The surface water potentials for these three provinces are 126 m^3/sec (4.6%), 150 m^3/sec (5.7%) and 61 m^3/sec (2.2%) respectively in an average year, but only 42 m^3/sec, 77 m^3/sec and 14 m^3/sec in a drought year.

The average per capita surface water potential for each province is also shown in the table. It can be seen that, for these three provinces (Lusaka, Copperbelt, Southern), the per capita discharge in an average year is around 10 m^3/day/person compared to the national average of 32 m^3/day. The corresponding figures for Northern and North Western provinces are 79 and 100 m^3/day/person. Consequently, it is apparent that the most abundant available resources are located away from the areas of highest population and hence highest demands.

Table 5-1 Surface Water and Groundwater Potential by Province

Province		Lusaka	Copper belt	Central	North Western	Western	South ern	Luapula	North ern	Eastern	Zambia
Rainfall											
Province area	km^2	22,094	31,217	94,684	125,280	127,344	85,199	49,594	147,292	69,146	751,850
Annual rainfall	mm	857	1,231	947	1,173	808	737	1,259	1,138	961	1,001
Equivalent discharge	m^3/ sec	600	1,219	2,843	4,660	3,263	1,991	1,980	5,315	2,107	23,978
Population	'000	987	1,428	721	388	607	907	525	855	966	7,383
Surface Water Potential - Average Year (30 year average)											
Average discharge	m^3/ sec	126	150	389	450	235	61	305	782	249	2,747
Daily discharge	Tm^3 /day	10,800	13,000	33,600	38,900	20,300	5,300	26,300	67,500	21,500	237,300
Per capita discharge	m^3/ day	11	9	47	100	34	6	50	79	22	32
Surface Water Potential - Drought Year (10 year return period)											
Average discharge	m^3/ sec	42	77	128	249	188	14	205	519	155	1,576
Daily discharge	Tm^3 /day	3,700	6,600	11,000	21,500	16,300	1,200	17,700	44,800	13,400	136,200
Per capita discharge	m^3/ day	4	5	15	55	27	1	34	52	14	18
Groundwater Potential											
Potential abstraction	m^3/ sec	48	83	245	362	223	182	122	363	194	1,822
Daily potential	Tm^3 /day	4,100	7,200	21,200	31,300	19,200	15,700	10,600	31,400	16,700	157,400

Notes: i) Surface Water Potential taken from Table 4-8
ii) Groundwater Potential taken from Table 4-31

5.1.2 Current Water Demands

(1) Existing Water Rights

An indication of the level of current water demands can be obtained from the existing water right records for surface water abstraction held by the Water Development Board of MEWD. A survey of these existing records was undertaken on behalf of the Study Team by a local consultant, and the results of the survey input to a computer database. This current water use survey is described in detail in Supporting Report - Part G.

Approximately 1830 water right records were found and the distributions of water rights by province and by river basin are shown in Tables 5-2 and 5-3 respectively. The province with the highest abstraction volume is the Copperbelt, followed by Central and Southern Provinces. These tables show that the number of water rights, and the volume of surface water abstracted, are not evenly distributed across the country, and that the regions with higher concentrations of population have a greater number of granted water rights. One noticeable exception to this observation is Northern Province which has a very large number of relatively small water rights, mainly on the Chambeshi and Luapula basins. From Table 5-3, it is readily apparent that the Kafue river basin is subject to the heaviest demands in terms of both number of water rights and volume of water allocated - nearly 670 water rights totally 5.3 million m^3/day, or more than 50% of the national total.

Table 5-2 Distribution of Water Rights by Province

Code	Province	Total WR		Valid WR			
		No.	Total Volume	No.	%	Volume	%
10	Lusaka	218	645,918	92	42.2	423,752	65.6
20	Copperbelt	375	2,778,931	126	33.6	971,754	35.0
30	Central	230	1,852,924	118	51.3	479,917	25.9
40	North Western	67	151,215	24	35.8	91,572	60.6
50	Western	6	8,950	2	33.3	600	6.7
60	Southern	189	1,930,088	70	37.0	1,225,659	63.5
70	Luapula	184	866,815	81	44.0	700,299	80.8
80	Northern	464	1,247,408	194	41.8	657,313	52.7
90	Eastern	82	40,059	27	32.9	27,530	68.7
99	Unknown	17	29,969	5	29.4	6,280	21.0
		1832	9,552,277	739	40.3	4,584,676	48.0

