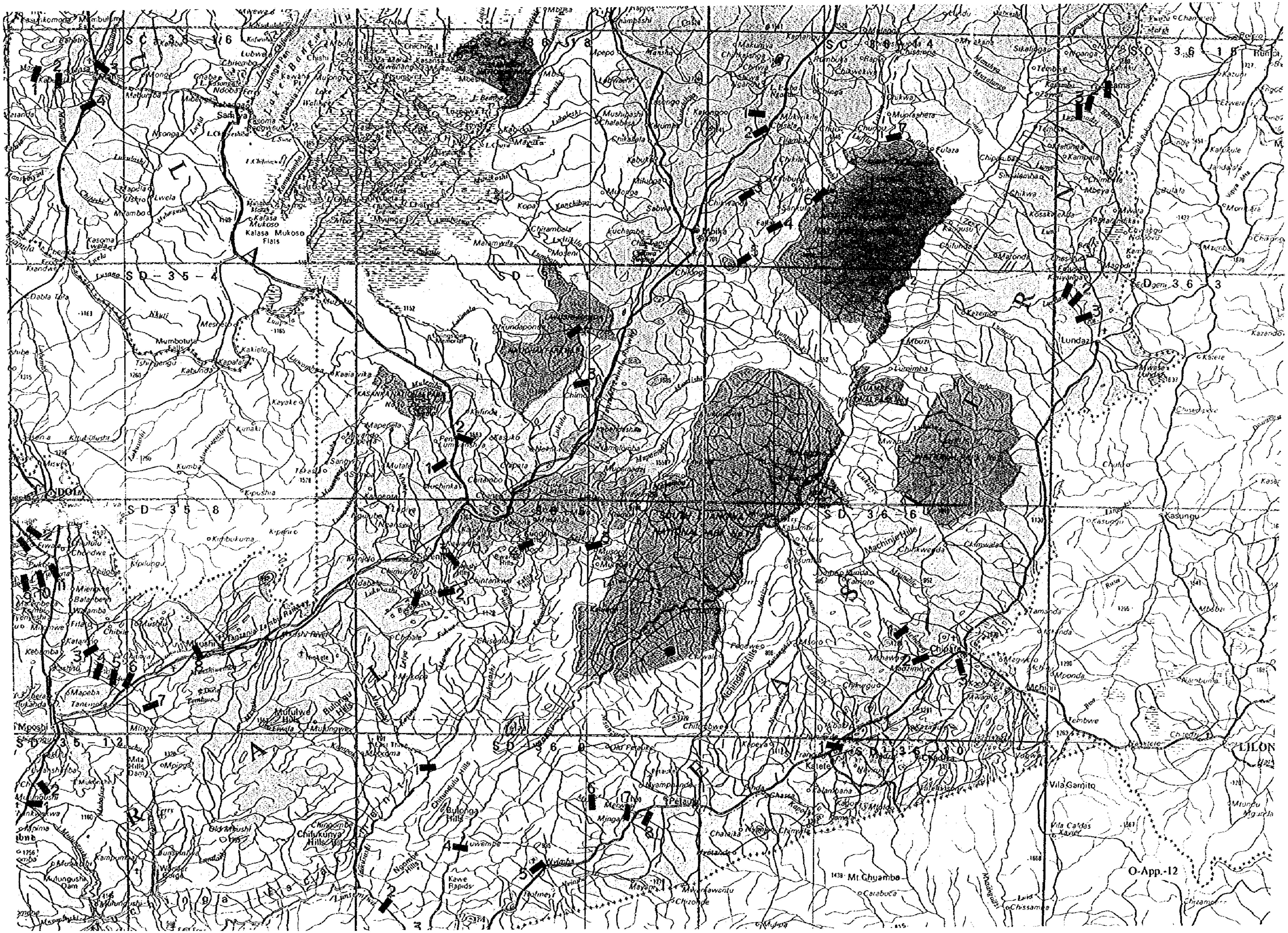
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SD-35-8
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SD-36-3
SD-36-16
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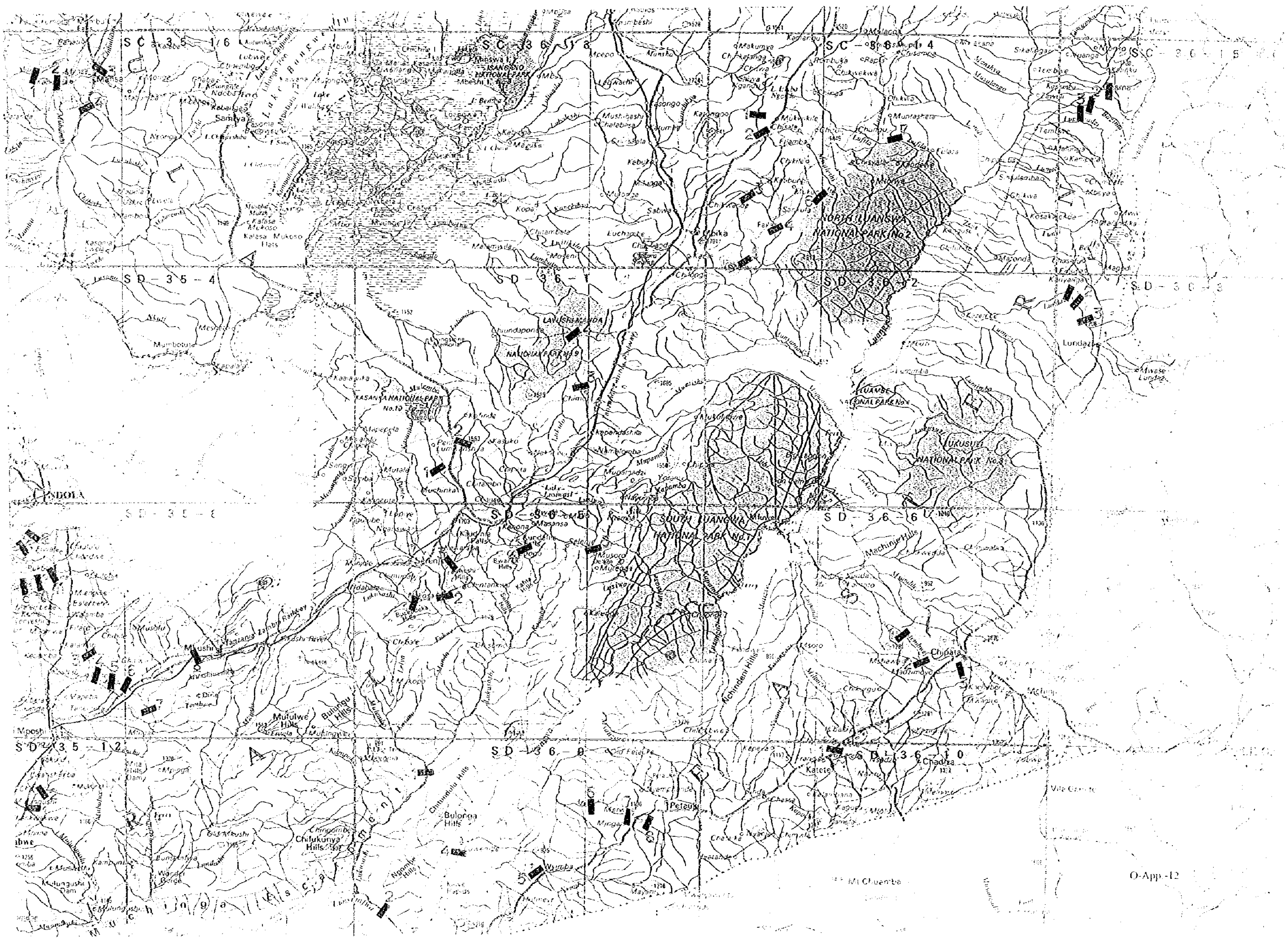
Lundazi
Kasungu
Chipata
Mchinji
Petauke
Mkushi
Mulungushi Dam
Mt Chyamba
Vila Gamito
Machinje Hills
Mufulwe Hills
Bulonga Hills
Chifukunya Hills
Nchindeni Hills
SOUTH LUANGWA NATIONAL PARK
KASANKA NATIONAL PARK
O-App.-12



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SC-36-13
SC-36-14
SC-36-15
SD-35-4
SD-36-1
SD-36-2
SD-36-3
SD-35-8
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SD-36-6
SD-35-12
SD-36-9
SD-36-10
ISANGANO NATIONAL PARK
NORTH LUANGWA NATIONAL PARK No.2
LAVUSHI MANDA NATIONAL PARK No.9
KASANKA NATIONAL PARK No.10
LUKUSUZI NATIONAL PARK No.3
SOUTH LUANGWA NATIONAL PARK No.1
Mansa
Samfya
Mpika
Lundazi
NDOLA
Mkushi
Tanzania Zambia Railway
Chipata
Petauke
Nyimba
Mulungushi Dam
Mt Chuemba

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF ZAMBIA
MINISTRY OF ENERGY AND WATER DEVELOPMENT

THE STUDY

ON

THE NATIONAL WATER RESOURCES MASTER PLAN

IN

THE REPUBLIC OF ZAMBIA

FINAL REPORT

SUPPORTING REPORT [P]

WATER SUPPLY PLAN

OCTOBER, 1995

YACHIYO ENGINEERING CO., LTD.
(YEC)

THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT (T)
METEOROLOGY

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CHAPTER 1 FRAMEWORK OF PLAN

1.1 Water Demand Scenario

Water demands are projected for the three development scenarios outlined below. The corresponding socio-economic and sectoral projections are shown in Table 1-1.

1) Base Scenario - Agricultural Expansion

Water Supply Sector (Base Demand):	Population - Base Projection, Middle Water Demand
Agricultural Development Plan-1:	High Growth in Value Added of Agricultural Sector, Promotion of Export of Agricultural Products

2) Base Scenario - Industrialisation

Water Supply Sector (High Demand):	Population - High Projection, High Water Demand for Domestic and Industrial Use, Rapid Urbanisation and High Demand for Municipal Water Supply
Agricultural Development Plan-2:	Middle Growth in Value Added (VA) of Agricultural Sector, Self-supply of Agricultural Products to Highly Increased Population

3) Conservative Scenario

Water Supply Sector (Low Demand):	Population - Low Projection, Low Water Demand
Agricultural Development Plan-3:	Low Growth in Value Added of Agricultural Sector, Self-supply of Agricultural Products to Moderately Increased Population

Table 1-1 Economic and Population Projection for Each Scenario

	Base Scenario - Agricultural Expansion	Base Scenario - Industrialisation	Conservative Scenario
Economic Growth	Growth Rate in GDP per capita: 2.5% per annum to 2000, 1.25% per annum afterwards Growth Rate in VA of Agricultural Sector: 6% per annum to 2000 (based on ASIP), 3% per annum afterwards	Growth Rate in GDP per capita: same as Base Case Growth Rate in VA of Agricultural Sector: 1.1 times the Growth Rate of Population, the rest of VA to be covered by Manufacturing Sector	Growth Rate in GDP per capita: 0.3% per annum to 2000, 0.15% per annum afterwards Growth Rate in VA of Agricultural Sector: 1.1 times the Growth Rate of Population
	<Economic Indices in 2015> GDP: K. 3,230 billion (US$ 7.43 billion) GDP per capita: K. 254 thousand (US$ 583)	<Economic Indices in 2015> GDP: K. 3,630 billion (US$ 8.36 billion) GDP per capita: K. 254 thousand (US$ 583)	<Economic Indices in 2015> GDP: K. 2,170 billion (US$ 4.98 billion) GDP per capita: K. 187 thousand (US$ 480)
Population	Decrease in Population Growth Rate in 1970's and 1980's to continue after 1990, Population Growth Rate to decrease at an annual rate of 1.34%	Population Growth Rate in 1980's to continue after 1990, Annual Population Growth Rate to be 2.69%	Decrease in Population Growth Rate in 1970's and 1980's to double after 1990, Population Growth Rate to decrease at an annual rate of 2.69%
	< Population in 2015 > National: 12.74 million Urban: 4.82 million (38 %) Rural: 7.91 million (62 %) Ratio (1990=100): 173	< Population in 2015 > National: 14.34 million Urban: 6.95 million (48 %) Rural: 7.39 million (52 %) Ratio (1990=100): 194	< Population in 2015 > National: 11.59 million Urban: 4.51 million (39 %) Rural: 7.08 million (62 %) Ratio (1990=100): 159

1.2 Future Water Demand

Using the criteria outlined in the previous section, the source water requirement necessary to meet the projected demands for domestic and industrial water was calculated for the three development scenarios. The results are given below for the large urban, small urban and rural areas, as well as the national total water requirements.

<Total Water Requirement>

The total water requirement of all the urban and rural areas in the country was estimated at 1.21 million m^3/day in 1995, 1.61 million m^3/day in 2005 and 2.01 million m^3/day for the Base Scenario - Agricultural Expansion, as shown in Table 1-2. For the Base Scenario - Industrialisation, the total requirement sums to 2.00 million m^3/day in 2005, or 124% of the Base Scenario - Agricultural Expansion, increasing to 2.68 million m^3/day or 133% in 2015. For the Conservative Scenario, the total requirement is limited to 1.49 million m^3/day, accounting for 93% of the Base Scenario - Agricultural Expansion in 2005, and to 1.79 million m^3/day or 89% in 2015.

Table 1-2 Water Demand for Domestic and Industrial Use and Additional Capacity Requirement (Zambia Total)

(Unit: 1000 m^3/day)

	Base Scenario-Agricultural Expansion (medium population projection)				Base Scenario-Industrialisation (high population projection)				Conservative Scenario (low population projection)			
	Large Urban Areas	Small Urban Areas	Rural Areas	Total	Large Urban Areas	Small Urban Areas	Rural Areas	Total	Large Urban Areas	Small Urban Areas	Rural Areas	Total
Demand/ 1995												
Domestic Use	461	99	179	739	469	123	178	770	459	108	178	745
Industrial Use	210	55	0	265	265	77	0	342	195	57	0	252
Losses	168	23	18	209	183	30	18	231	163	25	18	206
Total	838	177	197	1,213	918	231	196	1,343	817	190	196	1,203
Demand/ 2005												
Domestic Use	618	122	217	957	663	199	214	1,076	593	128	208	929
Industrial Use	293	76	0	369	447	129	0	576	233	69	0	302
Losses	228	29	22	279	278	49	21	348	207	30	21	258
Total	1,139	227	239	1,608	1,388	378	235	2,000	1,033	226	229	1,489
Demand/ 2015												
Domestic Use	810	145	255	1,210	940	322	251	1,513	738	144	231	1,113
Industrial Use	362	85	0	447	552	145	0	697	287	77	0	364
Losses	293	34	25	352	373	70	25	468	256	33	23	312
Total	1,465	264	280	2,009	1,865	537	276	2,678	1,282	254	254	1,790
<Balance>												
Present Capacity	809	137	43	989	809	137	43	989	809	137	43	989
Shortage in 2005	-330	-90	-196	-619	-579	-241	-192	-1,011	-224	-89	-186	-500
(%)	29	40	82	38	42	64	82	51	22	39	81	34
Shortage in 2015	-655	-127	-237	-1,020	-1,056	-400	-233	-1,689	-473	-117	-211	-801
(%)	45	48	85	51	57	74	84	63	34	46	83	45

<Large Urban Areas (LUA's)>

The total water requirement of the public water supply systems for the 12 LUA's (3 cities and 9 municipalities) was estimated at 0.84 million m³/day in 1995, 1.14 million m³/day in 2005 and 1.46 m³/day in 2015, for the Base Scenario - Agricultural Expansion, as shown in Table 1-3. Of these 12 major towns, Lusaka city requires the largest water source of 0.31 million m³/day in 1995 increasing to 0.49 million m³/day in 2005 and 0.71 million m³/day in 2015. This demand accounts for 40% of the total requirement of the 12 major towns in 1995, 44% in 2005 and 50% in 2015.

Table 1-3 Source Water Requirement of Public Water Supply Systems and Water Balance in Large Urban Areas (Base Scenario - Agricultural Expansion)

(Unit: 1000 m³/day)

	111 Lusaka	211 Ndola	271 Kitwe	231 Chilila-bombwe	241 Chin-gola	251 Mufulira	261 Kalu-lushi	281 Luan-shya	311 Kabwe	611 Living-stone	811 Kasama	911 Chipata	Total
1995													
Domestic Water	174.2	69.9	57.7	9.1	27.7	23.5	5.5	22.7	35.0	15.3	9.6	10.7	461.1
Industrial Water	90.6	27.9	24.1	4.0	11.8	10.4	2.6	9.8	10.2	7.7	4.7	5.7	209.5
Sub-total	264.8	97.8	81.8	13.1	39.6	33.9	8.1	32.5	45.3	22.9	14.3	16.5	670.6
Losses	66.2	24.5	20.5	3.3	9.9	8.5	2.0	8.1	11.3	5.7	3.6	4.1	167.7
Total	331.0	122.3	102.3	16.4	49.5	42.4	10.1	40.7	56.6	28.7	17.9	20.6	838.3
2005													
Domestic Water	267.0	91.3	69.0	9.8	31.5	25.0	7.2	25.1	49.2	18.0	11.6	13.6	618.1
Industrial Water	126.9	39.1	33.6	5.6	16.5	14.5	3.7	13.7	14.5	10.6	6.5	8.0	293.2
Sub-total	393.9	130.4	102.6	15.4	48.0	39.5	10.9	38.8	63.7	28.6	18.1	21.6	911.3
Losses	98.5	32.6	25.6	3.9	12.0	9.9	2.7	9.7	15.9	7.1	4.5	5.4	227.8
Total	492.3	162.9	128.2	19.3	60.0	49.4	13.6	48.5	79.6	35.7	22.6	27.0	1139.1
2015													
Domestic Water	392.5	114.3	79.2	10.1	34.3	25.5	10.9	26.6	66.4	20.4	13.3	16.5	809.9
Industrial Water	177.3	46.5	36.7	5.5	17.0	13.9	4.4	13.8	18.6	11.4	7.1	9.3	361.5
Sub-total	569.8	160.8	115.9	15.6	51.3	39.4	15.3	40.4	85.0	31.8	20.4	25.8	1171.4
Losses	142.5	40.2	29.0	3.9	12.8	9.8	3.8	10.1	21.2	7.9	5.1	6.5	292.9
Total	712.3	201.0	144.8	19.5	64.1	49.2	19.1	50.5	106.2	39.7	25.5	32.3	1464.3
Balance													
Present Capacity	190.0	147.0	136.4	34.2	67.0	48.0	11.0	45.4	77.5	20.0	12.0	20.6	809.1
1995	-141.0	24.7	34.1	17.8	17.5	5.6	0.9	4.7	20.9	-8.7	-5.9	0.0	-29.2
2005	-302.3	-15.9	8.2	14.9	7.0	-1.4	-2.6	-3.1	-2.1	-15.7	-10.6	-6.4	-330.0
2015	-522.3	-54.0	-8.4	14.7	2.9	-1.2	-8.1	-5.1	-28.7	-19.7	-13.5	-11.7	-655.2

Note : Present supply capacity of Chipata is assumed to be the same as the present water demand because of no information.

<Townships (SUA's)>

The total water requirement of the public water supply systems for the other 80 townships (SUA's) across all 9 provinces was estimated at 0.17 million m³/day in 1995, 0.23 million m³/day in 2005 and 0.26 m³/day in 2015, for the Base Scenario - Agricultural Expansion, as shown in Table 1-4. Of the 9 provinces, Southern province with 21 townships, requires the largest water source of 41,900 m³/day in 1995, 53,100 m³/day in 2005 and 60,800 m³/day in 2015, which accounts for 24% of the total requirement in the 80 townships in 1995, 23% in 2005 and 23% in 2015.

Table 1-4 Source Water Requirement of Public Water Supply Systems and Water Balance in Small Urban Areas by Province (Base Scenario - Agricultural Expansion)

(Unit: 1000 m³/day)

	10 Lusaka	20 Copper-belt	30 Central	40 North-western	50 Western	60 Southern	70 Luapula	80 Northern	90 Eastern	00 Zambia
1995										
Domestic Water	10.8	4.3	8.8	9.3	12.5	22.7	13.7	11.5	5.2	99.0
Industrial Water	7.2	2.2	3.2	5.6	9.1	13.8	3.9	6.9	3.4	55.4
Sub-total	18.0	6.6	12.1	15.0	21.6	36.5	17.6	18.4	8.6	154.4
Losses	2.7	0.9	1.8	2.2	3.2	5.4	2.6	2.7	1.3	22.8
Total	20.7	7.5	13.9	17.2	24.8	41.9	20.2	21.1	9.9	177.2
2005										
Domestic Water	15.1	5.7	11.1	11.9	14.6	27.5	16.1	13.2	6.4	121.7
Industrial Water	9.8	3.1	4.3	7.7	12.4	18.7	5.3	9.4	4.7	75.5
Sub-total	24.9	8.8	15.4	19.6	27.0	46.2	21.4	22.7	11.1	197.2
Losses	3.7	1.3	2.3	2.9	4.1	6.9	3.2	3.4	1.6	29.4
Total	28.6	10.1	17.7	22.6	31.1	53.1	24.6	26.1	12.7	226.6
2015										
Domestic Water	20.2	7.3	13.4	14.8	16.5	32.1	18.3	14.7	7.6	144.9
Industrial Water	12.6	2.9	4.9	9.1	13.2	20.8	5.7	10.1	5.4	84.7
Sub-total	32.8	10.2	18.3	23.9	29.7	52.9	24.0	24.8	13.0	229.6
Losses	4.9	1.5	2.7	3.5	4.5	7.9	3.6	3.7	1.9	34.2
Total	37.7	11.7	21.0	27.4	34.2	60.8	27.6	28.5	14.9	263.8
Balance										
Present Capacity	17.3	7.0	9.6	14.2	17.4	43.7	14.0	10.8	3.2	137.2
1995	-3.4	-0.5	-4.3	-3.0	-7.4	1.8	-6.2	-10.3	-6.7	-40.0
2005	-11.3	-3.1	-8.1	-8.4	-13.7	-9.4	-10.6	-15.3	-9.5	-89.4
2015	-20.4	-4.7	-11.4	-13.2	-16.8	-17.1	-13.6	-17.7	-11.7	-126.6

<Rural Areas>
The total water requirement of rural areas in the country was estimated at 0.20 million m³/day in 1995, 0.24 million m³/day in 2005 and 0.28 m³/day in 2015, for the Base Scenario - Agricultural Expansion, as shown in Table 1-5. Of the 9 provinces, Eastern province requires the largest water source of 38,500 m³/day in 1995, 48,000 m³/day in 2005 and 57,500 m³/day in 2015, which accounts for 20% of the total requirement of all rural areas in 1995, 20% in 2005 and 21% in 2015.

