new run-of-river intake and 3) the groundwater resource of the Bansbari well field. The groundwater should first be pretreated 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 the 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.

(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.

(5) Mahankal Chaur system

The water source for this system consists of groundwater in the Gokarna, Manohara and Dhobi 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-of-river intake.

The groundwater of 18,600 m^3/day should first be pretreated by bio-filters to remove the high concentrations of both ammonia and iron and then by the 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.

(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 water 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.

(7) Shaibhu system

The water resources for this system consist of existing spring water and groundwater in the Pharphing 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.

(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-of-river intake at W406 in the Manohara Khola. The treated water should be sent into two new water distribution reservoirs of 1,850 m^3 ,each of which serves 6,300 m^3/day by a booster pump system.

(9) Balkhu system

The water supply area is the southwest area of the city of Kathmandu. A conventional water treatment plant should be constructed for the surface water abstracted at W802 in the Balkhu Khola through a new run-of-river intake.

The treated water should be sent into two new water distribution reservoirs of 1,850 m^3 ,each of which serves 6,300 m^3/day by gravity flow and the same quantity from the other reservoir by booster pump.

6.3 Optimum Implementation Plan

For implementing the systems of water supply facilities described in section 6.2, the following implementation order by schemes is recommended so that the incresing water supply amount by implementing the schemes shall be in balance with the planned water supply amount up to the year 2001 without any reduction or disturbance to the water supply amount by existing facilities.

Order	Name of Scheme	Systems included
1st	Mahankal Chaur scheme	Mahankal Chaur
2nd	Bansbari - Maharajganj scheme	Bansbari, Maharajganj
3rd	Shaibhu scheme	Shaibhu
4th	Balaju scheme	Balaju
5th	Lambagar scheme	Lambagar
6th	Sundarijal scheme	Sundarijal
7th	Manohara scheme	Manohara
8th	Balkhu scheme	Balkhu

The above implementation order was decided as the result of comparative examination of possible implementation plans based on the following basic concepts.

1) Quality Improvement:
Improvement of a scheme which use groundwater,causing problems in terms of both water quality and quantity, shall in principle take precedence of all otherschemes. Following systems are classifiedintothiscategory.
   - Mahankal Chaur system
   - Bansubari system

2) Rehabilitation :
A scheme with an existing water treatment plant which does not fully function because of deterioration should be rehabilitated or reconstructed quickly. Following systems are classifiedintothiscategory.
   - Balaju and Lambagar systems
   - Sundarijal system
   - Shaibhu system

3) New Scheme :
An implementation of new scheme shall follow that of the schemes with quality improvement or rehabilitation/reconstruction of existing facilities. Following systems are classifiedintothiscategory.
   - Manohara system
   - Balkhu system

4) Scheduling of schemes :
Implementation schedule of schemes are finally adjusted to meet the increasing demand by 2001, with assessing the economical and financial aspects. If periods for survey, design and fund procurement are taken into consideration, these schemes will be implemented from the year 1992 corresponding in the order given above.

Upon executing the foregoing implementation plan, the monthly water supply from the proposed systems to meet demand up to the year 2001 should be as shown in Table 6.3.1. The daily average water supply from each resource is shown in Fig. 6.3.1. The relationship between the planned water supply (annual maximum) and water supply capacity under the optimum implementation plan, should also be as shown in Table 6.3.2 and Fig. 6.3.2.

6.4 Cost Estimates

6.4.1 Project cost

The project cost for the proposed construction plan mentioned above was estimated for the following conditions.

1) Prices : January, 1990
2) Foreign exchange rates: US$1.00 = NRs.30.00 = Yen150.00
3) Conditions on procurement of the main construction materials and equipment :
   Local
   - Construction materials (cement, sand, gravel, brick)
   Foreign
   - Construction materials (reinforcement bar form, support and scaffolding materials, chemicals of water proofing)
   - Construction equipment
   - Plant materials and equipment
4) Costs for freight, insurance and inland transportation: included in the project cost

5) Cost for import tax: excluded in the project cost
6) Engineering services: 8% of the direct cost
7) The unit price for land acquisition:
   estimation according to precedents around the project site
8) Physical contingency:
   10% of the direct cost and engineering service
9) Price contingency for annual inflation :
   - 4% for foreign currency portion
   - 8% for local currency portion

The total project cost and disbursement schedule for each scheme is given in Table 6.4.1. A summary of total project costs and direct cost are as follows:

Unit: US$ Thousand

Total Cost

SCHEME	F/C	L/C	Total
1. Mahankal Chaur	14,030	4,300	18,330
2. Bansbari	11,599	3,816	15,415
3. Shaibhu	3,579	1,346	4,925
4. Balaju	4,271	973	5,244
5. Lambagar	8,201	3,052	11,253
6. Sundarijal	11,118	4,452	15,570
7. Manohara	12,746	5,988	18,734
8. Balkhu	11,230	5,790	17,020
TOTAL	76,774	29,717	106,491

Direct Cost (including enginerring service)

SCHEME	F/C	L/C	Total
1. Mahankal Chaur	11,180	2,795	13,975
2. Bansbari	8,888	2,313	11,201
3. Shaibhu	2,744	882	3,626
4. Balaju	3,146	591	3,626
5. Lambagar	6,043	1,436	7,479
6. Sundarijal	7,874	1,664	9,538
7. Manohara	8,352	2,226	10,578
8. Balkhu	6,802	1,840	8,642
TOTAL	55,029	13,747	68,776

The disbursement schedule of the project cost in accordance with the implementation plan is as shown in Table 6.4.2 .

6.4.2 Operation and maintenance costs

The operation and maintenance costs required pursuant to implementing this plan consist of personnel costs, power costs, chemical costs and equipment replacement costs for the intake facilities, wells, water treatment plants and water distribution reservoirs, and any other operation and maintenance costs. These operation and maintenance costs are summarized per system in Table 6.4.3 .

7. PROJECT EVALUATION

7.1 Economic Analysis

7.1.1 General

An economic analysis is carried out to ascertain the economic viability of the proposed development scheme. This scheme is composed of eight systems of water supply: Mahankal Chaur, Bansbari & Maharajganj, Shaibhu, Balaju, Lambagar, Sundarijal, Manohara, and Balkhu.

As described in Chapter 6, partial improvement and new construction of water supply facilities in these systems have been planned in order to supply domestic water in adequate quantity and good quality for the urban area of Kathmandu and Lalitpur (Greater Kathmandu) up to 2001.

Generally, a domestic water supply project seldom yields a high economic return on investment. Therefore, in terms of selection of the optimum scheme among alternatives, economic comparison among them is of little significance. In the present study, the proposed optimum scheme is chosen from the viewpoint of future water demand and the existing condition of supply facilities. This proposed scheme is designed to comprise construction of the said eight systems as a whole, over the period 1992-2000. The economic evaluation is accordingly made for the package project of eight systems.

The economic life of the project is taken as 30 years after completion of construction. The economic benefits and costs to be adopted for the project evaluation are estimated under the conditions and assumptions indicated in Table 7.1.1.

7.1.2 Economic costs

(1) Construction Costs

The economic construction cost compared with the financial construction cost is given below:

Unit: US$ Thousand

Year	Financial Cost			Economic Cost		
	F/C	L/C	Total	F/C	L/C	Total
1. 1992	7,932	2,581	10,513	7,932	1,842	9,774
2. 1993	12,661	3,658	16,319	12,661	2,737	15,398
3. 1994	10,988	3,005	13,993	10,988	2,045	13,033
4. 1995	9,142	2,861	12,003	9,142	1,602	10,744
5. 1996	3,119	441	3,560	3,119	348	3,467
6. 1997	6,041	2,609	8,650	6,041	1,543	7,584
7. 1998	3,146	580	3,726	3,146	457	3,603
8. 1999	4,865	2,167	7,032	4,865	1,278	6,143
9. 2000	2,617	477	3,094	2,617	376	2,993
Total	60,511	18,379	78,890	60,511	12,228	72,739

The economic construction cost is estimated at approximately US$ 72.7 million in total under the conditions and assumptions shown in Table 7.1.1. This is a decrease of about US$ 6.2 million (8%) against the financial cost.

(2) Operating, Maintenance and Replacement Costs

Operating, maintenance and replacement costs (OMR cost) also are converted from financial costs to economic costs by the same adjustment method as the construction cost as shown below:

Unit: US$ thousand

Year	Financial costs	Economic costs	Year	Financial costs	Economic costs
1. 1992	0	0	12. 2003	915	810
2. 1993	0	0	. .	.	.
3. 1994	202	175	. .	.	.
4. 1995	387	339	32. 2023	915	810
5. 1996	496	440	33. 2024	728	647
6. 1997	669	591	34. 2025	551	489
7. 1998	694	611	35. 2026	378	337
8. 1999	793	703	36. 2027	230	206
9. 2000	825	728	37. 2028	230	206
10. 2001	915	810	38. 2029	106	95
11. 2002	915	810	39. 2030	106	95

The economic annual OMR cost is estimated at US$ 810 thousand for the period from 2001 to 2023 when all the eight systems will be fully active. This shows a decrease of about US$ 100 thousand (11%) against the financial OMR cost.

7.1.3 Economic benefits

The proposed scheme aims to increase the quantity of domestic water supplied to meet the demand up to 2001, and to improve the quality of water at the same time. The economic benefits of the project are therefore evaluated for improved water quantity and quality in terms of the difference between the conditions of with and without the projects.

(1) Benefit of Increase in Water Quantity Supplied

The economic benefits of increasing the quantity of water supply can be estimated by multiplying the quantity of paid water by the economic price of water.

A. Economic Price of paid Water

The economic price of paid water depends generally on the economic situation in the regions concerned. For example, in desert areas of African countries, it could scarcely put the economic price for domestic water carried by women and children of household from distant water sources. In these areas, if supply facilities of adequate and safe domestic water are established, the economic benefit of the facilities would be mainly given as a decrease in their working time spent for carrying water and a reduction in cases of waterborne diseases.

On the other hand, the water tariff level which is presently being imposed in some developing countries does not necessarily correspond to the general economic price level in the region because the tariff is intentionally set at a low price, taking account of consumers capacity to pay for water.

The World Bank suggests that water charge per household should be less than 5% of household income. On the other hand, The Japan Water Works Association (JWWA) carried out a survey in 1982 in terms of the average water charge per household by a questionnaire to 47 cities in 25 countries. In cities matured economically without subsidies for water charges by the government and other authorities concerned, the average water charge ranged from 0.5% to 2.5% (average: 1.5%) of the average income per household. The water tariff in an economically mature community, as well as prices of general goods, may be regarded as the market prices, so it seems that the said percentage of the JWWA's survey could be an index for estimating the economic water price.

The value of the water charge in relation to household income in developing countries, moreover, may be expected to be high relatively, because of larger family sizes and lower income. This could be also analogized from the Engel's coefficient viewpoint.

Based on the afore-mentioned discussion, in the present study a water charge corresponding to 1.5% of the average household income is assumed as a conservative rate in estimating the economic water price.

According to results of a consumer survey which was carried out in 1989 in the course of this study, the average water consumption indicated NRs. 18.4 per month corresponding to about 0.4% of the average household income in urban areas of the Kathmandu valley. Where, the household income in 1989 was estimated on the basis of "A Survey of Employment, Income Distribution and Consumption Patterns in Nepal, 1977, National Planning Commission Secretariat". This percentage (0.4%) is considered to be a very small charge, judging from the real growth in household income and the increase in household water consumption in recent years. The rate of 0.4% would correspond to a unit water price of approximately NRs. 1.2/m^3. Accordingly, in the present study the economic water price to be applied for estimating the economic benefits is set at NRs. 4.5/m^3 (NRs. 1.2/m^3 x 1.5/0.4).

This price would be applied for the period from 1994 to 2001, but during the period of project life after the year 2001, it is assumed that the price increases by 2% every year to take into account the expected increase in the real income of household.

According to the said consumer survey, the water supply in Greater Kathmandu by the NWSC has been made not only for domestic use, but also for industrial, commercial and institutional uses, at the same tariff rate. But, the water supply quantity for domestic use has accounted for about 90% of the total quantity every year. In the present study therefore, the economic water price mentioned above for the domestic use is also applied to other uses than the domestic use as an approximation.

B. Increase in Paid Water Quantity

The increase in paid water quantity to be object of the project benefit is given as the difference between the paid water quantities under conditions of with and without the projects. Where, the paid water is given by subtracting unpaid water such as lost and unmeasured water from the production water, assuming that the rate of paid water quantity to production will be 72.5% in 1994, 73% in 1995, 73.5% in 1996, 74% in 1997, 74.5% in 1998, and 75% for the period 1999- 2001(See Table 6.3.3). The total annual increase in the quantity of paid water is summarized below:

Annual Increase Quantity of Paid Water

Unit: 1,000 m^3

Item	1994	1995	1996	1997	1998	1999	2000	2001
With Project	6,852	15,432	16,770	23,136	24,823	26,655	28,612	30,713
Without Project	1,527	7,315	7,315	7,315	7,315	7,315	7,315	7,315
Increase	4,938	8,117	9,455	15,821	17,508	19,340	21,297	23,398

In the above table, the water quantity supplied without the project is assumed as follows:

(i) Water quantity of 1,527 x 10^3m^3 in 1993 supplied by the Mahankal Chaur system, 1,454 x 10^3m^3 in 1993 by the Bansbari system and 4,334 x 10^3m^3 in 1994 by the Shaibhu system will be continued to the end year of the project life of each proposed new system.

(ii) The existing systems of Maharajganj, Balaju and Sundarijal will lose their water supply functions in the year of completion of their new proposed systems.

C. Benefit of Increase in Paid Water Quantity

The benefit of increase in the paid water quantity is estimated by multiplying the economic water price by the increased quantity of paid water shown in the above Items "A" and "B", respectively. The annual benefit, as a result, is estimated at US$ 741 thousand in 1994, and on the increase of its amount every year after 1994,it will amount to US$ 3,510 thousand in 2001 (Where, the foreign exchange rate is set to be US$ 1 = NRs. 30, based on the average rate in January 1990.). The benefit of each year is summarized in (3) below.

(2) Benefit of Reduction in Cases of WaterBorne Diseases

The benefits of a reduction in cases of waterborne diseases are of two kinds: one is the reduction in medical expenses and the other is the increase in economic activities.

(2.1) Reduction in Medical Expenses

In general waterborne diseases are caused by the inadequate and unsanitary conditions of the four principal sources; water supply, sanitation facilities, domestic and personal cleanliness, and food hygiene. In regard to the relationship between waterborne diseases and these principal sources, various studies have been carried out in connection with "The International Drinking Water Supply and Sanitation Decade". In one of these studies, Richard G. Feachem indicated that unsafe and inadequate water supply would account for about 35% of cases of waterborne diseases. This percentage will be used as a yardstick in estimating the benefits.

According to hospital statistics, the annual cases of waterborne diseases in the Kathmandu valley were as follows:

Cases of WaterBorne Diseases in Kathmandu Valley

Item	1980	1981	1982	1983	1984	1985	1986	1987
Total cases	4,243	4,345	4,625	6,892	6,966	6,359	6,035	6,644
cases per 1,000 persons	5.66	5.67	5.91	8.63	8.54	7.62	7.08	7.64

From the above table, the average is estimated at 7.1 cases/1,000 persons in the Kathmandu valley, taking account of the intercensal population growth rate of 2.14% per annum for the period 1971-1981. This average incidence is approximately applied also to the waterborne diseases for the period 1994-2001, under the condition of without project.

In estimating the cases of waterborne diseases which will be reduced by supplying safe water under condition of the with project, the following conditions are set:

- Population for the period 1994-2001 is given from the forecast indicated in Section 4.1 "Population Projections";

- Cases of waterborne diseases in Greater Kathmandu estimated from the disease cases in the valley, using the proportion of both population of Greater Kathmandu and the valley; and

- After 1994, the cases of waterborne diseases will be reduced in proportion to the water supply quantity by the proposed new system as compared to the entire supply quantity. The net rate of reduction is assumed to be 35% of this proportion, according to the study of Richard G. Feachem mentioned above.

Under the above conditions, the reduction in cases of waterborne diseases for the period 1994-2001 is estimated as follows:

Year	1994	1995	1996	1997	1998	1999	2000	2001
cases reduced	482	1,068	1,139	1,529	1,595	1,664	1,737	1,798

For estimating the annual benefit from reduction in the disease cases, the average days required for medical treatment and the average medical expenses are assumed to be one month per case and US$ 10 (NRs. 300) per day respectively, based on statistics of WHO and other medical agencies. As a result, the annual benefit resulting from the reduction in medical expenses is estimated at US$ 144 thousand in 1994 and US$ 540 in 2001 in Greater Kathmandu.

(2.2) Increase in Economic Activities

Benefit of the increase in economic activities expected from the reduction in cases of waterborne diseases is given by the rise in the average income of Greater Kathmandu inhabitants. Estimation of this benefit is made by using the per capita GDP, for the period suspended due to infectious diseases and reduced cases of diseases.

It is supposed that the per capita GDP in Greater Kathmandu will be more than that in the country as a whole. However, since it is difficult to estimate it reasonably, in the present study it is simply regarded as 10% above the country as a whole since the effect on benefit is not large.

The per capita GDP for the period of project life (1994-2030) is firstly estimated for the 1990 value based on the 1988 value (US$ 209 per annum) using its annual growth rate of 10% at current prices because the 1990 prices are taken as the base of the project cost in this study, and after that year it is estimated using an expected real annual growth rate of 2%. Where, both rates of 10% and 2% are assumed based on current and real growth rates in recent years. As a result, the per capita GDP per month in Greater Kathmandu is estimated to be US$ 22.8 in 1994, US$ 26.2 in 2001 and US$ 46.6 in 2030.

Besides, the period suspended due to infectious diseases is taken as one month, taking account of only serious cases. A large number of light cases other than the serious cases also would be expected to get relief from the waterborne diseases, but its effect is not included in the tangible benefit for lack of data. This effect would be described as an intangible benefit in Paragraph 7.1.4.

Under these conditions, the annual benefit brought from the increase in economic activities is estimated at US$ 11 thousand in 1994, US$ 47 thousand in 2001 and US$ 84 thousand in 2030. For the period 2001- 2030, a mean value of both annual benefits in 2001 and 2030, US$ 65 thousand, is approximately applied to the annual benefit in each year. The benefits for other years are given in table in (3) below.

(3) Summary of Economic Tangible Benefit

The economic tangible benefits of the Project, which consist of the benefits of the increase in paid water quantity and the benefits of reduction in cases of waterborne diseases, are summarized below:

Economic Benefit of the Project

Unit: US$ 1,000

Classification	1994	1995	1996	1997	1998	1999	2000	2001
(1) Increase in paid water quantity	741	1,218	1,418	2,373	2,626	2,901	3,194	3,510
(2) Reduction in water-borne diseases	155	345	369	496	518	542	566	605
(2.1) Reduction in medical expenses	144	320	342	459	479	500	521	540
(2.2) Increase in economic activities	11	25	27	37	39	42	45	65
Total	896	1,563	1,787	2,869	3,144	3,443	3,760	4,115

As seen in the above table, the annual economic benefits of the project will amount to US$ 896 thousand in 1994 and increasing from year to year. The 2001 benefit will amount to US$ 4,115 thousand. The project will bring a full benefit during the period (2001-2023) which is the project life for all the eight systems, and its occurrence will be extinguished in 2031, declining its amount year by year after the year 2023 in accordance with expiration of project life of each system (See Table 7.1.2).

Where, the benefit of the increase in paid water quantity is assumed to be increased at a rate of 2% per annum after 2001, according as the assumption shown in (1)A of this paragraph.

7.1.4 Economic evaluation

Using the annual flow of the economic costs and benefits shown in Table 7.1.2, a comparison of the discounted costs and benefits is carried out by means of the Economic Internal Rate of Return (EIRR), as a result of which the EIRR comes to 3.35%.

Such a low EIRR is mainly caused by the comparatively low incomes of households in Greater Kathmandu, and in addition to that the domestic water supply project cannot be generally expected to generate large tangible effects economically. Nevertheless, this rate results from only two kinds of tangible benefits out of multifarious direct and indirect effects. Some major intangible effects are summarized below:

(1) The large number of light cases of waterborne diseases which have not been included in the above cases would be expected to get relief from waterborne diseases by completion of the project.

(2) According to statistics of Teku Kathmandu Hospital, the number of deaths from waterborne diseases amounted to 3% of the disease cases. Accordingly, the reduction in cases of waterborne diseases will lead naturally to a reduction in the number of the deaths, especially a reduction in infant mortality. As a result, the average life expectancy of inhabitants will be prolonged.

(3) One result of the interview survey described in Paragraph 4.3 is that *approximately 80% of the consumers as a whole are not satisfied with the* water quality supplied. It is probable that most of the consumers unsatisfied would have done some purification by themselves to water supplied and/or have purchased some clean water for drinking purposes. Accordingly, completion of this project will lighten the economical and physical burden imposed on them.

(4) Safe drinking water supply to inhabitants will have significant impacts on the improvement of sanitation, and domestic and personal cleanliness in Greater Kathmandu.