Units : m^3/day

Table 5-3 Distribution of Water Rights by River Basin

Code	River Basin	Total WR		Valid WR			
		No.	Total Volume	No.	%	Volume	%
1	Zambezi	229	592,908	84	36.7	124,669	21.0
2	Kafue	669	5,296,425	249	37.2	2,803,343	52.9
3	Luangwa	286	1,543,791	127	44.4	285,307	18.5
4	Luapula	304	940,045	137	45.1	725,584	77.2
5	Chambeshi	255	966,752	105	41.2	461,878	47.8
6	Tanganyika	76	194,965	32	42.1	169,645	87.0
99	Unknown	13	17,391	5	38.5	14,250	81.9
		1832	9,552,277	739	40.3	4,584,676	48.0

Units : m^3/day

Although Table 5-3 above gives a breakdown of the distribution of water rights by main river basin, it is more difficult to determine the precise location of the point of abstraction without detailed examination of each individual water right record. For this reason, the distribution by sub-basin can only be estimated, based on the district of the water right holder. This estimated distribution is then used in the analysis in the following section.

(2) Actual Water Use

Table 5-4 shows a breakdown of current water use by main river basin and by the 'block' sub-division used in Section 4.1 for estimation of surface water resources potential. Although water right volumes are shown in the table for comparison purposes, they are not used in the analysis for the reasons outlined in the previous section. The water use figures quoted in the table are taken from earlier sections of the report adjusted to reflect the river basin block sub-divisions. Domestic water use was estimated based on population figures multiplied by unit water consumption rates, as explained in Section 3.2. Industrial water use was also estimated based on unit water consumption rates, calculated in this case from a questionnaire survey undertaken by the Study Team, as explained in Section 3.3. Agricultural water use figures are calculated from the water right database, although not directly from the abstraction volume stated on the water right certificate. Applications for secondary water use, ie for agricultural purposes, include an estimate of the hectarage of crops to be irrigated. The figures for current agricultural water use are based on these stated areas for dry season crops, which agree reasonably well with figures obtained from the Ministry of Agriculture, multiplied by an assumed irrigation water requirement per hectare. These figures represent the peak demand during the dry season and therefore the worst case scenario for current agricultural water demand.

The table also compares the actual water use with the average flow regime for each of the river basin block sub-divisions. Water use is presented as a 'utilisation percentage' of river flow for the three cases of drought discharge, Q(355), minimum discharge and average discharge for each block. This analysis clearly shows that surface water resources of Zambia's main streams, with the exception of the Kafue, are under-utilised and have significant potential for development. In the case of the Kafue, while the utilisation percentage is only around 10-15% of the average annual flow, the utilisation in the dry season is equivalent to between 40 and 80% of the minimum flow condition. This suggests that there is little potential for further expansion of either domestic/industrial water supply projects in the Copperbelt or irrigation projects in Central and Southern Provinces which would require increased abstraction from the Kafue basin.

5.1.3 Current Water Balance

Water demands were discussed in Chapter 3 and the current situation is summarised by province in Table 5-5. The main consumptive water demands are for public water supply (domestic and industrial use, including losses, for the 12 large and 80 small urban areas; and for rural water supplies) and for agricultural use, including irrigation, livestock watering and fishpond requirements. The public water supply demands shown are based on the analysis of the Study Team - domestic demand for both urban and rural areas is calculated from the population projection for 1995 multiplied by assumed per capita consumption rates. Actual levels of water supply around the country (particularly in the rural areas) are likely to be lower than the calculated demands. Industrial and agricultural water use were estimated from the results of questionnaire surveys and analysis of the water rights records and are therefore thought to be reasonably representative. The agricultural demands are based on the dry season irrigation requirement and therefore represent the 'worst case' scenario in terms of water demand.