Table 1-5 Source Water Requirement of Public Water Supply Systems and Water Balance in Rural Areas by Province (Base Scenario - Agricultural Expansion)

(Unit: 1000 m³/day)

	10 Lusaka	20 Copper-belt	30 Central	40 North-western	50 Western	60 Southern	70 Luapula	80 Northern	90 Eastern	00 Zambia
1995										
Domestic Water	6.6	12.5	20.2	12.9	20.0	27.5	16.8	27.9	35.0	179.4
Losses	0.7	1.3	2.0	1.3	2.0	2.7	1.7	2.8	3.5	18.0
Total	7.3	13.8	22.2	14.2	22.0	30.2	18.5	30.7	38.5	197.4
2005										
Domestic Water	9.2	15.9	25.3	15.4	22.7	34.1	19.3	31.9	43.6	217.4
Losses	0.9	1.6	2.5	1.6	2.3	3.4	1.9	3.2	4.4	21.8
Total	10.1	17.5	27.8	17.0	25.0	37.5	21.2	35.1	48.0	239.2
2015										
Domestic Water	12.2	19.5	30.4	18.0	25.1	40.6	21.4	35.0	52.3	254.5
Losses	1.2	1.9	3.0	1.8	2.5	4.0	2.1	3.5	5.2	25.3
Total	13.4	21.4	33.4	19.8	27.6	44.6	23.6	38.5	57.5	279.8
Balance										
Present Capacity	1.9	3.3	3.8	1.9	13.9	7.4	2.2	2.4	5.9	42.6
1995	-5.4	-10.5	-18.4	-12.3	-8.1	-22.8	-16.3	-28.3	-32.6	-154.8
2005	-8.2	-14.2	-24.0	-15.1	-11.1	-30.1	-19.0	-32.7	-42.1	-196.6
2015	-11.5	-18.1	-29.6	-17.9	-13.7	-37.2	-21.4	-36.1	-51.6	-237.2

CHAPTER 2 WATER SUPPLY PROJECTS

2.1 Policies for Water Resources Development

The objective of this Water Resources Master Plan is to facilitate the effective execution of water resources development projects, including domestic and industrial water supply projects for urban and rural areas and agricultural water projects for irrigation, livestock and fishery, in accordance with the water demands projected up to the target year of 2015 and the calculated water resources potential.

In the "Social Sector Rehabilitation and Development Programme", the government addressed the water supply goal to fulfil the supply of sustainable safe drinking water to the people. The immediate objective extends the coverage of safe water supplies to 70% of urban and 35% of rural population by the year 1996. Targets after 1996 have yet to be officially addressed. In this current study, the goal is set as fulfilling safe water supply to urban and rural people as follows:

- For urban areas, to achieve complete coverage (100 %) in the 12 large urban areas (cities and municipalities) and 80 small urban areas (towns) by 2015.
- For rural areas, to provide water to 55% of the rural population by the year 2005 and to 75% by 2015.

Water resources development plans for respective areas are prepared on the basis of the following criteria in consideration of the present water use situation.

1) Both domestic and industrial water are served by public water supply systems. Since water for mining activity in Zambia is generally supplied by the mining companies themselves, the public water supply system does not cover industrial use for mining activities. The water demand for the public supply systems is therefore determined to cover domestic and manufacturing requirements.
2) Water supply systems should utilise stable and sustainable sources. Source of supply is chosen as surface or groundwater by taking the economic feasibility and required water volume into account. For surface water development, the average one in ten year "drought discharge" is applied to ensure stable supply. For groundwater supply, developed amount for each borehole is planned based on safe yields to avoid excessive abstraction.
3) Water supply systems are divided into the following three categories according to the population and the volume of water demand.
   - Large urban areas (12 cities and municipalities); including Lusaka, Ndola, Kitwe, Chililabombwe, Chingola, Mufulira, Kalulushi, Luanshya, Kabwe, Livingstone, Kasama and Chipata.
   - Small urban areas (80 townships); having population of over 1,000 persons in the 1990 census.
   - Rural areas; all areas other than the above urban areas.
4) Total required water amount is obtained by adding allowance for losses and leakage to domestic and industrial water demands. The allowance covers losses and leakage which occur at intake, conveyance, treatment, distribution etc. The assumed design rates for these losses are set as follows.

- Large Urban Areas : 25 % of water demand
- Small Urban Areas : 15 % of water demand
- Rural Areas : 10 % of water demand

2.2 Water Supply for Large Urban Areas

As seen from Table 1-3, the water supply situation in the large urban areas, excluding Chililabombwe and Chingola, is already critical now or will become critical in future. These cities and municipalities need to secure new sources for domestic and industrial water by the year 2015. The water demand and supply plan for Lusaka is shown in Table 2-1 as an example. The plans for the other cities and municipalities are shown in Appendix -1.2. . The main points of each plan are as follows:

<u>Lusaka Urban</u>
- 1995 ~ 2000: - Installation of Boreholes (Supply volume: 20,000m^3/day)
  - Chongwe Multi-purpose Dam (Supply volume: 100,000m^3/day)
- 2000 ~ 2005: - Kafue Pipeline Project (Phase-1, Supply volume: 100,000m^3/day)
- 2005 ~ 2010: - Kafue Pipeline Project (Phase-2, Supply volume: 150,000m^3/day)
- 2010 ~ 2015: - Kafue Pipeline Project (Phase-3, Supply volume: 150,000m^3/day)

<u>Ndola Urban</u>
- 2005 ~ 2010: - Kafubu Multi-purpose Dam (Supply volume: 60,000m^3/day)

<u>Mufulira</u>
- 2005 ~ 2010: - Mutundu Multi-purpose Dam (Supply volume: 5,000m^3/day)

<u>Kalulushi</u>
- 2005 ~ 2010: - Mutundu Multi-purpose Dam (Supply volume: 10,000m^3/day)

<u>Kitwe</u>
- 2005 ~ 2010: - Mutundu Multi-purpose Dam (Supply volume: 20,000m^3/day)

<u>Luanshya</u>
- 2005 ~ 2010: - Kafubu Multi-purpose Dam (Supply volume: 5,000m^3/day)

<u>Kabwe Urban</u>
- 2000 ~ 2005: - Extension of Mulungushi River Water Works (Phase-1) (Supply volume: 19,500m^3/day)
- 2000 ~ 2005: - Extension of Mulungushi River Water Works (Phase-2) (Supply volume: 37,500m^3/day)

<u>Livingstone</u>
- 1995 ~ 2000: - Extension of Water Works (Phase-1) (Supply volume: 10,000m^3/day)
- 2000 ~ 2005: - Extension of Water Works (Phase-1) (Supply volume: 10,000m^3/day)

<u>Kasama</u>
- 2000 ~ 2005: - Extension of Water Works:(Supply volume: 14,000m^3/day)

<u>Chipata</u>
- 2000 ~ 2005: - Installation of Boreholes (Supply volume: 12,000m^3/day)

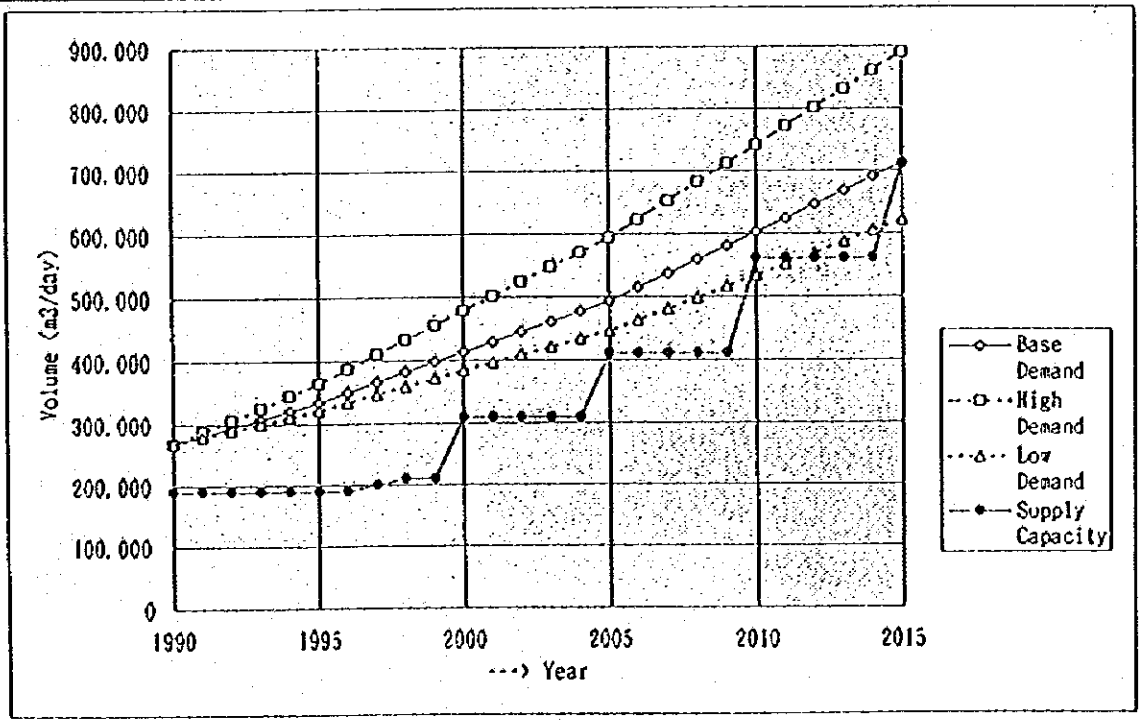
Table 2-1 Water Demand and Supply Plan (Lusaka Urban)

Township		DISTRICT		PROVINCE	
111	Lusaka	11	Lusaka Urban	10	Lusaka

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	769,353	(1) Base Projection	967,970	1,483,197	2,180,740
- Household	148,609	(2) High Projection	976,307	1,558,053	2,455,730
- Family Size	5.2	(3) Low Projection	960,128	1,420,524	1,984,501

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
Lusaka Water Supply	Lusaka Sew. & W/Supply Co.	190,000
Total		190,000
Surface Water Source : Kafue River		90,000
Groundwater Source : 45 boreholes		100,000

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	138,484	174,235	220,605	266,975	329,754	392,533
	(High)	138,484	175,735	228,092	280,450	361,240	442,031
	(Low)	138,484	172,823	214,259	255,694	306,452	357,210
< Industrial Water >							
Water Demand (m3/day)	(Base)	76,500	93,300	110,100	126,900	152,100	177,300
	(High)	76,500	115,567	154,633	193,700	232,200	270,700
	(Low)	76,500	84,567	92,633	100,700	120,350	140,000
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	214,984	267,535	330,705	393,875	481,854	569,833
	(High)	214,984	291,302	382,726	474,150	593,440	712,731
	(Low)	214,984	257,390	306,892	356,394	426,802	497,210
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	268,729	334,418	413,381	492,344	602,318	712,292
	(High)	268,729	364,127	478,407	592,687	741,801	890,914
	(Low)	268,729	321,737	383,615	445,493	533,503	621,513
< Water Supply Program >							
- Existing Capacity (m3/day)		190,000	190,000	190,000	190,000	190,000	190,000
(1) Lusaka Wells				20,000	20,000	20,000	20,000
(2) Chongwe Dam				100,000	100,000	100,000	100,000
(3) Kafue Pipeline(Phase-1)					100,000	100,000	100,000
(4) Kafue Pipeline(Phase-2)						150,000	150,000
(5) Kafue Pipeline(Phase-3)							150,000
- Total Water Supply (m3/day)		190,000	190,000	310,000	410,000	560,000	710,000

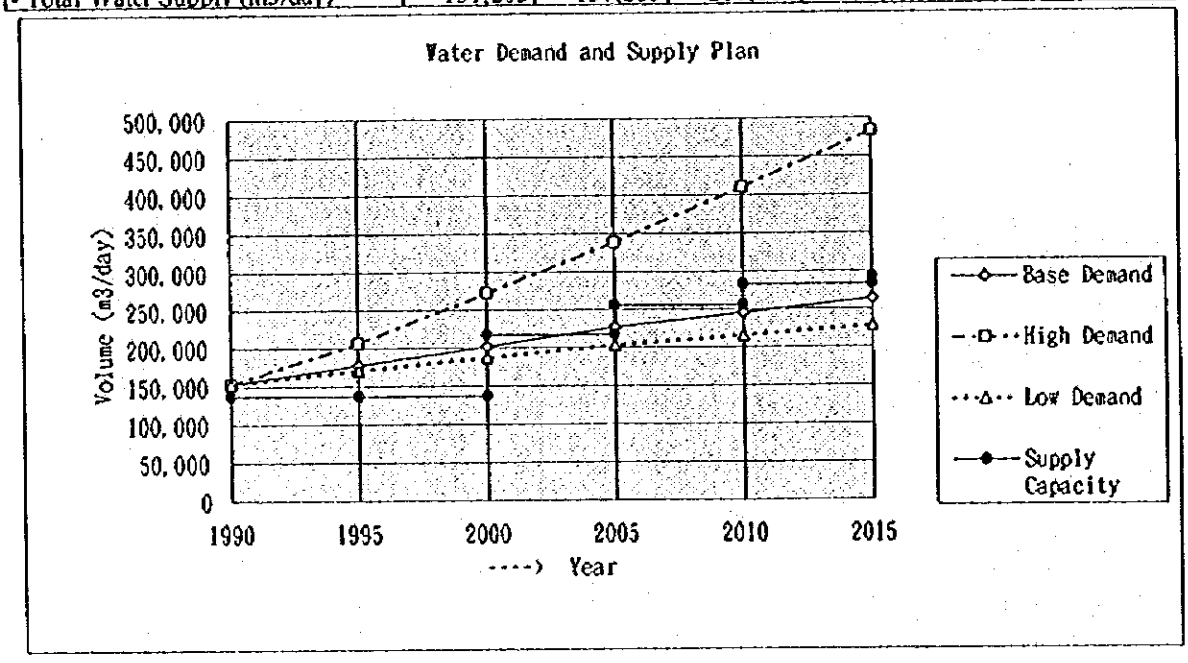


2.3 Water Supply for Small Urban Areas

The water demand and supply plan for small urban areas (Zambia total) is summarised in Table 2-2. The province level plans are shown in Appendix-1.2.1. The plan for each township is shown in Appendix-1.2.2.

Table 2-2 Water Demand and Supply Plan for Small Urban Areas (Zambia Total)

SMALL URBAN AREAS					ZAMBIA TOTAL		
1990 CENSUS POPULATION AND FUTURE PROJECTION							
1990 Census Data		Projection Scenarios			1995	2005	2015
- Population	585,668	(1) Base Projection			658,811	810,846	964,899
- Household	125,887	(2) High Projection			744,493	1,203,886	1,947,575
- Family Size	4.7	(3) Low Projection			653,279	776,623	869,978
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	87,850	98,822	110,224	121,627	133,181	144,735
	(High)	87,850	111,674	146,128	180,583	236,360	292,136
	(Low)	87,850	97,992	107,243	116,493	123,495	130,497
< Industrial Water >							
Water Demand (m3/day)	(Base)	45,345	55,375	65,404	75,434	80,100	84,765
	(High)	45,345	68,154	90,964	113,773	120,772	127,771
	(Low)	45,345	50,344	55,344	60,343	63,982	67,620
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	133,195	154,196	175,629	197,061	213,280	229,500
	(High)	133,195	179,828	237,092	294,356	357,132	419,907
	(Low)	133,195	148,336	162,586	176,836	187,477	198,117
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	153,174	177,326	201,973	226,620	245,272	263,925
	(High)	153,174	206,803	272,656	338,509	410,701	482,893
	(Low)	153,174	170,587	186,974	203,362	215,598	227,834
< Water Supply Program >							
- Existing Capacity (m3/day)		137,203	137,203	137,203	137,203	137,203	137,203
- New Water Supply (m3/day)				79,801	79,801	79,801	79,801
- New Water Supply					38,493	38,493	38,493
- New Water Supply						27,923	27,923
- New Water Supply							9,661
- Total Water Supply (m3/day)		137,203	137,203	217,004	255,497	283,420	293,081

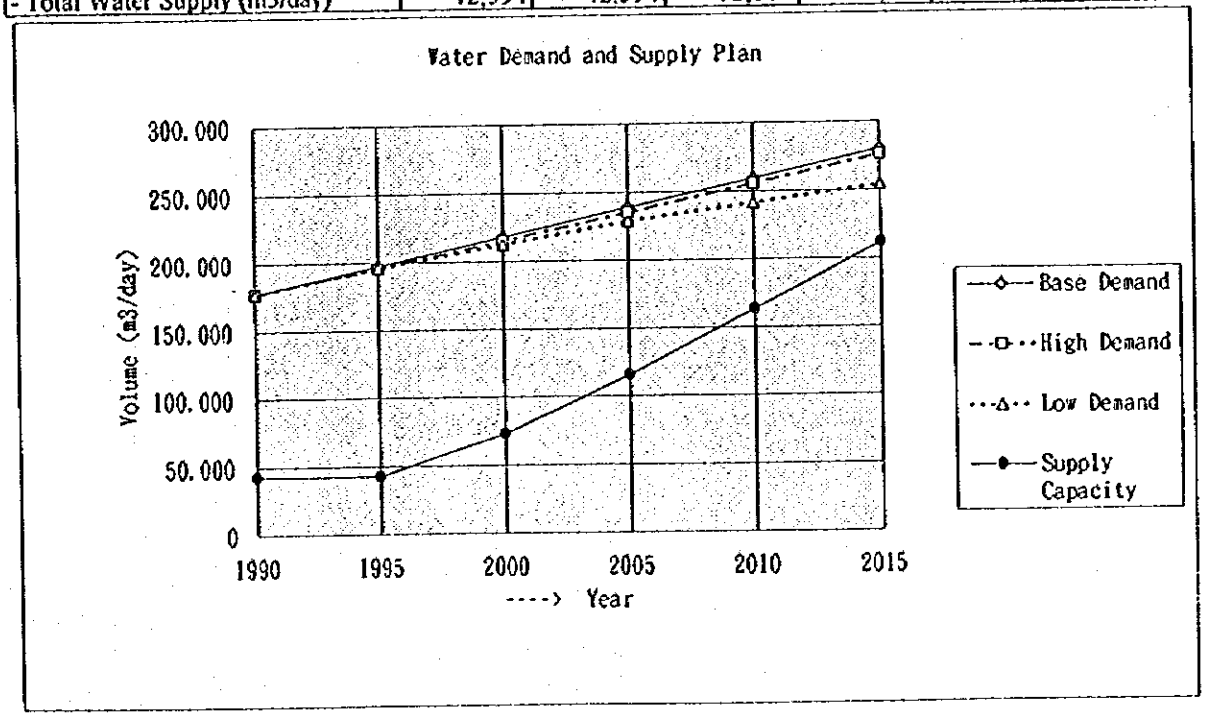


2.4 Water Supply for Rural Areas

Water demand and supply plan for rural areas (Zambia total) is summarised in Table 2-3. The province level plans are shown in Appendix-1.3.

Table 2-3 Water Demand and Supply Plan for Rural Areas (Zambia Total)

RURAL					ZAMBIA TOTAL		
1990 CENSUS POPULATION AND FUTURE PROJECTION							
1990 Census Data		Projection Scenarios			1995	2005	2015
- Population	4,601,554	(1) Base Projection			5,127,000	6,210,000	7,270,000
- Household	992,525	(2) High Projection			5,082,000	6,112,000	7,165,000
- Family Size	4.6	(3) Low Projection			5,089,000	5,951,000	6,609,000
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		35	35	35	35	35	35
Rural Water Demand (m3/day)	(Base)	161,054	179,445	198,398	217,350	235,900	254,450
	(High)	161,054	177,870	195,895	213,920	232,348	250,775
	(Low)	161,054	178,115	193,200	208,285	219,800	231,315
- Water Loss Rate (%)		10	10	10	10	10	10
Rural Net Water Demand (m3/day)	(Base)	177,160	197,390	218,237	239,085	259,490	279,895
	(High)	177,160	195,657	215,485	235,312	255,582	275,853
	(Low)	177,160	195,927	212,520	229,114	241,780	254,447
< Water Supply Program >							
- Existing Capacity (m3/day)		42,594	42,594	42,594	42,594	42,594	42,594
(1) Boreholes (4009 wells)				30,068	30,068	30,068	30,068
(2) Boreholes (5671 wells)					42,533	42,533	42,533
(3) Boreholes (6424 wells)						48,180	48,180
(4) Boreholes (6424 wells)							48,180
- Total Water Supply (m3/day)		42,594	42,594	72,662	115,195	163,375	211,555



CHAPTER 3 COST ESTIMATES

Construction costs of proposed projects are estimated using January 1995 prices. Foreign exchange rate at that time was 610 Kwacha for one US Dollar. Estimated costs show the approximate scale of projects, including direct construction and engineering services costs, but excluding land acquisition and contingency costs.