(5) Implementation of the project will crease employment opportunities for inhabitants in the Kathmandu valley during the construction period 1992-2000.

(6) The investment of some US$ 80 million for construction will have a large stimulative effect on socio-economic development in the Kathmandu valley.

This project is thus expected to provide significant intangible benefits, even though the EIRR estimated by tangible benefits is comparatively low. Accordingly, the project is not necessarily infeasible economically.

7.1.5 Sensitivity test

Various conditions and assumptions in the present study have been set by the careful study based on professional experience and appropriate judgment of experts, but there always remains the question as to the degree of reliability of inputs. Therefore, a test is carried out for sensitivity of the EIRR to variations in the economic costs and benefits estimated.

The sensitivity of EIRR is tested for the 5% and 10% increases in the economic costs and the 5% and 10% decreases in the economic benefits, and the results are as follows:

Sensitivity Test of EIRR (%)

Increase in Cost	Decrease in Benefit		
	0%	-5%	-10%
0%	3.35	2.94	2.51
+5%	2.96	2.56	2.13
+10%	2.59	2.19	1.78

In both cases of 10% increase in the costs and 10% decrease in the benefits, the EIRR falls in 2.59% and 2.51%, respectively. Furthermore, in case that both conditions are combined, the EIRR becomes a low rate of 1.78%.

7.2 Consideration of Financial Aspects

7.2.1 General

In the present study, financial aspect of the project is examined assuming some models, not precise financial analysis. Accordingly, the result would be provided as a reference for more detailed study in the future. The financial aspect is examined compared financial costs with financial benefits. The financial costs consist of capital cost and OMR cost (operating, maintenance and replacement costs). If a loan is applied to the capital cost, an interest of the loan also is added in the financial costs. The financial benefits are assumed to be only revenue from water charge.

A comparison between the costs and the revenue is made assuming the inflation rates: for the foreign currency portion, am annual rate of 4% during the period from 1990 to the end of project life (1990-2030), and for the local currency portion, an annual rate of 8% for the period 1990-2001 and 6% for the period 2002-2030.

7.2.2 Financial costs

The capital cost amounts to US$ 106,468 thousand in total, consisting of US$ 76,750 thousand for the foreign currency portion and US$ 29,718 thousand for the local currency portion, and these amounts are invested for the construction costs of eight water supply systems extending over nine years from 1992 to 2000. On the other hand, the operating, maintenance and replacement costs (OMR cost) of the proposed facilities is required extending over the entire period of project life of 30 years.

To examine financial aspect of the project, a loan condition for the construction fund is assumed for the foreign and local portions as follows:

- Annual interest rate : 1.0%
- Grace period : 10 years
- Repayment period: 30 years (including grace period)

Annual flow of the financial cost together with repayment flow of capital and interest is given in Tables 7.2.1 and 7.2.2.

7.2.3 Financial benefits

In previous Section 7.1, the economic price of paid water is set at NRs. 4.5/m^3 (equivalent to US$ 0.15/m^3) which corresponds to approximately 3.75 times of the average water tariff at present (NRs. 1.2/m^3), and as a result of which the EIRR comes to 3.35% as shown in subsection 7.1.4.

On the other hand, the financial costs exceed the economic costs in amount, and in addition the benefit of reduction in cases of waterborne diseases is not included in the financial benefits.

Accordingly, a water tariff should be set at 3.75 times or more of the current rate to be possible to repay the construction fund together with its interest by the water charge within the period of project life.

From such a view point, examination of the financial aspect is tried as to both tariffs of 4 times (US$ 0.16/m^3) and 3.75 times (US$ 0.15/m^3) of the present tariff. These rates are applied for the period 1994-2001, and after 2001 an annual rise rate of 6% is applied during the period of project life, assuming that it will rise together with the forecaste consumer prices. Annual cash flows of both revenues are given in Tables 7.2.1 (Case 1) and 7.2.2 (Case 2), respectively.

7.2.4 Comparison between cost and benefit

Under the foregoing conditions and assumptions, Financial Internal Rate of Return (FIRR) is estimated at 1.7% for Case 1 and 1.1% for Case 2. In either case, although the FIRR is very low, it remains as a plus percentage, i.e. the total benefit discounted exceeds the total cost discounted. On the other hand, as shown in Tables 7.2.1 and 7.2.2, the loan inclusive of its interest could be repaid within the period of project life in either Case (1) and Case (2).

This indicates that the project would be feasible financially, under condition of loan and revenue mentioned above.

7.3 Summary

Results of economic and financial analyses are summarized below:

Though the project shows a low EIRR of 3.35%, it will be expected to bring serious social and economic intangible effects. Accordingly, the project is not necessarily infeasible economically.

On the other hand, the project will be feasible financially, under the said loan conditions (1% interest, grace period of 10 years and repayment period of 30 years) and by assuming a water tariff of approximately 4 times of the existing tariff rate to the financial revenue.

Despite there are the said various economic and financial restrictions for realizing of the project, the project is expected to be realized at an early stage from a viewpoint that it is essential and urgent issues for inhabitants of Greater Kathmandu.

8. CONCLUSION AND RECOMMENDATION

8.1 Conclusion

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

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

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

8.2 Recommendation

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

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

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

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

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

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

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

(II) The eight projects proposed in this report

1. Mahankal Chaur Project,
2. Bansbari - Maharajganj Project,
3. Shaibhu Project,
4. Balaju Project,
5. Lambagar Project,
6. Sundarijal Project,
7. Manohara Project,
8. Balkhu Project

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

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

TABLES

Table 1.4.1 List of Counterpart Personnel

Personnel Incharge of Coordination

Dr.B.P. Shah (Chairman, NWSC)
Mr.D.R. Sharma (Chief Engineer, NWSC)

Counterpart Personnel

Mr.Madan S. Shrestha
Mr.Chandra K. Shrestha
Mr.Himesh A. Vaidya
Mr.Ramesh Rijal
Ms.Sagun Shah
Ms.Roshana shakya
Mr.Bahandur U. Shrestha
Mr.Ananta Gautam
Mr.Narayan Shani
Mr.Pradeep S. Kunwar
Mr.Ramji

Table 2.4.1 ESTIMATED GROUNDWATER ABSTRACTIONS FROM NWSC WELL FIELD (1989)

WELL FIELD	BANSBARI	DHOBIKHOLA	GOKARNA	MANOHARA	BAKUTAPUR	PHARPHING	TOTAL
JANUARY	318073	92501	48036	228005	89497	0	776112
FEBRUARY	260144	78344	34190	203747	81561	0	657986
MARCH	383323	91390	46272	213380	95786	0	830151
APRIL	411156	93617	76000	198260	94885	48771	922689
MAY	436881	88848	96309	235705	86854	52760	997357
JUNE	466499	90187	126897	329160	98184	47193	1158120
JULY	447059	94300	116332	376630	109363	0	1143684
AUGUST	506253	95343	119461	309428	104592	0	1135077
SEMPTEMBER	502814	85346	101722	344106	201348	0	1235336
OCTOBER	503300	101531	110250	326103	101479	0	1142663
NOVEMBER	442994	89909	73162	264685	117151	0	987901
DECEMBER	414986	80858	37590	256393	124892	0	914719
TOTAL	5093482	1082174	986221	3285602	1305592	148724	11901795
AVERAGE	423550	91141	87547	276452	106355	14872	999918

UNIT IN CUBIC METER

Table 2.4.2 RESULTS OF SPOUTS SURVEY(1/2)
(KATHMANDU)

No.	Name & Location	Type	No.of Tap	Discharge rate* (L/s) Mar.'89	Aug.'89	EC (MS/cm)	Temperature (°C) Aug.'89
1.	Bang Gang Baneswore	B	2	0.68	1.48	540	20.5
2.	Dhungedhara Batisputali	B	1	0.32	0.29	340	21
3.	Dhungedhara Chabhill	B	3	0.48	1.22	420	19.5
4.	Dhungedhara Bhatbhatini	A	1	1.00	1.17	360	19.5
5.	Gauridhara Tangel	A	1	0.37	0.29	550	20
6.	Nandakeshari Naksal	A	3	**	0.73	660	20
7.	Pipalbat Dillibazar	A	1	0.17	0.45	560	19.5
8.	Sundhara Sundhara	A	5	0.35	0.77	920	19.5
9.	Kohiti Kohiti tole	A	1	0.31	0.40	850	18.5
10.	Bhimsen hiti Bhimsenthan	A	1	0.19	0.21	840	19
11.	Maruhiti Marutole	A	4	1.34	1.90	360	19.5
12.	Banjahiti Dhokatole	B	3	0.30	0.43	780	20
13.	Dallundhara Dallu	B	1	0.13	0.64	500	19.5
14.	Dhimabazardhara Dallu	B	1	0.02	0.02	800	21.5
15.	Kinadoledhara Swayanbhu	B	1	0.09	0.23	810	20.5
16.	Kapoordhara Lainchour	B	2	0.63	0.53	180	20.5
17.	Dillibazardara Dillibazar	A	1	0.01	0.10	680	21.5

Note; Type A: Tap located on the wall in the pit,Type B:Tap located on the slope of cliff with open drain *:Total tap discharge rate, **:Submergence, due to closed drainage system since January 1989.

Table 2.4.2 RESULTS OF SPOUTS SURVEY(2/2)
(LALITPUR)

No.	Name & Location	Type	No.of Tap	Discharge rate* (L/s) Mar.'89	Aug.'89	EC (MS/cm)	Temperature (^{o}C) Aug.'89
1.	Jawalakheldara Jawalakhel	A	1+2**	0.12	0.39	540	21
2.	Dhobidhara1 Dhobigat	B	5+1**	4.72	8.55	380	19.5
3.	Dhobidhara2 Dhobigat	B	3	1.38	1.73	320	19.5
4.	Pulchokhiti Pulchok	A	1	0.15	0.48	870	20
5.	Natolehiti Natole	A	2	0.11	0.40	780	19.5
6.	Chhabahalhiti Chhabahal	A	1+1**	0.22	0.30	780	19.5
7.	Tapahiti Tapahiti	A	1	1.87	2.84	620	19.5
8.	Alukodhara Ekhachhen	A	5	3.06	5.07	590	19.5
9.	Nagbahalhiti Nagbahal	A	1+2**	0.06	5.19	670	19.5
10.	Gahhiti Kumbherswar	A	7+5**	3.64	10.62	510	19.5
11.	Manghadhara Manganbazar	A	3	0.79	1.46	500	19.5
12.	Chyasalhiti Chyasal	A	2+3**	3.41	15.30	660	19.5
13.	Sundhara Sundhara	B	3+1**	0.33	0.02	490	21
14.	Thapahiti Nadon	A	3	0.51	1.78	380	20

Note; Type A: Tap located on the wall in the pit,Type B:Tap located on the slope of cliff with open drain. *: Total tap discharge rate, **:The number of no working (dried up)tap.

Table 2.4.3 STATIC WATER LEVLE TRENDS IN THE STUDY AREA

Year / Month	WELL NUMBER									
	B12	WHO3A	WHO5A	WHO7	BB5	DK1	JP1	GK5	MH6	BH4
1972										
Feb.	17.10	22.80								
Sep.			9.40							
1974										
Feb.				14.10						
1984										
Jan.					1.75	29.38				
May							7.44			
1985										
Feb.										+1.50
May									+1.2	
1988										
Feb.	31.10	36.30	23.18	15.00			7.00	25.20		
Mar.								23.92		
1989										
Jan.								27.00	7.15	12.00
Feb.	33.82			14.80	17.77	42.24	7.59			
Mar.	33.92	41.39	23.61	14.80	17.71	42.35	7.18	27.30	7.86	12.97
Aug.	38.92	46.27		14.35		42.18	7.30	31.33	10.09	15.00
Sep.	38.90					42.26		31.28	12.82	
Dec.									14.12	

Note; Unit in meter below ground surface

TABLE 2.4.4 RESULTS OF WATER QUALITY ANALYSIS (1/6)
(EXISTING WELLS)

Well No.	BB2	BB3	BB7	DK3	DK4	DK5
Sample No.	1	2	3	4	5	6
pH	7.18	6.95	6.62	6.68	6.8	6.44
EC(mS/cm)	130	120	160	140	180	160
O.R.P.(mV)*	+550	+550	+540	+560	+530	+540
KMnO4.Con.(mg/l)	4	3.9	8.4	8.6	6.9	5.9
Fe(mg/l)	2.4	0.9	1.1	2.7	2	3
Mn(mg/l)	0.2	<0.1	<0.1	0.1	0.2	0.1
Ca(mg/l)	11	8.4	9.9	11	14	10
Mg(mg/l)	2.6	2.2	3	2.9	3.6	3.2
Na(mg/l)	16	16	22	17	13	11
K(mg/l)	1.2	1.1	1.3	1.3	1.6	1.5
Cl(mg/l)	0.6	1	0.7	1.7	9.4	6.7
Po4(mg/l)	0.5	1.2	1	1.6	0.7	2.4
So4(mg/l)	<5	<5	<5	<5	21	11
H2Co3(mg/l)	17	16	56	22	17	59
HCo3(mg/l)	71	67	75	91	71	79
Co3(mg/l)	0.03	0.03	0.01	0.04	0.03	0.01
NH4(mg/l)	<0.05	<0.05	2.5	<0.05	5.1	6.5
Kjeldahl N(mg/l)**	0.1	0.2	2	0.1	3.7	4.7

NOTE; * Oxidation reduction potentials
** Total Kjeldahl nitrogen

TABLE 2.4.4 RESULTS OF WATER QUALITY ANALYSIS (2/6)
(EXISTING WELLS)

Well No.	GK3	MH2	BH1	BID1	YAK&ETI	DMG5
Sample No.	7	8	9	10	11	12
pH	6.68	6.61	6.47	6.54	6.75	6.76
EC(mS/cm)	140	170	210	240	390	1050
O.R.P.(mV)*	+560	+540	+520	+520	+510	+540
KMnO4.Con.(mg/l)	9.2	16	9.6	3	27	46
Fe(mg/l)	1	3.7	1.9	1	0.3	1.4
Mn(mg/l)	<0.1	0.3	0.4	0.2	0.4	0.5
Ca(mg/l)	9.9	8.3	12	33	20	75
Mg(mg/l)	2.6	2.5	3.7	5.4	5.6	14
Na(mg/l)	20	23	23	10	28	66
K(mg/l)	1.2	1.5	1.9	1.3	2.5	5.1
Cl(mg/l)	1.6	1.3	2.4	4.4	1.4	2.9
Po4(mg/l)	1.4	3.4	3.6	<0.1	8.8	23
So4(mg/l)	<5	<5	<5	<5	<5	50
H2Co3(mg/l)	22	46	78	80	63	150
HCo3(mg/l)	94	62	100	110	270	660
Co3(mg/l)	0.04	0.01	0.02	0.02	0.13	0.31
NH4(mg/l)	<0.05	1.8	6.4	2.3	33	78
Kjeldahl N(mg/l)**	0.1	2.3	4.8	<0.1	23	58

NOTE; * Oxidation reduction potentials
** Total Kjeldahl nitrogen

TABLE 2.4.4 RESULTS OF WATER QUALITY ANALYSIS (3/6)
(EXISTING WELLS AND SPOUT)

Well No.	H.HIMALA	PEPSICOLA	HIM.CEME	PH1	PH2	SPO/KTM
Sample No.	13	14	15	16	17	18
pH	6.95	6.86	7.11	7.37	7.53	6.41
EC(mS/cm)	990	460	640	330	540	540
O.R.P.(mV)*	+500	+550	+460	+540	+510	+500
KMnO4.Con.(mg/l)	51	22	15	1.3	1.1	5.1
Fe(mg/l)	0.3	0.9	0.9	0.2	0.9	0.1
Mn(mg/l)	0.4	0.8	<0.1	0.1	0.1	<0.1
Ca(mg/l)	56	28	38	57	38	20
Mg(mg/l)	12	7.3	7.3	6.9	5.5	8.5
Na(mg/l)	45	57	48	10	75	48
K(mg/l)	5.1	3.9	2.2	1.5	1.6	57
Cl(mg/l)	2.6	2.3	1.3	1.3	8.1	58
Po4(mg/l)	30	5.9	7.7	<0.1	<0.1	24
So4(mg/l)	<5	<5	58	15	140	13
H2Co3(mg/l)	140	72	71	16	13	100
HCo3(mg/l)	580	310	300	220	180	140
Co3(mg/l)	0.28	0.15	0.14	0.31	0.26	0.02
NH4(mg/l)	100	15	46	0.08	0.36	<0.05
Kjeldahl N(mg/l)**	62	10	33	<0.1	0.2	<0.1

NOTE; * Oxidation reduction potentials
** Total Kjeldahl nitrogen

TABLE 2.4.4 RESULTS OF WATER QUALITY ANALYSIS (4/6)
(SPOUTS,SPRINGS AND RIVERS)

Well No.	SPO/LAL	SPO/DHOB	SPR/DOOD	SPR/PHAR	SPR/GODA	BISUNUMA.
Sample No.	19	20	21	22	23	24
pH	6.38	6.7	7.45	7.4	7.15	6.79
EC(mS/cm)	540	380	220	230	260	100
O.R.P.(mV)*	+490	+510	+520	+560	+530	+480
KMnO4.Con.(mg/l)	1.6	2.2	0.4	1.4	0.7	7.8
Fe(mg/l)	<0.1	<0.1	<0.1	0.3	<0.1	1
Mn(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ca(mg/l)	37	31	40	37	55	10
Mg(mg/l)	14	8.7	5.3	8.5	2.7	1.9
Na(mg/l)	40	28	1.1	1	1.2	7.5
K(mg/l)	31	16	0.8	0.8	0.6	1.7
Cl(mg/l)	52	40	0.6	1.1	0.6	4.1
Po4(mg/l)	4.3	1.4	<0.1	<0.1	<0.1	<0.1
So4(mg/l)	31	16	<5	<5	<5	<5
H2Co3(mg/l)	97	23	9.7	9.9	37	9.2
HCo3(mg/l)	130	99	130	130	160	39
Co3(mg/l)	0.02	0.05	0.19	0.19	0.07	0.02
NH4(mg/l)	<0.05	<0.01	0.17	<0.05	0.22	0.11
Kjeldahl N(mg/l)**	<0.1	<0.1	<0.1	<0.1	<0.1	0.5

NOTE; * Oxidation reduction potentials
** Total Kjeldahl nitrogen

TABLE 2.4.4 RESULTS OF WATER QUALITY ANALYSIS (5/6)
(RIVERS)

Well No.	SUND.JARU	BAGMATI	MANOHARA	GODAWARI	KODHU KH.	NAKUH KH.
Sample No.	25	26	27	28	29	30
pH	7.03	7.45	7.47	7.63	7.53	7.53
EC(mS/cm)	31	51	60	260	210	180
O.R.P.(mV)*	+460	+490	+480	+470	+470	+470
KMnO4.Con.(mg/l)	4.5	6.6	8.4	3.3	0.8	3.7
Fe(mg/l)	0.1	1.1	1.6	0.9	0.1	0.6
Mn(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ca(mg/l)	1.6	2.7	2.3	50	42	32
Mg(mg/l)	0.4	0.8	1	3.5	3	3.1
Na(mg/l)	4.2	6	6.6	3.3	0.9	3.9
K(mg/l)	0.7	1.2	1.8	1	0.8	0.9
Cl(mg/l)	1.1	2.4	2.9	1.8	1.1	1.9
Po4(mg/l)	0.1	0.1	0.2	<0.1	<0.1	0.1
So4(mg/l)	<5	<5	<5	<5	<5	<5
H2Co3(mg/l)	3.5	2	2	12	10	8.2
HCo3(mg/l)	15	26	26	170	130	110
Co3(mg/l)	<0.01	0.04	0.04	0.24	0.2	0.16
NH4(mg/l)	0.08	0.08	<0.05	<0.05	0.08	0.06
Kjeldahl N(mg/l)**	<0.1	0.3	0.4	0.1	<0.1	<0.1

NOTE; * Oxidation reduction potentials
** Total Kjeldahl nitrogen

TABLE 2.4.4 RESULTS OF WATER QUALITY ANALYSIS (6/6)
(RIVER,JICA WELLS)

Well No.	BHALK KH.	JW1	JW2	JW3	JW4
Sample No.	31				
pH	7.74	6.94	7.2	7	6.9
EC(mS/cm)	230	210	140	470	690
O.R.P.(mV)*	+470	+450	+490	+500	+470
KMnO4.Con.(mg/l)	7.7	16	5	28	130
Fe(mg/l)	0.9	1.5	1.8	2.1	7.4
Mn(mg/l)	<0.1	0.3	0.2	<0.1	1.6
Ca(mg/l)	38	1.6	8.3	11	27
Mg(mg/l)	5	2.7	3.8	3.2	9.8
Na(mg/l)	7.2	24	14	75	59
K(mg/l)	1.6	1.8	1.2	3.3	5.5
Cl(mg/l)	6.4	1	2	0.8	14
Po4(mg/l)	0.5	2.2	0.8	24	4.6
So4(mg/l)	<5	<5	<5	5.4	<5
H2Co3(mg/l)	9.5	40	10	67	47
HCo3(mg/l)	130	130	44	280	200
Co3(mg/l)	0.19	0.06	0.02	0.14	0.1
NH4(mg/l)	<0.05	3.3	0.07	16	2.5
Kjeldahl N(mg/l)**	0.1	2.9	0.1	13	22