Table 5-4 Current Water Use Amount by River Basin

No.	River Basin	Tributary	Block	Discharge Reference Point	Catchment Area (km2)	Water Right Amount		Actual Water Use Amount								Average Flow Regime (m3/s)			Utilisation Percentage (%)		
								Agriculture water		Domestic water		Industrial water		Total							
						Total (m3/s)	Accum. Total (m3/s)	Total (m3/s)	Accum. (m3/s)	Total (m3/s)	Accum. (m3/s)	Total (m3/s)	Accum. (m3/s)	Total (m3/s)	Accum. (m3/s)	Q(355)	Min.	Average	Q(355)	Min.	Average
1	Zambezi		BZ-1	PZ-6(1)	89,874	0.16	0.16	0.0	0.0	0.04	0.04	0.02	0.02	0.06	0.06	67.7	60.8	664.6	0.1	0.1	0.0
2		Kabompo	BZ-2	PZ-3	42,740	0.59	0.59	0.1	0.1	0.07	0.07	0.02	0.02	0.19	0.19	54.3	51.5	221.2	0.3	0.4	0.1
3		Kabompo	BZ-3	PZ-6(2)	72,751	0.00	0.59	0.0	0.1	0.03	0.10	0.02	0.04	0.05	0.24	68.9	64.9	261.9	0.4	0.4	0.1
4			BZ-4	PZ-10	284,538	0.10	0.85	0.0	0.1	0.24	0.38	0.09	0.13	0.33	0.61	290.8	279.0	963.3	0.2	0.2	0.1
5			BZ-5	PZ-11	336,053	0.01	0.86	0.0	0.1	0.06	0.44	0.00	0.13	0.06	0.67	296.4	283.3	1013.6	0.2	0.2	0.1
6			BZ-6	PZ-13	513,780	0.00	0.86	0.0	0.1	0.06	0.51	0.00	0.13	0.06	0.74	315.8	298.3	1187.4	0.2	0.2	0.1
7			BZ-7	PZ-14(2)	663,880	3.38	4.24	0.9	1.0	0.34	0.85	0.10	0.23	1.34	2.08	482.0	455.0	1299.0	0.4	0.5	0.2
8			BZ-8	PZ-15(1)	667,970	0.04	4.28	0.0	1.0	0.03	0.87	0.00	0.23	0.03	2.10	484.3	457.1	1325.0	0.4	0.5	0.2
9			BZ-9	PZ-16	844,044	2.58	6.86	3.2	4.2	0.61	1.48	0.34	0.57	4.15	6.25	619.6	568.0	1757.8	1.0	1.1	0.4
10	Kafue		BK-1	PK-1	5,775	0.00	0.00	0.1	0.1	0.02	0.02	0.01	0.01	0.13	0.13	2.2	2.0	34.0	5.6	6.3	0.4
11			BK-2	PK-3	8,914	15.94	15.94	2.9	3.0	0.71	0.72	0.27	0.28	3.88	4.00	9.7	8.6	73.6	41.1	46.4	5.4
12			BK-3	PK-4	12,001	4.35	20.29	5.5	8.5	0.90	1.62	0.35	0.63	6.75	10.75	15.1	13.9	92.6	71.2	77.4	11.6
13			BK-4	PK-5(1)	24,264	11.69	31.98	3.7	12.2	0.80	2.42	0.28	0.91	4.78	15.53	21.0	19.6	142.7	73.8	79.1	10.9
14		Luswishi	BK-5	PK-6(2)	8,839	0.00	0.00	0.0	0.0	0.01	0.01	0.00	0.00	0.01	0.01	2.8	2.7	31.6	0.2	0.2	0.0
15			BK-6	PK-8	55,962	2.02	34.00	0.5	12.7	0.06	2.49	0.01	0.92	0.57	16.11	29.5	26.8	189.5	54.6	60.1	8.5
16		Lunga	BK-7	PK-10(1)	23,767	0.96	0.96	0.5	0.5	0.07	0.07	0.00	0.00	0.57	0.57	20.0	18.4	92.4	2.8	3.1	0.6
17			BK-8	PK-11	96,239	0.03	34.99	0.0	13.2	0.01	2.57	0.00	0.92	0.01	16.69	54.6	49.2	308.1	30.6	33.9	5.4
18			BK-9	PK-12(2)	107,191	0.00	34.99	0.0	13.2	0.00	2.57	0.00	0.92	0.00	16.69	109.4	85.0	278.4	15.3	19.6	6.0
19			BK-10	PK-13(2)	153,826	26.22	61.21	23.0	36.2	1.53	4.10	0.67	1.59	25.20	41.89	123.3	99.8	295.6	34.0	42.0	14.2
20			BK-11	PZ-15(2)	156,995	0.06	61.27	0.6	36.8	0.01	4.11	0.00	1.59	0.61	42.50	125.1	101.4	315.8	34.0	41.9	13.5
21	Luangwa		BL-1	PL-1	73,422	0.37	0.37	0.8	0.8	0.40	0.40	0.09	0.09	1.29	1.29	39.0	33.9	282.6	3.3	3.8	0.5
22			BL-2	PL-2	91,861	0.14	0.51	0.1	0.9	0.07	0.48	0.00	0.09	0.17	1.47	12.3	11.1	326.5	12.0	13.2	0.4
23		Lunsemfwa	BL-3	PL-3(1)	27,443	3.63	3.63	9.1	9.1	0.42	0.42	0.12	0.12	9.64	9.64	15.1	14.0	174.7	63.8	69.0	5.5
24		Lukusashi	BL-4	PL-3(2)	14,711	1.26	1.26	0.1	0.1	0.02	0.02	0.00	0.00	0.12	0.12	8.1	7.5	93.7	1.5	1.6	0.1
25			BL-5	PZ-17(1)	147,622	0.09	5.49	0.0	10.1	0.05	0.97	0.00	0.21	0.05	11.28	43.0	39.5	681.5	26.2	28.5	1.7
26	Chambeshi		BC-1	PC-1	34,745	1.46	1.46	3.7	3.7	0.16	0.16	0.02	0.02	3.88	3.88	35.1	33.1	184.8	11.0	11.7	2.1
27			BC-2	PC-3	44,427	1.27	2.73	3.0	6.7	0.10	0.26	0.02	0.04	3.12	7.00	71.4	67.6	277.2	9.8	10.4	2.5
28	Luapula		BP-1	PP-1	92,452	0.66	3.39	3.0	9.7	0.15	0.41	0.02	0.06	3.17	10.17	74.7	65.0	375.0	13.6	15.6	2.7
29			BP-2	PP-2	123,072	0.80	4.19	0.3	10.0	0.05	0.45	0.01	0.07	0.36	10.52	99.4	86.5	499.2	10.6	12.2	2.1
30			BP-3	PP-3	161,275	0.63	4.82	3.0	13.0	0.10	0.55	0.01	0.08	3.11	13.63	190.4	173.7	740.9	7.2	7.9	1.8
31		Kalungwishi	BP-4	PP-5	25,936	1.28	1.28	1.1	1.1	0.05	0.05	0.02	0.02	1.17	1.17	106.8	101.7	284.0	1.1	1.2	0.4
32			BP-5	PP-6	217,823	-	-	0.8	14.9	0.13	0.74	0.01	0.11	0.94	15.75	-	-	-	-	-	-
33	Tanganyika		BT-1	PT-1	9,027	-	-	0.0	0.0	0.01	0.01	0.00	0.00	0.01	0.01	-	-	-	-	-	-
34			BT-2	-	15,856	2.26	2.26	0.4	0.4	0.05	0.05	0.02	0.02	0.47	0.47	14.5	13.6	66.0	3.3	3.5	0.7