Direct construction cost comprises source development cost (dam or borehole cost), conveyance facility cost, treatment facility cost, and cost for distribution facilities. Total construction cost in the Base Scenario - Agricultural Expansion (middle population projection) amounts to US$ 1,010 million for 1.048 million m^3/day of developed water, equivalent to unit cost for 1,000 m^3/day of US$ 964 thousand or US$ 89.3 million /m^3/sec. Large urban areas account for US$ 648 million, or 64% of the total construction cost, while small urban areas account US$ 153 million, or 15%, and rural areas account for US$ 209 million, or 21%. Water supply projects in Lusaka are estimated to cost US$ 447.6 million. Refer to Tables 3-1 and 3-2.

Estemated costs of each water supply project for large urban areas, small urban areas and rural areas are mentioned in detail in Appendix-2.

Table 3-1 Construction Cost of Water Supply Projects

Province	Lusaka	Copperbelt	Central	N'western	Western	Southern	Luapula	Northern	Eastern	<Total>
Base Scenario- Agricultural Expansion										
Large Urban Area										
Water Dvlp.	520,000	100,000	57,000	-	-	20,000	-	14,000	12,000	723,000
Cost	447.58	112.55	43.46	-	-	20.58	-	12.65	11.04	647.86
Unit Price	861	1,126	762	-	-	1,029	-	904	920	896
Small Urban Area										
Water Dvlp.	24,560	5,818	13,590	14,820	22,578	27,060	15,374	19,326	12,782	155,908
Cost	27.70	3.66	13.32	18.24	18.55	25.23	15.80	16.25	14.28	153.03
Unit Price	1,128	629	980	1,231	822	932	1,028	841	1,117	982
Rural Area										
Water Dvlp.	8,176	12,780	21,256	13,066	7,936	26,372	15,512	26,596	32,276	163,970
Cost	10.14	15.85	26.36	16.20	9.84	32.70	19.23	32.98	46.22	209.52
Unit Price	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,432	1,278
Total										
Water Dvlp.	552,736	118,598	91,846	27,886	30,514	73,432	30,886	59,922	62,058	1,047,878
Cost	485.42	132.06	83.14	34.44	28.39	78.51	35.03	61.88	71.54	1010.41
Unit Price	878	1,114	905	1,235	930	1,069	1,134	1,033	1,254	969
Base Scenario- Industrialisation										
Large Urban Area										
Water Dvlp.	720,000	210,000	80,000	-	-	30,000	-	35,000	20,000	1,095,000
Cost	562.70	191.67	55.62	-	-	25.92	-	23.99	18.19	878.09
Unit Price	782	913	695	-	-	864	-	685	910	802
Small Urban Area										
Water Dvlp.	64,028	15,512	31,390	44,220	40,756	62,073	34,270	36,988	24,030	353,267
Cost	56.00	10.07	32.38	45.79	31.01	56.69	32.76	31.66	26.68	323.04
Unit Price	875	649	1,032	1,036	761	913	956	856	1,110	914
Rural Area										
Water Dvlp.	3,892	13,470	21,923	11,460	7,298	25,935	15,188	26,603	38,565	164,334
Cost	4.83	16.70	27.18	14.21	9.05	32.16	18.83	32.99	47.82	203.77
Unit Price	1,241	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240
Total										
Water Dvlp.	787,920	238,982	133,313	55,680	48,054	118,008	49,458	98,591	82,595	1,612,601
Cost	623.53	218.44	115.18	60.00	40.06	114.77	51.59	88.64	92.69	1404.90
Unit Price	991	914	864	1,078	834	973	1,043	899	1,122	871
Conservative Scenario										
Large Urban Area										
Water Dvlp.	420,000	51,000	45,000	-	-	16,000	-	10,000	9,000	551,000
Cost	387.82	55.28	37.44	-	-	18.50	-	10.47	8.83	518.34
Unit Price	923	1,084	832	-	-	1,156	-	1,047	981	941
Small Urban Area										
Water Dvlp.	14,276	3,542	9,390	10,220	14,864	14,170	11,836	14,850	9,878	103,026
Cost	20.37	2.12	9.14	13.22	12.92	13.62	12.70	12.27	11.11	107.47
Unit Price	1,427	599	973	1,294	869	961	1,073	826	1,125	1,043
Rural Area										
Water Dvlp.	7,275	11,100	18,975	11,693	4,958	23,130	13,860	23,888	33,390	148,269
Cost	9.02	13.76	23.53	14.50	6.15	28.68	17.19	29.62	41.40	183.85
Unit Price	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240
Total										
Water Dvlp.	441,551	65,642	73,365	21,913	19,822	53,300	25,696	48,738	52,268	802,295
Cost	417.23	71.16	70.11	27.72	19.07	60.80	29.89	52.36	61.34	809.66
Unit Price	945	1,084	956	1,265	962	1,141	1,163	1,078	1,174	1,009

(note) Water Dvlp. = Amount of Water Developed in m^3/day, Cost = Construction Cost in US$ million,
Unit Price = Unit Price of Water Developed in US$/ m^3/day

Table 3-2 Construction Cost for Large Urban Water Supply Projects

	Base Scenario-Agricultural Expansion			Base Scenario- Industrialisation			Conservative Scenario		
	Water Dvlp. (m^3/day)	Cost (US$million)	Unit Price (US$/$m^3$/day)	Water Dvlp. (m^3/day)	Cost (US$million)	Unit Price (US$/$m^3$/day)	Water Dvlp. (m^3/day)	Cost (US$million)	Unit Price (US$/$m^3$/day)
Lusaka Well	20,000	15.75	788	Same as Agricultural Expansion			Same as Agricultural Expansion		
Chongwe Dam	100,000	109.87	1,099	Same as Agricultural Expansion			Same as Agricultural Expansion		
Kafue Pipe Line	400,000	321.96	805	600,000	437.08	728	300,000	262.20	874
- Phase-1	100,000	87.40	874	150,000	117.28	782	100,000	87.40	874
- Phase-2	150,000	117.28	782	150,000	117.28	782	100,000	87.40	874
- Phase-3	150,000	117.28	782	300,000	202.52	675	100,000	87.40	874
<Lusaka Total>	520,000	447.58	861	720,000	562.27	782	420,000	387.82	923
Ndola	60,000	53.50	892	110,000	86.85	790	45,000	41.54	923
Luanshya	5,000	8.80	1,760	20,000	18.51	926	no project		
Kitwe	20,000	22.99	1,150	50,000	46.64	933	no project		
Kalulushi	10,000	17.63	1,763	15,000	21.75	1,450	6,000	13.74	2,290
Mufulira	5,000	9.63	1,926	15,000	17.92	1,195	no project		
Kabwe	57,000	43.46	762	80,000	55.62	695	45,000	37.44	832
- Phase-1	19,500	16.82	863	27,000	21.26	787	15,000	14.43	962
- Phase-2	37,500	26.64	710	53,000	34.36	648	30,000	23.01	767
Livingstone	20,000	20.58	1,029	30,000	25.92	864	16,000	18.50	1,156
- Phase-1	10,000	10.29	1,029	15,000	12.96	864	8,000	9.25	1,156
- Phase-2	10,000	10.29	1,029	15,000	12.96	864	8,000	9.25	1,156
Kasama	14,000	12.65	904	35,000	3.99	114	10,000	10.47	1,047
Chipata	12,000	11.04	920	20,000	18.19	909	9,000	8.83	981
< Total >	723,000	647.86	896	1,095,000	878.09	784	551,000	518.34	941

CHAPTER 4 IMPLEMENTATION SCHEDULE

Implementation schedule of water supply projects for domestic and industrial use in the Base Scenario-Agricultural Expansion is shown as an example in Table 4-1. The most urgent large urban water supply projects, to be implemented during the first five years, are two projects in Lusaka (Northern Lusaka Production Well Project and Chongwe Dam Project) and phase-1 of two Extension Projects in Kabwe and Livingstone. The next most urgent projects, to be implemented in the following five years, are phase-1 of Kafue Pipeline Project, phase-2 of Livingstone Extension Project, Kasama Extension Project, and Chipata Production Well Project. Other projects are to be implemented during the latter ten years.

Many projects for small urban areas should be implemented in the ten years to 2005, because of the present low service coverage in small towns, and the schedule for each township is included in Appendix-1.2.2. For rural water supply projects, the preparatory works, such as procurement of boring equipment and facilities, and training of staff, mean that smaller numbers of projects are planned to be implemented in the first five years. Later, projects are to be implemented at a constant pace.

Table 4-1 Implementation Schedule of Water Supply Projects for Domestic and Industrial Use (Base Scenario - Agricultural Expansion)

Project Name	Water Developed (m^3/day)	Construction Cost (mil.US$)	Construction Schedule
			'96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
<Large Urban Area>			
Northern Lusaka Well Project	20,000	15.70	
Lusaka (Chongwe Dam)	100,000	109.87	
Lusaka Kafue Pipeline Project)	400,000	321.96	
Ndola (Kafubu Dam)	60,000	53.50	
Luanshya (Kafubu Dam)	5,000	8.80	
Kitwe (Mutundu Dam)	20,000	20.58	
Kalulushi (Mutundu Dam)	10,000	17.63	
Mufulira (Mutundu Dam)	5,000	9.63	
Kabwe (Expansion)	57,000	43.46	
Livingstone (Expansion)	20,000	20.58	
Kasama (Expansion)	14,000	12.65	
Chipata Well Project	12,000	11.04	
(5 year Progress Rate)	723,000	647,000	22% 23% 34% 21%
<Small Urban Area>			
(5 year Progress Rate)	155,908	153.03	50% 26% 17% 7%
<Rural Area>			
(5 year Progress Rate)	168,970	209.52	18% 26% 28% 28%

CHAPTER 5 PROJECT EVALUATION

5.1 Economic Evaluation

(1) General Conditions

The economic worth of Master Plan projects was assessed by the rates of economic efficiency at which the present worth of both economic costs and economic benefits equalised over the project life.

The prices of internationally tradable goods and services are basically estimated on the basis of the World Bank projection to 2000, or the international market price in January, 1995. The prices of local goods and services are the normalised price in January, 1995. The transfer payments such as tax, subsidies and interests are deducted from all prices. The ratio of transfer payment to financial cost is assumed to be 10% of financial cost.

For economic evaluation, Economic Internal Rates of Return (EIRR) of respective projects are calculated to verify economic viability in the national economy. In calculation of other economic indices such as Net Present Value (NPV) and Benefit-Cost Ratio (B/C), costs and benefits are discounted at the rate of 10% for the respective project lives.

In estimating the economic cost and benefit, the economic values are estimated applying the following conditions and assumptions for every sector related to water.

(a) Price Level

For economic evaluation activities, the basic price level for cost and benefit estimates was set at the end of January, 1995. Foreign exchange rate was set at K610 to US$1.00 in accordance with the official exchange rate at the same time.

(b) Opportunity Cost of Capital

Opportunity cost of capital represents the permissible economic rate of return for development projects. In Zambia, 10% of this opportunity cost of capital is applied as a discount rate for assessing economic viability of proposed projects, which is mostly used in IBRD's reports.

(c) Economic Value

In economic analysis, all goods and services applied in the project costs and benefits are estimated on the basis of real economic value. In terms of non-tradable goods and services in local market, the following points have to be considered in the case of converting their financial values to economic ones: (a) internal transfer payment and (b) shadow wage of unskilled labour in particular because of taking unemployment and underemployment conditions into account. On the other hand, the tradable goods and services are estimated based on the international market prices, so their values reflect real economic ones. In this current report, however, economic values are estimated to be 90% of total financial values in the case of including both local portions and foreign portions.

(d) Economic Life

The economic life of the projects is taken as 50 years for water supply facilities. However, a part of mechanical facilities is considered as 20 years, so it would be replaced within the above main economic life. The economic life is considered to start just after completion of the construction works.

(2) Evaluation of Projects

The basic economic benefit from water supply schemes is based on the maximum affordable value. It is generally adopted as 3 to 5 per cent of household income. In this master plan study, the benefit for water supply system are estimated to be 5% of income for domestic water supply schemes. Applying this rule, the total annual benefit in the country could be estimated at K47 billion (approximately US$77 million equivalent) in the year 1995, as shown in Table 5-1.

For municipal use, economic benefit is based on also the maximum affordable payment for water. In this study, a percentage of water cost to value added of all invisible services is adopted for benefit estimation. From the 1985 input-output table for Zambia, the rate of for water is assumed to be 0.28%, as shown in Table 5-1. Applying this rate to the sector performance projected in 1995, an economic flat rate of this sector was estimated K18/m³. This rate was quite small as compared with the domestic water rate of K191/m³. It would be caused that the sector does not count water charge in general expenditure since the sector gets water not only through piped water system but also through its own free water resources such as well and other personal sources. Thus, the economic flat rate of municipal water was assumed to be the same rate of K191/m³ as the domestic value. Incidentally, the water cost is calculated to account for almost 3% of the value added of the sector, applying this value for the sector. As a result, the annual economic benefit for municipal water in the country is estimated at K16 billion (approximately US$26 million equivalent) in total in 1995.

In the same manner, the rate of maximum affordable value for water is assumed to be 3%, which was the same rate as applied in the municipal sector. The annual benefit for industrial water is expected to be K10 billion (approximately US$16 million equivalent), as shown in the table.

The financial construction costs of the proposed projects in urban and rural areas are described in detail in Chapter 3 and Appendix-2. The costs are converted to economic costs by making adjustments base on the aforesaid conversion method. For economic evaluation activities, the construction schedule is assumed to be divided into two phases. The construction works of the first phase are assumed to start in 1996 and to end in 2005, of which the capacity fully covers the 2005 water demand. Those of the second phase are between 2006 and 2015, covering the 2015 water demand.

The O&M costs are annually required during the economic life of the projects just after completion of the construction works. The costs are assumed to be 5% of the total construction costs for urban water supply schemes. For rural water supply schemes, the O&M costs were estimated individually, which accounted for about 1% annually of the initial investment costs for maintenance and rehabilitation activities.

Table 5-1 Total Economic Benefit Accruing from Water Supply in Zambia

1. Domestic Water

Annual benefit(*1) in 1995

a) Annual benefit

Sector	GDP per Capita*2 (K1000 at 1993	Disposable Income per Capita *3 Constant Prices)	Income Ratio*1 (%)	Population Projected (1000)	Economic Benefit*4 (K'million)	
Urban Schemes	340	207	5	3,227	30,101	*5
Rural Schemes	81	73	5	5,132	16,824	*5
Total	186	140	5	8,359	46,925	*5

b) Total Economic Benefit of Residential Sector (K'Billion)	46.93	
Water Consumption Volume (1000 cu.m.)		245,232
Economic Flat Rate of Domestic Use on Average (K/cu.m.)	191	

2. Municipal (Trade, Catering, Government Services, etc.) Water

a) Annual benefit in 1986 (Reference: Input-Output Table 1985)

Item	Gross Output	Gross Value Added	Gross Input	Expense for Water	Ratio of Water Exp. to Gross VA	
Zambia in 1985 (Unit: K'1000 in 1985 at Current Prices)	5,539.8	3,936.8	1,603.0	10.9	0.28%	
(Ref) Japanese Case (Unit: Billion Yen in 1986)	232,251	151,672	80,579	867	0.57%	
Benefit = The same flat rate of Domestic Use (Maximum affordable value of water)					3.0%	*4

b) Value Added of Municipal Sector in 1995 (K'Billion)	585	
Total Economic Benefit of Municipal Sector (K'Billion)	15.80	*6
Water Consumption Volume (1000 cu.m./annum)	80,090	
Economic Flat Rate of Municipal Use on Average (K/cu.m.)	197	

3. Industrial Water

a) Annual benefit in 1985 (Reference: Input-Output Table 1985)

Item	Gross Output	Gross Value Added	Gross Input	Expense for Water	Ratio of Water Exp. to Gross VA	
Zambia in 1985 (Unit: K'1000 in 1985 at Current Prices)	4,240.0	1,481.0	2,759.0	14.8	1.00%	
(Ref) Japanese Case (Unit: Billion Yen in 1986)	114,525	94,443	20,082	450	0.48%	
Benefit = Maximum affordable value of water					3.0%	*5

b) Value Added of Manufacturing Sector in 1995 (K'billion)	370.5	
Total Economic Benefit of Manufacturing Sector (K'billion)	10.00	*6
Water Consumption Volume (1000 cu.m./annum)	96,021	
Economic Flat Rate of Industrial Use on Average (K/cu.m.)	104	

Source : Input-Output Table in 1985, CSO (Not yet published as of March 1995)

Remark : *1 Traditional Rule of income ratio (Maximum affordable water value)

*2 Refer to Table 3.1-10 *3 Refer to Table 2.1-9

*4 Assumed to be 3% of value added which resulted into the same flat rate as residential one, because water expenses were not always accounted in expenditure item in the case of well users in particular.

*5 Assumed to be 3% of value added which was the same rate as municipal one.

*6 Converted to economic values, i.e., 90% of financial values.

While the economic life is assumed to be 50 years, some mechanical facilities such as pumps have shorter life than the civil and plumbing works. They are assumed to be 20 years for major mechanical equipment and 10 years for small pumps. The replacement costs are assumed to be 20% for the conveyance and treatment costs.

(a) Large Urban Areas

The twelve urban systems are examined in economic efficiency through factors of NPV, B/C and EIRR. Table 5-2 shows the results of the examination. Of 12 schemes, four schemes resulted in exceeding 10%, the opportunity cost of capital as mentioned above. They are in order of economic efficiency: Kitwe, Kasama, Luanshya and Ndola,. In Lusaka City, although the economic efficiency of proposed projects has positive EIRR, its value seems to be comparatively low. It means to be costly to provide potable water for the people in Lusaka.

Table 5-2 Economic Efficiency of Large Urban Water Supply Projects

Code	Urban Name		EIRR*1 (%)	NPV*2 (US$million)	B/C*2
111	Lusaka	Lusaka Wells	8.4%	-1.9	0.90
	Lusaka	Chongwe Dam	3.8%	-45.9	0.61
	Lusaka	Kafue Pipeline	3.7%	-72.8	0.68
211	Ndola Township	Kafubu Dam	10.2%	1.1	1.02
251	Mufulira	Mutundu Dam	7.4%	-1.8	0.81
261	Kalulushi	Mutundu Dam	---	-12.1	0.37
271	Kitwe	Mutundu Dam	17.9%	19.2	1.77
281	Luanshya	Kafubu Dam	12.4%	1.8	1.19
311	Kabwe Township	Water Supply Extension	6.7%	-5.3	0.82
611	Livingstone		2.9%	-9.3	0.57
811	Kasama		14.0%	4.8	1.32
911	Chipata	Chipata Wells	7.0%	-2.8	0.77

Note: *1 "---" means that EIRR marks less than zero percent.
*2 Discounted at 10%

(b) Small Urban Areas

For the other 80 small town schemes, the economic efficiency was examined as shown in Table 5-3. 33 townships schemes have a positive EIRR. Of the 33 townships, three townships resulted EIRR in excess of 10%, which is the border of economic feasibility. They are Choma, Monze and Zimba in Southern province. Most of them are groundwater projects. It seems to be difficult to supply potable water using surface water sources because of the high water treatment costs.

(c) Rural Areas

The economic efficiency of rural water supply was examined for each province covering all the schemes in each province. Of the nine provinces, six had a positive EIRR, as shown in Table 5-4. They are Lusaka, Copperbelt, Central, Southern, Luapula and Eastern. Of the six provinces, two provinces of Copperbelt and Central resulted in EIRR in excess of 10%.