NOTE; * Oxidation reduction potentials
** Total Kjeldahl nitrogen

Table 2.6.1 YIELD 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 2.6.2 WATER QUALITY OF PRESENT GROUNDWATER SOURCES

Well Field		Iron (mg/l)	Manganese (mg/l)	Ammonia (mg/l)
(1) Gokarna	max	2.6	0.18	6.2
	min	0.81	0.02	0.3
(2) Manohara	max	7.4	0.26	12.5
	min	4.4	0.08	0.7
(3) Dhobi Khora	max	5.5	0.35	6.3
	min	2.2	0.22	0.8
(4) Bansbari	max	3.0	0.27	3.2
	min	1.2	0.03	0.4
(5) Pharping	max	0.13	0.22	0.1
	min	0.12	0.06	0.1
(6) Bhaktapur	max	9.0	0.42	4.0
	min	1.2	0.03	0.4

Table 2.6.3 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
Sub-Total	39,080	21,890	60,970	-185	61,155
(6) Others					1,600
TOTAL					62,755

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 3.1.1 GROUNDWATER LEVEL 1972

Leakage Permeability = 0.00033 m/day
Abstraction Condition : Year 1972

NO.	NODE	NAME	H(CAL) (m)	DATE (m)	H(OBS.) (m)	ERR (OBS-CAL)	H(PRES.) (m)	ERR (PRES.-CAL)
1	278	BB3-----	1313.86	3 30 84	1314.13	0.27	1297.40	-16.46
2	280	BB4	1312.25	12 26 84	1311.01	-1.24	-	-
3	336	BB6	1311.60	4 13 84	1308.63	-2.97	-	-
4	284	WH03A	1311.98	2 72	1308.79	-3.19	-	-
5	335	BB5	1310.37	1 18 85	1308.14	-2.23	1292.10	-18.27
6	388	BB8	1309.06	9 7 84	1307.88	-1.18	-	-
7	284	BBOLD	1311.98	2 12 72	1305.79	-6.19	1292.30	-19.68
8	437	BB7	1307.85	3 19 85	1303.58	-4.27	-	-
9	285	JW2	1311.12	8 23 89	-	-	1287.10	-24.02
10	484	JW1/B12	1304.43	9 24 89	1310.60	6.17	1288.60	-15.83
11	293	DK2---*-	1311.81	5 7 84	1319.60	7.79	-	-
12	294	DK3	1311.06	2 13 84	1325.71	14.65	-	-
13	295	DK4	1310.27	4 30 84	1325.92	15.65	-	-
14	347	DK6	1309.44	1 29 84	1311.20	1.76	1303.50	-5.94
15	399	DK5	1308.23	12 28 83	1308.14	-0.09	-	-
16	446	DK1	1307.66	1 17 84	1307.56	-0.10	1294.50	-13.16
17	345	DK8 *	1309.64	3 1 84	1303.60	-6.04	-	-
18	352	JK1	1311.40	5 22 84	1314.97	3.57	-	-
19	19	WH07----	1338.04	5 3 72	1344.00	5.96	-	-
20	62	GK1	1334.69	12 24 85	1336.49	1.80	1326.60	-8.09
21	83	GK2	1334.37	5 31 84	1333.77	-0.60	-	-
22	60	GK3	1334.57	7 4 84	-	-	-	-
23	61	GK4	1334.80	7 15 85	1337.66	2.86	1321.40	-13.40
24	41	GK5	1335.80	6 8 84	1337.84	2.04	1330.70	-5.10
25	198	MH2-----	1320.71	10 18 84	1322.03	1.32	-	-
26	200	MH7 *	1321.58	11 4 85	1322.62	1.04	1297.80	-23.78
27	250	MH3	1318.01	11 26 84	1322.73	4.72	-	-
28	305	MH4	1315.73	11 1 85	1323.93	8.20	-	-
29	306	MH5	1315.50	4 13 85	1319.96	4.46	-	-
30	359	MH6	1313.87	5 4 85	1317.50	3.63	1308.40	-5.47
31	461	BH1-----	1312.59	12 8 84	1321.12	8.53	-	-
32	363	BH3	1315.75	2 3 85	1320.89	5.14	1308.00	-7.75
33	362	BH4	1315.75	2 26 85	1320.17	4.42	1305.70	-10.05
34	459	WH05A	1310.70	3 8 72	1311.23	0.53	1308.70	-2.00
35	1080	PH2-----	1318.29	2 12 77	-	-	1248.30	-69.99
36	585	P2 ---*-	1300.76	8 17 84	1288.70	-12.06	1287.70	-13.06
37	389	P5 *	1308.31	3 27 88	1295.90	-12.41	-	-
38	390	P6 *	1306.69	85	1285.74	-20.95	-	-
39	439	P7 *	1305.75	7 30 88	1290.40	-15.35	-	-
40	553	P8 *	1301.05	72	1305.77	4.72	-	-
41	589	P9 *	1299.85	1 11 87	1286.25	-13.60	-	-
42	592	P10 *	1300.01	75	1298.40	-1.61	-	-
43	487	P11 *	1302.98	78	1305.90	2.92	1293.30	-9.68
44	594	P15 *	1299.53	80	1299.24	-0.29	-	-
45	740	P17 *	1296.55	4 24 87	1290.90	-5.65	-	-
46	740	P18 *	1296.55	8 26 86	1288.25	-8.30	-	-
47	676	P19 *	1297.74	10 20 87	1286.00	-11.74	-	-
48	685	P23 *	1299.66	1 24 78	1300.00	0.34	1285.00	-14.66
49	566	P24 *	1304.05	7 27 86	1310.50	6.45	-	-
50	568	P25 *	1305.14	6 2 86	1293.00	-12.14	-	-
51	568	P26 *	1305.14	10 2 86	1297.45	-7.69	1290.00	-15.14
52	571	P27 *	1306.19	83	1310.90	4.71	-	-
53	572	P28 *	1307.30	82	1317.00	9.70	-	-
54	750	P29 *	1297.59	85	1294.90	-2.69	1288.60	-8.99
55	816	P32 *	1293.93	89	1277.07	-16.86	-	-
56	818	P33 *	1295.00	78	1278.00	-17.00	-	-
57	821	P34 *	1295.92	12 79	1313.90	17.98	-	-
58	961	P36 *	1300.45	5 10 87	1278.50	-21.95	-	-
59	827	P37 *	1302.77	7 27 87	1297.50	-5.27	-	-
60	714	DMG1 *	1297.13	1 11 87	1276.25	-20.88	-	-
61	712	DMG4	1297.16	6 9 86	1285.68	-11.48	-	-
62	712	DMG5 *	1297.16	7 7 86	1290.65	-6.51	-	-
63	635	DMG6	1298.21	88	1299.50	1.29	-	-
64	814	JW3	1292.93	11 9 89	1281.10	-11.83	-	-
65	648	JW4	1301.93	7 25 89	1291.65	-10.28	-	-

Remark *: observed data is uncertain

Table 3.1.2 GROUNDWATER LEVEL IN 1983

Leakage Permeability = 0.00033 m/day
Abstraction Condition : Year 1983

NO.	NODE	NAME	H(CAL) (m)	DATE (m)	H(OBS.) (m)	ERR (OBS-CAL)	H(PRES.) (m)	ERR (PRES.-CAL)
1	278	BB3-----	1312.27	3 30 84	1314.13	1.86	1297.40	-14.87
2	280	BB4	1310.56	12 26 84	1311.01	0.45	-	-
3	336	BB6	1309.83	4 13 84	1308.63	-1.20	-	-
4	284	WH03A	1308.62	2 72	1308.79	0.17	-	-
5	335	BB5	1308.61	1 18 85	1308.14	-0.47	1292.10	-16.51
6	388	BB8	1307.26	9 7 84	1307.88	0.62	-	-
7	284	BBOLD	1308.62	2 12 72	1305.79	-2.83	1292.30	-16.32
8	437	BB7	1306.07	3 19 85	1303.58	-2.49	-	-
9	285	JW2	1308.94	8 23 89	-		1287.10	-21.84
10	484	JW1/B12	1302.92	9 24 89	1310.60	7.68	1288.60	-14.32
11	293	DK2---*-	1310.81	5 7 84	1319.60	8.79	-	-
12	294	DK3	1310.05	2 13 84	1325.71	15.66	-	-
13	295	DK4	1309.23	4 30 84	1325.92	16.69	-	-
14	347	DK6	1308.35	1 29 84	1311.20	2.85	1303.50	-4.85
15	399	DK5	1307.11	12 28 83	1308.14	1.03	-	-
16	446	DK1	1306.52	1 17 84	1307.56	1.04	1294.50	-12.02
17	345	DK8 *	1308.51	3 1 84	1303.60	-4.91	-	-
18	352	JK1	1310.33	5 22 84	1314.97	4.64	-	-
19	19	WH07----	1337.80	5 3 72	1344.00	6.20	-	-
20	62	GK1	1334.36	12 24 85	1336.49	2.13	1326.60	-7.76
21	83	GK2	1334.04	5 31 84	1333.77	-0.27	-	-
22	60	GK3	1334.25	7 4 84	-	-	-	-
23	61	GK4	1334.47	7 15 85	1337.66	3.19	1321.40	-13.07
24	41	GK5	1335.51	6 8 84	1337.84	2.33	1330.70	-4.81
25	198	MH2-----	1319.37	10 18 84	1322.03	2.66	-	-
26	200	MH7 *	1320.27	11 4 85	1322.62	2.35	1297.80	-22.47
27	250	MH3	1316.48	11 26 84	1322.73	6.25	-	-
28	305	MH4	1314.00	11 1 85	1323.93	9.93	-	-
29	306	MH5	1313.63	4 13 85	1319.96	6.33	-	-
30	359	MH6	1311.92	5 4 85	1317.50	5.58	1308.40	-3.52
31	461	BH1-----	1309.76	12 8 84	1321.12	11.36	-	-
32	363	BH3	1313.60	2 3 85	1320.89	7.29	1308.00	-5.60
33	362	BH4	1313.63	2 26 85	1320.17	6.54	1305.70	-7.93
34	459	WH05A	1308.45	3 8 72	1311.23	2.78	1308.70	0.25
35	1080	PH2-----	1318.29	2 12 77	-	-	1248.30	-69.99
36	585	P2 ---*-	1299.19	8 17 84	1288.70	-10.49	1287.70	-11.49
37	389	P5 *	1306.54	3 27 88	1295.90	-10.64	-	-
76	390	P6 *	1305.06	85	1285.74	-19.32	-	-
39	439	P7 *	1304.21	7 30 88	1290.40	-13.81	-	-
40	553	P8 *	1299.53	72	1305.77	6.24	-	-
41	589	P9 *	1298.30	1 11 87	1286.25	-12.05	-	-
42	592	P10 *	1298.31	75	1298.40	0.09	-	-
43	487	P11 *	1301.65	78	1305.90	4.25	1293.30	-8.35
44	594	P15 *	1297.81	80	1299.24	1.43	-	-
45	740	P17 *	1295.73	4 24 87	1290.90	-4.83	-	-
46	740	P18 *	1295.73	8 26 86	1288.25	-7.48	-	-
47	676	P19 *	1296.41	10 20 87	1286.00	-10.41	-	-
48	685	P23 *	1297.25	1 24 78	1300.00	2.75	1285.00	-12.25
49	566	P24 *	1302.60	7 27 86	1310.50	7.90	-	-
50	568	P25 *	1303.67	6 2 86	1293.00	-10.67	-	-
51	568	P26 *	1303.67	10 2 86	1297.45	-6.22	1290.00	-13.67
52	571	P27 *	1304.60	83	1310.90	6.30	-	-
53	572	P28 *	1305.58	7 82	1317.00	11.42	-	-
54	750	P29 *	1296.11	85	1294.90	-1.21	1288.60	-7.51
55	816	P32 *	1292.97	89	1277.07	-15.90	-	-
56	818	P33 *	1293.50	78	1278.00	-15.50	-	-
57	821	P34 *	1295.06	12 79	1313.90	18.84	-	-
58	961	P36 *	1300.42	5 10 87	1278.50	-21.92	-	-
59	827	P37 *	1302.64	7 27 87	1297.50	-5.14	-	-
60	714	DMG1 *	1295.90	1 11 87	1276.25	-19.65	-	-
61	712	DMG4	1295.98	6 9 86	1285.68	-10.30	-	-
62	712	DMG5 *	1295.98	7 7 86	1290.65	-5.33	-	-
63	635	DMG6	1296.81	88	1299.50	2.69	-	-
64	814	JW3	1292.19	11 9 89	1281.10	-11.09	-	-
65	648	JW4	1300.65	7 25 89	1291.65	-9.00	-	-

Remark * : Observed groundwater level is uncertain.

Table 3.1.3 DECISION OF STORAGE COEFFICIENT

(1: Simulation Result)

Name	Period	Drawdown (m)							
		Observed	S=0.0001	S=0.0005	S=0.001	S=0.002	S=0.005	S=0.0075	S=0.01
BB5	Jan.,1985 - Mar.,1989	16.04	17.06	17.024	16.962	16.79	15.556	14.344	13.252
JW1/B12	Aug.,1972 - Sep.,1989	22.00	13.326	13.24	13.072	12.609	12.986	9.835	8.839
GK5	Jun.,1984 - Feb.,1989	7.14	6.71	6.6	6.33	5.54	3.695	2.88	2.37
MH6	May, 1985 - Feb.,1989	9.10	8.51	8.462	8.29	7.61	5.634	4.548	3.804
BH3	Feb.,1985 - Mar.,1989	12.89	9.878	9.854	9.691	8.991	6.788	5.544	4.684
BH4	Feb.,1985 - Mar.,1989	14.47	10.009	9.97	9.807	9.107	6.915	5.678	4.802

(2: Pump Test Result)

WELL NAME	Storage Coefficient	Method	Conducted by	Date
WHO 3	0.0019	JACOB	B&P	5/20 Feb.'72
	0.00243	WALTON	-do-	
WHO 5	0.00086	JACOB	-do-	7/17 Mar.'72
	0.00412			
	0.0037	THEIS	-do-	
WHO 7	0.000232	JACOB	-do-	1/6 Jun. '72
JW1/B12	0.00065	JACOB	JICA	
	0.00185	HANTUSH/JACOB		

MAXIMUM 0.00412 ; MINIMUM 0.000232

Table 3.1.4 NON-STEADY STATE CONDITION (1/3)

Storage Coefficient S= 0.0002 Leakage Permeability = 0.00033 m/day
Steady Condition (year 1985)

NO.	NODE	NAME	H(1983) (m)	H(CAL) (m)	DRAWDOWN (m)	DATE	H(OBS.) (m)	ERR (OBS-CAL)	H(PRES.) (m)	ERR (PRES.-CAL)
1	278	BB3-----	1313.45	1310.30	-3.15	3 30 84	1314.13	3.83	1297.44	-12.86
2	280	BB4	1311.23	1308.79	-2.44	12 26 84	1311.01	2.22		
3	336	BB6	1308.61	1307.84	-0.77	4 13 84	1308.63	0.79		
4	284	WHO3A	1308.89	1306.13	-2.76	2 72	1308.79	2.66		
5	335	BB5	1309.72	1306.92	-2.80	1 18 85	1308.14	1.22	1292.18	-14.74
6	388	BB8	1308.73	1305.57	-3.17	9 7 84	1307.88	2.31		
7	284	BBOLD	1308.89	1306.13	-2.76	2 12 72	1305.79	-0.34	1292.33	-13.80
8	437	BB7	1305.79	1303.97	-1.82	3 19 85	1303.58	-0.39		
9	285	JW2	1308.62	1306.09	-2.54	8 23 89			1287.12	-18.97
10	484	JW1/B12	1304.09	1300.76	-3.33	9 24 89	1310.60	9.84	1288.68	-12.08
11	293	DK2---*-	1309.57	1306.81	-2.76	5 7 84	1319.60	12.79		
12	294	DK3	1310.81	1306.15	-4.66	2 13 84	1325.71	19.56		
13	295	DK4	1310.05	1305.86	-4.19	4 30 84	1325.92	20.06		
14	347	DK6	1307.36	1304.32	-3.04	1 29 84	1311.20	6.88	1303.51	-0.81
15	399	DK5	1307.15	1302.42	-4.73	12 28 83	1308.14	5.72		
16	446	DK1	1305.02	1302.37	-2.65	1 17 84	1307.56	5.19	1294.59	-7.78
17	345	DK8 *	1307.06	1304.79	-2.27	3 1 84	1303.60	-1.19		
18	352	JK1	1309.66	1307.75	-1.90	5 22 84	1314.97	7.22		
19	19	WHO7----	1339.18	1338.31	-0.87	5 3 72	1344.00	5.69		
20	62	GK1	1334.47	1334.36	-0.12	12 24 85	1336.49	2.13	1326.67	-7.69
21	83	GK2	1333.98	1333.98	0.00	5 31 84	1333.77	-0.21		
22	60	GK3	1334.64	1334.25	-0.39	7 4 84				
23	61	GK4	1334.25	1334.42	0.18	7 15 85	1337.66	3.24	1321.42	-13.00
24	41	GK5	1334.92	1335.51	0.59	6 8 84	1337.84	2.33	1330.70	-4.81
25	198	MH2-----	1321.77	1318.89	-2.88	10 18 84	1322.03	3.14		
26	200	MH7 *	1318.67	1319.45	0.78	11 4 85	1322.62	3.17	1297.81	-21.64
27	250	MH3	1317.38	1316.07	-1.31	11 26 84	1322.73	6.66		
28	305	MH4	1315.17	1313.47	-1.70	11 1 85	1323.93	10.46		
29	306	MH5	1313.99	1313.10	-0.89	4 13 85	1319.96	6.86		
30	359	MH6	1312.46	1311.33	-1.13	5 4 85	1317.50	6.17	1308.44	-2.89
31	461	BH1-----	1309.08	1309.21	0.12	12 8 84	1321.12	11.91		
32	363	BH3	1313.63	1313.12	-0.52	2 3 85	1320.89	7.77	1308.04	-5.08
33	362	BH4	1313.17	1313.06	-0.12	2 26 85	1320.17	7.11	1305.70	-7.36
34	459	WHO5A	1308.18	1307.81	-0.38	3 8 72	1311.23	3.42	1308.79	0.98
35	1080	PH2-----	1315.83	1308.67	-7.16	2 12 77			1248.34	-60.33
36	585	P2 ---*-	1302.99	1293.42	-9.57	8 17 84	1288.70	-4.72	1287.71	-5.71
37	389	P5 *	1307.26	1304.60	-2.66	3 27 88	1295.90	-8.70		
38	390	P6 *	1306.55	1302.92	-3.62	85	1285.74	-17.18		
39	439	P7 *	1304.15	1301.95	-2.20	7 30 88	1290.40	-11.55		
40	553	P8 *	1299.79	1297.16	-2.62	72	1305.77	8.61		
41	589	P9 *	1298.05	1295.78	-2.27	1 11 87	1286.25	-9.53		
42	592	P10 *	1299.05	1295.92	-3.13	75	1298.40	2.48		
43	487	P11 *	1302.53	1299.34	-3.19	78	1305.90	6.56	1293.30	-6.04
44	594	P15 *	1298.42	1295.10	-3.32	80	1299.24	4.14		
45	740	P17 *	1296.45	1293.90	-2.55	4 24 87	1290.90	-3.00		
46	740	P18 *	1296.45	1293.90	-2.55	8 26 86	1288.25	-5.65		
47	676	P19 *	1297.08	1293.56	-3.52	10 20 87	1286.00	-7.56		
48	685	P23 *	1297.36	1295.76	-1.60	1 24 78	1300.00	4.24	1285.00	-10.76
49	566	P24 *	1301.54	1301.62	0.08	7 27 86	1310.50	8.88		
50	568	P25 *	1302.55	1302.77	0.22	6 2 86	1293.00	-9.77		
51	568	P26 *	1302.55	1302.77	0.22	10 2 86	1297.45	-5.32	1290.04	-12.73
52	571	P27 *	1304.23	1303.78	-0.45	83	1310.90	7.12		
53	572	P28 *	1304.60	1304.76	0.16	7 82	1317.00	12.24		
54	750	P29 *	1295.81	1293.60	-2.21	85	1294.90	1.30	1288.60	-5.00
55	816	P32 *	1292.04	1291.43	-0.61	89	1277.07	-14.36		
56	818	P33 *	1293.15	1292.27	-0.89	78	1278.00	-14.27		
57	821	P34 *	1294.42	1294.44	0.02	12 79	1313.90	19.46		
58	961	P36 *	1298.87	1299.58	0.71	5 10 87	1278.50	-21.08		
59	827	P37 *	1299.64	1302.65	3.02	7 27 87	1297.50	-5.15		
60	714	DMG1 *	1296.32	1291.91	-4.41	1 11 87	1276.25	-15.66		
61	712	DMG4	1296.30	1292.52	-3.78	6 9 86	1285.68	-6.84		
62	712	DMG5 *	1296.30	1292.52	-3.78	7 7 86	1290.65	-1.87		
63	635	DMG6	1297.32	1294.30	-3.02	88	1299.50	5.20		
64	814	JW3	1291.67	1290.87	-0.80	11 9 89	1281.10	-9.77		
65	648	JW4	1300.38	1300.06	-0.31	7 25 89	1291.65	-8.41		