The known and estimated water demands are balanced against the potential available water resources in Table 5-5. Although the groundwater potential is included in the table, the balance is assessed against only the surface water potential for both the average year and drought year conditions. This is because the current level of groundwater use is almost insignificant in relation to the available potential. As discussed previously, the provinces with the lowest potential water resources, namely Lusaka, Copperbelt and Southern Provinces, are also those with the highest demands and this is clearly indicated in the table.

Table 5-5 Current Water Balance by Province

(Unit: 1000 m^3/day)

	Lusaka	Copper-belt	Central	North-western	Western	Southern	Luapula	Northern	Eastern	Zambia
Consumptive Demands										
Domestic Water	192	233	64	22	33	66	31	49	51	741
Industrial Water	98	93	13	6	9	22	4	12	9	266
Losses	70	79	15	4	5	14	4	9	9	209
Sub-Total (PS)	360	405	92	32	47	102	39	70	69	1,216
Irrigation	490	803	564	45	0	1,660	185	790	43	4,580
Livestock	5	4	22	3	23	50	1	5	16	129
Fishponds	4	84	1	1	1	7	3	13	4	117
Sub-Total (Ag)	499	891	587	49	24	1,717	189	808	63	4,826
TOTAL	859	1,296	679	81	71	1,819	228	878	132	6,042
Surface Water Potential										
Average year	10,800	13,000	33,600	38,900	20,300	5,300	26,300	67,500	21,500	237,200
Drought year	3,700	6,600	11,000	21,500	16,300	1,200	17,700	44,800	13,400	136,200
[Groundwater]	4,100	7,200	21,200	31,300	19,200	15,700	10,600	31,400	16,700	157,400
Balance - Average Year										
1995	9,941	11,704	32,921	38,819	20,229	3,481	26,072	66,622	21,368	231,158
% Not Utilised	92%	90%	98%	100%	100%	66%	99%	99%	99%	98%
Balance - Drought Year										
1995	2,841	5,304	10,321	21,419	16,229	-619	17,472	43,922	13,268	130,158
% Not Utilised	77%	80%	94%	100%	100%	-52%	99%	98%	99%	96%

Notes : 1. Demand sub-totals : PS - Public Supply, Ag - Agriculture
2. Groundwater potential is shown for information only - not included in the water balance.