Table 5-3(1) Economic Efficiency of Small Urban Water Supply Projects

Code	Province	Code	Town	EIRR	NPV	B/C	System
10	Lusaka	121	Chongwe	--	-3.47	0.14	SWP
		122	Kafue	3.9%	-6.13	0.52	SWP
		123	Chilanga	--	-3.04	0.33	SWP
		124	Rufunsa	5.8%	-0.24	0.64	GP
		131	Luangwa	--	-1.09	0.13	SWP
20	Copperbelt	221	Masaiti	1.7%	-0.16	0.46	GP
		222	Mpongwe	6.4%	-0.48	0.70	GP
		262	Chambishi	4.3%	-0.67	0.56	GP
30	Central	321	Chibombo	--	-1.29	0.13	GP
		322	Chisamba	5.7%	-0.12	0.62	GP
		323	Kapiri Mposhi	2.5%	-0.94	0.50	GP
		331	Mumbwa	--	-2.07	0.32	GP
		332	Nampundwe	--	-2.07	0.32	GP
		341	Mkushi	0.7%	-1.12	0.35	GP
		351	Serenje	1.3%	-0.79	0.45	GP
40	Northwestern	411	Solwezi	1.7%	-5.61	0.35	SWP
		421	Mwinilunga	--	-1.96	0.12	SWP
		431	Zambezi	--	-2.38	0.11	SWP
		432	Chavuma	0.2%	-0.76	0.31	SWP
		441	Kabompo	--	-1.33	0.11	SWP
		451	Mfumbwe	--	-1.64	0.19	GP
		461	Kasempa	2.2%	-0.60	0.35	GP
50	Western	511	Mongu	7.8%	-0.55	0.82	GP
		512	Limulunga	1.5%	-0.59	0.43	GP
		513	Namushakande	--	-0.43	0.24	GP
		521	Lukulu	--	-0.58	0.30	GP
		531	Kalabo	--	-3.23	0.08	SWP
		532	Sikongo	--	-0.27	0.21	GP
		541	Kaoma	2.8%	-0.98	0.49	GP
		551	Senanga	--	-3.40	0.07	SWP
		552	Shangombo	--	-0.24	0.28	GP
		561	Sesheke	--	-2.32	0.08	SWP
		562	Mulobezi	--	-0.25	0.25	GP
		563	Katima-Mulilo	--	-0.32	0.07	GP
60	Southern	621	Namwala	5.4%	-0.32	0.62	GP
		622	Itezhi-Tezhi	2.9%	-0.60	0.54	GP
		631	Mazabuka	7.3%	-0.68	0.77	GP
		632	Magoye	1.4%	-0.29	0.43	GP
		633	Nakambala	5.0%	-0.39	0.62	GP
		634	Nega-nega	--	-0.33	0.33	GP

Table 5-3(2) Economic Efficiency of Small Urban Water Supply Projects

Code	Province	Code	Town	EIRR	NPV	B/C	System
60	Southern	635	Kafue-gorge	3.7%	-0.24	0.52	GP
		636	Chikankata	1.6%	-0.40	0.48	GP
		641	Monze	18.6%	0.52	1.53	GP
		642	Chisekesi	1.8%	-0.19	0.46	GP
		651	Choma	34.6%	1.55	1.74	GP
		652	Batoka	--	-0.22	0.35	GP
		653	Pemba	2.2%	-0.22	0.46	GP
		654	Mbabala	1.3%	-0.18	0.44	GP
		661	Kalomo	6.7%	-0.34	0.76	GP
		662	Zimba	10.8%	0.02	1.06	GP
		672	Chirundu	--	-1.10	0.13	SWP
		681	Gwembe	--	-0.37	0.34	GP
		691	Sinazongwe	--	-2.18	0.07	SWP
		692	Maamba	3.8%	-0.64	0.56	GP
70	Luapula	711	Mansa	6.2%	-1.52	0.70	GP
		721	Nchelenge	--	-4.62	0.22	SWP
		722	Chiengi	--	-1.38	0.11	SWP
		732	Mwansabombwe	9.4%	-0.03	0.94	GP
		751	Samfya	--	-2.78	0.10	SWP
80	Northern	821	Kaputa	--	-1.15	0.13	GP
		831	Mbala	--	-0.95	0.39	GP
		841	Mporokoso	--	-0.92	0.24	GP
		851	Luwingu	--	-0.35	0.37	GP
		861	Chilubi	--	-0.21	0.22	GP
		871	Isoka	--	-1.56	0.26	GP
		872	Nakonde	--	-0.66	0.30	GP
		881	Chinsali	--	-0.82	0.29	GP
		891	Mpika	--	-3.90	0.34	GP
90	Eastern	921	Chama Township	--	-1.59	0.11	GP
		931	Lundazi	--	-1.66	0.20	GP
		941	Chadiza Township	2.0%	-0.27	0.47	GP
		951	Katete Township	--	-3.07	0.12	GP
		961	Petauke	--	-3.12	0.18	GP
		962	Nyimba	--	-0.64	0.18	GP
		963	Kacholola	--	-0.20	0.36	GP

Remark: *1 "--" means that EIRR marks less than zero percent.
*2 Discounted at 10%

Table 5-4 Economic Efficiency of Rural Water Supply Projects

Code	Province	EIRR*1 (%)	NPV*2 (US$million)	B/C*2
10	Lusaka	7.4%	-1.7	0.70
20	Copperbelt	18.7%	10.4	1.93
30	Central	13.5%	2.7	1.19
40	Northwestern	--	-7.3	0.32
50	Western	--	-2.3	0.61
60	Southern	9.3%	-0.5	0.97
70	Luapula	6.9%	-2.9	0.76
80	Northern	--	-11.9	0.45
90	Eastern	1.2%	-18.1	0.47

Note: *1 "--" means that EIRR marks less than zero percent.
*2 Discounted at 10%

5.2 Financial Evaluation

(1) National Financial Situation

The capital investment for water system is basically funded by the public sectors in Zambia. As discussed in Section 3.2 of the Main Report, the public entities concerned to the system are: central government, local governments and parastatals. Besides them, non-governmental organisations (NGOs), missionaries and some private sectors are running water supply systems. However, most of schemes managed by not public sectors are in small scale system except Lusaka water and sanitation system.

In order to consider the possibility of capital investment for water resources development, it is important to figure out the framework and extent of the public budget. The future trend of public investment for the system was estimated as budgetary ceilings. The trend of public investment for water sector was estimated in Table 3-11 of the Main Report. The future investment amounts by the central government were accumulated as: K119 billion (approximately US$0.27 billion) by the year 2005 and K275 billion (US$0.63 billion) by 2015. Even apply the total amount in 2015, the above total requirement of investment costs corresponded with almost twice of the estimate of the public investment.

Moreover, these amounts are based on the assumption that the capital investment environment and foreign economic cooperation in the future will keep the same conditions as in the past. On the other hand, the country's total external debt stood at US$7 billion in 1992. It rated at 193% of GDP in the same year. The total arrears on principal and interest payments amounted to US$358 million. Then, a debt-service ratio became to 29%. This means that Zambia has exceeded the critical line of foreign debt. In other words, as far as the country increases more foreign exports in the future than in the past trend, it might be difficult to get more new foreign loans.

In 1992, the total ODA was aggregated to US$1.13 billion which was segregated to US$0.79 billion or 69% of grants and US$0.35 billion or 44% of loans. During the recent six years from 1987 to 1992, an average of ODA comprised 73% of grants and 37% of loans. Accordingly, since new loans will be restricted in the future in consideration of the national financial situation, the country has to rely on more grants as ODA than loans.

(2) Managing Bodies

The cost recovery policy in water resources development and use projects varies in different countries. They range from zero to full cost recovery including the payment of interest cost. In between, partial cost recoveries are widely in practice in accordance with different criteria and socio-political considerations particular to each countries.

It is said to be burdensome for financial status of water supply system to be kept in surplus condition, in general. In spite of large investment and comparatively expensive operation, it is troublesome to charge beneficiaries for water supply service on the basis of tariff corresponding to its all costs. To implement the system successfully, thus, it is imperative to procure lower cost of funds in addition to understanding of beneficiaries.

The cost recovery policy of sewage service is not clear in Zambia. At present, however, managing bodies in urban areas make all possible efforts to make both their income and expenditure meet in a same year. This endeavour is fundamentally based on "Full recovery policy". Therefore, once the income does not meet the expenditure, the bodies would try to revise the water service tariff.

On the other hand, the "O&M cost recovery policy" is to cover only operation and maintenance (O&M) costs of water supply system. In this policy, capital cost of system is customarily covered by general account of governments concerned or by grant of foreign assistance.

Water resources development in Zambia will require an accelerated and large amount of investment to keep up with rapid socio-economic development. To meet this requirement, not only effective investment but also efficient recovery of public expenditures should be pursued.

This study envisages two general criteria for formulating the water cost sharing policy.

(1) The first criterion is a leading criterion that the beneficiaries are required to share, according to the benefits they receive, the entire cost of the public facilities including construction, operation and maintenance costs if the beneficiaries are identifiable and are confined to certain sections of the community. In principal this cost should not be covered by tax revenue collected from general tax payers who include non-beneficiaries, but should be recovered from the beneficiaries themselves as a separate charge. This criterion is based on the free market economy principle and the principle of equity, which encourages the economic efficiency and optimum allocation of national resources.

(2) The second criterion is that the government grant should be provided only if it is necessary in order (a) to encourage the beneficiaries' participation in development or (b) to provide social amenities from the standpoint of subsidising low income people. Even in this case, the cost recovery policy would rather be discussed with beneficiaries. For instance, in construction period some beneficiaries might have an opportunity to share some tasks of construction works as task force. In operation and maintenance stage, some O/M works such as simple periodic inspection could be managed by some beneficiaries. By this participation works, the costs for water supply works could be saved in accordance with beneficiaries' attendance.

(3) Household Economy

The average household expenditure of the country was K5,042 in 1991 and distributed as K9,251 in urban area and K1,920 in rural area, as discussed in Section 2.1.6. Among household expenditure, housing expense accounted for 19% of the total expenditure in urban and 11% in rural. Expenditure for water was only 0.57% of the total expenditure in urban and 0.11% in rural. Since an average household monthly expenditure in 1991 was K9,251 in urban areas and K1,920 in rural areas, an average monthly expenditure for water was estimated at K53 (approximately equivalent to US$0.65) in urban areas and K2 (US$0.024) in rural areas.

In economic evaluation, the benefit from water supply for household was estimated to be 5% of household income as the maximum affordable value which is recommended in the World Bank report of " Investing in Development". This percentage was much larger than the above research results. As analysed in economic evaluation, however, many projects were not viable from the economic point of view even applying the maximum affordable value. Thus, it is seems to be difficult to find the most suitable water value for both consumer and water supplier. It is important for the both as well as the government to understand these difficulties and to try to find rules of cost sharing.

(4) Financial Evaluation of Water Supply Projects

Construction cost of water supply projects are estimated for each scenario, and variation in construction cost by fluctuation of parameters, such as unit consumption rate and service coverage, is examined in Table 5-5. This Study assumes unit consumption rate for domestic use in large urban area, in small urban area and in rural areas as 180 lit./person/day, 150 lit./person/day and 35 lit./person/day respectively. However, the unit consumption rate in Lusaka is estimated at between 130 ~ 150 lit/person/day. The cost variations if the unit consumption rate decreases by 10% or 20% are as shown in Table 5-5, fluctuating the industrial unit consumption rate in the same way. The result of the examination shows that 10% decrease in the amount of water developed would save 20% of the construction cost.

The coverage of the water supply services in large urban, small urban and rural areas are assumed as 100%, 100% and 75% for this Study. If the coverage rates for large urban areas, small urban areas and rural areas are changed to 100% (same), 80% and 50%, the construction cost would decrease by around 10%. The construction cost varies from US$ 1,010 million to US$ 500 million when unit consumption rate is decreased by 0% to 20% and the supply coverage changes as described above, for the Base Scenario-Agricultural Expansion (medium population projection) and the Conservative Scenario (low population projection).

The cumulative capital expenditure of the central government for water supply projects during the years up to 2015 can be estimated as US$ 650 million, assuming continuous foreign assistance and government expenditure for the sector. The ratio of estimated government capital expenditure to the construction cost is calculated as 1.6 to 0.8. The gap between the two is not so wide. The estimation of cumulative government capital expenditure is made based on the past record of government investment, which might be smaller than it should be. Further, if the target of economic growth is achieved as the

scenarios assume, government investment will consequently grow. It would therefore be possible to secure the investment to cover the required construction cost as proposed in the Base Scenario-Agricultural Expansion and in the Conservative Scenario.

Table 5-5 Effect of Variations in Water Demand

Demand Decrease	Area	Unit Consumpt.	Service Coverage	Domestic Use	Industrial Use	Loss	Present Capacity	Water Developed	Const. Cost
		l/person/day	%	1000m³/day	1000m³/day	1000m³/day	1000m³/day	1000m³/day	US$ million
Base Scenario - Agricultural Expansion									
0%	Large U.	180	100	810	362	293	989	1,048	1,010
	Small U.	150	100	145	85	34			(1.00)
	Rural	35	75	255	0	25			
10%	Large U.	162	100	729	326	264	989	822	792
	Small U.	135	100	131	77	31			(0.78)
	Rural	32	75	230	0	23			
10%	Large U.	162	100	729	326	264	989	706	680
	Small U.	135	80	104	77	27			(0.67)
	Rural	32	50	153	0	15			
20%	Large U.	144	100	648	290	235	989	620	598
	Small U.	120	100	116	68	28			(0.59)
	Rural	28	75	204	0	20			
20%	Large U.	144	100	648	290	235	989	519	500
	Small U.	120	80	93	68	24			(0.50)
	Rural	28	50	136	0	14			
Conservative Scenario									
0%	Large U.	180	100	738	287	256	989	802	807
	Small U.	150	100	144	77	33			(1.00)
	Rural	35	75	231	0	23			
10%	Large U.	162	100	664	258	231	989	622	626
	Small U.	135	100	130	69	30			(0.78)
	Rural	32	75	208	0	21			
10%	Large U.	162	100	664	258	231	989	514	517
	Small U.	135	80	104	69	26			(0.64)
	Rural	32	50	137	0	14			

CHAPTER 6 ACTION PLAN OF WATER SUPPLY PROJECT

Action Plans are formulated after selection from the proposed projects in the water supply sector, applying the following criteria:

1) Projects whose implementation is scheduled in the first 5years of the 20 year period covered by this Study
2) Projects serving higher population
3) Projects which require longer periods for the study and design

Selected projects are Commencement of the Water Supply Project for Lusaka Urban Area, including Northern Lusaka Production Well Project and Chongwe Dam Water Supply Project, and Groundwater Development Training Centre Project.

6.1 Commencement of the Water Supply Project for Lusaka Urban Area

The Lusaka Water Supply Project is the largest in scale of the large urban water supply projects and is given the highest priority. This project consists of Northern Lusaka Production Well Project, Chongwe Dam Water Supply Project and the Kafue Pipeline Project. Two proposed projects, the Production Well Project and the Chongwe Dam Project are programmed in the first five year stage up to the year 2000.

Northern Lusaka Production Well Project

The development potential of the groundwater basin in northern Lusaka is estimated at about 38,000m^3/day and is barely developed at the moment. Northern Lusaka Production Well Project, comprising 50 wells of 20,000m^3/day pumpage, corresponding to 53% of the development potential, and estimated to cost about 16 million US$, is recommended. The standard designs for pumping wells for Lusaka water supply, township water and rural supplies are shown in Figure 6-1. The supervising ministry in charge of water supply projects, the Ministry of Local Government and Housing, and the implementing agencies, Lusaka City Council and Lusaka Water and Sewerage Company, should commence this project immediately.

Chongwe Dam Water Supply Project

Chongwe Dam is a multi-purpose dam project to supply domestic and industrial water and irrigation schemes. Preliminary layout drawings of Chongwe Dam, including plane, longitudinal cross section and typical cross section, are shown in Figure 6-2. Chongwe Dam Water Supply Project will provide 100,000m^3/day potable water to the Lusaka waterworks. The estimated cost for this project is 109.87 million US$. This project is promising as a new multi-purpose source development. Feasibility Study of this project should be commenced at an early stage by the supervising ministry, the Ministry of Energy and Water Development and the implementing agency, the Department of Water Affairs.

Figure 6-1 Standard Design of Pumping Wells

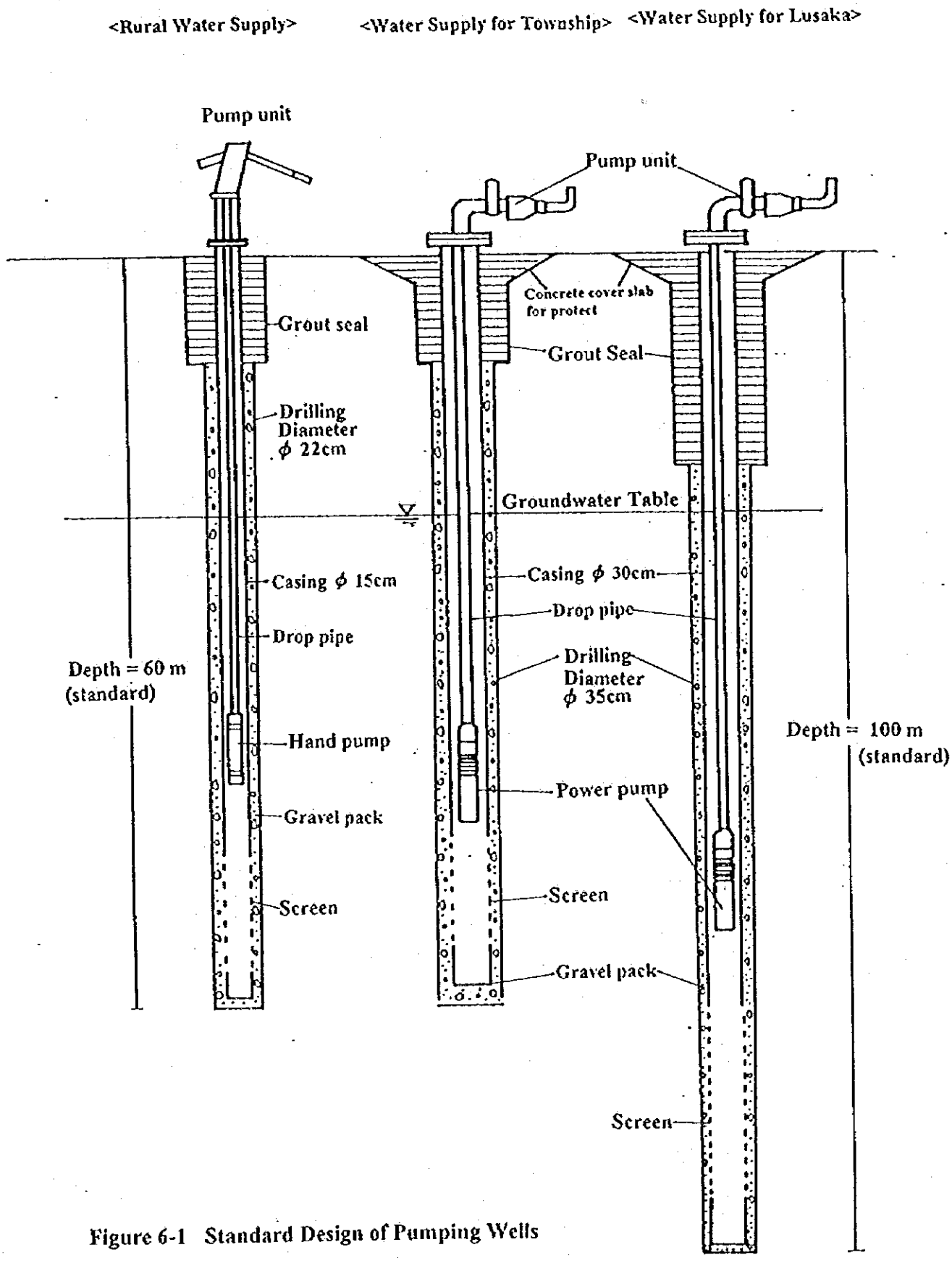
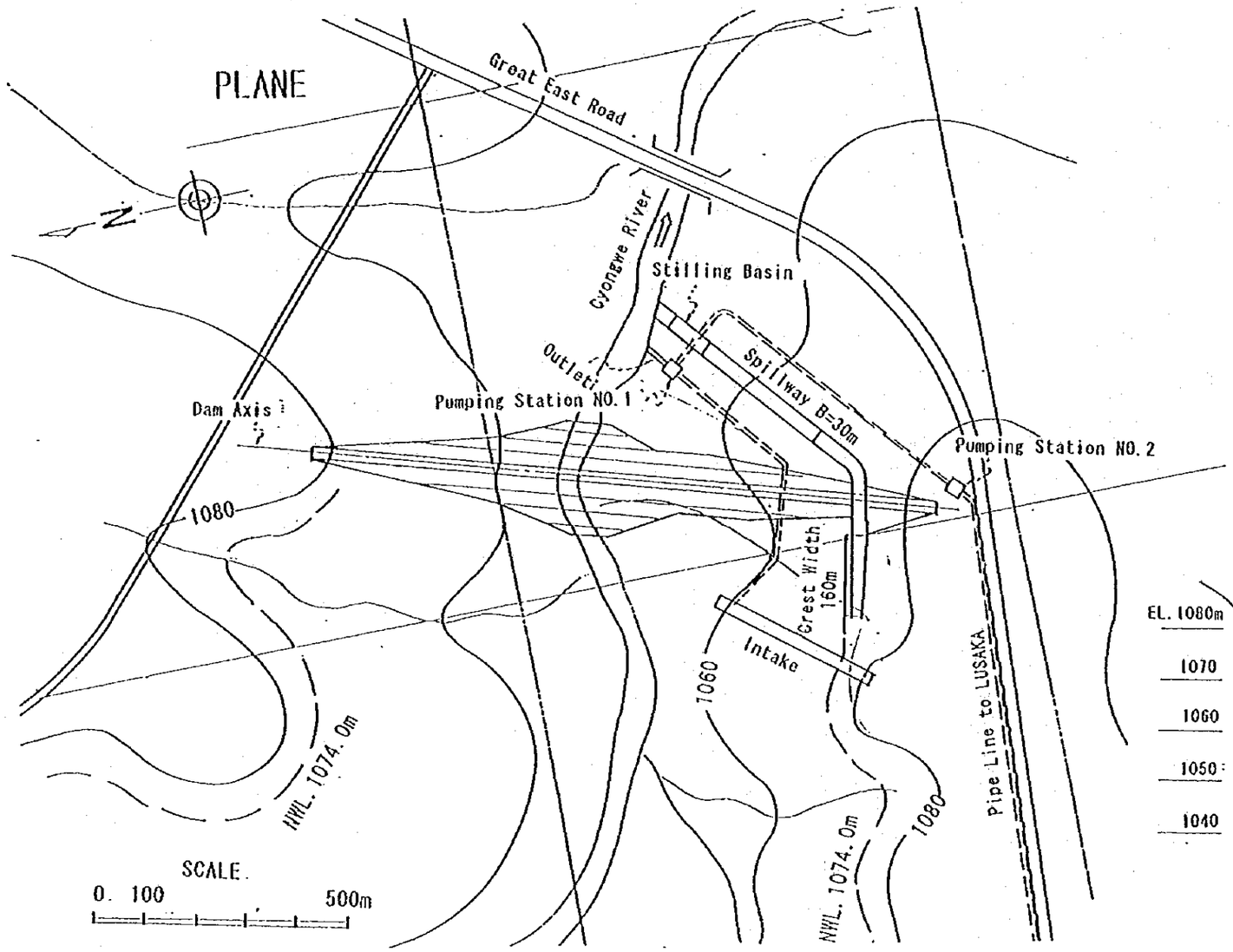
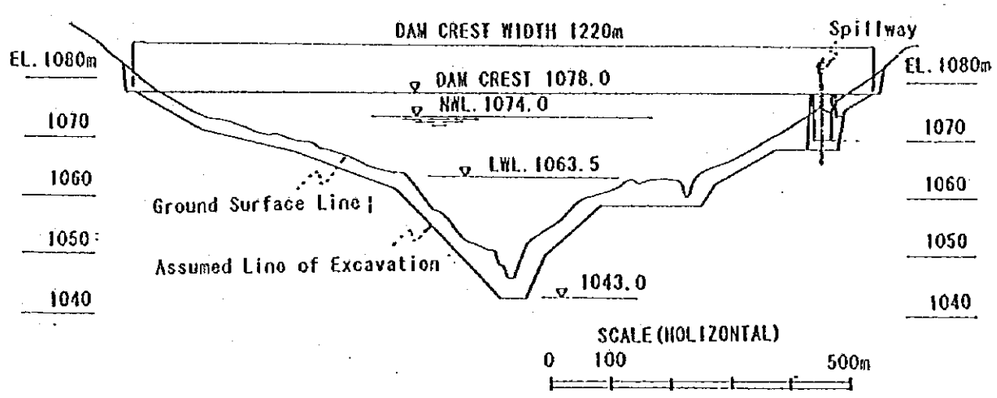