Remark * : Observed groundwater level is uncertain

Table 3.1.4 NON-STEADY STATE CONDITION (2/3)

Storage Coefficient S= 0.0002 Leakage Permeability = 0.00033 m/day
Steady Condition (year 1987)

NO.	NODE	NAME	H(1983) (m)	H(CAL) (m)	DRAWDOWN (m)	DATE	H(OBS.) (m)	ERR (OBS-CAL)	H(PRES.) (m)	ERR (PRES.-CAL)
1	278	BB3-----	1313.45	1294.83	-18.62	3 30 84	1314.13	19.30	1297.44	2.61
2	280	BB4	1311.23	1293.55	-17.68	12 26 84	1311.01	17.46		
3	336	BB6	1308.61	1291.12	-17.49	4 13 84	1308.63	17.51		
4	284	WHO3A	1308.89	1296.26	-12.63	2 72	1308.79	12.53		
5	335	BB5	1309.72	1292.10	-17.62	1 18 85	1308.14	16.04	1292.18	0.08
6	388	BB8	1308.73	1289.77	-18.96	9 7 84	1307.88	18.11		
7	284	BBOLD	1308.89	1296.26	-12.63	2 12 72	1305.79	9.53	1292.33	-3.93
8	437	BB7	1305.79	1288.19	-17.60	3 19 85	1303.58	15.39		
9	285	JW2	1308.62	1298.15	-10.48	8 23 89			1287.12	-11.03
10	484	JW1/B12	1304.09	1292.71	-11.38	9 24 89	1310.60	17.89	1288.68	-4.03
11	293	DK2---*-	1309.57	1302.17	-7.41	5 7 84	1319.60	17.43		
12	294	DK3	1310.81	1301.40	-9.41	2 13 84	1325.71	24.31		
13	295	DK4	1310.05	1300.49	-9.56	4 30 84	1325.92	25.43		
14	347	DK6	1307.36	1299.65	-7.72	1 29 84	1311.20	11.55	1303.51	3.86
15	399	DK5	1307.15	1298.06	-9.09	12 28 83	1308.14	10.08		
16	446	DK1	1305.02	1298.08	-6.94	1 17 84	1307.56	9.48	1294.59	-3.49
17	345	DK8 *	1307.06	1300.05	-7.02	3 1 84	1303.60	3.55		
18	352	JK1	1309.66	1303.88	-5.78	5 22 84	1314.97	11.09		
19	19	WHO7----	1339.18	1335.56	-3.62	5 3 72	1344.00	8.44		
20	62	GK1	1334.47	1330.01	-4.46	12 24 85	1336.49	6.48	1326.67	-3.34
21	83	GK2	1333.98	1328.32	-5.66	5 31 84	1333.77	5.45		
22	60	GK3	1334.64	1328.59	-6.05	7 4 84				
23	61	GK4	1334.25	1329.36	-4.88	7 15 85	1337.66	8.30	1321.42	-7.94
24	41	GK5	1334.92	1331.58	-3.34	6 8 84	1337.84	6.26	1330.70	-0.88
25	198	MH2-----	1321.77	1312.92	-8.86	10 18 84	1322.03	9.11		
26	200	MH7 *	1318.67	1312.59	-6.08	11 4 85	1322.62	10.03	1297.81	-14.78
27	250	MH3	1317.38	1311.15	-6.23	11 26 84	1322.73	11.58		
28	305	MH4	1315.17	1308.90	-6.27	11 1 85	1323.93	15.03		
29	306	MH5	1313.99	1308.50	-5.49	4 13 85	1319.96	11.46		
30	359	MH6	1312.46	1306.94	-5.52	5 4 85	1317.50	10.56	1308.44	1.50
31	461	BH1-----	1309.08	1302.61	-6.47	12 8 84	1321.12	18.51		
32	363	BH3	1313.63	1308.58	-5.05	2 3 85	1320.89	12.31	1308.04	-0.54
33	362	BH4	1313.17	1308.48	-4.70	2 26 85	1320.17	11.69	1305.70	-2.78
34	459	WHO5A	1308.18	1303.52	-4.66	3 8 72	1311.23	7.71	1308.79	5.27
35	1080	PH2-----	1315.83	1308.67	-7.16	2 12 77			1248.34	-60.33
36	585	P2 ---*-	1302.99	1288.43	-14.56	8 17 84	1288.70	0.27	1287.71	-0.72
37	389	P5 *	1307.26	1290.31	-16.95	3 27 88	1295.90	5.59		
38	390	P6 *	1306.55	1292.57	-13.97	85	1285.74	-6.83		
39	439	P7 *	1304.15	1293.21	-10.94	7 30 88	1290.40	-2.81		
40	553	P8 *	1299.79	1291.97	-7.82	72	1305.77	13.80		
41	589	P9 *	1298.05	1291.26	-6.79	1 11 87	1286.25	-5.01		
42	592	P10 *	1299.05	1291.36	-7.70	75	1298.40	7.04		
43	487	P11 *	1302.53	1294.58	-7.95	78	1305.90	11.32	1293.30	-1.28
44	594	P15 *	1298.42	1290.94	-7.48	80	1299.24	8.30		
45	740	P17 *	1296.45	1289.31	-7.14	4 24 87	1290.90	1.59		
46	740	P18 *	1296.45	1289.31	-7.14	8 26 86	1288.25	-1.06		
47	676	P19 *	1297.08	1289.69	-7.39	10 20 87	1286.00	-3.69		
48	685	P23 *	1297.36	1293.09	-4.27	1 24 78	1300.00	6.91	1285.00	-8.09
49	566	P24 *	1301.54	1298.63	-2.91	7 27 86	1310.50	11.87		
50	568	P25 *	1302.55	1299.60	-2.96	6 2 86	1293.00	-6.60		
51	568	P26 *	1302.55	1299.60	-2.96	10 2 86	1297.45	-2.15	1290.04	-9.56
52	571	P27 *	1304.23	1300.67	-3.56	83	1310.90	10.23		
53	572	P28 *	1304.60	1301.59	-3.01	7 82	1317.00	15.41		
54	750	P29 *	1295.81	1291.08	-4.73	85	1294.90	3.82	1288.60	-2.48
55	816	P32 *	1292.04	1290.03	-2.01	89	1277.07	-12.96		
56	818	P33 *	1293.15	1290.77	-2.38	78	1278.00	-12.77		
57	821	P34 *	1294.42	1293.26	-1.16	12 79	1313.90	20.64		
58	961	P36 *	1298.87	1298.87	0.00	5 10 87	1278.50	-20.37		
59	827	P37 *	1299.64	1302.45	2.81	7 27 87	1297.50	-4.95		
60	714	DMG1 *	1296.32	1287.27	-9.05	1 11 87	1276.25	-11.02		
61	712	DMG4	1296.30	1288.22	-8.08	6 9 86	1285.68	-2.54		
62	712	DMG5 *	1296.30	1288.22	-8.08	7 7 86	1290.65	2.43		
63	635	DMG6	1297.32	1290.71	-6.61	88	1299.50	8.79		
64	814	JW3	1291.67	1289.66	-2.01	11 9 89	1281.10	-8.56		
65	648	JW4	1300.38	1297.63	-2.75	7 25 89	1291.65	-5.98		

Remark * : Observed groundwater level is uncertain

Table 3.1.4 NON-STEADY STATE CONDITION (3/3)

Storage Coefficient S= 0.0002 Leakage Permeability = 0.00033 m/day
Steady Condition (year 1989)

NO.	NODE	NAME	H(1983) (m)	H(CAL) (m)	DRAWDOWN (m)	DATE	H(OBS.) (m)	ERR (OBS-CAL)	H(PRES.) (m)	ERR (PRES.-CAL)
1	278	BB3-----	1313.45	1293.01	-20.44	3 30 84	1314.13	21.12	1297.44	4.43
2	280	BB4	1311.23	1291.42	-19.82	12 26 84	1311.01	19.59		
3	336	BB6	1308.61	1288.59	-20.03	4 13 84	1308.63	20.04		
4	284	WH03A	1308.89	1294.36	-14.53	2 72	1308.79	14.43		
5	335	BB5	1309.72	1288.56	-21.17	1 18 85	1308.14	19.58	1292.18	3.62
6	388	BB8	1308.73	1287.50	-21.23	9 7 84	1307.88	20.38		
7	284	BBOLD	1308.89	1294.36	-14.53	2 12 72	1305.79	11.43	1292.33	-2.03
8	437	BB7	1305.79	1286.84	-18.95	3 19 85	1303.58	16.74		
9	285	JW2	1308.62	1296.30	-12.32	8 23 89			1287.12	-9.18
10	484	JW1/B12	1304.09	1290.97	-13.12	9 24 89	1310.60	19.63	1288.68	-2.29
11	293	DK2---*-	1309.57	1300.67	-8.90	5 7 84	1319.60	18.93		
12	294	DK3	1310.81	1299.59	-11.22	2 13 84	1325.71	26.12		
13	295	DK4	1310.05	1298.41	-11.64	4 30 84	1325.92	27.51		
14	347	DK6	1307.36	1297.84	-9.52	1 29 84	1311.20	13.36	1303.51	5.67
15	399	DK5	1307.15	1296.13	-11.02	12 28 83	1308.14	12.01		
16	446	DK1	1305.02	1296.32	-8.70	1 17 84	1307.56	11.24	1294.59	-1.73
17	345	DK8 *	1307.06	1298.28	-8.78	3 1 84	1303.60	5.32		
18	352	JK1	1309.66	1300.87	-8.79	5 22 84	1314.97	14.10		
19	19	WH07----	1339.18	1331.17	-8.01	5 3 72	1344.00	12.83		
20	62	GK1	1334.47	1321.93	-12.54	12 24 85	1336.49	14.56	1326.67	4.74
21	83	GK2	1333.98	1322.27	-11.71	5 31 84	1333.77	11.50		
22	60	GK3	1334.64	1321.43	-13.21	7 4 84				
23	61	GK4	1334.25	1322.33	-11.92	7 15 85	1337.66	15.33	1321.42	-0.91
24	41	GK5	1334.92	1325.44	-9.49	6 8 84	1337.84	12.40	1330.70	5.26
25	198	MH2-----	1321.77	1299.97	-21.81	10 18 84	1322.03	22.06		
26	200	MH7 *	1318.67	1302.51	-16.16	11 4 85	1322.62	20.11	1297.81	-4.70
27	250	MH3	1317.38	1293.89	-23.49	11 26 84	1322.73	28.84		
28	305	MH4	1315.17	1296.52	-18.65	11 1 85	1323.93	27.41		
29	306	MH5	1313.99	1297.65	-16.34	4 13 85	1319.96	22.31		
30	359	MH6	1312.46	1298.25	-14.21	5 4 85	1317.50	19.25	1308.44	10.19
31	461	BH1-----	1309.08	1296.22	-12.86	12 8 84	1321.12	24.90		
32	363	BH3	1313.63	1299.40	-14.24	2 3 85	1320.89	21.49	1308.04	8.64
33	362	BH4	1313.17	1299.32	-13.85	2 26 85	1320.17	20.85	1305.70	6.38
34	459	WH05A	1308.18	1298.10	-10.08	3 8 72	1311.23	13.13	1308.79	10.69
35	1080	PH2-----	1315.83	1308.66	-7.16	2 12 77			1248.34	-60.32
36	585	P2 ---*-	1302.99	1287.21	-15.78	8 17 84	1288.70	1.49	1287.71	0.50
37	389	P5 *	1307.26	1288.35	-18.91	3 27 88	1295.90	7.55		
38	390	P6 *	1306.55	1290.70	-15.84	85	1285.74	-4.96		
39	439	P7 *	1304.15	1291.33	-12.82	7 30 88	1290.40	-0.93		
40	553	P8 *	1299.79	1290.23	-9.56	72	1305.77	15.54		
41	589	P9 *	1298.05	1289.49	-8.56	1 11 87	1286.25	-3.24		
42	592	P10 *	1299.05	1289.55	-9.50	75	1298.40	8.85		
43	487	P11 *	1302.53	1292.76	-9.77	78	1305.90	13.14	1293.30	0.54
44	594	P15 *	1298.42	1288.96	-9.46	80	1299.24	10.28		
45	740	P17 *	1296.45	1287.83	-8.62	4 24 87	1290.90	3.07		
46	740	P18 *	1296.45	1287.83	-8.62	8 26 86	1288.25	0.42		
47	676	P19 *	1297.08	1287.27	-9.81	10 20 87	1286.00	-1.27		
48	685	P23 *	1297.36	1290.74	-6.62	1 24 78	1300.00	9.26	1285.00	-5.74
49	566	P24 *	1301.54	1295.42	-6.12	7 27 86	1310.50	15.08		
50	568	P25 *	1302.55	1296.03	-6.53	6 2 86	1293.00	-3.03		
51	568	P26 *	1302.55	1296.03	-6.53	10 2 86	1297.45	1.42	1290.04	-5.98
52	571	P27 *	1304.23	1296.87	-7.36	83	1310.90	14.03		
53	572	P28 *	1304.60	1297.60	-6.99	7 82	1317.00	19.40		
54	750	P29 *	1295.81	1288.99	-6.81	85	1294.90	5.91	1288.60	-0.39
55	816	P32 *	1292.04	1289.02	-3.02	89	1277.07	-11.95		
56	818	P33 *	1293.15	1289.64	-3.52	78	1278.00	-11.64		
57	821	P34 *	1294.42	1292.31	-2.11	12 79	1313.90	21.59		
58	961	P36 *	1298.87	1298.84	-0.03	5 10 87	1278.50	-20.34		
59	827	P37 *	1299.64	1302.24	2.61	7 27 87	1297.50	-4.74		
60	714	DMG1 *	1296.32	1284.96	-11.36	1 11 87	1276.25	-8.71		
61	712	DMG4	1296.30	1286.03	-10.28	6 9 86	1285.68	-0.35		
62	712	DMG5 *	1296.30	1286.03	-10.28	7 7 86	1290.65	4.62		
63	635	DMG6	1297.32	1287.45	-9.87	88	1299.50	12.05		
64	814	JW3	1291.67	1288.81	-2.86	11 9 89	1281.10	-7.71		
65	648	JW4	1300.38	1294.95	-5.43	7 25 89	1291.65	-3.30		

Remark * : Observed groundwater level is uncertain

Table 3.1.5 CONDITIONS FOR OPTIMIZATION

No.	Node	Name	Limits on Elevation (m)		Pump Capacity (m^3/day)
			Pump Elevation	Upper limit of Aquifer	
1	231	BB2	1294.0	1302.2	1728.0
2	278	BB3	1291.0	1279.7	3456.0
3	280	BB4	1292.0	1277.8	3168.0
4	336	BB6	1283.0	1266.0	3602.0
5	335	BB5	1275.0	1269.6	3168.0
6	388	BB8	1276.0	1244.8	2952.0
7	284	BBLD	1285.0	1273.7	1368.0
8	437	BB7	1275.0	1199.1	2952.0
9	480	BALAJU	1265.0	1195.5	1000.0
32	293	DK2	1305.0	1317.9	-
33	446	DK1	1305.0	1277.3	-
10	294	DK3	1305.0	1317.5	504.0
11	295	DK4	1317.0	1318.3	1128.0
12	347	DK6	1300.0	1299.4	720.0
13	399	DK5	1295.0	1290.7	1560.0
14	62	GK1	1300.0	1315.9	2760.0
15	83	GK2	1314.0	1318.0	2424.0
16	60	GK3	1314.0	1316.7	1992.0
17	61	GK4	1307.0	1315.9	1440.0
18	41	GK5	1327.0	1319.9	1440.0
19	198	MH2	1299.0	1280.1	3456.0
20	200	MH7	1302.0	1280.2	2160.0
21	250	MH3	1293.0	1280.1	3120.0
22	305	MH4	1310.0	1278.7	3024.0
23	306	MH5	1278.0	1271.8	3456.0
24	359	MH6	1294.0	1273.8	2400.0
28	1080	PH2	1225.0	1163.1	2900.0
29	1064	PH1	1245.0	1167.3	864.0
65	414	BHOLD	1306.0	1263.8	1600.0
25	461	BH1	1306.0	1264.2	1283.0
26	363	BH3	1288.0	1265.3	1473.0
27	362	BH4	1284.0	1266.6	1300.0

Table 3.1.6 OPTIMUM PUMP OPERATION OF EXISTING WELLS (3/5)

OPTIMUM PUMP ABSTRACTION= 15631.5 m^3/day
WELL LOSS : 50 % OF TOTAL DRAWDOWN

NAME	PUMP CAPACITY (m^3/day)	OPTIMUM CASE (m^3/day)	TOTAL HEAD (m)	CRITICAL EL. (m)	ALLOWANCE (m)	DRAWDOWN (m)	WELL LOSS (m)
BB2	1728.000	346.072	1302.160	1302.160	0.000	10.320	5.155
BB3	3456.000	468.474	1291.000	1291.000	0.000	25.003	13.431
BB4	3168.000	0.000	1287.000	1287.000	0.000	25.710	13.080
BB6	3602.000	510.471	1285.171	1283.000	2.171	23.774	11.287
BB5	3168.000	3168.000	1275.881	1275.000	0.881	34.512	17.021
BB8	2952.000	2444.399	1276.000	1276.000	0.000	33.111	16.865
BALAJU	1000.000	1000.000	1268.539	1265.000	3.539	38.648	18.079
GK1	2760.000	0.000	1324.038	1315.910	8.128	14.184	8.157
GK2	2424.000	326.010	1318.000	1318.000	0.000	19.621	9.675
GK3	1992.000	745.197	1317.224	1316.690	0.534	20.830	10.275
GK4	1440.000	0.000	1324.872	1315.910	8.962	12.996	8.093
GK5	1440.000	0.000	1327.000	1327.000	0.000	11.560	6.945
MH3	3120.000	1016.882	1293.000	1293.000	0.000	33.197	19.723
MH5	3456.000	3456.000	1292.850	1278.000	14.850	27.292	16.811
MH7	2160.000	550.023	1302.000	1302.000	0.000	24.547	13.448
PH2	1600.000	1600.000	1264.970	1225.000	39.970	41.386	20.688

Table 3.2.1 METEORO-HYDROLOGICAL FEATURES IN BASINS OF BALANCE POINTS (1)

River Basin	Balance Points*	CA (sq.km)	Rainfall (mm/y)	R/F Rate	MD (cms)	IA (ha)	AF	MF
1. Bisnumati Kh.	I101	1	2,366	0.2	0	60	1	0
	W101	1.7	2,677	0	0.0145	0	1	0
	W102	2	2,727	0	0.0145	0	1	0
	W103	1.2	2,836	0	0.0186	0	1	0
	W104	3.4	2,897	0	0.013	0	1	0
	I107	0	2,897	0.2	0	123	1	0
	I108	3.7	2,383	0.2	0	60	1	0
	W106	0	2,383	0	0	0	1	0
	I109	5.7	1,770	0.2	0	30	0.75	0.02
	I102	0.6	2,365	0.2	0	60	1	0
	I103	3.3	2,010	0.2	0	8	0.8	0
	W105	17.9	1,805	0	0.0331	0	0.75	0.03
	I104	2.8	2,491	0.2	0	30	1	0.01
	I106	0.7	2,013	0.2	0	147	1	0
	I105	1.1	2,473	0.2	0	25	1	0
	I110	9.7	1,881	0.2	0	107	0.8	0
	B-1	48.6	1,675	0	0	0	0.65	0
								0
2. Dhobi Kh.	W201	2.2	2,889	0	0.0231	0	1	0
	I201	1.7	2,832	0.2	0	40	1	0
	I202	0.3	2,275	0.2	0	100	1	0
	I203	6.3	2,129	0.2	0	70	0.8	0
	W202	13.6	1,637	0	0	0	0.65	0.04
								0
3. Bagmati Kh.	I302	13.5	1,931	0.2	0	100	0.75	0
	I301	0.2	2,125	0.2	0	35	1	0
	W302	0	2,125	0	0	0	1	0
	W301	33.6	2,852	0	0.231	0	1	0
	D301	0.3	2,250	0	0	0	1	0
	G/S Temple	8.2	1,812	0	0	0	0.75	0.2
	I303	0	1,812	0.2	0	152	1	0
	W303	0	1,812	0	0	0	1	0
	W304	2.3	1,625	0	0	0	0.75	0
	P/N Temple	9.6	1,555	0	0	0	0.65	0.3
	I104	0	1,555	0.2	0	20	1	0
								0
4. Manohara Kh.	W402	5.5	2,352	0	0	0	1	0
	I403	0.2	2,125	0.2	0	82	1	0
	I404	2.8	2,447	0.2	0	100	1	0
	W401	8	2,596	0	0	0	1	0
	I401	2.5	2,181	0.2	0	6	1	0
	I402	2.4	2,165	0.2	0	80	1	0
	I405	30.9	1,949	0.2	0	226	0.75	0
	W403	18.5	1,550	0	0	0	0.65	0
	I406	0.8	1,350	0.2	0	17	0.65	0.09
								0
5. Hanumante Kh.	W501	6.5	2,347	0	0.05	0	1	0
	I501	1.8	1,875	0.2	0	90	0.8	0
	I502	3.7	1,897	0.2	0	100	0.8	0
	I503	1.3	1,731	0.2	0	60	0.75	0
	I511	12	1,671	0.2	0	120	0.75	0
	I5004/I505	15	2,021	0.2	0	336	0.75	0
	I506/I506a /I507/I508	6.8	2,008	0.2	0	540	0.8	0
	1609/1510	7.1	1,862	0.2	0	397	0.75	0
	B-5-1	37	1,652	0	0	0	0.65	0
								0

Note, CA = catchment area, R/F = irrigation return flow, MD = municipal watre demand
IA = irrigation area, AF = adjustment factor, MF = river maintenance flow
* The locations are schematically illustrated in Fig. 3.2.1.