As shown in the table, Southern province is subject to the heaviest demands and is the only province where a significant proportion of the available resource is currently utilised. For the drought year condition, it can be seen that the demands actually exceed the available resources within the province. However, the inflow from Western and North-western provinces via the Zambezi and Kafue rivers, combined with the fact that these rivers are already developed in the form of Itezhi-Tezhi, Kafue Gorge and Kariba Dams, ensures that there is sufficient potential to meet the demands. Southern province, and in particular the Kafue basin, is the most critical area of Zambia in terms of water demands - any increase in future demands will need to be carefully assessed.

With the exception of Lusaka and Copperbelt provinces, the demands in the other provinces are all typically less than 2% of the potential resource in an average year. This gives an indication of the abundance of Zambia's surface water resources and the potential for development.

Table 5-6 shows a simplified nation-wide water balance for the present situation - the potential surface water resource (based on annual mean flows for both average and drought years) is balanced against known demands. From the table it can be seen that nationally only a very small proportion of the resources are currently consumed (less than 3%) in the form of urban, industrial or agricultural demands. Of the available surface water, about 68 m^3/sec is abstracted for consumptive use and 1150 m^3/sec (42%) is utilised for hydropower generation. The water used for hydropower then flows to other countries and together with other flows to other countries accounts for 97% of the total surface water resource. The amount of groundwater currently abstracted is less than 0.5% of the total available and there is considerable scope for development of groundwater resources.

Table 5-6 National Water Balance - Current Situation 1995

Water Resource					Water Use		
Description	Average Year		Drought Year (10-year return period)		Type of Use	Current Situation in 1995	
	million m^3/day	m^3/second	million m^3/day	m^3/second		million m^3/day	m^3/second
Surface Water	237.3	2,747	136.2	1,576	Domestic & Industrial	1.2	14
					(Groundwater)	(0.2)	(2)
(Groundwater)	(157.4)	(1,822)			Agricultural	5.2	60
					(Groundwater)	(0.3)	(4)
					Flow to other countries	230.9	2,673
					(Hydropower)	(99.4)	(1,150)
< Total >	237.3	2,747	136.2	1,576	< Total >	237.3	2,747

Note: ( ) shows included volume

5.2 Future Balance

5.2.1 Future Water Demands

(1) Domestic and Industrial Water Demands

The future projection of domestic water demands by province has been calculated from predicted population growth multiplied by assumed per capita consumption rates and is explained fully in section 3.2 and Supporting Report Part E. The predicted demands for domestic water given in the table are a summary of the water requirements for the 12 large urban areas (cities and municipalities), 80 small urban areas (population greater than 1,000 in the 1990 Census) and all village supplies throughout Zambia. Industrial water demands (section 3.3) are based on the questionnaire survey carried out by the Study Team combined with anticipated growth in economic activity. Table 5-7 summarises the results for both domestic and industrial water demands (including assumed system losses) by province for the target years of 2005 and 2015 for the base scenario of median population growth combined with agricultural expansion.

Table 5-7 Projection of Domestic and Industrial Water Demand by Province (Base Scenario - Agricultural Expansion)

(Unit: 1000 m^3/day)

	Lusaka	Copper-belt	Central	North-western	Western	Southern	Luapula	Northern	Eastern	Zambia
1995										
Domestic Water	192	233	64	22	33	66	31	49	51	741
Industrial Water	98	93	13	6	9	22	4	12	9	266
Losses	70	79	15	4	5	14	4	9	9	209
Total Supply	360	405	92	32	47	102	39	70	69	1,216
Total (m^3/sec)	4.2	4.7	1.1	0.4	0.5	1.2	0.4	0.8	0.8	14.1
2005										
Domestic Water	291	281	86	27	37	80	35	57	64	958
Industrial Water	137	130	19	8	12	29	5	16	13	369
Losses	103	99	21	5	6	17	5	11	11	278
Total Supply	531	510	126	40	55	126	45	84	88	1,605
Total (m^3/sec)	6.1	5.9	1.5	0.5	0.6	1.5	0.5	1.0	1.0	18.6
2015										
Domestic Water	425	328	110	33	42	93	40	63	76	1,210
Industrial Water	190	141	24	9	13	32	6	17	15	447
Losses	149	113	27	5	7	20	6	12	14	353
Total Supply	764	582	161	47	62	145	52	92	105	2,010
Total (m^3/sec)	8.8	6.7	1.9	0.5	0.7	1.7	0.6	1.1	1.2	23.2