Figure 6-1 Standard Design of Pumping Wells





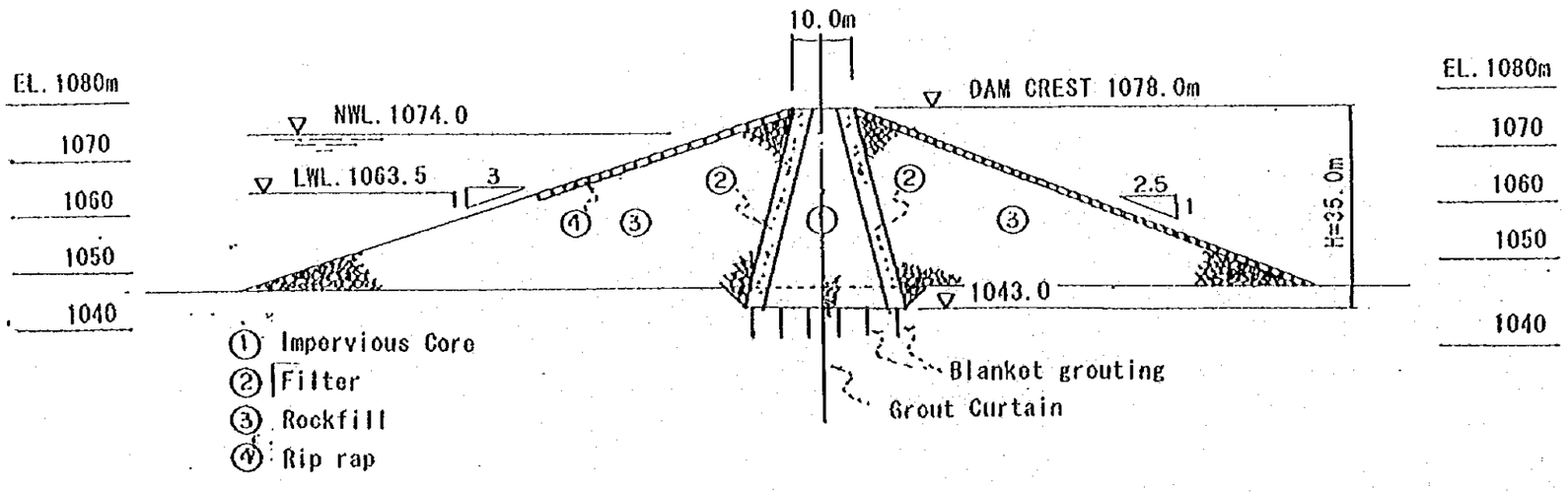


Figure 6-2 Layout of Chongwe Dam

CHONGWE DAM (NO. 16)

Financial Evaluation of the Proposed Projects

Applying the capital recovery factor (CRF) to the annualised capital investment cost, the proposed projects in the action plan, Northern Lusaka Production Well Project (Northern Wells Case) and Chongwe Dam Water Supply Project (Chongwe Dam Case), were examined regarding project viability with some financial counter-measures. The cost items are summarised as follows:

Table 6-1 Flat Water Rate of Proposed Projects

Item	Northern Wells Case	Chongwe Dam Case
Capital Investment Cost (US$ Million)	15.75	109.87
CRF (α) *1	0.1019	0.1019
Annualised Capital Cost (US$ Million)	1.605	11.196
Annual O/M Cost (US$ Million)	0.788	5.494
Annual Total Cost (US$ Million)	2.393	16.690
Water Consumption (Million m³/year)	7.3	36.5
Flat Water Rate (US$/ m³)	0.328	0.457
Flat Water Rate (Kwacha/ m³) *2	195	279

Note: *1) Interest rate: 8%, Repayment period: 20 years
*2) Exchange rate: K610/US$

If a financial source is procured under the terms shown in the note of the table, i.e., 8% annual interest rate and 20 years repayment period, a flat water cost would be rated at approximately K200 per m³ for Northern Wells Case and K280 per m³ for Chongwe Dam Case. The rate of K200/m³ is close to the present water rate of Lusaka Water and Sewerage Company. Although this estimation is approximate, Northern Well Case seems to be feasible from the financial point of view, if the above mentioned financial source is available for the project. The flat water rate of Chongwe Dam Case was estimated at K280/m³. This rate was almost 50% higher than the present rate. Thus, any of the following countermeasures would be necessary for the project to be feasible:

1) Half of the capital investment cost (approximately US $55 million) is grant aid;
2) A loan under the terms of annual interest rate of 2% and repayment period of 25 years is available;
3) Water consumers have a willingness to pay the higher estimated water charge.

Actually, a combination of the above countermeasures could be considered in the case that one measure could not be applied fully. In any case, these countermeasures are considered to be affordable.

6.2 Groundwater Development Training Centre

In the water supply plan for the Base Scenario-Agricultural Expansion, about 24,000 boreholes are planned to be constructed during 20 years to 2015. There are eight DTH type drilling rigs at present in Zambia, but more than twenty DTH type rigs are needed to complete 1,200 boreholes per year. More than 20 drilling teams are needed, with more than 200 personnel, including hydrogeologists, drilling engineers and mechanical engineers. In addition, strengthening of maintenance and management system for completed boreholes is needed and an educational institute to train personnel related to groundwater development

is recommended. For the purpose of attaining these aims above, "Drilling Centre Project" and "Groundwater Development Training Centre Project" are proposed as projects for the promotion of groundwater development. Drilling centres should be constructed in each province and the existing equipment and staff of DWA should be utilised in the drilling centres. (Refer to Table 6-2).

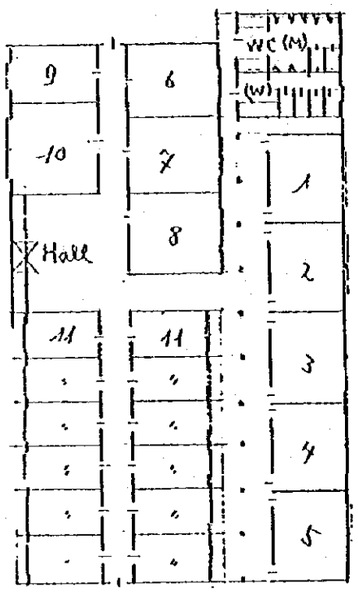
Table 6-2 Drilling Centre Projects

Province	Number of Rigs	Number of Boreholes to be Developed (Base Scenario-Agricultural Expansion)				Project Cost (mil. US$)	Note
		Large Urban	Small Urban	Rural Areas	Total		
Lusaka	(2)*	50	5	1,090	1,145	13.40	Facilities have function of both groundwater development centre and drilling centre. Two Drilling teams.
Copperbelt	2		17	1,704	1,721	6.46	Drilling centre to be newly constructed in Ndola. Three drilling teams.
Central	(3)*		230	2,834	3,064	-	Existing drilling centre in Kabwe to be utilised. Five drilling teams.
Northwestern	2		92	1,742	1,834	6.46	Drilling centre to be newly constructed in Solwezi. Three drilling teams.
Western	(1)*		36	1,058	1,094	-	Existing drilling centre in Mongu to be utilised. Two drilling teams.
Southern	(2)*		315	3,516	3,831	-	Existing drilling centre in Monze to be utilised. Five drilling teams.
Luapula	2		79	2,068	2,147	6.46	Drilling centre to be newly constructed in Mansa. Three drilling teams.
Northern	3		221	3,546	3,767	9.57	Drilling centre to be newly constructed in Kasama. Five drilling teams.
Eastern	4	120	286	4,970	5,376	12.69	Drilling centre to be newly constructed in Chipata. Six drilling teams.
<Total>	13 (8)*	170	1,281	22,528	23,979	55.04	

(Note) * : Number of existing drilling rigs

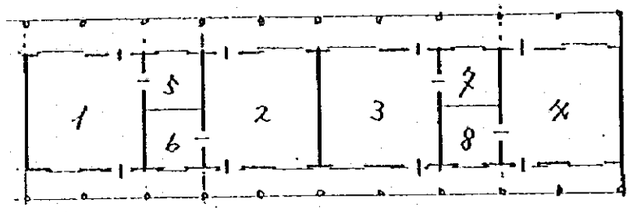
Before constructing the provincial drilling centres, a Groundwater Development Centre and the Lusaka Province drilling centre should be constructed at the same time in Lusaka, where the engineers related to groundwater development and personnel in charge of well maintenance and management will be trained. Preliminary layout drawings of Groundwater Development Centre facilities are shown in Figure 6-3. In this Training Centre, four training corses, hydrogeology, drilling, mecanical engineering and village instructor corses, will be held. Proposed Groundwater Development Training Center should be staffed by about 40 persons, consist of Zambian training and administrative staffs. Outlines of training contents are shown in Table 6-3. For the time being, these projects should be promoted in co-operation with MLGH and MEWD. Project description is summarised in Table 6-4.

Research Block Buildings



CLASSROOM BLDG.

1. Water, Soil Research
2. Well Drilling
3. Machine Operation
4. Well Maintenance
5. Computer Operation

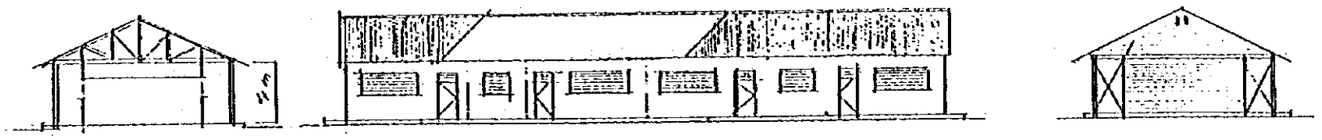


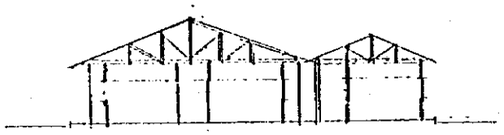
LABORATORY BLDG.

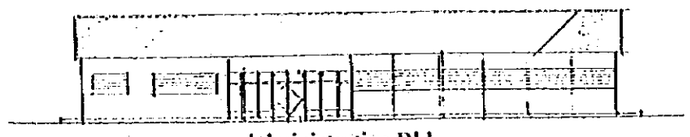
1. Soil Labo → 5. Personal R.
2. Water Labo → 6. Personal R.
3. Machine Labo → 7. Personal R.
4. Spare Labo → 8. Personal R.

ADMINISTRATIVE BLDG.

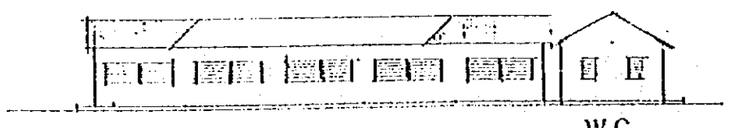
6. Computer R.
7. Library
8. Audio Visual & Meeting
9. Director R.
10. Office
11. Teacher R.





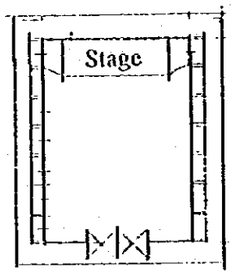


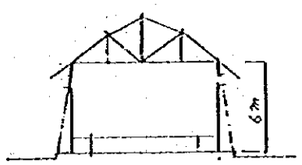
Administrative Bldg.



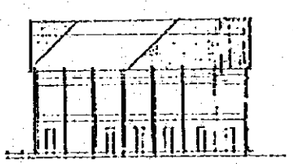
Classroom Bldg.

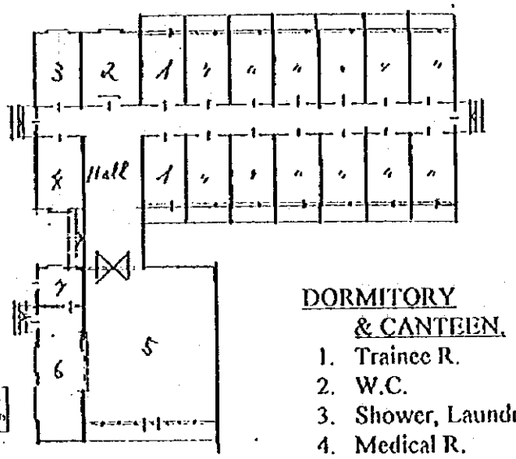
W.C.

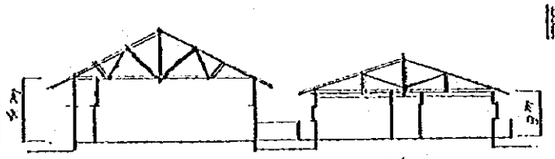




SEMINAR HALL
& LECTURE HALL



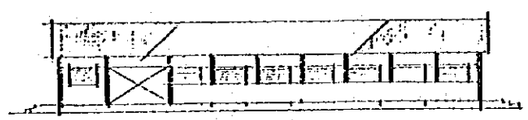




Canteen Dormitory

DORMITORY
& CANTEEN.

1. Trainee R.
2. W.C.
3. Shower, Laundry
4. Medical R.
5. Dining R.
6. Kitchen
7. Storage



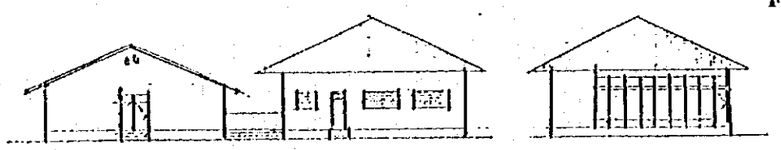


Figure 6-3 Layout of Groundwater Development Centre Facilities

Table 6-3 Training Corses in Groundwater Development Training Centre

Training Corse	Number of Trainees	Training Periode	Lectures Items
Hydrogeology Corse	10 persons	1 year	Topography, Geology, Hydrogeology, Fielgd Geological Reconnaissance, Geophysical Prospecting, Soil Test, Well Logging, Groundwater Simulation and Evaluation of the Potential
Drilling Corse	10 persons	1 year	Well Drilling, Pumping Test, Well Repairing
Mechanical Engineering Corse	10 persons	6 months	Repairing and Maintenance of Drilling Machines and Supporting Vehicles, Setting and Repairing of Handpumps
Village Instructor Corse	11 persons	1 month	Health Education, Water Quality, Community Participation

Table 6-4 Groundwater Development Training Centre Projects

1.Objectives	- Training of technicians for groundwater development to implement groundwater development projects proposed in the Master Plan. - Target trainees are hydrogeologists, drilling engineers, mechanics, and staff for extension services in rural areas
2.Location	- Lusaka City - Groundwater Development Training Centre and Drilling Centre of Lusaka Province should be located in the same place
3.Size	Total Land Area: 10,000 m^2 Total Building Area: 3,000 m^2, 2 rigs
4.Main Facilities	Training Rooms, Auditorium, Reference Room, Audio-visual Room, Computer Room, Dormitory, Workshop
5.Implementation Schedule	Phase 1: construction and establishment, initial training by consultants (3 years) Phase 2: technical transfer from foreign experts (5 years) Phase 3: training by Zambian trainers (after technical transfer)
6.Project Cost	Phase 1: - Construction: US$ 13.40 million - Initial Training: US$ 3.00 million - Operation and Maintenance: US$ 70,000/year (facility) US$ 30,000/year (training)after Phase 2 - Operation and Maintenance: US$ 234,000/year (facility) US$ 30,000/year (training)

APPENDICES

APPENDICES

THE STUDY ON NATIONAL WATER RESOURCES MASTER PLAN
IN THE REPUBLIC OF ZAMBIA

SUPPORTING REPORT (P)
WATER SUPPLY PLAN

APPENDIX - 1

WATER DEMAND SUPPLY CHARTS

Appendix-1.1 Water Demand and Supply Plan for Large Urban Areas

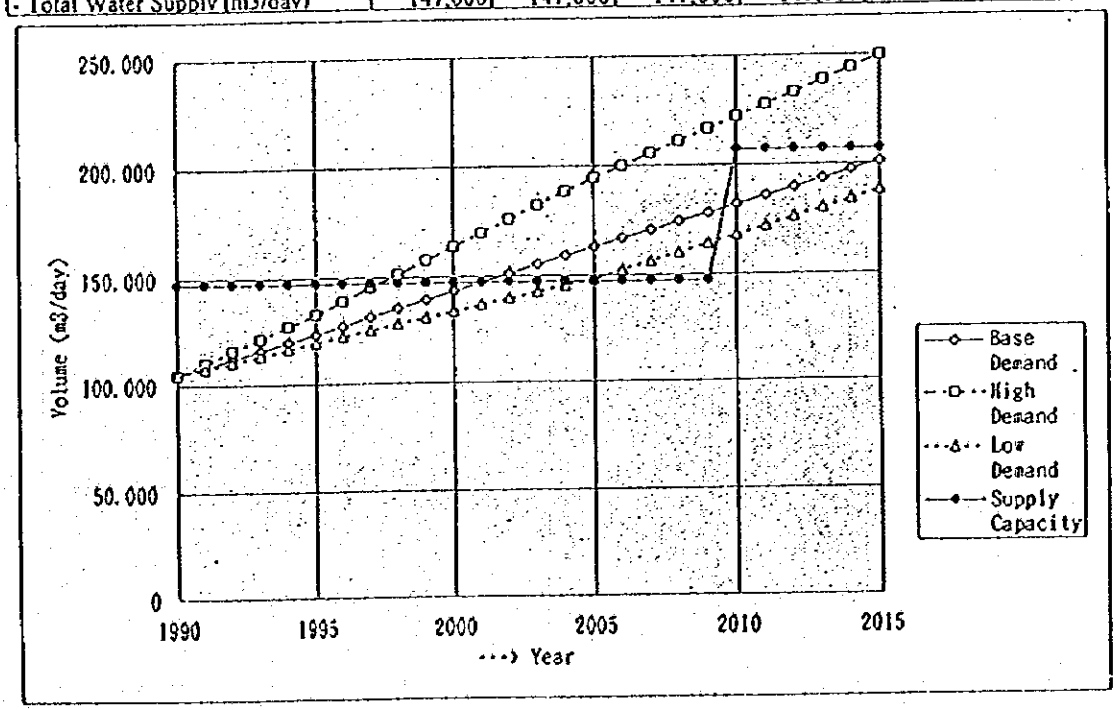
(1) Water Demand and Supply Plan (Ndola Urban)

Township		DISTRICT		PROVINCE	
211	Ndola Township	21	Ndola Urban	20	Copperbelt

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	334,531	(1) Base Projection	388,375	506,943	635,129
- Household	60,679	(2) High Projection	391,783	532,432	714,849
- Family Size	5.5	(3) Low Projection	385,372	485,657	577,936

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
Ndola Water Supply	Council	147,000
Total		147,000
Surface Water Source : Kafubu River (Kafue River)		47,000
Groundwater Source : 21 Production Wells		100,000

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	60,216	69,908	80,579	91,250	102,786	114,323
	(High)	60,216	70,521	83,179	95,838	112,255	128,673
	(Low)	60,216	69,367	78,393	87,418	95,723	104,028
< Industrial Water >							
Water Demand (m3/day)	(Base)	23,600	28,767	33,933	39,100	42,800	46,500
	(High)	23,600	35,667	47,733	59,800	65,450	71,100
	(Low)	23,600	26,100	28,600	31,100	38,800	46,500
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	83,816	98,674	114,512	130,350	145,586	160,823
	(High)	83,816	106,188	130,913	155,638	177,705	199,773
	(Low)	83,816	95,467	106,993	118,518	134,523	150,528
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	104,769	123,343	143,140	162,937	181,983	201,029
	(High)	104,769	132,735	163,641	194,547	222,132	249,716
	(Low)	104,769	119,334	133,741	148,148	168,154	188,161
< Water Supply Program >							
- Existing Capacity (m3/day)		147,000	147,000	147,000	147,000	147,000	147,000
(1) Kafubu Dam						60,000	60,000
- Total Water Supply (m3/day)		147,000	147,000	147,000	147,000	207,000	207,000