Table 3.2.1 METEORO-HYDROLOGICAL FEATURES IN BASINS OF BALANCE POINTS (2)

River Basin	Balance Points*	CA (sq.km)	Rainfall (mm/y)	R/F Rate	MD (cms)	IA (ha)	AF	MF
6. Godawari Kh.	I517	3	1,683	0.2	0	85	0.75	0
	I515	7.2	1,858	0.2	0	205	0.8	0
	W502	5.1	2,568	0	0	0	1	0
	I512	8.5	2,382	0.2	0	0	0.8	0
	I513	3.7	1,927	0.2	0	200	0.8	0
	W503	2.4	1,801	0	0	0	0.8	0
	I514	1.2	1,435	0.2	0	635	0.75	0
	I516	8.2	1,455	0.2	0	100	0.75	0
	B-5-2	5.8	1,407	0	0	0	0.65	0.05
								0
7. Kodku Kh.	I601	4.2	1,828	0.2	0	75	1	0
	I602	11.8	1,791	0.2	0	275	0.8	0
	D601	0	1,791	0	0	0	0.8	0
	I603	4.5	1,418	0.2	0	30	0.75	0
	W601	3.5	1,283	0	0	0	0.65	0
	I604	10.2	1,260	0.2	0	200	0.65	0.04
								0
8. Nakhu Kh.	I703	5.1	2,199	0.2	0	329	1	0
	I701	5.6	2,878	0.2	0	24	1	0
	I702	21.7	2,445	0.2	0	0	0.85	0
	I704	10	2,022	0.2	0	400	0.8	0
	D701	0	2,022	0	0	0	1	0
	D702	0.5	1,875	0	0	0	0.85	0
	I705	0	1,875	0.2	0	100	1	0
	I706	3.7	1,643	0.2	0	200	0.75	0
	I707	4.3	1,349	0.2	0	925	0.75	0.06
								0
9. Balkhu Kh.	I801	15.2	2,375	0.2	0	260	0.8	0
	D801	21.8	2,013	0	0	0	0.75	0
	I802	0	2,013	0.2	0	50	0.75	0.07
10. Bagmati Kh.	Cobhar (B-10)	59.8	1,338				0.65	0.7

Note, CA = catchment area, R/F = irrigation return flow, MD = municipal watre demand
IA = irrigation area, AF = adjustment factor, MF = river maintenance flow
* The locations are schematically illustrated in Fig. 3.2.1.

Table 3.2.2 DIVERSION WATER REQUIREMENT FOR IRRIGATION

Unit:l/s/ha

River Basin	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1. Bisnumati Kh.	0.4	0.6	0.9	0.7	0.6	1.1	0.9	0.9	0.8	1.0	0.3	0.3	0.7
2. Dhobi Kh.	0.4	0.6	0.9	0.7	0.6	1.1	0.9	0.9	0.8	1.0	0.3	0.3	0.7
3. Bagmati Kh.	0.4	0.6	0.9	0.7	0.6	1.1	1.0	0.9	0.9	1.0	0.3	0.3	0.7
4. Manohara Kh.	0.4	0.6	1.0	0.7	0.6	1.0	0.8	0.6	0.5	0.9	0.3	0.3	0.6
5. Hanumante Kh.	0.4	0.6	0.9	0.7	0.5	1.1	0.9	0.8	0.8	0.9	0.3	0.3	0.7
6. Godawari Kh.	0.4	0.6	1.0	0.8	0.6	1.2	1.1	1.0	1.0	1.0	0.3	0.3	0.8
7. Kodku Kh.	0.4	0.6	1.0	0.8	0.6	1.2	1.1	1.0	1.0	1.0	0.3	0.3	0.8
8. Nakhu Kh.	0.4	0.6	1.0	0.8	0.6	1.2	1.1	1.0	1.0	1.0	0.3	0.3	0.8
9. Balkhu Kh.	0.4	0.6	0.9	0.7	0.6	1.1	0.9	0.9	0.8	1.0	0.3	0.3	0.7
10. Others	0.4	0.6	1.0	0.7	0.6	1.2	1.1	1.0	1.0	1.0	0.3	0.3	0.8
Max.	0.4	0.6	1.0	0.8	0.6	1.2	1.1	1.0	1.0	1.0	0.3	0.3	0.8
Min.	0.4	0.6	0.9	0.7	0.5	1.0	0.8	0.6	0.5	0.9	0.3	0.3	0.6
Mean	0.4	0.6	1.0	0.7	0.6	1.1	1.0	0.9	0.9	1.0	0.3	0.3	0.7

Table 3.2.3 SURPLUS RIVER WATER IN THE KATHMANDU VALLEY

Unit:cms

Time (%)	Balance Points**											
	Bisnumati Kh.						Dhobi Kh.		Bagmati Kh.			
	W101*	W105*	W102*	W103*	W104*	W106	W201*	W202	W301*	D301	W303	W304
5	0.34	2.79	0.41	0.24	0.65	1.28	0.47	2.69	7.15	7.20	9.39	9.63
10	0.26	2.17	0.32	0.19	0.48	0.99	0.36	2.10	5.56	5.60	7.30	7.49
15	0.20	1.69	0.25	0.15	0.36	0.76	0.28	1.62	4.40	4.43	5.70	5.86
20	0.16	1.34	0.20	0.12	0.26	0.57	0.23	1.27	3.54	3.56	4.55	4.67
25	0.11	1.04	0.16	0.09	0.18	0.42	0.17	0.97	2.78	2.80	3.53	3.65
30	0.07	0.72	0.11	0.06	0.10	0.27	0.11	0.67	1.94	1.96	2.42	2.52
35	0.04	0.49	0.07	0.04	0.06	0.17	0.06	0.43	1.30	1.31	1.61	1.68
40	0.02	0.35	0.05	0.02	0.04	0.12	0.04	0.32	0.91	0.92	1.14	1.19
45	0.01	0.27	0.04	0.01	0.02	0.09	0.02	0.25	0.69	0.70	0.86	0.91
50	0	0.21	0.03	0.01	0.01	0.06	0.01	0.19	0.52	0.53	0.64	0.68
55	0	0.17	0.02	0	0	0.04	0	0.15	0.39	0.40	0.50	0.53
60	0	0.14	0.02	0	0	0.03	0	0.13	0.31	0.31	0.39	0.42
65	0	0.12	0.01	0	0	0.02	0	0.11	0.24	0.25	0.30	0.33
70	0	0.11	0.01	0	0	0.01	0	0.09	0.20	0.20	0.22	0.25
75	0	0.09	0.01	0	0	0.01	0	0.08	0.15	0.15	0.17	0.20
80	0	0.08	0.01	0	0	0	0	0.07	0.12	0.12	0.12	0.15
85	0	0.07	0	0	0	0	0	0.06	0.07	0.07	0.07	0.11
90	0	0.06	0	0	0	0	0	0.06	0.01	0.01	0.01	0.05
95	0	0.04	0	0	0	0	0	0.04	0	0	0	0.02
100	0	0.01	0	0	0	0	0	0.03	0	0	0	0
Mean	0.07	0.70	0.10	0.06	0.13	0.29	0.10	0.67	1.78	1.80	2.30	2.38
Max.	0.93	7.71	1.12	0.69	1.95	3.75	1.29	7.52	19.64	19.78	25.97	26.58

Time (%)	Balance Points**									
	Manohara Kh.			Godawari Kh.		Kodku Kh.		Nakhu Kh.		Balkhu Kh.
	W401	W402	W403	W502	W503	D601	W601	D701	D702	D801
5	1.60	0.98	8.68	1.01	2.33	1.60	2.20	5.94	5.94	4.55
10	1.25	0.76	6.80	0.79	1.61	1.16	1.66	4.24	4.24	3.56
15	1.00	0.60	5.34	0.63	1.09	0.86	1.28	3.00	3.00	2.76
20	0.82	0.47	4.29	0.50	0.70	0.62	0.95	2.03	2.03	2.17
25	0.65	0.35	3.28	0.32	0.39	0.42	0.68	1.26	1.26	1.68
30	0.47	0.23	2.30	0.16	0.20	0.25	0.42	0.71	0.71	1.17
35	0.33	0.15	1.54	0.10	0.11	0.16	0.27	0.44	0.44	0.78
40	0.25	0.11	1.13	0.04	0.04	0.10	0.19	0.26	0.26	0.57
45	0.20	0.09	0.91	0	0	0.07	0.13	0.13	0.13	0.45
50	0.16	0.07	0.71	0	0	0.04	0.09	0	0	0.35
55	0.14	0.05	0.57	0	0	0.01	0.04	0	0	0.29
60	0.12	0.04	0.49	0	0	0	0.01	0	0	0.24
65	0.10	0.03	0.40	0	0	0	0	0	0	0.20
70	0.09	0.02	0.33	0	0	0	0	0	0	0.16
75	0.08	0.01	0.27	0	0	0	0	0	0	0.14
80	0.07	0	0.22	0	0	0	0	0	0	0.12
85	0.05	0	0.16	0	0	0	0	0	0	0.11
90	0.02	0	0.11	0	0	0	0	0	0	0.09
95	0	0	0.07	0	0	0	0	0	0	0.07
100	0	0	0.03	0	0	0	0	0	0	0
Mean	0.43	0.23	2.20	0.22	0.42	0.32	0.48	1.14	1.14	1.15
Max.	4.31	2.68	23.69	2.72	7.68	4.86	6.46	17.82	17.92	12.58

Note,(1) Time = dependable time(%)
(2) * existing municipal water intake site
(3) ** The locations are shown in Figs. 3.2.1 & 3.2.4.
(4) W = ROR type, D = storage dam type

Table 4.1.1 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 4.1.2 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	9,412,996	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	618,911	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	59,049	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 4.1.3 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

Table 4.3.1 RESULTS OF INTERVIEW SURVEY ON WATER QUANTITY AND QUALITY

Survey Area	Number of Samples	Satisfactory (%)		Unsatisfactory (%)		
		Yes	No	Quantity	Quality	Quantity & Quality
I. Kathmandu	2,798	18	82	14	33	53
1. Maharajganj	352	32	68	17	50	33
2. Chhetrapati	440	32	68	24	42	34
3. Tripureswar	585	22	78	11	38	51
4. Mahankal Chaur	434	11	89	29	37	34
5. Kamaladi	369	3	97	10	12	78
6. Baneswar	618	10	90	4	26	70
II. Lalitpur	1,233	35	65	43	14	43
1. Jawalakhel	400	12	88	19	26	55
2. Kupondol	373	75	25	92	8	0
3. Tangal	460	23	77	54	3	43
III. Kathmandu/ Lalitpur	4,031	23	77	22	28	50

Table 4.4.1 PRESENT WATER CONSUMPTION (YEAR 1989)

(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 4.4.2 PRESENT WATER CONSUMPTION IN VILLAGE AREA (YEAR 1989)

(UNIT: m3/d)

SYSTEM	Number of Connection	Original Unit	Water Consumption
(1) Sundarijal (Transmission line)			
funct	408	0.670	273
unfunct	117	0.737	86
non-meter	116	1.186	138
(2) Bansbari (Conveyance line)			
funct	152	0.670	102
unfunct	44	0.737	32
non-meter	43	1.186	51
(3) BALAJU (Conveyance line)			
funct	302	0.670	202
unfunct	86	0.737	63
non-meter	86	1.186	102
(4) Shaibhu (Conveyance line)			
funct	955	0.534	510
unfunct	111	0.588	65
non-meter	179	0.946	169
(5) Chapagaun			
funct	748	0.534	399
unfunct	87	0.588	51
non-meter	140	0.946	132
(6) Godawari			
funct	40	0.534	21
unfunct	5	0.588	3
non-meter	8	0.946	8
(7) Lokhat			
funct	146	0.534	78
unfunct	17	0.588	10
non-meter	27	0.946	26
(8) Doodpokari			
funct	127	0.534	68
unfunct	15	0.588	9
non-meter	24	0.946	23
TOTAL	3,983	0.658	2,621

Table 4.4.3 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	78	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 4.4.4 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 4.4.5 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 4.4.6 PLANNED PER CAPITA CONSUMPTION OF FOREIGN COUNTRIES

COUNTRY	PLANNED PER CAPITA CONSUMPTION Target Year	PLANNED PER CAPITA CONSUMPTION Consumption * (lcd)	PLAN / PROJECT
SRI LANKA	1990	house connection 152 public post 38 - 57	National Development Plan
INDONESIA	1985	house connection 100 - 180 public post 60	National Development Plan
BANGALADESH	1990	house connection 75 - 114 public post 28 - 34	The Establishment Plan for Water Supply Facilities in the New District Towns - JICA, 1984
MYANMAR	1990	house connection 120	National Development Plan
INDIA	1990	house connection 150	National Development Plan
PAKISTAN	(1988)	113.3	(actual condition in 1988) - Journal of JWWA
MADAGASCAR	1990	house connection 115 public post 45	National Development Plan
SOMALIA	1990	house connection 130 public post 50	National Development Plan

NOTE *: values in urban area.

Table 4.4.7 PREDICTION OF 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 5.2.1 PLANNED WATER SUPPLY AMOUNT

(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.

Table 5.4.1 PROPOSED WELL OPERATION PLAN

WELL FIELD		WELL NO.	WELL CAPACITY (m3/hr)	STANDARD YEILD (M3/day)	WELL TYPE
BALAJU	BALAJU	Balaju	42	1,000	S
BANSBARI	BANSBARI	BBold	57	-	E
		BB2	72	346	S
		BB3	144	468	S
		BB4	132	-	E
		BB5	132	3,168	S
		BB6	150	510	S
		BB7	123	-	E
		BB8	123	2,444	S
MAHANKAL CHAUR	DHOBIKHOLA	DK1	-	-	M
		DK3	21	-	E
		DK4	47	-	E
		DK5	65	-	E
		DK6	30	-	E
	GOKARNA	GK1	115	-	E
		GK2	101	326	S
		GK3	83	745	S
		GK4	60	-	E
		GK5	-	-	M
	MANOHARA	MH2	144	-	E
		MH3	130	1,016	S
		MH4	126	-	E
		MH5	144	3,456	S
		MH6	-	-	M
		MH7	90	550	S
PHARPHING	PHARAPHING	PH1	36	-	E
		PH2	120	1,600	S
TOTAL				15,629	

Note; S:Standard operation well
E:Extra operation or standby well
M:Monitoring well

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1990-1993) (1/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	4,320	4,320	0	8,640
Feb	0	1,080	1,080	2,052	4,212
Mar	648	2,700	4,320	2,052	9,720
Apr	648	4,860	6,480	2,052	14,040
May	648	6,804	6,696	2,052	16,200
Jun	648	8,100	8,100	2,052	18,900
Jul	648	8,100	8,100	2,052	18,900
Aug	648	8,100	8,100	2,052	18,900
Sep	648	8,100	8,100	2,052	18,900
Oct	648	8,100	8,100	2,052	18,900
Nov	0	7,020	6,912	0	13,932
Dec	0	4,320	4,860	0	9,180
Ave.	432	5,967	6,264	1,539	14,202

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1994) (2/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	0	0	0	0
Mar	648	0	9,000	3,132 *	12,780
Apr	648	0	9,000	3,132 *	12,780
May	648	0	9,000	3,132 *	12,780
Jun	648	0	9,000	3,132 *	12,780
Jul	0	0	6,454	3,132 *	9,586
Aug	0	0	10,000	3,132 *	13,132
Sep	0	0	9,410	0	9,410
Oct	0	0	5,249	0	5,249
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	0	5,593	1,566	7,375

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1995) (3/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	4,487	0	3,132 *	7,619
Mar	648	11,693	12,318 *	3,132 *	27,792
Apr	648	14,458 *	15,230 *	3,132 *	33,468
May	648	15,846 *	16,691 *	3,132 *	36,317
Jun	648	12,827	13,513 *	3,132 *	30,120
Jul	0	0	0	0	0
Aug	0	0	0	0	0
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	4,943	4,813	1,305	11,276

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1996) (4/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	0	0	0	0
Mar	0	5,307	5,590	3,132 *	14,029
Apr	648	8,678	9,140	3,132 *	21,598
May	648	10,174	10,717	3,132 *	24,670
Jun	648	8,476	0	3,132 *	12,256
Jul	0	0	0	0	0
Aug	0	0	0	0	0
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	162	2,720	2,121	1,044	6,046

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1997) (5/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	0	0	0 *	0
Mar	648	8,008	8,437	3,132 *	20,225
Apr	648	11,571	12,188 *	3,132 *	27,539
May	648	13,193	13,897 *	3,132 *	30,871
Jun	648	7,228	7,615	3,132 *	18,624
Jul	0	0	0	0	0
Aug	0	0	0	0	0
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	3,333	3,511	1,044	8,105

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1998) (6/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	1,126	0	3,132 *	4,258
Mar	648	10,850	11,429	3,132 *	26,058
Apr	648	14,612 *	15,392 *	3,132 *	33,785
May	648	15,120 *	17,242 *	3,132 *	36,142
Jun	648	11,051	11,051	3,132 *	25,881
Jul	0	1,495	0	0	1,495
Aug	0	1,094	0	0	1,094
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	4,612	4,593	1,305	10,726

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (1999) (7/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	0	0	0 *	0
Mar	648	8,184	8,622	3,132 *	20,586
Apr	648	12,165	12,814 *	3,132 *	28,759
May	648	13,623	14,350 *	3,132 *	31,753
Jun	648	7,385	7,778	3,132 *	18,943
Jul	0	0	0	0	0
Aug	0	0	0	0	0
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	3,446	3,630	1,044	8,337

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (2000) (8/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	0	0	3,132 *	3,132
Mar	648	60	12,424 *	3,132 *	16,265
Apr	648	11,795	16,887 *	3,132 *	32,462
May	648	16,030 *	18,561 *	3,132 *	38,371
Jun	648	17,698 *	12,144	3,132 *	33,621
Jul	0	11,529	3,728	0	15,257
Aug	0	0	3,270	0	3,270
Sep	0	0	521	0	521
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	4,759	5,628	1,305	11,908

Note; * Peak operation

TABLE 5.4.2 PROPSED DISCHARGE OF NWSC WELL FILED (2001) (9/9)

Unit;m3/day

	Balaju	Bansbari	Mahankar	Shaibu	Total
Jan	0	0	0	0	0
Feb	0	0	0	3,132 *	3,132
Mar	648	10,823	11,400	3,132 *	26,003
Apr	648	15,333 *	16,152 *	3,132 *	35,265
May	648	16,709 *	17,583 *	3,132 *	38,072
Jun	648	9,353	9,852	3,132 *	22,985
Jul	0	0	0	0	0
Aug	0	0	0	0	0
Sep	0	0	0	0	0
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0
Ave.	216	4,351	4,582	1,305	10,455

Note; * Peak operation

Table 5.5.1 MONTHLY EXPLOITABLE WATER WITH 80% DEPENDABILITY IN AMOUNT

Unit:cms

Balance Points**	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
(I) Bisnumati Kh.													
W105	0.14	0.11	0.10	0.09	0.08	0.22	1.76	2.57	1.75	0.59	0.31	0.18	0.66
W106	0.03	0.04 *	0.03 *	0.01 *	0.01 *	0.05 *	0.73	1.18	0.65	0.11	0.12	0.05	0.25
(II) Dhobi Kh.													
W202	0.13	0.09	0.08	0.08	0.08	0.16	1.67	2.48	1.56	0.46	0.31	0.17	0.61
(III) Bagmati Kh.													
W301	0.29	0.15	0.03 *	0.01 *	0.01 *	0.17	4.91	7.32	4.46	1.47	0.69	0.41	1.66
(IV) Manohara Kh.													
W403	0.51	0.31	0.16	0.16	0.21	0.38	5.88	8.92	5.57	1.69	1.07	0.63	2.12
(V) Balkhu Kh.													
D801	0.26	0.16	0.13	0.12	0.13	0.27	3.06	4.17	2.85	0.82	0.56	0.33	1.07

Note, * with highest dependability, though less than 80 %
** The locations are shown in Fig. 3.2.4.

Table 5.5.2 LAND USE AND MAJOR PROPATY IN RESERVOIR AREAS

NO.	Name of Dam/ Reservoir	Dam Crest EL*1 (m)	Reservoir Area (sq.km)	Land Use (ha)			Nos. of Buildings (Nos)	Other Propaty
				Paddy Field	Upland Field	Others*2		
1	Balkhu Kh.	1,350	2.50	240.0	0.0	10.0	130	- Bishnu Devi Temple - several truss towers of cable-way (Kathmandu-Hetauda) - 3 truss towers of electricity power transmission line - paved road to Pokala (8 m width; 0.8 km)
2	Sundarijal	1,643	0.34	2.0	0.0	32.0	0	- low intake dam for Sundarijal hydroelectric power plant (750 kW)
3	Kodku Kh.	1,395	1.14	110.0	4.0	0.0	20	- irrigation intake weir
4	Lele Kh.	1,507	0.93	80.0	13.0	0.1	60	- irrigation intake weir
5	Nakhu Kh.	1,510	1.63	130.0	20.0	13.0	150	- irrigation intake weir - diversion fasilities for Naldu Kh. water to above intake

Note, (1) *1 maximum development
(2) *2 including forest and grass land

Table 6.3.1 (1/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1990)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	600	600	600	600	0	0
2. LAMBAGAR	-	-	-	-	-	-	-	-	-	-	-	-
3. MAHARAJGANJ	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4. BANSBARI												
-Shivapuri	-	-	-	-	-	-	-	-	-	-	-	-
-Bisnumati	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	3,583	1,000	2,500	4,500	6,300	7,500	7,500	7,500	7,500	7,500	6,500	4,000
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	-	-	-	-	-	-	-	-	-	-	-	-
-Dhobi khola	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	3,582	1,000	4,000	6,000	6,200	7,500	7,500	7,500	7,500	7,500	6,400	4,087
7. SHAIBHU												
-Surface water	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700
-Groundwater	0	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	51,865	48,600	53,700	57,700	59,700	61,800	61,800	61,800	61,800	61,800	57,200	52,787

Table 6.3.1 (2/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1991)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	600	600	600	600	0	0
2. LAMBAGAR	-	-	-	-	-	-	-	-	-	-	-	-
3. MAHARAJGANJ	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4. BANSBARI												
-Shivapuri	-	-	-	-	-	-	-	-	-	-	-	-
-Bisnumati	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	4,000	1,000	2,500	4,500	6,300	7,500	7,500	7,500	7,500	7,500	6,500	4,000
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	-	-	-	-	-	-	-	-	-	-	-	-
-Dhobi khola	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	4,000	1,000	4,000	6,000	6,200	7,500	7,500	7,500	7,500	7,500	6,400	4,500
7. SHAIBHU												
-Surface water	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700
-Groundwater	0	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	52,700	48,600	53,700	57,700	59,700	61,800	61,800	61,800	61,800	61,800	57,200	53,200

Table 6.3.1 (3/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1992)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	600	600	600	600	0	0
2. LAMBAGAR	-	-	-	-	-	-	-	-	-	-	-	-
3. MAHARAJGANJ	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4. BANSBARI												
-Shivapuri	-	-	-	-	-	-	-	-	-	-	-	-
-Bisnumati	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	4,000	1,000	2,500	4,500	6,300	7,500	7,500	7,500	7,500	7,500	6,500	4,000
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	-	-	-	-	-	-	-	-	-	-	-	-
-Dhobi khola	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	4,000	1,000	4,000	6,000	6,200	7,500	7,500	7,500	7,500	7,500	6,400	4,500
7. SHAIBHU												
-Surface water	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700
-Groundwater	0	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	52,700	48,600	53,700	57,700	59,700	61,800	61,800	61,800	61,800	61,800	57,200	53,200

Table 6.3.1 (4/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1993)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	600	600	600	600	0	0
2. LAMBAGAR	-	-	-	-	-	-	-	-	-	-	-	-
3. MAHARAJGANJ	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4. BANSBARI												
-Shivapuri	-	-	-	-	-	-	-	-	-	-	-	-
-Bisnumati	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	4,000	1,000	2,500	4,500	6,300	7,500	7,500	7,500	7,500	7,500	6,500	4,000
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	-	-	-	-	-	-	-	-	-	-	-	-
-Dhobi khola	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	4,000	1,000	4,000	6,000	6,200	7,500	7,500	7,500	7,500	7,500	6,400	4,500
7. SHAIBHU												
-Surface water	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700
-Groundwater	0	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	52,700	48,600	53,700	57,700	59,700	61,800	61,800	61,800	61,800	61,800	57,200	53,200

Table 6.3.1 (5/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1994)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	-	-	-	-	-	-	-	-	-	-	-	-
3. MAHARAJGANJ	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
4. BANSBARI												
-Shivapuri	-	-	-	-	-	-	-	-	-	-	-	-
-Bisnumati	-	-	-	-	-	-	-	-	-	-	-	-
-Groundwater	-	-	-	-	-	-	-	-	-	-	-	-
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	7,724	7,550	5,870	5,870	6,710	10,900	12,600	12,600	12,600	12,600	10,648	5,319
-Groundwater	0	0	8,370	8,370	8,370	8,370	7,040	8,262	8,751	4,882	0	0
7. SHAIBHU												
-Surface water	11,286	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700
-Groundwater	0	0	2,900	2,900	2,900	2,900	2,900	2,900	0	0	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	61,610	62,310	62,440	62,440	63,280	71,260	79,440	80,662	78,251	74,382	67,548	62,619

Table 6.3.1 (6/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1995)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	-	-	-	-	-
-Groundwater	0	0	600	600	600	600	0	-	-	-	-	-
2. LAMBAGAR	-	-	-	-	-	-	-	9,000	9,000	9,000	8,000	7,246
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	2,280	0	0	0	0	0	12,600	12,600	12,600	8,380	7,526	3,350
-Groundwater	0	4,155	10,827	8,489	10,127	11,000	0	0	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	5,657	6,050	5,870	5,870	6,710	10,900	9,320	8,411	6,556	6,370	1,113	0
-Groundwater	0	0	9,306	10,000	11,000	4,389	0	0	0	0	0	0
7. SHAIBHU												
-Surface water	14,700	14,700	14,700	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	2,900	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	65,237	67,865	74,203	79,459	82,937	85,179	85,720	85,411	83,556	79,150	72,039	66,396

Table 6.3.1 (7/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1996)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	-	-	-	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	-	-	-	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	10,801	11,085	12,000	6,710	6,710	12,600	12,600	12,600	12,600	10,000	8,500	3,410
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	2,510	0	0	0	0	0	8,000	8,000	8,000	7,000	4,017	2,730
-Groundwater	0	0	6,640	7,498	8,743	7,848	0	0	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	0	7,550	5,870	5,870	6,710	10,900	6,411	6,083	4,118	3,051	0	0
-Groundwater	0	0	8,000	9,000	10,600	0	0	0	0	0	0	0
7. SHAIBHU												
-Surface water	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	0	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	69,111	71,895	78,610	84,178	87,863	90,238	90,811	90,483	88,518	83,851	76,317	70,340

Table 6.3.1 (8/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1997)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	7,057	8,157	7,550	6,710	6,710	12,600	12,600	12,600	12,600	12,000	8,000	7,386
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	1,761	0	0	0	0	0	10,000	10,000	10,000	8,380	8,380	3,350
-Groundwater	0	0	7,415	10,714	12,216	6,693	0	0	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	7,057	7,349	5,870	5,870	6,710	10,900	10,345	9,996	7,902	5,150	1,124	0
-Groundwater	0	0	7,812	11,285	12,868	7,051	0	0	0	0	0	0
7. SHAIBHU												
-Surface water	15,152	21,027	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	0	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	73,627	76,593	83,747	89,679	93,604	96,134	96,745	96,396	94,302	89,330	81,304	74,936

Table 6.3.1 (9/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1998)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	8,137	8,380	7,550	6,710	6,710	12,600	12,600	12,600	12,600	12,600	10,000	9,000
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	2,030	0	0	0	0	0	12,600	12,600	12,600	8,380	8,380	3,350
-Groundwater	0	1,043	10,046	13,530	15,156	9,712	1,384	1,013	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	8,137	7,550	5,870	5,870	6,710	10,900	12,600	12,600	11,384	10,311	4,367	3,218
-Groundwater	0	0	10,582	14,252	15,965	10,232	0	0	0	0	0	0
7. SHAIBHU												
-Surface water	17,472	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	2,900	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	-	-	-	-	-	-	-	-	-	-	-	-
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	78,376	81,533	89,148	95,462	99,641	102,334	102,984	102,613	100,384	95,091	86,547	79,768

Table 6.3.1 (10/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 1999)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	6,438	7,638	7,550	6,710	6,710	12,600	12,600	12,600	12,600	12,600	9,000	8,000
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	1,606	0	0	0	0	0	12,600	12,600	12,600	8,380	8,380	3,350
-Groundwater	0	0	7,578	11,264	12,614	6,838	0	0	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	6,438	6,882	5,870	5,870	6,710	10,900	8,123	7,727	5,353	3,933	0	0
-Groundwater	0	0	7,983	11,865	13,287	7,202	0	0	0	0	0	0
7. SHAIBHU												
-Surface water	13,822	19,688	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	0	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	12,600	12,600	10,900	10,900	11,740	12,600	12,600	12,600	12,600	12,600	11,031	9,438
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	83,504	86,868	94,981	101,709	106,161	109,030	109,723	109,327	106,953	101,313	92,211	84,988

Table 6.3.1 (11/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 2000)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	7,810	8,380	7,550	6,710	6,710	12,600	12,600	12,600	12,600	12,600	10,000	9,000
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	1,949	0	0	0	0	0	12,600	12,600	12,600	8,380	8,380	3,350
-Groundwater	0	56	10,921	14,843	16,387	10,675	0	0	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	7,810	7,550	5,870	5,870	6,710	10,900	12,600	12,600	12,600	11,254	5,694	4,580
-Groundwater	0	0	11,504	15,636	17,186	11,244	3,452	3,028	482	0	0	0
7. SHAIBHU												
-Surface water	16,770	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	2,900	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	12,600	12,600	10,900	10,900	11,740	12,600	12,600	12,600	12,600	12,600	11,000	10,000
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	-
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	89,539	93,146	101,845	109,059	113,833	116,909	117,652	117,228	114,682	108,634	98,874	91,130

Table 6.3.1 (12/12) WATER SUPPLY AMOUNT FROM EACH SYSTEM (YEAR 2001)

(UNIT: m3/d)

SYSTEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. BALAJU												
-Surface water	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	0	0	600	600	600	600	0	0	0	0	0	0
2. LAMBAGAR	6,419	7,924	7,550	6,710	6,710	12,600	12,600	12,600	12,600	12,600	10,000	9,000
3. MAHARAJGANJ	-	-	-	-	-	-	-	-	-	-	-	-
4. BANSBARI												
-Shivapuri	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
-Bisnumati	1,601	0	0	0	0	0	12,600	12,600	12,600	8,380	8,380	3,350
-Groundwater	0	0	10,021	14,197	15,471	8,660	0	0	0	0	0	0
5. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	17,600	17,600	17,600	17,600	17,600	17,600	18,000
6. MAHANKAL CHAUR												
-Sundarijal	12,600	10,060	0	0	0	4,190	12,600	12,600	12,600	12,600	12,600	12,600
-Dhobi khola	6,419	7,139	5,870	5,870	6,710	10,900	11,968	11,513	8,783	6,518	1,851	1,176
-Groundwater	0	0	10,556	14,956	16,281	9,122	0	0	0	0	0	0
7. SHAIBHU												
-Surface water	13,781	20,425	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	0	0	2,900	2,900	2,900	2,900	0	0	0	0	0	0
8. MANOHARA	12,600	12,600	10,900	10,900	11,740	12,600	12,600	12,600	12,600	12,600	11,000	10,000
9. BALKHU	12,600	11,740	9,220	9,220	10,060	12,600	12,600	12,600	12,600	12,600	11,000	10,000
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
TOTAL	96,020	99,888	109,217	116,953	122,072	125,372	126,168	125,713	122,983	116,498	106,031	97,726

Table 6.3.2 SUPPLY CAPACITY OF EACH SYSTEM AND PLANNED WATER SUPPLY AMOUNT

(UNIT: m3/d)

SYSTEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. MAHANKAL CHAUR												
-Surface water	-	-	-	-	14,700	14,700	14,700	14,700	14,700	14,700	14,700	14,700
-Groundwater	(7,500)	(7,500)	(7,500)	(7,500)	17,200	17,200	17,200	17,200	17,200	17,200	17,200	17,200
2. Bansbari												
-Surface water	-	-	-	-	-	4,400	4,400	4,400	4,400	4,400	4,400	4,400
-Groundwater	(7,500)	(7,500)	(7,500)	(7,500)	(7,500)	16,400	16,400	16,400	16,400	16,400	16,400	16,400
3. MAHARAJGANJ	(2,000)	(2,000)	(2,000)	(2,000)	(2,000)	-	-	-	-	-	-	-
4. SHAIBHU												
-Surface water	14,700	14,700	14,700	14,700	14,700	21,600	21,600	21,600	21,600	21,600	21,600	21,600
-Groundwater	1,900	1,900	1,900	1,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900	2,900
5. BALAJU												
-Surface water	(8,400)	(8,400)	(8,400)	(8,400)	(8,400)	(8,400)	8,400	8,400	8,400	8,400	8,400	8,400
-Groundwater	(600)	(600)	(600)	(600)	(600)	(600)	600	600	600	600	600	600
6. LAMBAGAR	-	-	-	-	-	-	12,600	12,600	12,600	12,600	12,600	12,600
7. SUNDARIJAL	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000
8. MANOHARA	-	-	-	-	-	-	-	-	-	12,600	12,600	12,600
9. BALKHU	-	-	-	-	-	-	-	-	-	-	-	12,600
10. OTHERS	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
Capacity of Supply												
-Surfafe water	44,700	44,700	44,700	44,700	59,400	68,700	81,300	81,300	81,300	93,900	93,900	106,500
-Groundwater	17,500	17,500	17,500	17,500	28,200	37,100	37,100	37,100	37,100	37,100	37,100	37,100
TOTAL	62,200	62,200	62,200	62,200	87,600	105,800	118,400	118,400	118,400	131,000	131,000	143,600
Planned Water Supply *1	68,150	73,049	74,371	77,550	80,954	85,720	90,811	96,745	102,984	109,723	117,652	126,168

NOTE *1 : Annual maximum
( ): No treatment or insufficient treatment
Supply capacity mentioned is the value during the period that groundwater is used maximum.

Table 6.3.3 ANNUAL PAID WATER QUANTITY

(UNIT: 1,000 m3)

SYSTEM	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<EXISTING SYSTEM>												
1. Mahankal Chaur	1,471	1,490	1,511	1,527	-	-	-	-	-	-	-	-
2. Bansbari	1,410	1,419	1,439	1,454	0	-	-	-	-	-	-	-
3. Shaibhu	4,120	4,120	4,178	4,222	4,334	-	-	-	-	-	-	-
4. Maharajganj	511	511	518	524	529	-	-	-	-	-	-	-
5. Balaju	2,249	2,249	2,281	2,305	1,905	0	-	-	-	-	-	-
6. Sundarijal	4,548	4,548	4,613	4,662	4,710	4,743	4,775	-	-	-	-	-
7. Others	409	409	415	419	423	426	429	432	435	438	438	438
Sub-Total	14,718	14,746	14,955	15,113	11,901	5,169	5,204	432	435	438	438	438
<PROPOSED SYSTEM>												
1. Mahankal Chaur	-	-	-	-	6,465	6,103	4,980	5,569	6,118	5,627	6,341	5,936
2. Bansbari	-	-	-	-	-	3,419	2,233	2,537	3,010	2,589	3,140	2,931
3. Shaibhu	-	-	-	-	-	5,910	4,982	5,406	5,826	5,381	5,850	5,502
4. Balaju	-	-	-	-	-	-	2,308	2,324	2,339	2,355	2,355	2,355
5. Lambagar	-	-	-	-	-	-	2,267	2,492	2,690	2,478	2,701	2,546
6. Sundarijal	-	-	-	-	-	-	-	4,808	4,840	4,873	4,873	4,873
7. Manohara	-	-	-	-	-	-	-	-	-	3,352	3,352	3,352
8. Balkhu	-	-	-	-	-	-	-	-	-	-	-	3,218
Sub-Total	0	0	0	0	6,465	15,432	16,770	23,136	24,823	26,655	28,612	30,713
TOTAL	14,718	14,746	14,955	15,113	18,366	20,601	21,974	23,568	25,258	27,093	29,050	31,151

Table 6.4.1 (1/8) PROJECT COST FOR EACH SYSTEM

- MAHANKAL CHAUR - (UNIT: US$1,000)

DESCRIPTION	TOTAL			1992			1993		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	278	278	0	278	278	0	0	0
(2) Direct Cost	10,145	2,795	12,940	6,522	2,094	8,616	3,623	701	4,324
	576	689	1,265	370	516	886	206	173	379
(3) Engineering Service	1,035	0	1,035	689	0	689	346	0	346
(2) x 8%	1,035	0	1,035	689	0	689	346	0	346
(4) Sub-Total	11,180	2,795	13,975	7,211	2,094	9,305	3,969	701	4,670
(2) + (3)	1,611	689	2,300	1,059	516	1,575	552	173	725
(5) Physical Contingency	1,118	279	1,397	721	209	930	397	70	467
(4) x 10%	161	69	230	106	52	158	55	17	72
(6) Sub-Total	12,298	3,352	15,650	7,932	2,581	10,513	4,366	771	5,137
(1)+(4)+(5)	1,772	758	2,530	1,165	568	1,733	607	190	797
(7) Price Contingency	1,732	948	2,680	990	670	1,660	742	278	1,020
	248	216	464	145	148	293	103	68	171
(8) TOTAL	14,030	4,300	18,330	8,922	3,251	12,173	5,108	1,049	6,157
	2,020	974	2,994	1,310	716	2,026	710	258	968

NOTE Lower line: Personnel expenses

Table 6.4.1 (2/8) PROJECT COST FOR EACH SYSTEM

- BANSBARI - (UNIT: US$1,000)

DESCRIPTION	TOTAL			1993			1994		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	213	213	0	213	213	0	0	0
(2) Direct Cost	8,059	2,313	10,372	5,198	1,769	6,967	2,861	544	3,405
	488	509	997	315	389	704	173	120	293
(3) Engineering Service	829	0	829	557	0	557	272	0	272
(2) x 8%	829	0	829	557	0	557	272	0	272
(4) Sub-Total	8,888	2,313	11,201	5,755	1,769	7,524	3,133	544	3,677
(2) + (3)	1,317	509	1,826	872	389	1,261	445	120	565
(5) Physical Contingency	889	231	1,120	576	177	753	313	54	367
(4) x 10%	132	51	183	87	39	126	45	12	57
(6) Sub-Total	9,777	2,757	12,534	6,331	2,159	8,490	3,446	598	4,044
(1)+(4)+(5)	1,449	560	2,009	959	428	1,387	490	132	622
(7) Price Contingency	1,822	1,059	2,881	1,075	778	1,853	747	281	1,028
	269	216	485	163	154	317	106	62	168
(8) TOTAL	11,599	3,816	15,415	7,406	2,937	10,343	4,193	879	5,072
	1,718	776	2,494	1,122	582	1,704	596	194	790

NOTE Lower line: Personnel expenses

Table 6.4.1 (3/8) PROJECT COST FOR EACH SYSTEM

- SHAIBHU - (UNIT: US$1,000)

DESCRIPTION	TOTAL F/C	TOTAL L/C	TOTAL TOTAL	1993 F/C	1993 L/C	1993 TOTAL	1994 F/C	1994 L/C	1994 TOTAL
(1) Land Acquisition	0	0	0	0	0	0	0	0	0
(2) Direct Cost	2,475	882	3,357	1,621	662	2,283	854	220	1,074
	160	176	336	105	132	237	55	44	99
(3) Engineering Service	269	0	269	183	0	183	86	0	86
(2) x 8%	269	0	269	183	0	183	86	0	86
(4) Sub-Total	2,744	882	3,626	1,804	662	2,466	940	220	1,160
(2) + (3)	429	176	605	288	132	420	141	44	185
(5) Physical Contingency	274	88	362	180	66	246	94	22	116
(4) x 10%	43	17	60	29	13	42	14	4	18
(6) Sub-Total	3,018	970	3,988	1,984	728	2,712	1,034	242	1,276
(1)+(4)+(5)	472	193	665	317	145	462	155	48	203
(7) Price Contingency	561	376	937	337	262	599	224	114	338
	88	75	163	54	52	106	34	23	57
(8) TOTAL	3,579	1,346	4,925	2,321	990	3,311	1,258	356	1,614
	560	268	828	371	197	568	189	71	260

NOTE Lower line: Personnel expenses

Table 6.4.1 (4/8) PROJECT COST FOR EACH SYSTEM

- BALAJU - (UNIT: US$1,000)