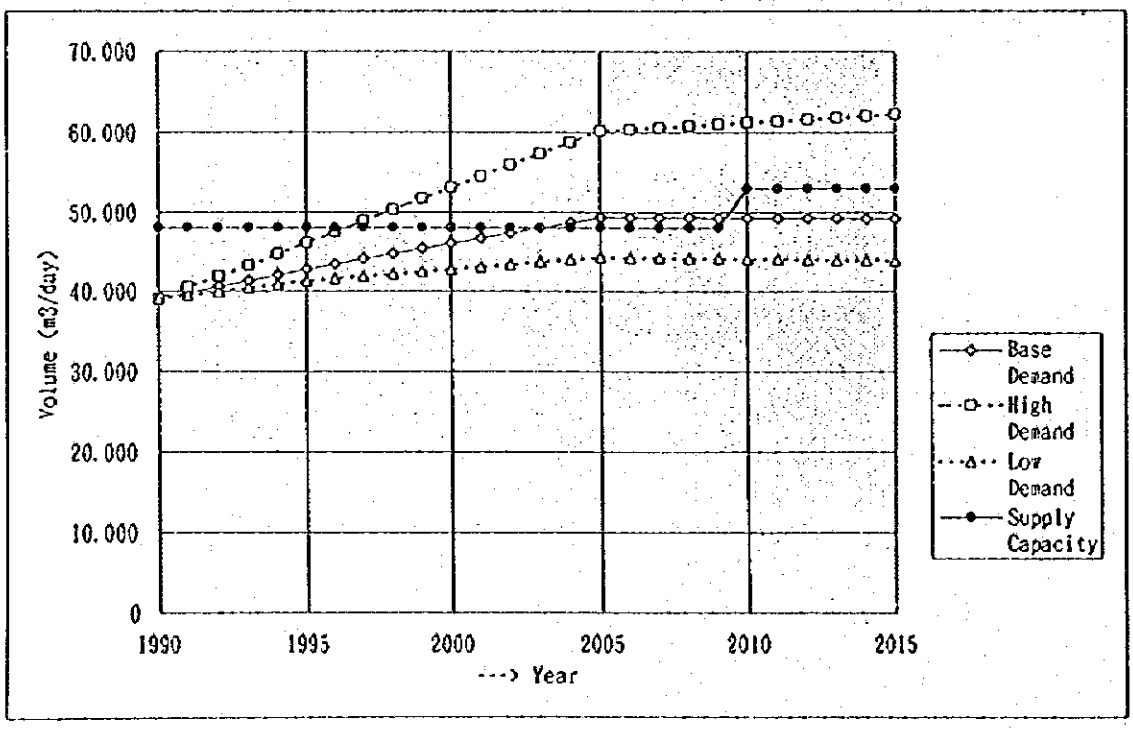
(2) Water Demand and Supply Plan (Mufulira)

Township		DISTRICT		PROVINCE	
251	Mufulira	25	Mufulira	20	Copperbelt

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	124,746	(1) Base Projection	130,658	138,776	141,511
- Household	21,908	(2) High Projection	131,824	145,834	159,342
- Family Size	5.7	(3) Low Projection	129,626	132,968	133,432

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
- Mufulira Mine Water Works	ZCCM	48,000
Total		48,000
Surface Water Source : Mufulira River (Kafue River)		48,000
Groundwater Source :		

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap/day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	22,454	23,518	24,249	24,980	25,226	25,472
	(High)	22,454	23,728	24,989	26,250	27,466	28,682
	(Low)	22,454	23,333	23,633	23,934	23,976	24,018
< Industrial Water >							
Water Demand (m3/day)	(Base)	8,800	10,700	12,600	14,500	14,200	13,900
	(High)	8,800	13,167	17,533	21,900	21,500	21,100
	(Low)	8,800	9,700	10,600	11,500	11,300	11,100
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	31,254	34,218	36,849	39,480	39,426	39,372
	(High)	31,254	36,895	42,523	48,150	48,966	49,782
	(Low)	31,254	33,033	34,233	35,434	35,276	35,118
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	39,068	42,773	46,061	49,350	49,282	49,215
	(High)	39,068	46,119	53,153	60,188	61,207	62,227
	(Low)	39,068	41,291	42,792	44,293	44,095	43,897
< Water Supply Program >							
- Existing Capacity (m3/day)		48,000	48,000	48,000	48,000	48,000	48,000
(1) Mutundu Dam						5,000	5,000
- Total Water Supply (m3/day)		48,000	48,000	48,000	48,000	53,000	53,000



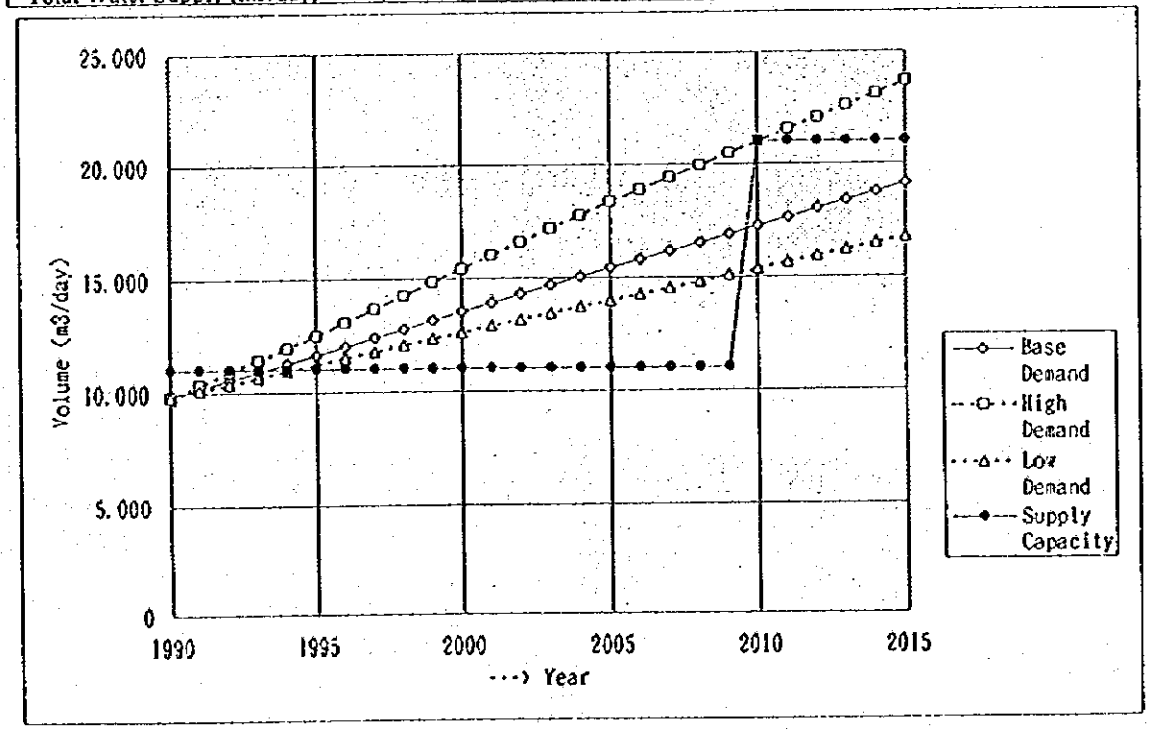
(3) Water Demand and Supply Plan (Kalulushi)

Township		DISTRICT		PROVINCE	
261	Kalulushi	26	Kalulushi	20	Copperbelt

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	31,474	(1) Base Projection	36,628	48,020	60,457
- Household	5,829	(2) High Projection	36,950	50,458	68,043
- Family Size	5.4	(3) Low Projection	36,329	46,006	54,989

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
- Chibuluma Mine W. Works	ZCCM & Council	11,000
Total		11,000
Surface Water Source :		
Groundwater Source :		11,000

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	5,665	6,593	7,618	8,644	9,763	10,882
	(High)	5,665	6,651	7,867	9,082	10,665	12,248
	(Low)	5,665	6,539	7,410	8,281	9,090	9,898
< Industrial Water >							
Water Demand (m3/day)	(Base)	2,200	2,700	3,200	3,700	4,050	4,400
	(High)	2,200	3,333	4,467	5,600	6,150	6,700
	(Low)	2,200	2,433	2,667	2,900	3,200	3,500
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	7,865	9,293	10,818	12,344	13,813	15,282
	(High)	7,865	9,984	12,333	14,682	16,815	18,948
	(Low)	7,865	8,973	10,077	11,181	12,290	13,398
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	9,832	11,616	13,523	15,430	17,266	19,103
	(High)	9,832	12,480	15,417	18,353	21,019	23,685
	(Low)	9,832	11,216	12,596	13,976	15,362	16,748
< Water Supply Program >							
- Existing Capacity (m3/day)		11,000	11,000	11,000	11,000	11,000	11,000
(1) Mutundu Dam						10,000	10,000
- Total Water Supply (m3/day)		11,000	11,000	11,000	11,000	21,000	21,000



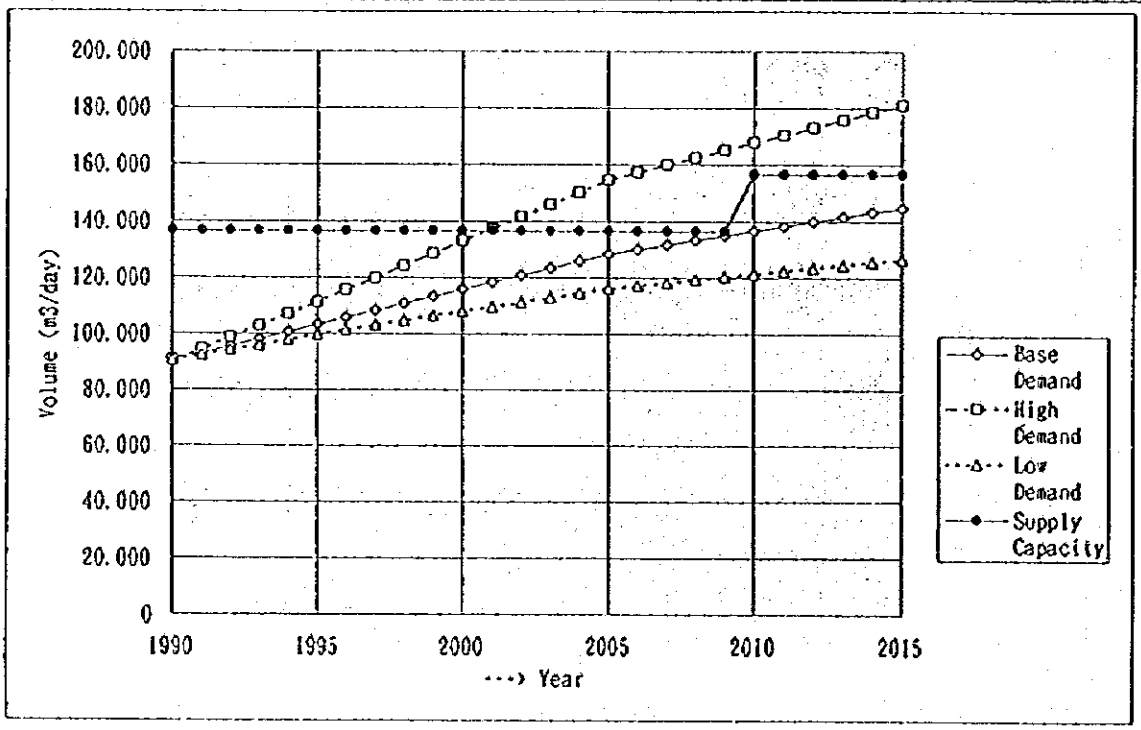
(4) Water Demand and Supply Plan (Kitwe)

Township		DISTRICT		PROVINCE	
271	Kitwe	27	Kitwe	20	Copperbelt

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	288,592	(1) Base Projection	320,666	383,289	439,808
- Household	47,222	(2) High Projection	323,504	402,540	494,797
- Family Size	6.1	(3) Low Projection	318,161	367,236	400,065

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
- Kitwe Water Supply	Kitwe City Council	54,550
- New/Old W/Treatment P.	ZCCM	81,818
Total		136,368
Surface Water Source : Kafue River		54,550
Surface Water Source : Kafue River		81,818

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	51,947	57,720	63,356	68,992	74,079	79,165
	(High)	51,947	58,231	65,344	72,457	80,760	89,063
	(Low)	51,947	57,269	61,686	66,102	69,057	72,012
< Industrial Water >							
Water Demand (m3/day)	(Base)	20,400	24,800	29,200	33,600	35,150	36,700
	(High)	20,400	30,667	40,933	51,200	53,500	55,800
	(Low)	20,400	22,533	24,667	26,800	28,000	29,200
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	72,347	82,520	92,556	102,592	109,229	115,865
	(High)	72,347	88,897	106,277	123,657	134,260	144,863
	(Low)	72,347	79,802	86,352	92,902	97,057	101,212
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	90,433	103,150	115,695	128,240	136,536	144,832
	(High)	90,433	111,122	132,847	154,572	167,825	181,079
	(Low)	90,433	99,753	107,940	116,128	121,321	126,515
< Water Supply Program >							
- Existing Capacity (m3/day)		136,368	136,368	136,368	136,368	136,368	136,368
(1) Mutundu Dam						20,000	20,000
- Total Water Supply (m3/day)		136,368	136,368	136,368	136,368	156,368	156,368



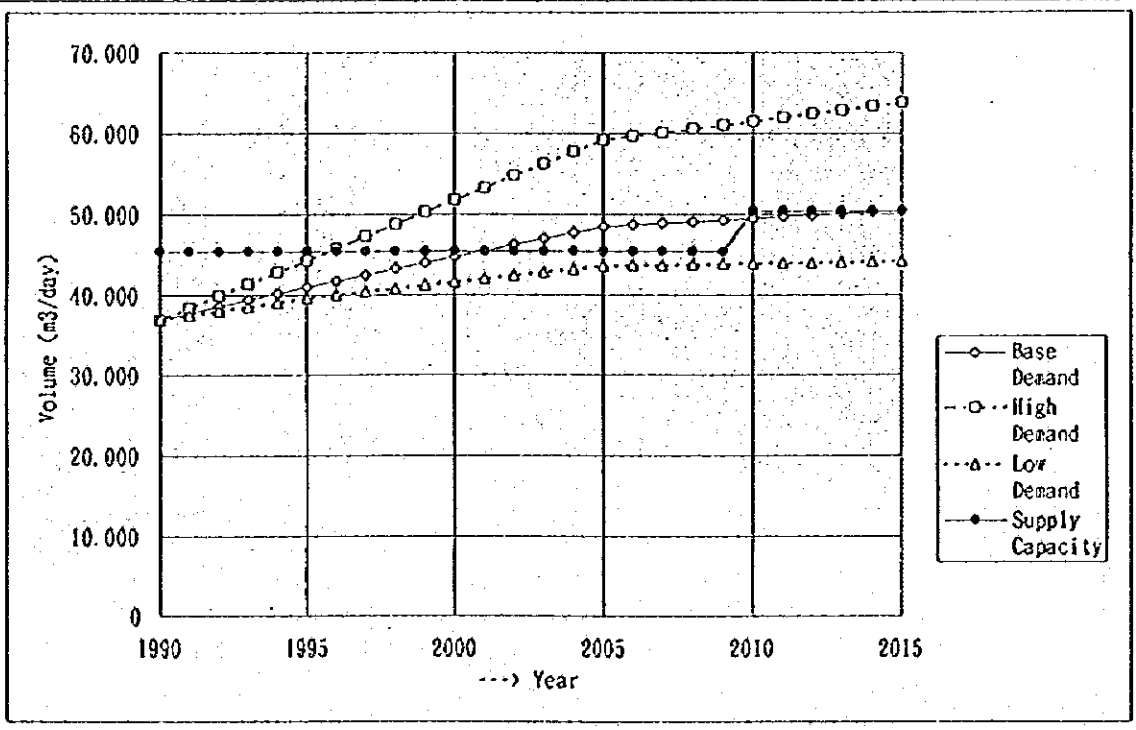
(5) Water Demand and Supply Plan (Luanshya)

Township		DISTRICT		PROVINCE	
281	Luansha	28	Luansha	20	Copperbelt

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	118,143	(1) Base Projection	126,214	139,345	147,713
- Household	21,974	(2) High Projection	127,273	146,402	166,259
- Family Size	5.4	(3) Low Projection	125,158	133,398	135,414

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
- Luansha W. Supply Imp.	Council	12,400
- Makoma Water Works	ZCCM	33,000
Total		45,400
Surface Water Source : Kafubu River		45,400
Groundwater Source :		

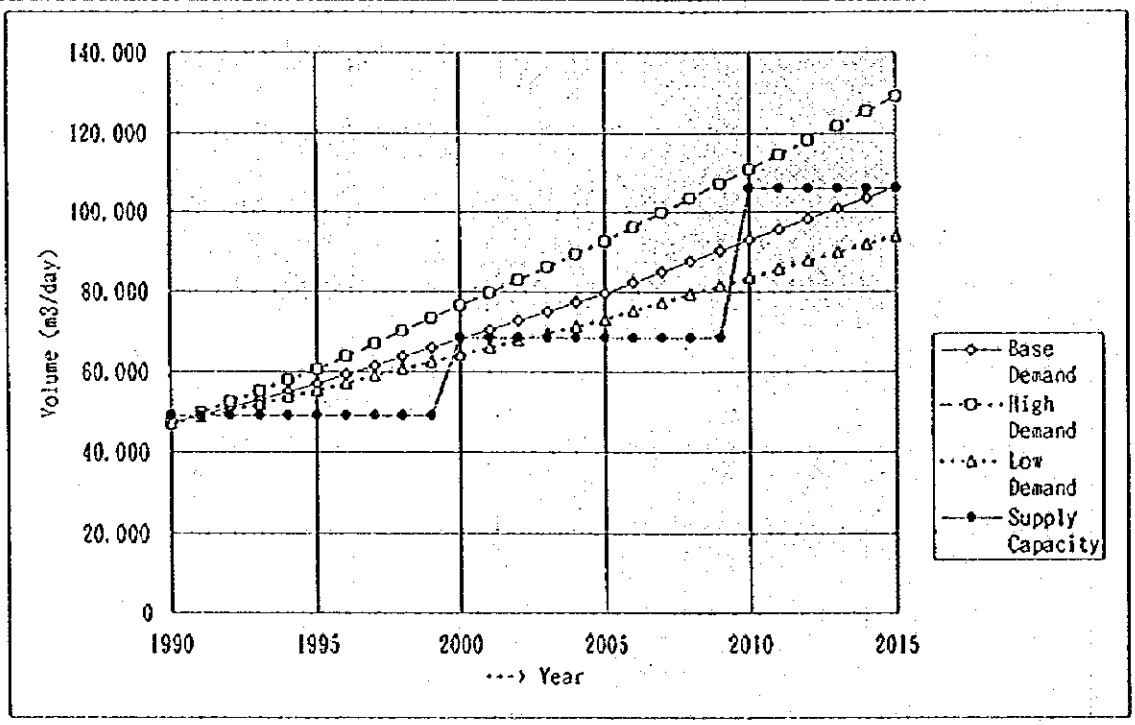
WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	21,266	22,719	23,900	25,082	25,835	26,588
	(High)	21,266	22,909	24,631	26,352	28,139	29,927
	(Low)	21,266	22,528	23,270	24,012	24,193	24,375
< Industrial Water >							
Water Demand (m3/day)	(Base)	8,300	10,100	11,900	13,700	13,750	13,800
	(High)	8,300	12,533	16,767	21,000	21,050	21,100
	(Low)	8,300	9,167	10,033	10,900	10,950	11,000
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	29,566	32,819	35,800	38,782	39,585	40,388
	(High)	29,566	35,442	41,397	47,352	49,189	51,027
	(Low)	29,566	31,695	33,303	34,912	35,143	35,375
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	36,957	41,023	44,750	48,478	49,482	50,485
	(High)	36,957	44,303	51,747	59,190	61,487	63,783
	(Low)	36,957	39,619	41,629	43,640	43,929	44,218
< Water Supply Program >							
- Existing Capacity (m3/day)		45,400	45,400	45,400	45,400	45,400	45,400
(1) Kafubu Dam						5,000	5,000
- Total Water Supply (m3/day)		45,400	45,400	45,400	45,400	50,400	50,400



(6) Water Demand and Supply Plan (Kabwe)

Township		DISTRICT		PROVINCE		
311	Kabwe Township	31	Kabwe Urban	30	Central	
1990 CENSUS POPULATION AND FUTURE PROJECTION						
1990 Census Data		Projection Scenarios		1995	2005	2015
- Population	161,456	(1) Base Projection		194,556	273,376	368,824
- Household	33,849	(2) High Projection		196,243	287,304	415,359
- Family Size	4.8	(3) Low Projection		192,965	261,982	335,846
CURRENT DOMESTIC WATER SUPPLY PROJECT						
Name of Water Supply Project		Type of Managing Body		Water Supply Volume (m3/day)		
- Mulungushi R. W. Works		Council		33,000 S+G		
- Makululu Water Field		ZCCM		16,000		
Total				49,000		
Surface Water Source : Mulungushi River				18,000		
Groundwater Source : Council W/Field + ZCCM W/Field				31,000		