DESCRIPTION	TOTAL F/C	TOTAL L/C	TOTAL TOTAL	1994 F/C	1994 L/C	1994 TOTAL	1995 F/C	1995 L/C	1995 TOTAL
(1) Land Acquisition	0	0	0	0	0	0	0	0	0
(2) Direct Cost	2,869	591	3,460	1,821	453	2,274	1,048	138	1,186
	172	179	351	113	138	251	59	41	100
(3) Engineering Service	277	0	277	182	0	182	95	0	95
(2) x 8%	277	0	277	182	0	182	95	0	95
(4) Sub-Total	3,146	591	3,737	2,003	453	2,456	1,143	138	1,281
(2) + (3)	449	179	628	295	138	433	154	41	195
(5) Physical Contingency	314	59	373	200	45	245	114	14	128
(4) x 10%	45	18	63	30	14	44	15	4	19
(6) Sub-Total	3,460	650	4,110	2,203	498	2,701	1,257	152	1,409
(1)+(4)+(5)	494	197	691	325	152	477	169	45	214
(7) Price Contingency	811	323	1,134	477	234	711	334	89	423
	115	97	212	70	71	141	45	26	71
(8) TOTAL	4,271	973	5,244	2,680	732	3,412	1,591	241	1,832
	609	294	903	395	223	618	214	71	285

NOTE Lower line: Personnel expenses

Table 6.4.1 (5/8) PROJECT COST FOR EACH SYSTEM

- LAMBAGAR - (UNIT: US$1,000)

DESCRIPTION	TOTAL			1994			1995		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	467	467	0	467	467	0	0	0
(2) Direct Cost	5,489	1,436	6,925	3,543	1,091	4,634	1,946	345	2,291
	333	318	651	215	241	456	118	77	195
(3) Engineering Service	554	0	554	371	0	371	183	0	183
(2) x 8%	554	0	554	371	0	371	183	0	183
(4) Sub-Total	6,043	1,436	7,479	3,914	1,091	5,005	2,129	345	2,474
(2) + (3)	887	318	1,205	586	241	827	301	77	378
(5) Physical Contingency	604	144	748	391	109	500	213	35	248
(4) x 10%	89	32	121	59	24	83	30	8	38
(6) Sub-Total	6,647	2,047	8,694	4,305	1,667	5,972	2,342	380	2,722
(1)+(4)+(5)	976	350	1,326	645	265	910	331	85	416
(7) Price Contingency	1,554	1,005	2,559	933	782	1,715	621	223	844
	228	174	402	140	124	264	88	50	138
(8) TOTAL	8,201	3,052	11,253	5,238	2,449	7,687	2,963	603	3,566
	1,204	524	1,728	785	389	1,174	419	135	554

NOTE Lower line: Personnel expenses

Table 6.4.1 (6/8) PROJECT COST FOR EACH SYSTEM

- SUNDARIJAL - (UNIT: US$1,000)

DESCRIPTION	TOTAL			1995			1996		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	940	940	0	940	940	0	0	0
(2) Direct Cost	7,167	1,664	8,831	4,572	1,263	5,835	2,595	401	2,996
	434	400	834	278	303	581	156	97	253
(3) Engineering Service	707	0	707	467	0	467	240	0	240
(2) x 8%	707	0	707	467	0	467	240	0	240
(4) Sub-Total	7,874	1,664	9,536	5,039	1,263	6,302	2,835	401	3,236
(2) + (3)	1,141	400	1,541	745	303	1,048	396	97	493
(5) Physical Contingency	788	166	954	504	126	630	284	40	324
(4) x 10%	115	40	155	75	30	105	40	10	50
(6) Sub-Total	8,662	2,770	11,432	5,543	2,329	7,872	3,119	441	3,560
(1)+(4)+(5)	1,256	440	1,696	820	333	1,153	436	107	543
(7) Price Contingency	2,456	1,682	4,138	1,471	1,367	2,838	985	315	1,300
	356	271	627	218	195	413	138	76	214
(8) TOTAL	11,118	4,452	15,570	7,014	3,696	10,710	4,104	756	4,860
	1,612	711	2,323	1,038	528	1,566	574	183	757

NOTE Lower line: Personnel expenses

Table 6.4.1 (7/8) PROJECT COST FOR EACH SYSTEM

- MANOHARA - (UNIT: US$1,000)

DESCRIPTION	TOTAL			1997			1998		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	740	740	0	740	740	0	0	0
(2) Direct Cost	7,568	2,226	9,794	4,959	1,699	6,658	2,609	527	3,136
	429	464	893	281	354	635	148	110	258
(3) Engineering Service	784	0	784	533	0	533	251	0	251
(2) x 8%	784	0	784	533	0	533	251	0	251
(4) Sub-Total	8,352	2,226	10,578	5,492	1,699	7,191	2,860	527	3,387
(2) + (3)	1,213	464	1,677	814	354	1,168	399	110	509
(5) Physical Contingency	835	223	1,058	549	170	719	286	53	339
(4) x 10%	121	46	167	81	35	116	40	11	51
(6) Sub-Total	9,187	3,189	12,376	6,041	2,609	8,650	3,146	580	3,726
(1)+(4)+(5)	1,334	510	1,844	895	389	1,284	439	121	560
(7) Price Contingency	3,559	2,799	6,358	2,227	2,220	4,447	1,332	579	1,911
	516	452	968	330	331	661	186	121	307
(8) TOTAL	12,746	5,988	18,734	8,268	4,829	13,097	4,478	1,159	5,637
	1,850	962	2,812	1,225	720	1,945	625	242	867

NOTE Lower line: Personnel expenses

Table 6.4.1 (8/8) PROJECT COST FOR EACH SYSTEM

- BALKHU - (UNIT: US$1,000)

DESCRIPTION	TOTAL			1999			2000		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	620	620	0	620	620	0	0	0
(2) Direct Cost	6,162	1,840	8,002	3,991	1,406	5,397	2,171	434	2,605
	352	382	734	228	292	520	124	90	214
(3) Engineering Service	640	0	640	432	0	432	208	0	208
(2) x 8%	640	0	640	432	0	432	208	0	208
(4) Sub-Total	6,802	1,840	8,642	4,423	1,406	5,829	2,379	434	2,813
(2) + (3)	992	382	1,374	660	292	952	332	90	422
(5) Physical Contingency	680	184	864	442	141	583	238	43	281
(4) x 10%	99	38	137	66	29	95	33	9	42
(6) Sub-Total	7,482	2,644	10,126	4,865	2,167	7,032	2,617	477	3,094
(1)+(4)+(5)	1,091	420	1,511	726	321	1,047	365	99	464
(7) Price Contingency	3,748	3,146	6,894	2,336	2,511	4,847	1,412	635	2,047
	546	504	1,050	349	372	721	197	132	329
(8) TOTAL	11,230	5,790	17,020	7,201	4,678	11,879	4,029	1,112	5,141
	1,637	924	2,561	1,075	693	1,768	562	231	793

NOTE Lower line: Personnel expenses

Table 6.4.2 PROJECT COST IN EACH YEAR

(UNIT: US$1,000)

DESCRIPTION	TOTAL			1992			1993			1994			1995		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	3,258	3,258	0	278	278	0	213	213	0	467	467	0	940	940
(2) Direct Cost	49,934 2,944	13,747 3,117	63,681 6,061	6,522 370	2,094 516	8,616 886	10,442 626	3,132 694	13,574 1,320	9,079 556	2,308 543	11,387 1,099	7,566 455	1,746 421	9,312 876
(3) Engineering Service (2) x 8%	5,095 5,095	0 0	5,095 5,095	689 689	0 0	689 689	1,086 1,086	0 0	1,086 1,086	911 911	0 0	911 911	745 745	0 0	745 745
(4) Sub-Total (2) + (3)	55,029 8,039	13,747 3,117	68,776 11,156	7,211 1,059	2,094 516	9,305 1,575	11,528 1,712	3,132 694	14,660 2,406	9,990 1,467	2,308 543	12,298 2,010	8,311 1,200	1,746 421	10,057 1,621
(5) Physical Contingency (4) x 10%	5,502 805	1,374 311	6,876 1,116	721 106	209 52	930 158	1,153 171	313 69	1,466 240	998 148	230 54	1,228 202	831 120	175 42	1,006 162
(6) Sub-Total (1)+(4)+(5)	60,531 8,844	18,379 3,428	78,910 12,272	7,932 1,165	2,581 568	10,513 1,733	12,681 1,883	3,658 763	16,339 2,646	10,988 1,615	3,005 597	13,993 2,212	9,142 1,320	2,861 463	12,003 1,783
(7) Price Contingency	16,243 2,366	11,338 2,005	27,581 4,371	990 145	670 148	1,660 293	2,154 320	1,318 274	3,472 594	2,381 350	1,411 280	3,792 630	2,426 351	1,679 271	4,105 622
(8) TOTAL	76,774 11,210	29,717 5,433	106,491 16,643	8,922 1,310	3,251 716	12,173 2,026	14,835 2,203	4,976 1,037	19,811 3,240	13,369 1,965	4,416 877	17,785 2,842	11,568 1,671	4,540 734	16,108 2,405

DESCRIPTION	1996			1997			1998			1999			2000		
	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL	F/C	L/C	TOTAL
(1) Land Acquisition	0	0	0	0	740	740	0	0	0	0	620	620	0	0	0
(2) Direct Cost	2,595 156	401 97	2,996 253	4,959 281	1,699 354	6,658 635	2,609 148	527 110	3,136 258	3,991 228	1,406 292	5,397 520	2,171 124	434 90	2,605 214
(3) Engineering Service (2) x 8%	240 240	0 0	240 240	533 533	0 0	533 533	251 251	0 0	251 251	432 432	0 0	432 432	208 208	0 0	208 208
(4) Sub-Total (2) + (3)	2,835 396	401 97	3,236 493	5,492 814	1,699 354	7,191 1,168	2,860 399	527 110	3,387 509	4,423 660	1,406 292	5,829 952	2,379 332	434 90	2,813 422
(5) Physical Contingency (4) x 10%	284 40	40 10	324 50	549 81	170 35	719 116	286 40	53 11	339 51	442 66	141 29	583 95	238 33	43 9	281 42
(6) Sub-Total (1)+(4)+(5)	3,119 436	441 107	3,560 543	6,041 895	2,609 389	8,650 1,284	3,146 439	580 121	3,726 560	4,865 726	2,167 321	7,032 1,047	2,617 365	477 99	3,094 464
(7) Price Contingency	985 138	315 76	1,300 214	2,227 330	2,220 331	4,447 661	1,332 186	579 121	1,911 307	2,336 349	2,511 372	4,847 721	1,412 197	635 132	2,047 329
(8) TOTAL	4,104 574	756 183	4,860 757	8,268 1,225	4,829 720	13,097 1,945	4,478 625	1,159 242	5,637 867	7,201 1,075	4,678 693	11,879 1,768	4,029 562	1,112 231	5,141 793

NOTE Lower line: Personnel expenses

Table 6.4.3 (1/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- MAHANKAL CHAUR -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1994	7.6	0.5	70.4	41.0	8.0	74.9	202
1995	7.6	0.5	66.1	35.1	8.0	74.9	192
1996	7.6	0.5	53.6	24.6	8.0	74.9	169
1997	7.6	0.5	59.5	30.2	8.0	74.9	181
1998	7.6	0.5	65.1	33.9	8.0	74.9	190
1999	7.6	0.5	59.6	30.2	8.0	74.9	181
2000	7.6	0.5	67.2	35.2	8.0	74.9	193
2001	7.6	0.5	62.9	32.8	8.0	74.9	187
2002	7.6	0.5	62.9	32.8	8.0	74.9	187
2003	7.6	0.5	62.9	32.8	8.0	74.9	187
2004	7.6	0.5	62.9	32.8	8.0	74.9	187
2005	7.6	0.5	62.9	32.8	8.0	74.9	187
2006	7.6	0.5	62.9	32.8	8.0	74.9	187
2007	7.6	0.5	62.9	32.8	8.0	74.9	187
2008	7.6	0.5	62.9	32.8	8.0	74.9	187
2009	7.6	0.5	62.9	32.8	8.0	74.9	187
2010	7.6	0.5	62.9	32.8	8.0	74.9	187
2011	7.6	0.5	62.9	32.8	8.0	74.9	187
2012	7.6	0.5	62.9	32.8	8.0	74.9	187
2013	7.6	0.5	62.9	32.8	8.0	74.9	187
2014	7.6	0.5	62.9	32.8	8.0	74.9	187
2015	7.6	0.5	62.9	32.8	8.0	74.9	187
2016	7.6	0.5	62.9	32.8	8.0	74.9	187
2017	7.6	0.5	62.9	32.8	8.0	74.9	187
2018	7.6	0.5	62.9	32.8	8.0	74.9	187
2019	7.6	0.5	62.9	32.8	8.0	74.9	187
2020	7.6	0.5	62.9	32.8	8.0	74.9	187
2021	7.6	0.5	62.9	32.8	8.0	74.9	187
2022	7.6	0.5	62.9	32.8	8.0	74.9	187
2023	7.6	0.5	62.9	32.8	8.0	74.9	187

Table 6.4.3 (2/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- BANSBARI -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1995	6.7	0.5	38.3	47.5	6.7	63.6	163
1996	6.7	0.5	24.9	26.7	6.7	63.6	129
1997	6.7	0.5	28.2	31.2	6.7	63.6	137
1998	6.7	0.5	33.2	37.5	6.7	63.6	148
1999	6.7	0.5	28.5	31.5	6.7	63.6	138
2000	6.7	0.5	34.4	39.0	6.7	63.6	151
2001	6.7	0.5	32.2	36.3	6.7	63.6	146
2002	6.7	0.5	32.2	36.3	6.7	63.6	146
2003	6.7	0.5	32.2	36.3	6.7	63.6	146
2004	6.7	0.5	32.2	36.3	6.7	63.6	146
2005	6.7	0.5	32.2	36.3	6.7	63.6	146
2006	6.7	0.5	32.2	36.3	6.7	63.6	146
2007	6.7	0.5	32.2	36.3	6.7	63.6	146
2008	6.7	0.5	32.2	36.3	6.7	63.6	146
2009	6.7	0.5	32.2	36.3	6.7	63.6	146
2010	6.7	0.5	32.2	36.3	6.7	63.6	146
2011	6.7	0.5	32.2	36.3	6.7	63.6	146
2012	6.7	0.5	32.2	36.3	6.7	63.6	146
2013	6.7	0.5	32.2	36.3	6.7	63.6	146
2014	6.7	0.5	32.2	36.3	6.7	63.6	146
2015	6.7	0.5	32.2	36.3	6.7	63.6	146
2016	6.7	0.5	32.2	36.3	6.7	63.6	146
2017	6.7	0.5	32.2	36.3	6.7	63.6	146
2018	6.7	0.5	32.2	36.3	6.7	63.6	146
2019	6.7	0.5	32.2	36.3	6.7	63.6	146
2020	6.7	0.5	32.2	36.3	6.7	63.6	146
2021	6.7	0.5	32.2	36.3	6.7	63.6	146
2022	6.7	0.5	32.2	36.3	6.7	63.6	146
2023	6.7	0.5	32.2	36.3	6.7	63.6	146
2024	6.7	0.5	32.2	36.3	6.7	63.6	146

Table 6.4.3 (3/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- SHAIBHU -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1995	1.9	0.1	1.7	3.9	2.0	22.1	32
1996	1.9	0.1	1.5	3.2	2.0	22.1	31
1997	1.9	0.1	1.6	3.3	2.0	22.1	31
1998	1.9	0.1	1.7	3.9	2.0	22.1	32
1999	1.9	0.1	1.5	3.3	2.0	22.1	31
2000	1.9	0.1	1.7	3.9	2.0	22.1	32
2001	1.9	0.1	1.6	3.3	2.0	22.1	31
2002	1.9	0.1	1.6	3.3	2.0	22.1	31
2003	1.9	0.1	1.6	3.3	2.0	22.1	31
2004	1.9	0.1	1.6	3.3	2.0	22.1	31
2005	1.9	0.1	1.6	3.3	2.0	22.1	31
2006	1.9	0.1	1.6	3.3	2.0	22.1	31
2007	1.9	0.1	1.6	3.3	2.0	22.1	31
2008	1.9	0.1	1.6	3.3	2.0	22.1	31
2009	1.9	0.1	1.6	3.3	2.0	22.1	31
2010	1.9	0.1	1.6	3.3	2.0	22.1	31
2011	1.9	0.1	1.6	3.3	2.0	22.1	31
2012	1.9	0.1	1.6	3.3	2.0	22.1	31
2013	1.9	0.1	1.6	3.3	2.0	22.1	31
2014	1.9	0.1	1.6	3.3	2.0	22.1	31
2015	1.9	0.1	1.6	3.3	2.0	22.1	31
2016	1.9	0.1	1.6	3.3	2.0	22.1	31
2017	1.9	0.1	1.6	3.3	2.0	22.1	31
2018	1.9	0.1	1.6	3.3	2.0	22.1	31
2019	1.9	0.1	1.6	3.3	2.0	22.1	31
2020	1.9	0.1	1.6	3.3	2.0	22.1	31
2021	1.9	0.1	1.6	3.3	2.0	22.1	31
2022	1.9	0.1	1.6	3.3	2.0	22.1	31
2023	1.9	0.1	1.6	3.3	2.0	22.1	31
2024	1.9	0.1	1.6	3.3	2.0	22.1	31

Table 6.4.3 (4/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- BALAJU -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1996	3.0	0.2	24.2	1.1	2.5	16.4	47
1997	3.0	0.2	24.2	1.1	2.5	16.4	47
1998	3.0	0.2	24.2	1.1	2.5	16.4	47
1999	3.0	0.2	24.2	1.1	2.5	16.4	47
2000	3.0	0.2	24.2	1.1	2.5	16.4	47
2001	3.0	0.2	24.2	1.1	2.5	16.4	47
2002	3.0	0.2	24.2	1.1	2.5	16.4	47
2003	3.0	0.2	24.2	1.1	2.5	16.4	47
2004	3.0	0.2	24.2	1.1	2.5	16.4	47
2005	3.0	0.2	24.2	1.1	2.5	16.4	47
2006	3.0	0.2	24.2	1.1	2.5	16.4	47
2007	3.0	0.2	24.2	1.1	2.5	16.4	47
2008	3.0	0.2	24.2	1.1	2.5	16.4	47
2009	3.0	0.2	24.2	1.1	2.5	16.4	47
2010	3.0	0.2	24.2	1.1	2.5	16.4	47
2011	3.0	0.2	24.2	1.1	2.5	16.4	47
2012	3.0	0.2	24.2	1.1	2.5	16.4	47
2013	3.0	0.2	24.2	1.1	2.5	16.4	47
2014	3.0	0.2	24.2	1.1	2.5	16.4	47
2015	3.0	0.2	24.2	1.1	2.5	16.4	47
2016	3.0	0.2	24.2	1.1	2.5	16.4	47
2017	3.0	0.2	24.2	1.1	2.5	16.4	47
2018	3.0	0.2	24.2	1.1	2.5	16.4	47
2019	3.0	0.2	24.2	1.1	2.5	16.4	47
2020	3.0	0.2	24.2	1.1	2.5	16.4	47
2021	3.0	0.2	24.2	1.1	2.5	16.4	47
2022	3.0	0.2	24.2	1.1	2.5	16.4	47
2023	3.0	0.2	24.2	1.1	2.5	16.4	47
2024	3.0	0.2	24.2	1.1	2.5	16.4	47
2025	3.0	0.2	24.2	1.1	2.5	16.4	47

Table 6.4.3 (5/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- LAMBAGAR -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1996	3.7	0.3	24.5	31.4	4.7	55.3	120
1997	3.7	0.3	26.7	34.2	4.7	55.3	125
1998	3.7	0.3	28.6	36.6	4.7	55.3	129
1999	3.7	0.3	26.4	33.6	4.7	55.3	124
2000	3.7	0.3	28.6	36.5	4.7	55.3	129
2001	3.7	0.3	27.2	34.5	4.7	55.3	126
2002	3.7	0.3	27.2	34.5	4.7	55.3	126
2003	3.7	0.3	27.2	34.5	4.7	55.3	126
2004	3.7	0.3	27.2	34.5	4.7	55.3	126
2005	3.7	0.3	27.2	34.5	4.7	55.3	126
2006	3.7	0.3	27.2	34.5	4.7	55.3	126
2007	3.7	0.3	27.2	34.5	4.7	55.3	126
2008	3.7	0.3	27.2	34.5	4.7	55.3	126
2009	3.7	0.3	27.2	34.5	4.7	55.3	126
2010	3.7	0.3	27.2	34.5	4.7	55.3	126
2011	3.7	0.3	27.2	34.5	4.7	55.3	126
2012	3.7	0.3	27.2	34.5	4.7	55.3	126
2013	3.7	0.3	27.2	34.5	4.7	55.3	126
2014	3.7	0.3	27.2	34.5	4.7	55.3	126
2015	3.7	0.3	27.2	34.5	4.7	55.3	126
2016	3.7	0.3	27.2	34.5	4.7	55.3	126
2017	3.7	0.3	27.2	34.5	4.7	55.3	126
2018	3.7	0.3	27.2	34.5	4.7	55.3	126
2019	3.7	0.3	27.2	34.5	4.7	55.3	126
2020	3.7	0.3	27.2	34.5	4.7	55.3	126
2021	3.7	0.3	27.2	34.5	4.7	55.3	126
2022	3.7	0.3	27.2	34.5	4.7	55.3	126
2023	3.7	0.3	27.2	34.5	4.7	55.3	126
2024	3.7	0.3	27.2	34.5	4.7	55.3	126
2025	3.7	0.3	27.2	34.5	4.7	55.3	126

Table 6.4.3 (6/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- SUNDARIJAL -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1997	5.3	0.4	50.1	16.7	6.3	69.0	148
1998	5.3	0.4	50.1	16.7	6.3	69.0	148
1999	5.3	0.4	50.1	16.7	6.3	69.0	148
2000	5.3	0.4	50.1	16.7	6.3	69.0	148
2001	5.3	0.4	50.1	16.7	6.3	69.0	148
2002	5.3	0.4	50.1	16.7	6.3	69.0	148
2003	5.3	0.4	50.1	16.7	6.3	69.0	148
2004	5.3	0.4	50.1	16.7	6.3	69.0	148
2005	5.3	0.4	50.1	16.7	6.3	69.0	148
2006	5.3	0.4	50.1	16.7	6.3	69.0	148
2007	5.3	0.4	50.1	16.7	6.3	69.0	148
2008	5.3	0.4	50.1	16.7	6.3	69.0	148
2009	5.3	0.4	50.1	16.7	6.3	69.0	148
2010	5.3	0.4	50.1	16.7	6.3	69.0	148
2011	5.3	0.4	50.1	16.7	6.3	69.0	148
2012	5.3	0.4	50.1	16.7	6.3	69.0	148
2013	5.3	0.4	50.1	16.7	6.3	69.0	148
2014	5.3	0.4	50.1	16.7	6.3	69.0	148
2015	5.3	0.4	50.1	16.7	6.3	69.0	148
2016	5.3	0.4	50.1	16.7	6.3	69.0	148
2017	5.3	0.4	50.1	16.7	6.3	69.0	148
2018	5.3	0.4	50.1	16.7	6.3	69.0	148
2019	5.3	0.4	50.1	16.7	6.3	69.0	148
2020	5.3	0.4	50.1	16.7	6.3	69.0	148
2021	5.3	0.4	50.1	16.7	6.3	69.0	148
2022	5.3	0.4	50.1	16.7	6.3	69.0	148
2023	5.3	0.4	50.1	16.7	6.3	69.0	148
2024	5.3	0.4	50.1	16.7	6.3	69.0	148
2025	5.3	0.4	50.1	16.7	6.3	69.0	148
2026	5.3	0.4	50.1	16.7	6.3	69.0	148

Table 6.4.3 (7/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- MANOHARA -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
1999	4.5	0.3	34.8	14.6	5.7	64.9	125
2000	4.5	0.3	34.8	14.6	5.7	64.9	125
2001	4.5	0.3	34.8	14.6	5.7	64.9	125
2002	4.5	0.3	34.8	14.6	5.7	64.9	125
2003	4.5	0.3	34.8	14.6	5.7	64.9	125
2004	4.5	0.3	34.8	14.6	5.7	64.9	125
2005	4.5	0.3	34.8	14.6	5.7	64.9	125
2006	4.5	0.3	34.8	14.6	5.7	64.9	125
2007	4.5	0.3	34.8	14.6	5.7	64.9	125
2008	4.5	0.3	34.8	14.6	5.7	64.9	125
2009	4.5	0.3	34.8	14.6	5.7	64.9	125
2010	4.5	0.3	34.8	14.6	5.7	64.9	125
2011	4.5	0.3	34.8	14.6	5.7	64.9	125
2012	4.5	0.3	34.8	14.6	5.7	64.9	125
2013	4.5	0.3	34.8	14.6	5.7	64.9	125
2014	4.5	0.3	34.8	14.6	5.7	64.9	125
2015	4.5	0.3	34.8	14.6	5.7	64.9	125
2016	4.5	0.3	34.8	14.6	5.7	64.9	125
2017	4.5	0.3	34.8	14.6	5.7	64.9	125
2018	4.5	0.3	34.8	14.6	5.7	64.9	125
2019	4.5	0.3	34.8	14.6	5.7	64.9	125
2020	4.5	0.3	34.8	14.6	5.7	64.9	125
2021	4.5	0.3	34.8	14.6	5.7	64.9	125
2022	4.5	0.3	34.8	14.6	5.7	64.9	125
2023	4.5	0.3	34.8	14.6	5.7	64.9	125
2024	4.5	0.3	34.8	14.6	5.7	64.9	125
2025	4.5	0.3	34.8	14.6	5.7	64.9	125
2026	4.5	0.3	34.8	14.6	5.7	64.9	125
2027	4.5	0.3	34.8	14.6	5.7	64.9	125
2028	4.5	0.3	34.8	14.6	5.7	64.9	125

Table 6.4.3 (8/8) OPERATION, MAINTENANCE AND REPLACEMENT COST FOR EACH SYSTEM

- BALKHU -

YEAR	OPERATION, MAINTENANCE AND REPLACEMENT COST						TOTAL
	Personnel expenses	Office maintenance	Chemical reagent	Electoric energy	Facility maintenance	Facility replacement	(US$1000)
2001	4.5	0.3	33.2	10.4	4.7	52.4	106
2002	4.5	0.3	33.2	10.4	4.7	52.4	106
2003	4.5	0.3	33.2	10.4	4.7	52.4	106
2004	4.5	0.3	33.2	10.4	4.7	52.4	106
2005	4.5	0.3	33.2	10.4	4.7	52.4	106
2006	4.5	0.3	33.2	10.4	4.7	52.4	106
2007	4.5	0.3	33.2	10.4	4.7	52.4	106
2008	4.5	0.3	33.2	10.4	4.7	52.4	106
2009	4.5	0.3	33.2	10.4	4.7	52.4	106
2010	4.5	0.3	33.2	10.4	4.7	52.4	106
2011	4.5	0.3	33.2	10.4	4.7	52.4	106
2012	4.5	0.3	33.2	10.4	4.7	52.4	106
2013	4.5	0.3	33.2	10.4	4.7	52.4	106
2014	4.5	0.3	33.2	10.4	4.7	52.4	106
2015	4.5	0.3	33.2	10.4	4.7	52.4	106
2016	4.5	0.3	33.2	10.4	4.7	52.4	106
2017	4.5	0.3	33.2	10.4	4.7	52.4	106
2018	4.5	0.3	33.2	10.4	4.7	52.4	106
2019	4.5	0.3	33.2	10.4	4.7	52.4	106
2020	4.5	0.3	33.2	10.4	4.7	52.4	106
2021	4.5	0.3	33.2	10.4	4.7	52.4	106
2022	4.5	0.3	33.2	10.4	4.7	52.4	106
2023	4.5	0.3	33.2	10.4	4.7	52.4	106
2024	4.5	0.3	33.2	10.4	4.7	52.4	106
2025	4.5	0.3	33.2	10.4	4.7	52.4	106
2026	4.5	0.3	33.2	10.4	4.7	52.4	106
2027	4.5	0.3	33.2	10.4	4.7	52.4	106
2028	4.5	0.3	33.2	10.4	4.7	52.4	106
2029	4.5	0.3	33.2	10.4	4.7	52.4	106
2030	4.5	0.3	33.2	10.4	4.7	52.4	106

Table 7.1.1 CONDITIONS AND ASSUMPTIONS IN ESTIMATING ECONOMIC COST AND BENEFIT

Conditions and assumptions in estimating the economic cost and benefit of the project are set in consideration of historic trends and present situation of Nepalese economy as follows:

(1) The estimates are made based on prices in January 1990, and foreign exchange rate is set to be US$. 1 = NRs. 30;

(2) Transfer payments such as taxes and duties are assumed to be 10% of prices of goods and services procured locally, and to be exempted from duties for commodities imported from abroad (except facilities to be replaced during the period 2001-2030);

(3) Standard conversion rate of 93%, which is estimated from the export and import statistics for recent five years, is applied for commodities and services procured locally;

(4) Economic wage of unskilled laborers for construction works is assumed to be 75% of the actual market wage, taking account of the employment opportunity of laborers in the Kathmandu valley;

(5) Opportunity cost of land acquired for the construction of proposed facilities is assumed to be 10% of the actual acquisition cost, taking account of the existing land use.

Table 7.1.2 ANNUAL FLOW OF ECONOMIC COST AND BENEFIT

Unit: US$ 1,000

Year in Order	Year	Economic Cost			Economic Benefit
		Construction cost	OMR cost	Total	
1.	1992	9,774	-	9,774	-
2.	1993	15,398	-	15,398	-
3.	1994	13,033	175	13,208	896
4.	1995	10,744	339	11,083	1,563
5.	1996	3,467	440	3,907	1,787
6.	1997	7,584	591	8,175	2,869
7.	1998	3,603	611	4,214	3,144
8.	1999	6,143	703	6,846	3,443
9.	2000	2,993	728	3,721	3,760
10.	2001	-	810	810	4,115
11.	2002	-	810	810	4,185
12.	2003	-	810	810	4,256
13.	2004	-	810	810	4,329
14.	2005	-	810	810	4,404
15.	2006	-	810	810	4,480
16.	2007	-	810	810	4,557
17.	2008	-	810	810	4,637
18.	2009	-	810	810	4,717
19.	2010	-	810	810	4,799
20.	2011	-	810	810	4,883
21.	2012	-	810	810	4,969
22.	2013	-	810	810	5,056
23.	2014	-	810	810	5,145
24.	2015	-	810	810	5,236
25.	2016	-	810	810	5,329
26.	2017	-	810	810	5,423
27.	2018	-	810	810	5,519
28.	2019	-	810	810	5,618
29.	2020	-	810	810	5,718
30.	2021	-	810	810	5,820
31.	2022	-	810	810	5,925
32.	2023	-	810	810	6,031
33.	2024	-	647	647	4,980
34.	2025	-	489	489	4,265
35.	2026	-	337	337	3,041
36.	2027	-	206	206	1,779
37.	2028	-	206	206	1,812
38.	2029	-	95	95	904
39.	2030	-	95	95	921
	Total	72,739	24,292	97,031	150,315

Table 7.2.1 CASH FLOW STATEMENT

Unit: US$ 1,000

Year in Order	Year	Capital Cost		Loan Payment (F/C)		Loan Payment (L/C)		OMR Cost	Total Cost	Const. Fund		Revenue	Total Revenue	Surplus or Deficit	Accumu-lation	Year
		F/C	L/C	Interest	Capital	Interest	Capital			F/C	L/C					
1.	1992	8,922	3,251	-	-	-	-	-	12,174	8,922	3,251	-	12,174	0	0	1992
2.	1993	14,812	4,977	89	-	33	-	-	19,910	14,812	4,977	-	19,788	-122	-122	1993
3.	1994	13,369	4,415	237	-	82	-	297	18,400	13,369	4,415	790	18,574	174	52	1994
4.	1995	11,568	4,540	371	-	126	-	614	17,219	11,568	4,540	1,299	17,406	187	239	1995
5.	1996	4,104	756	487	-	172	-	850	6,369	4,104	756	1,513	6,373	4	243	1996
6.	1997	8,268	4,829	528	-	179	-	1,238	15,042	8,268	4,829	2,531	15,628	586	829	1997
7.	1998	4,478	1,159	610	-	228	-	1,387	7,863	4,478	1,159	2,801	8,438	576	1,405	1998
8.	1999	7,201	4,678	655	-	239	-	1,712	14,486	7,201	4,678	3,094	14,974	488	1,893	1999
9.	2000	4,029	1,112	727	-	286	-	1,924	8,078	4,029	1,112	3,408	8,548	471	2,364	2000
10.	2001	-	-	767	-	297	-	2,304	3,369	-	-	3,744	3,744	375	2,739	2001
11.	2002	-	-	767	3,837	297	1,486	2,442	8,830	-	-	4,043	4,043	-4,787	-2,049	2002
12.	2003	-	-	729	3,837	282	1,486	2,589	8,924	-	-	4,367	4,367	-4,557	-6,606	2003
13.	2004	-	-	691	3,837	267	1,486	2,744	9,026	-	-	4,716	4,716	-4,310	-10,916	2004
14.	2005	-	-	652	3,837	253	1,486	2,909	9,137	-	-	5,093	5,093	-4,044	-14,960	2005
15.	2006	-	-	614	3,837	238	1,486	3,083	9,259	-	-	5,501	5,501	-3,758	-18,718	2006
16.	2007	-	-	576	3,837	223	1,486	3,268	9,390	-	-	5,941	5,941	-3,450	-22,167	2007
17.	2008	-	-	537	3,837	208	1,486	3,465	9,533	-	-	6,416	6,416	-3,117	-25,285	2008
18.	2009	-	-	499	3,837	193	1,486	3,672	9,688	-	-	6,929	6,929	-2,759	-28,043	2009
19.	2010	-	-	460	3,837	178	1,486	3,893	9,855	-	-	7,484	7,484	-2,371	-30,415	2010
20.	2011	-	-	422	3,837	163	1,486	4,126	10,035	-	-	8,082	8,082	-1,953	-32,368	2011
21.	2012	-	-	384	3,837	149	1,486	4,374	10,230	-	-	8,729	8,729	-1,501	-33,868	2012
22.	2013	-	-	345	3,837	134	1,486	4,636	10,439	-	-	9,427	9,427	-1,012	-34,880	2013
23.	2014	-	-	307	3,837	119	1,486	4,915	10,664	-	-	10,181	10,181	-482	-35,362	2014
24.	2015	-	-	269	3,837	104	1,486	5,209	10,905	-	-	10,996	10,996	90	-35,272	2015
25.	2016	-	-	230	3,837	89	1,486	5,522	11,165	-	-	11,876	11,876	711	-34,561	2016
26.	2017	-	-	192	3,837	74	1,486	5,853	11,443	-	-	12,826	12,826	1,383	-33,178	2017
27.	2018	-	-	153	3,837	59	1,486	6,204	11,741	-	-	13,852	13,852	2,111	-31,068	2018
28.	2019	-	-	115	3,837	45	1,486	6,577	12,060	-	-	14,960	14,960	2,900	-28,168	2019
29.	2020	-	-	77	3,837	30	1,486	6,971	12,401	-	-	16,157	16,157	3,755	-24,412	2020
30.	2021	-	-	38	3,837	15	1,486	7,390	12,766	-	-	17,449	17,449	4,683	-19,729	2021
31.	2022	-	-	-	-	-	-	7,833	7,833	-	-	18,845	18,845	11,012	-8,717	2022
32.	2023	-	-	-	-	-	-	8,303	8,303	-	-	20,353	20,353	12,050	3,332	2023
33.	2024	-	-	-	-	-	-	7,002	7,002	-	-	17,839	17,839	10,836	14,169	2024
34.	2025	-	-	-	-	-	-	5,618	5,618	-	-	16,582	16,582	10,964	25,133	2025
35.	2026	-	-	-	-	-	-	4,085	4,085	-	-	12,539	12,539	8,453	33,587	2026
36.	2027	-	-	-	-	-	-	2,635	2,635	-	-	7,775	7,775	5,140	38,727	2027
37.	2028	-	-	-	-	-	-	2,793	2,793	-	-	8,397	8,397	5,604	44,331	2028
38.	2029	-	-	-	-	-	-	1,364	1,364	-	-	4,442	4,442	3,077	47,408	2029
39.	2030	-	-	-	-	-	-	1,446	1,446	-	-	4,797	4,797	3,351	50,759	2030

Note: Fifures are rounded off for fractions at the first decimal place.

Table 7.2.2 CASH FLOW STATEMENT

Unit: US$ 1,000

Year in Order	Year	Capital Cost F/C	Capital Cost L/C	Loan Payment (F/C) Interest	Loan Payment (F/C) Capital	Loan Payment (L/C) Interest	Loan Payment (L/C) Capital	OMR Cost	Total Cost	Const. Fund F/C	Const. Fund L/C	Revenue	Total Revenue	Surplus or Deficit	Accumu- lation	Year
1.	1992	8,922	3,251	-	-	-	-	-	12,174	8,922	3,251	-	12,174	0	0	1992
2.	1993	14,812	4,677	89	-	33	-	-	19,910	14,812	4,977	-	19,788	-122	-122	1993
3.	1994	13,369	4,415	237	-	82	-	297	18,400	13,369	4,415	741	18,525	124	3	1994
4.	1995	11,568	4,540	371	-	126	-	614	17,219	11,568	4,540	1,218	17,325	106	109	1995
5.	1996	4,104	756	487	-	172	-	850	6,369	4,104	756	1,418	6,278	-90	18	1996
6.	1997	8,268	4,829	528	-	179	-	1,238	15,042	8,268	4,829	2,373	15,470	428	446	1997
7.	1998	4,478	1,159	610	-	228	-	1,387	7,863	4,478	1,159	2,626	8,263	401	847	1998
8.	1999	7,201	4,678	655	-	239	-	1,712	14,486	7,201	4,678	2,901	14,781	294	1,141	1999
9.	2000	4,029	1,112	727	-	286	-	1,924	8,078	4,029	1,112	3,195	8,335	258	1,399	2000
10.	2001	-	-	767	-	297	-	2,304	3,369	-	-	3,510	3,510	141	1,540	2001
11.	2002	-	-	767	3,837	297	1,486	2,442	8,830	-	-	3,790	3,790	-5,040	-3,500	2002
12.	2003	-	-	729	3,837	282	1,486	2,589	8,924	-	-	4,094	4,094	-4,830	-8,330	2003
13.	2004	-	-	691	3,837	267	1,486	2,744	9,026	-	-	4,421	4,421	-4,605	-12,935	2004
14.	2005	-	-	652	3,837	253	1,486	2,909	9,137	-	-	4,775	4,775	-4,362	-17,297	2005
15.	2006	-	-	614	3,837	238	1,486	3,083	9,259	-	-	5,157	5,157	-4,102	-21,399	2006
16.	2007	-	-	576	3,837	223	1,486	3,268	9,390	-	-	5,569	5,569	-3,821	-25,220	2007
17.	2008	-	-	537	3,837	208	1,486	3,465	9,533	-	-	6,015	6,015	-3,518	-28,738	2008
18.	2009	-	-	498	3,837	193	1,486	3,672	9,688	-	-	6,496	6,496	-3,192	-31,930	2009
19.	2010	-	-	460	3,837	178	1,486	3,893	9,855	-	-	7,016	7,016	-2,839	-34,769	2010
20.	2011	-	-	422	3,837	163	1,486	4,126	10,035	-	-	7,577	7,577	-2,458	-37,227	2011
21.	2012	-	-	384	3,837	149	1,486	4,374	10,230	-	-	8,183	8,183	-2,046	-39,273	2012
22.	2013	-	-	345	3,837	134	1,486	4,636	10,439	-	-	8,838	8,838	-1,601	-40,874	2013
23.	2014	-	-	307	3,837	119	1,486	4,915	10,664	-	-	9,545	9,545	-1,119	-41,993	2014
24.	2015	-	-	269	3,837	104	1,486	5,209	10,905	-	-	10,309	10,309	-597	-42,590	2015
25.	2016	-	-	230	3,837	89	1,486	5,522	11,165	-	-	11,133	11,133	-31	-42,621	2016
26.	2017	-	-	192	3,837	74	1,486	5,853	11,443	-	-	12,024	12,024	581	-42,040	2017
27.	2018	-	-	153	3,837	59	1,486	6,204	11,741	-	-	12,986	12,986	1,245	-40,795	2018
28.	2019	-	-	115	3,837	45	1,486	6,577	12,060	-	-	14,025	14,025	1,965	-38,830	2019
29.	2020	-	-	77	3,837	30	1,486	6,971	12,401	-	-	15,147	15,147	2,746	-36,084	2020
30.	2021	-	-	38	3,837	15	1,486	7,390	12,766	-	-	16,359	16,359	3,592	-32,492	2021
31.	2022	-	-	-	-	-	-	7,833	7,833	-	-	17,667	17,667	9,834	-22,658	2022
32.	2023	-	-	-	-	-	-	8,303	8,303	-	-	19,081	19,081	10,778	-11,880	2023
33.	2024	-	-	-	-	-	-	7,002	7,002	-	-	16,724	16,724	9,722	-2,159	2024
34.	2025	-	-	-	-	-	-	5,618	5,618	-	-	15,546	15,546	9,928	7,769	2025
35.	2026	-	-	-	-	-	-	4,085	4,085	-	-	11,755	11,755	7,670	15,439	2026
36.	2027	-	-	-	-	-	-	2,635	2,635	-	-	7,289	7,289	4,654	20,093	2027
37.	2028	-	-	-	-	-	-	2,793	2,793	-	-	7,872	7,872	5,079	25,173	2028
38.	2029	-	-	-	-	-	-	1,364	1,364	-	-	4,164	4,164	2,800	27,972	2029
39.	2030	-	-	-	-	-	-	1,446	1,446	-	-	4,497	4,497	3,051	31,024	2030

Note: Fifures are rounded off for fractions at the first decimal place.