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	29,062	35,020	42,114	49,208	57,798	66,388
	(High)	29,062	35,324	43,519	51,715	63,240	74,765
	(Low)	29,062	34,734	40,945	47,157	53,805	60,452
< Industrial Water >							
Water Demand (m3/day)	(Base)	8,600	10,567	12,533	14,500	16,550	18,600
	(High)	8,600	13,167	17,733	22,300	25,450	28,600
	(Low)	8,600	9,533	10,467	11,400	13,050	14,700
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	37,662	45,587	54,647	63,708	74,348	84,988
	(High)	37,662	48,490	61,253	74,015	88,690	103,365
	(Low)	37,662	44,267	51,412	58,557	66,855	75,152
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	47,078	56,983	68,309	79,635	92,935	106,235
	(High)	47,078	60,613	76,566	92,518	110,862	129,206
	(Low)	47,078	55,334	64,265	73,196	83,568	93,940
< Water Supply Program >							
- Existing Capacity (m3/day)		49,000	49,000	49,000	49,000	49,000	49,000
(1) M/W//W(Phase-1) Extension				19,500	19,500	19,500	19,500
(2) M/Water/Works (Phase-2)						37,500	37,500
- Total Water Supply (m3/day)		49,000	49,000	68,500	68,500	106,000	106,000



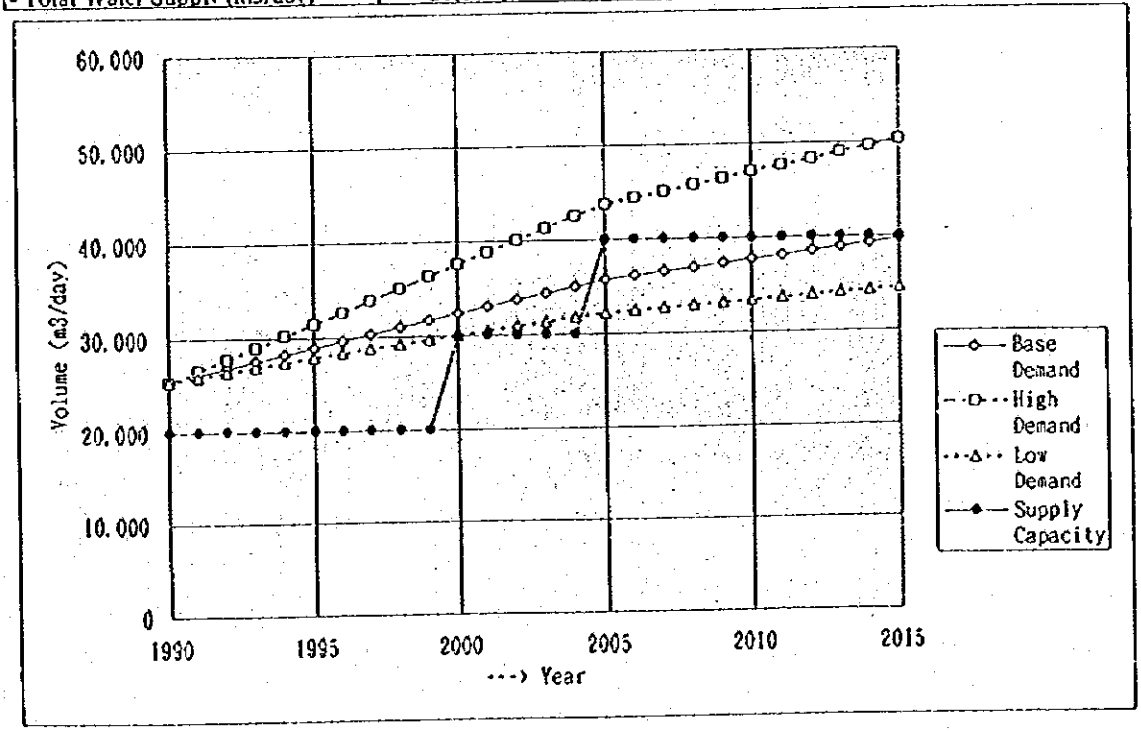
(7) Water Demand and Supply Plan (Livingstone)

Township		DISTRICT		PROVINCE	
611	Livingstone	61	Livingstone	60	Southern

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	76,875	(1) Base Projection	84,833	99,969	113,134
- Household	15,404	(2) High Projection	85,585	105,047	127,363
- Family Size	5.0	(3) Low Projection	84,174	95,824	102,950

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
- Municipal Water Supply	Council	20,000
Total		20,000
Surface Water Source : Zambezi River		20,000
Groundwater Source :		

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	13,838	15,270	16,632	17,994	19,179	20,364
	(High)	13,838	15,405	17,157	18,908	20,917	22,925
	(Low)	13,838	15,151	16,200	17,248	17,890	18,531
< Industrial Water >							
Water Demand (m3/day)	(Base)	6,500	7,867	9,233	10,600	11,000	11,400
	(High)	6,500	9,700	12,900	16,100	16,700	17,300
	(Low)	6,500	7,167	7,833	8,500	8,800	9,100
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	20,338	23,137	25,866	28,594	30,179	31,764
	(High)	20,338	25,105	30,057	35,008	37,617	40,225
	(Low)	20,338	22,318	24,033	25,748	26,690	27,631
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	25,422	28,921	32,332	35,743	37,724	39,705
	(High)	25,422	31,382	37,571	43,761	47,021	50,282
	(Low)	25,422	27,897	30,041	32,185	33,362	34,539
< Water Supply Program >							
- Existing Capacity (m3/day)		20,000	20,000	20,000	20,000	20,000	20,000
(1) W/Supply Extension (Phase-1)				10,000	10,000	10,000	10,000
(2) W/Supply Extension (Phase-2)					10,000	10,000	10,000
- Total Water Supply (m3/day)		20,000	20,000	30,000	40,000	40,000	40,000



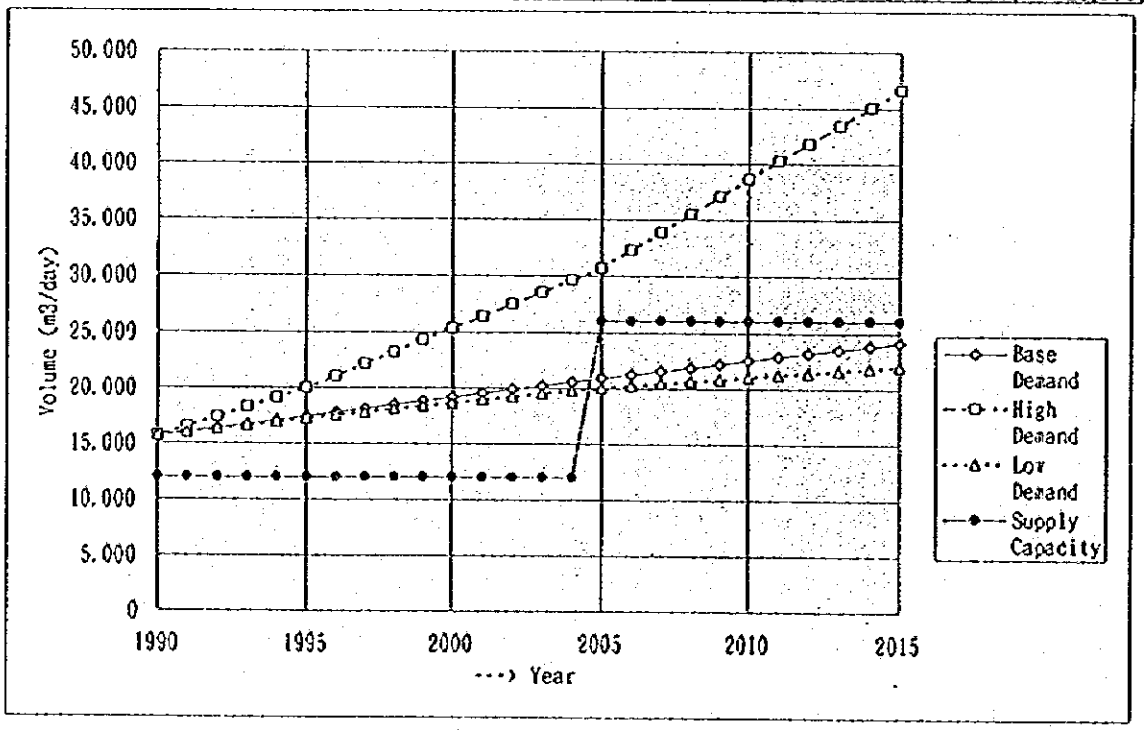
(8) Water Demand and Supply Plan (Kasama)

Township		DISTRICT		PROVINCE	
811	Kasama	81	Kasama	80	Northern

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	48,045	(1) Base Projection	53,513	64,219	74,015
- Household	10,422	(2) High Projection	60,450	94,054	142,740
- Family Size	4.6	(3) Low Projection	53,073	61,529	67,362

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
- Kasama Water Supply	Council	12,000
Total		12,000
Surface Water Source : Lukupa River		12,000
Groundwater Source :		

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	8,648	9,632	10,596	11,559	12,441	13,323
	(High)	8,648	10,881	13,905	16,930	21,311	25,693
	(Low)	8,648	9,553	10,314	11,075	11,600	12,125
< Industrial Water >							
Water Demand (m3/day)	(Base)	3,900	4,333	4,767	5,200	5,600	6,000
	(High)	3,900	5,133	6,367	7,600	9,600	11,600
	(Low)	3,900	4,267	4,633	5,000	5,250	5,500
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	12,548	13,966	15,363	16,759	18,041	19,323
	(High)	12,548	16,014	20,272	24,530	30,911	37,293
	(Low)	12,548	13,820	14,948	16,075	16,850	17,625
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	15,685	17,457	19,203	20,949	22,551	24,153
	(High)	15,685	20,018	25,340	30,662	38,639	46,617
	(Low)	15,685	17,275	18,684	20,094	21,063	22,031
< Water Supply Program >							
- Existing Capacity (m3/day)		12,000	12,000	12,000	12,000	12,000	12,000
(1) Water Supply Extension					14,000	14,000	14,000
- Total Water Supply (m3/day)		12,000	12,000	12,000	26,000	26,000	26,000



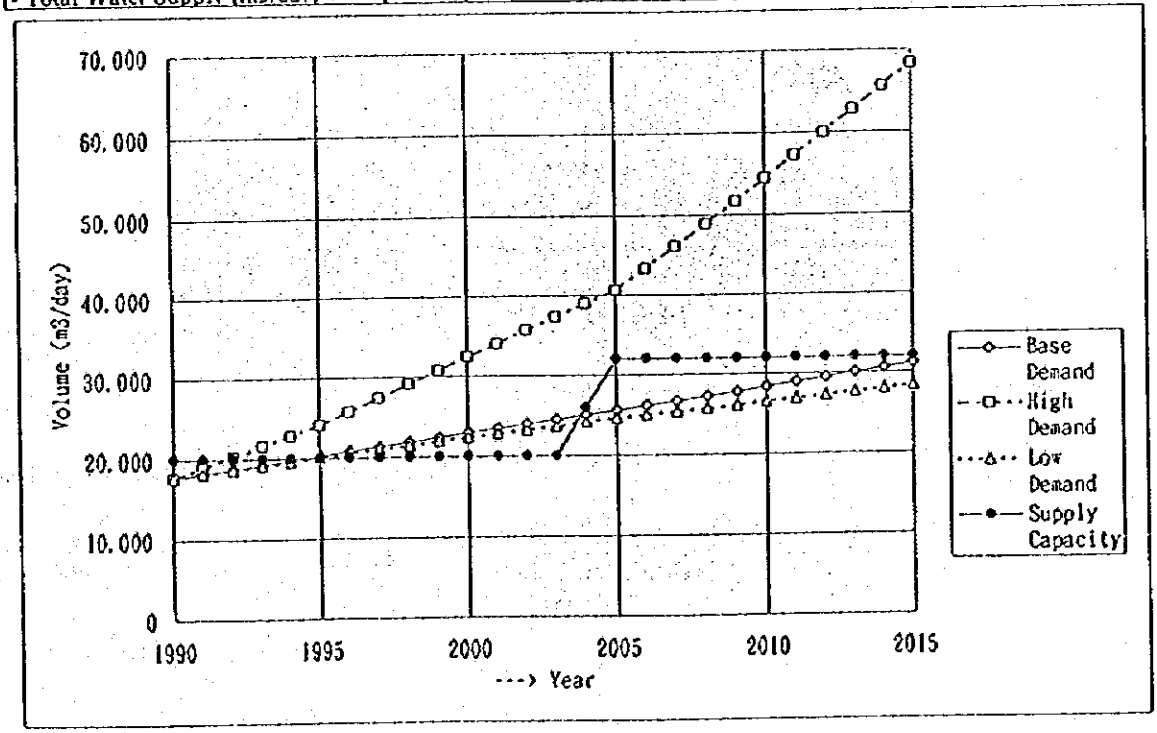
(9) Water Demand and Supply Plan (Chipata)

Township		DISTRICT		PROVINCE	
911	Chipata Township	91	Chipata	90	Eastern

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	52,213	(1) Base Projection	59,711	75,543	91,815
- Household	10,270	(2) High Projection	69,218	119,359	200,996
- Family Size	5.1	(3) Low Projection	59,219	72,399	83,526

CURRENT DOMESTIC WATER SUPPLY PROJECT		
Name of Water Supply Project	Type of Managing Body	Water Supply Volume (m3/day)
No Information	(Assumption Value)	20,000
Total		20,000
Surface Water Source :		
Groundwater Source :		

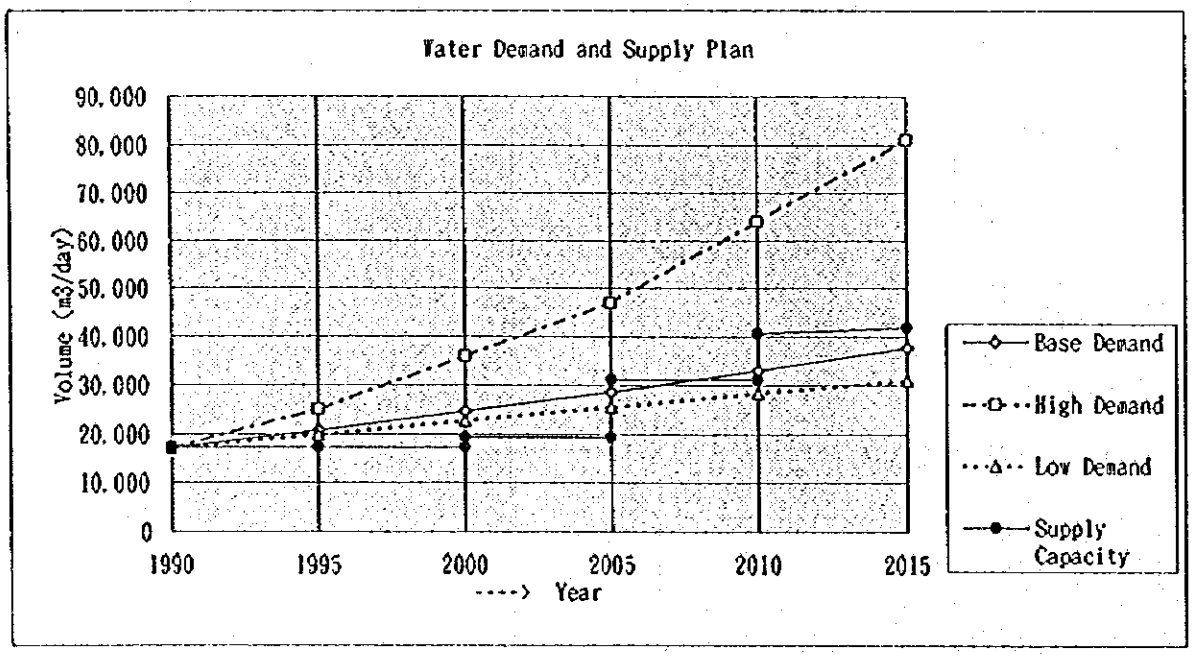
WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		180	180	180	180	180	180
Water Demand (m3/day)	(Base)	9,398	10,748	12,173	13,598	15,062	16,527
	(High)	9,398	12,459	16,972	21,485	28,832	36,179
	(Low)	9,398	10,659	11,846	13,032	14,033	15,033
< Industrial Water >							
Water Demand (m3/day)	(Base)	4,800	5,500	6,200	6,900	7,650	8,400
	(High)	4,800	6,867	8,933	11,000	14,750	18,500
	(Low)	4,800	5,433	6,067	6,700	7,200	7,700
< Domestic & Industrial Water >							
Cities & Municipalities Gross Water Demand (m3/day)	(Base)	14,198	16,248	18,373	20,498	22,712	24,927
	(High)	14,198	19,326	25,905	32,485	43,582	54,679
	(Low)	14,198	16,093	17,912	19,732	21,233	22,735
- Water Loss Rate (%)		25	25	25	25	25	25
Cities & Municipalities Net Water Demand (m3/day)	(Base)	17,748	20,310	22,966	25,622	28,390	31,158
	(High)	17,748	24,157	32,382	40,606	54,477	68,349
	(Low)	17,748	20,116	22,390	24,665	26,542	28,418
< Water Supply Program >							
- Existing Capacity (m3/ day)		20,000	20,000	20,000	20,000	20,000	20,000
(1) Chipata Wells					12,000	12,000	12,000
- Total Water Supply (m3/day)		20,000	20,000	20,000	32,000	32,000	32,000



Appendix-1.2 Water Demand and Supply Plan for Small Urban Areas
Appendix -1.2.1 Province level Demand and Supply Plan

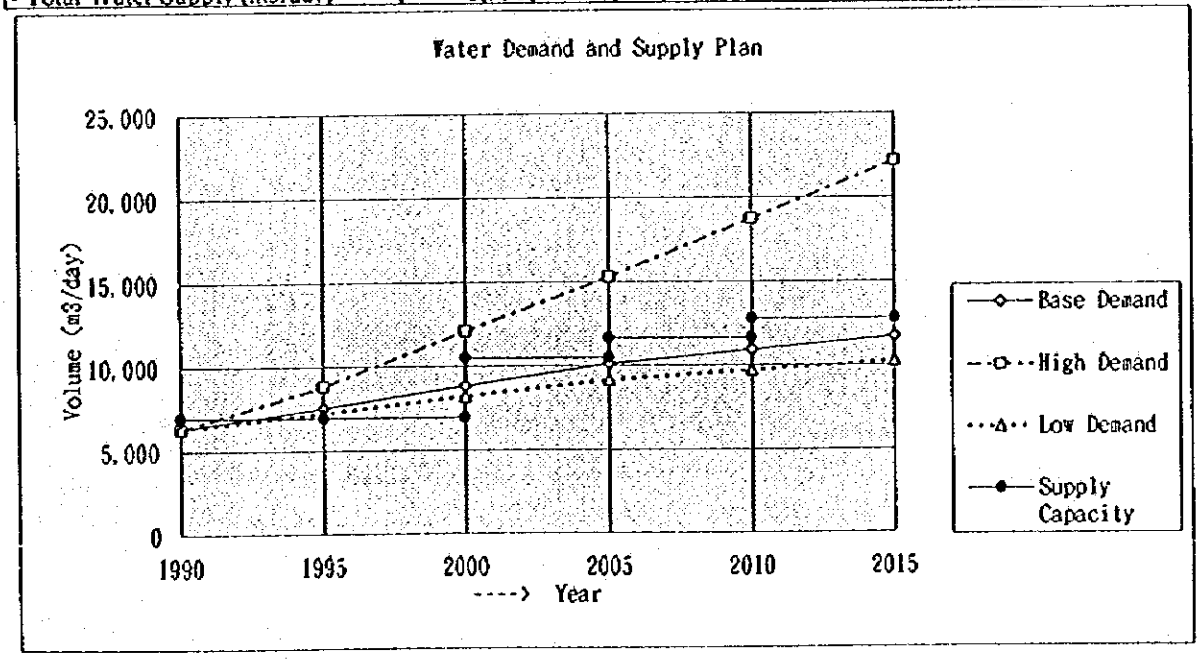
(1) Water Demand and Supply Plan for Small Urban Areas (Lusaka Province)

SMALL URBAN AREAS					PROVINCE		
					10	Lusaka	
1990 CENSUS POPULATION AND FUTURE PROJECTION							
1990 Census Data		Projection Scenarios			1995	2005	2015
- Population	60,120	(1) Base Projection			72,126	100,474	134,395
- Household	12,533	(2) High Projection			85,987	173,444	343,251
- Family Size	4.8	(3) Low Projection			71,538	96,194	113,195
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	9,018	10,819	12,945	15,071	17,615	20,159
	(High)	9,018	12,898	19,457	26,017	38,752	51,488
	(Low)	9,018	10,731	12,580	14,429	15,704	16,979
< Industrial Water >							
Water Demand (m3/day)	(Base)	5,902	7,201	8,501	9,800	11,201	12,601
	(High)	5,902	8,862	11,822	14,782	16,880	18,978
	(Low)	5,902	6,549	7,197	7,844	8,945	10,045
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	14,920	18,020	21,446	24,871	28,816	32,760
	(High)	14,920	21,760	31,279	40,799	55,632	70,466
	(Low)	14,920	17,280	19,777	22,273	24,649	27,024
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	17,158	20,723	24,663	28,602	33,138	37,674
	(High)	17,158	25,024	35,971	46,918	63,977	81,035
	(Low)	17,158	19,872	22,743	25,614	28,346	31,078
< Water Supply Program >							
- Existing Capacity (m3/day)		17,250	17,250	17,250	17,250	17,250	17,250
- New Water Supply (m3/day)				2,076	2,076	2,076	2,076
- New Water Supply					11,892	11,892	11,892
- New Water Supply						9,392	9,392
- New Water Supply							1,200
- Total Water Supply (m3/day)		17,250	17,250	19,326	31,218	40,610	41,810



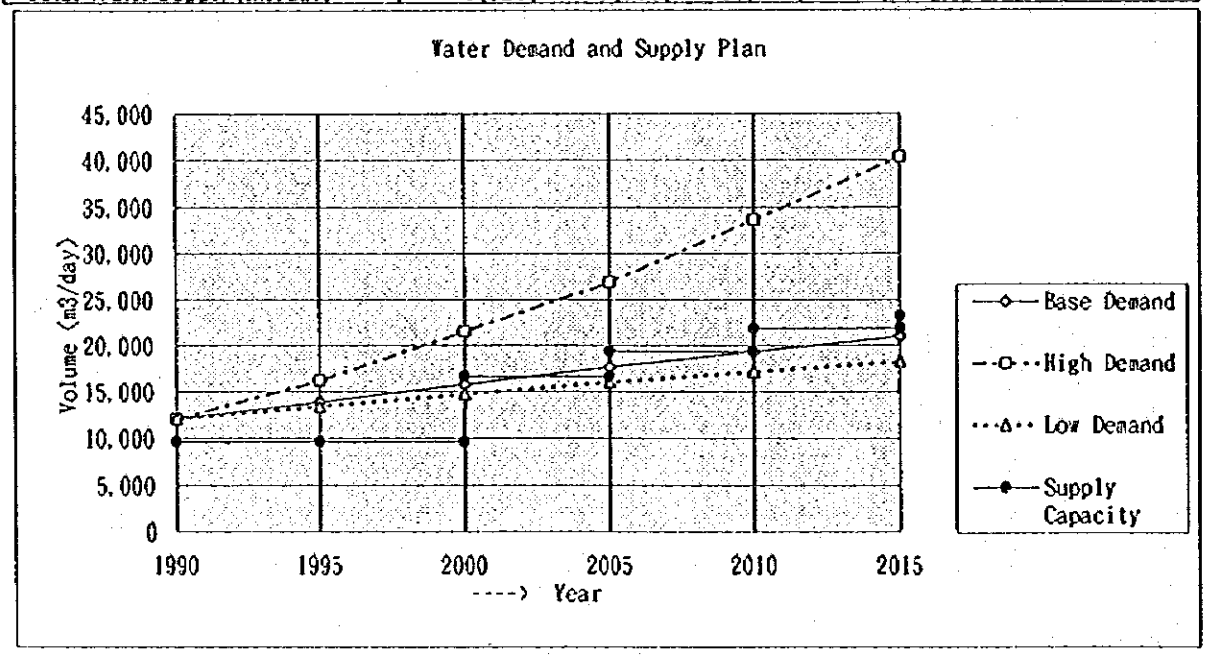
(2) Water Demand and Supply Plan for Small Urban Areas (Copperbelt Province)

SMALL URBAN AREAS					PROVINCE		
					20	Copperbelt	
1990 CENSUS POPULATION AND FUTURE PROJECTION							
1990 Census Data		Projection Scenarios			1995	2005	2015
- Population	24,717	(1) Base Projection			28,849	38,132	48,545
- Household	5,509	(2) High Projection			32,845	57,503	99,356
- Family Size	4.5	(3) Low Projection			28,621	36,538	44,218
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	3,708	4,327	5,024	5,720	6,501	7,282
	(High)	3,708	4,927	6,776	8,625	11,764	14,903
	(Low)	3,708	4,293	4,887	5,481	6,057	6,633
< Industrial Water >							
Water Demand (m3/day)	(Base)	1,800	2,233	2,666	3,099	3,000	2,900
	(High)	1,800	2,758	3,716	4,674	4,521	4,368
	(Low)	1,800	2,027	2,254	2,481	2,396	2,311
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	5,508	6,560	7,690	8,819	9,500	10,182
	(High)	5,508	7,685	10,492	13,299	16,285	19,271
	(Low)	5,508	6,320	7,141	7,962	8,453	8,944
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	6,334	7,544	8,843	10,142	10,925	11,709
	(High)	6,334	8,837	12,066	15,294	18,728	22,162
	(Low)	6,334	7,268	8,212	9,156	9,721	10,285
< Water Supply Program >							
- Existing Capacity (m3/day)		6,950	6,950	6,950	6,950	6,950	6,950
- New Water Supply (m3/day)				3,542	3,542	3,542	3,542
- New Water Supply					1,138	1,138	1,138
- New Water Supply						1,138	1,138
- Total Water Supply (m3/day)		6,950	6,950	10,492	11,630	12,768	12,768



(3) Water Demand and Supply Plan for Small Urban Areas (Central Province)

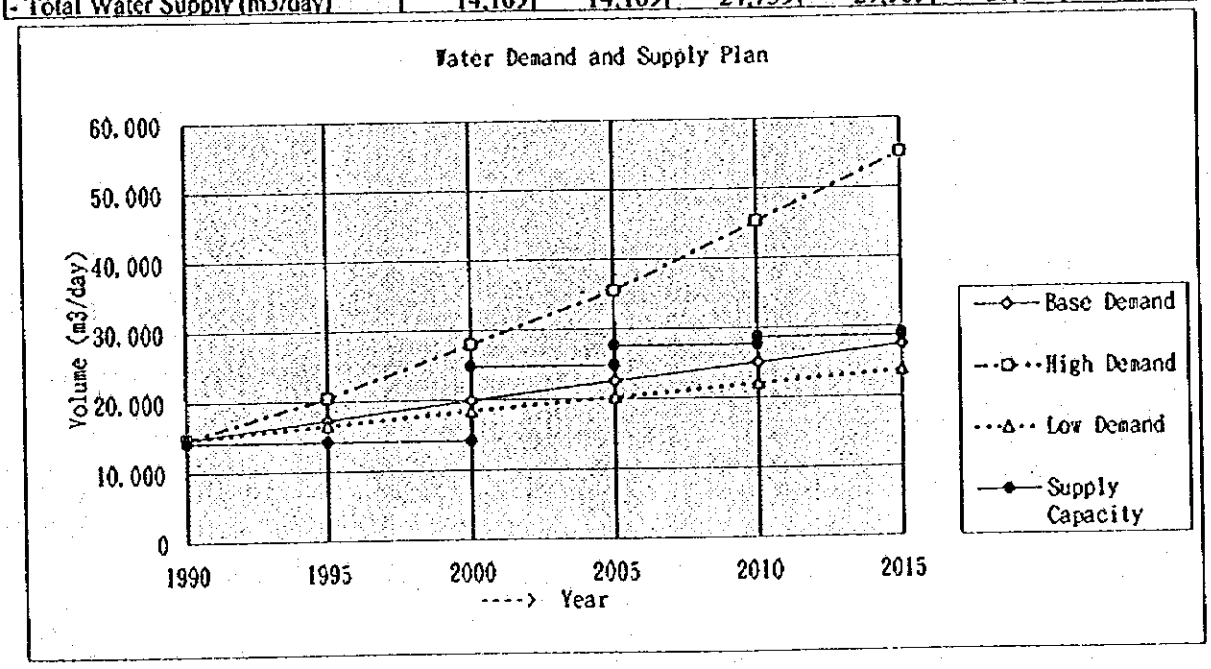
SMALL URBAN AREAS					PROVINCE 30 Central		
1990 CENSUS POPULATION AND FUTURE PROJECTION							
1990 Census Data		Projection Scenarios			1995	2005	2015
- Population	51,742	(1) Base Projection			58,914	73,956	89,280
- Household	10,784	(2) High Projection			67,355	112,660	184,956
- Family Size	4.8	(3) Low Projection			58,208	70,123	79,854
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	7,761	8,837	9,965	11,093	12,243	13,392
	(High)	7,761	10,103	13,501	16,899	22,321	27,743
	(Low)	7,761	8,731	9,625	10,518	11,248	11,978
< Industrial Water >							
Water Demand (m3/day)	(Base)	2,700	3,233	3,767	4,300	4,600	4,899
	(High)	2,700	3,962	5,224	6,486	6,932	7,378
	(Low)	2,700	2,937	3,174	3,411	3,658	3,904
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	10,461	12,070	13,732	15,393	16,842	18,291
	(High)	10,461	14,065	18,725	23,385	29,253	35,121
	(Low)	10,461	11,668	12,799	13,929	14,906	15,882
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	12,030	13,881	15,792	17,702	19,369	21,035
	(High)	12,030	16,175	21,534	26,893	33,641	40,390
	(Low)	12,030	13,418	14,719	16,019	17,142	18,264
< Water Supply Program >							
- Existing Capacity (m3/day)		9,626	9,626	9,626	9,626	9,626	9,626
- New Water Supply (m3/day)				7,001	7,001	7,001	7,001
- New Water Supply					2,717	2,717	2,717
- New Water Supply						2,507	2,507
- New Water Supply							1,365
- Total Water Supply (m3/day)		9,626	9,626	16,627	19,344	21,851	23,216



(4) Water Demand and Supply Plan for Small Urban Areas (North-western Province)

SMALL URBAN AREAS			PROVINCE	
			40	Northwestern
1990 CENSUS POPULATION AND FUTURE PROJECTION				
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	54,320	(1) Base Projection	62,281	79,628	98,364
- Household	11,552	(2) High Projection	72,334	128,376	227,870
- Family Size	4.7	(3) Low Projection	61,778	76,278	89,502

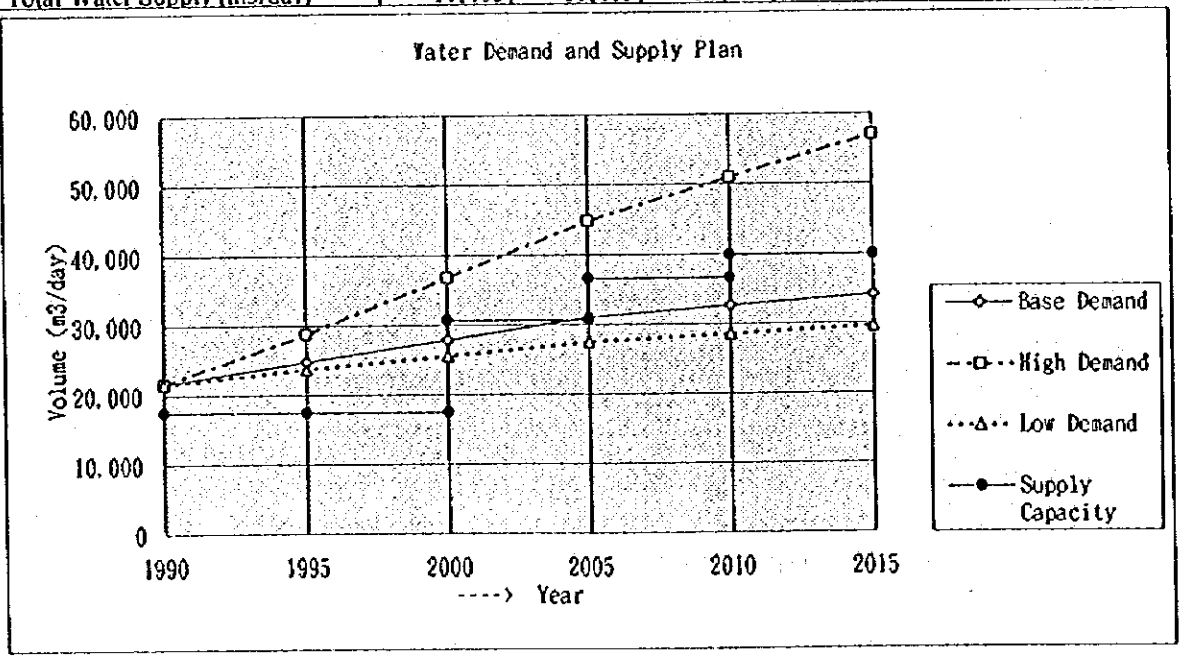
WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	8,148	9,342	10,643	11,944	13,349	14,755
	(High)	8,148	10,850	15,053	19,256	26,718	34,181
	(Low)	8,148	9,267	10,354	11,442	12,434	13,425
< Industrial Water >							
Water Demand (m3/day)	(Base)	4,601	5,634	6,666	7,699	8,399	9,098
	(High)	4,601	6,938	9,276	11,613	12,658	13,702
	(Low)	4,601	5,121	5,642	6,162	6,707	7,251
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	12,749	14,976	17,310	19,643	21,748	23,853
	(High)	12,749	17,788	24,329	30,869	39,376	47,883
	(Low)	12,749	14,388	15,996	17,604	19,140	20,676
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	14,661	17,222	19,906	22,590	25,010	27,430
	(High)	14,661	20,457	27,978	35,500	45,282	55,065
	(Low)	14,661	16,546	18,395	20,244	22,011	23,778
< Water Supply Program >							
- Existing Capacity (m3/day)		14,169	14,169	14,169	14,169	14,169	14,169
- New Water Supply (m3/day)				10,570	10,570	10,570	10,570
- New Water Supply					2,850	2,850	2,850
- New Water Supply						1,050	1,050
- New Water Supply							350
- Total Water Supply (m3/day)		14,169	14,169	24,739	27,589	28,639	28,989



(5) Water Demand and Supply Plan for Small Urban Areas (Western Province)

SMALL URBAN AREAS			PROVINCE		
			50	Western	
1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	75,741	(1) Base Projection	83,175	97,368	109,951
- Household	16,075	(2) High Projection	92,100	135,378	197,435
- Family Size	4.7	(3) Low Projection	82,497	93,416	100,965

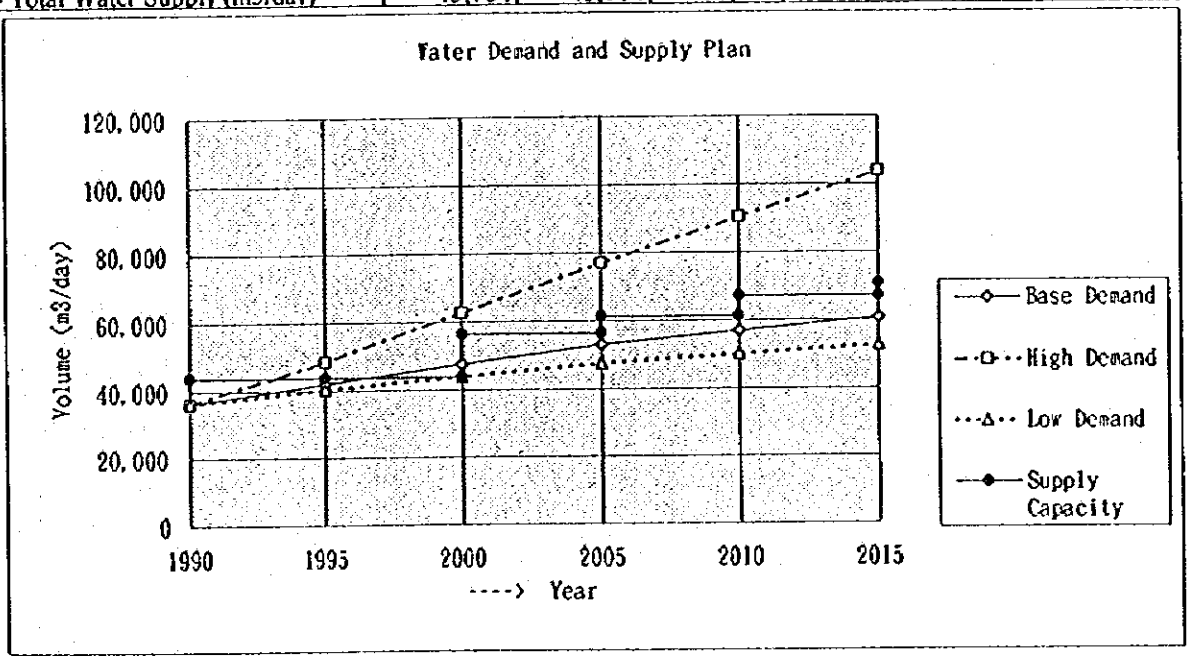
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	11,361	12,476	13,541	14,605	15,549	16,493
	(High)	11,361	13,815	17,061	20,307	24,961	29,615
	(Low)	11,361	12,375	13,193	14,012	14,579	15,145
< Industrial Water >							
Water Demand (m3/day)	(Base)	7,399	9,067	10,736	12,404	12,817	13,229
	(High)	7,399	11,166	14,934	18,701	19,366	20,030
	(Low)	7,399	8,241	9,082	9,924	10,263	10,601
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	18,760	21,544	24,276	27,009	28,365	29,722
	(High)	18,760	24,981	31,995	39,008	44,326	49,645
	(Low)	18,760	20,615	22,276	23,936	24,841	25,746
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	21,574	24,775	27,918	31,061	32,620	34,180
	(High)	21,574	28,729	36,794	44,859	50,975	57,092
	(Low)	21,574	23,707	25,617	27,527	28,567	29,608
< Water Supply Program >							
- Existing Capacity (m3/day)		17,403	17,403	17,403	17,403	17,403	17,403
- New Water Supply (m3/day)				13,328	13,328	13,328	13,328
- New Water Supply					5,944	5,944	5,944
- New Water Supply .						3,276	3,276
- Total Water Supply (m3/day)		17,403	17,403	30,731	36,675	39,951	39,951



(6) Water Demand and Supply Plan for Small Urban Areas (Southern Province)

SMALL URBAN AREAS			PROVINCE		
			60	Southern	
1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Projection Scenarios	1995	2005	2015
- Population	135,109	(1) Base Projection	151,134	183,308	213,856
- Household	28,164	(2) High Projection	168,410	258,864	392,376
- Family Size	4.8	(3) Low Projection	149,944	175,646	194,591

WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	20,266	22,670	25,083	27,496	29,787	32,078
	(High)	20,266	25,262	32,046	38,830	48,843	58,856
	(Low)	20,266	22,492	24,419	26,347	27,768	29,189
< Industrial Water >							
Water Demand (m3/day)	(Base)	11,298	13,765	16,233	18,700	19,750	20,800
	(High)	11,298	16,934	22,570	28,206	29,767	31,327
	(Low)	11,298	12,521	13,744	14,967	15,773	16,579
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	31,564	36,435	41,316	46,196	49,537	52,878
	(High)	31,564	42,196	54,616	67,036	78,610	90,183
	(Low)	31,564	35,013	38,163	41,314	43,541	45,768
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	36,299	41,901	47,513	53,126	56,968	60,810
	(High)	36,299	48,525	62,808	77,091	90,401	103,711
	(Low)	36,299	40,264	43,888	47,511	50,072	52,633
< Water Supply Program >							
- Existing Capacity (m3/day)		43,704	43,704	43,704	43,704	43,704	43,704
- New Water Supply (m3/day)				12,583	12,583	12,583	12,583
- New Water Supply					5,048	5,048	5,048
- New Water Supply						5,816	5,816
- New Water Supply							3,613
- Total Water Supply (m3/day)		43,704	43,704	56,287	61,335	67,151	70,764



(7) Water Demand and Supply Plan for Small Urban Areas (Luapula Province)

SMALL URBAN AREAS					PROVINCE		
					70	Luapula	
1990 CENSUS POPULATION AND FUTURE PROJECTION							
1990 Census Data		Projection Scenarios			1995	2005	2015
- Population	83,126	(1) Base Projection			91,329	107,309	122,141
- Household	19,628	(2) High Projection			101,506	151,213	224,281
- Family Size	4.2	(3) Low Projection			90,605	103,256	112,184
WATER DEMAND AND SUPPLY							
I t e m s		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		150	150	150	150	150	150
Water Demand (m3/day)	(Base)	12,469	13,699	14,898	16,096	17,209	18,321
	(High)	12,469	15,226	18,954	22,682	28,162	33,642
	(Low)	12,469	13,591	14,540	15,488	16,158	16,828
< Industrial Water >							
Water Demand (m3/day)	(Base)	3,199	3,900	4,600	5,301	5,500	5,699
	(High)	3,199	4,798	6,397	7,996	8,290	8,583
	(Low)	3,199	3,547	3,895	4,243	4,393	4,542
< Domestic & Industrial Water >							
Township Gross Water Demand (m3/day)	(Base)	15,668	17,599	19,498	21,397	22,709	24,020
	(High)	15,668	20,024	25,351	30,678	36,452	42,225
	(Low)	15,668	17,138	18,435	19,731	20,551	21,370
- Water Loss Rate (%)		15	15	15	15	15	15
Township Net Water Demand (m3/day)	(Base)	18,018	20,239	22,423	24,607	26,115	27,623
	(High)	18,018	23,027	29,154	35,280	41,919	48,559
	(Low)	18,018	19,708	21,200	22,691	23,633	24,575
< Water Supply Program >							
- Existing Capacity (m3/day)		14,046	14,046	14,046	14,046	14,046	14,046
- New Water Supply (m3/day)				9,970	9,970	9,970	9,970
- New Water Supply					3,178	3,178	3,178
- New Water Supply						1,166	1,166
							1,060
- Total Water Supply (m3/day)		14,046	14,046	24,016	27,194	28,360	29,420