Notes: i) Domestic water demand taken from Base Scenario - Agricultural Expansion (medium population growth) - Supporting Report Part E
ii) Industrial water demands taken from Table 3-22

(2) Water Supply Situation in Cities and Municipalities

Table 5-8 shows the current water supply situation in the major cities and municipalities, as reported by the managing bodies in the questionnaire survey carried out as part of the Current Water Use Survey. The table also shows the population projections and predicted

domestic and manufacturing water demands for the target years of 2005 and 2015. Water demands for the mining sector are excluded because it is assumed that the mining organisations will continue to meet their demands from independent supply systems. Losses from the water supply system are deducted and the deficit calculated to give an indication of the future water demands of each of the 12 large urban areas. From this table it can be seen that Lusaka, Livingstone and Kasama are already experiencing a shortage of available water resources. By the year 2015, the cities and municipalities likely to experience serious shortfalls in water supply are Lusaka, Ndola, Kalulushi, Luanshya, Kabwe and Livingstone; with the capital city Lusaka needing to increase its domestic and industrial water supply capacity by a factor of four in order to meet predicted demands.

Table 5-8 Current Water Supply Situation and Future Projections for Major Cities and Municipalities (Base Scenario - Agricultural Expansion)

	Lusaka	Ndola	Kitwe	Chilila-bombwe	Chin-gola	Mufu-lira	Kalu-lushi	Luan-shya	Kabwe	Living-stone	Kasama	Chipata
1990 Census	769	335	289	48	142	125	31	118	161	77	48	52
Current Supply	190.0	147.0	136.4	34.2	67.0	48.0	11.0	45.4	77.5	20.0	12.0	20.0
Year 1995												
Population	968	388	321	51	154	131	37	126	195	85	54	60
Domestic	174.2	69.9	57.7	9.1	27.7	23.5	5.5	22.7	35.0	15.3	9.6	10.7
Industrial	90.6	27.9	24.1	4.0	11.8	10.4	2.6	9.8	10.2	7.7	4.7	5.7
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
System 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
Req'd Supply	331.0	122.3	102.3	16.4	49.5	42.4	10.1	40.7	56.6	28.7	17.9	20.6
Balance	-141.0	24.7	34.1	17.8	17.5	5.6	0.9	4.7	20.9	-8.7	-5.9	0.0
Year 2005												
Population	1483	507	383	54	175	139	48	139	273	100	61	76
Domestic	267.0	91.3	69.0	9.8	31.5	25.0	7.2	25.1	49.2	18.0	11.6	13.6
Industrial	126.9	39.1	33.6	5.6	16.5	14.5	3.7	13.7	14.5	10.6	6.5	8.0
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
System 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
Req'd Supply	492.3	162.9	128.2	19.3	60.0	49.4	13.6	48.5	79.6	35.7	22.6	27.0
Balance	-302.3	-15.9	8.2	14.9	7.0	-1.4	-2.6	-3.1	-2.1	-15.7	-10.6	-6.4
Year 2015												
Population	2181	635	440	56	190	142	60	148	369	113	74	92
Domestic	392.5	114.3	79.2	10.1	34.3	25.5	10.9	26.6	66.4	20.4	13.3	16.5
Industrial	177.3	46.5	36.7	5.5	17.0	13.9	4.4	13.8	18.6	11.4	7.1	9.3
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
System 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
Req'd Supply	712.3	201.0	144.8	19.5	64.1	49.2	19.1	50.5	106.2	39.7	25.5	32.3
Balance	-522.3	-54.0	-8.4	14.7	2.9	-1.2	-8.1	-5.1	-28.7	-19.7	-13.5	-11.7

Units: Population - thousands, Water supply - 1000 m^3/day

Notes: 1. Current water supply volume taken from questionnaire survey of water suppliers
2. Current supply for Copperbelt towns is the combined total of ZCCM and Council operated projects
3. Current supply for Chipata assumed to equal current demand - no reply to questionnaire
4. Predicted domestic demand based on population projections and per capita consumption of 180 litres/capita/day - refer to Supporting Report Part E
5. Predicted industrial water use based on manufacturing demand taken from Table 3-22

(3) Agricultural Water Demands

The future development of agriculture and the demand projections of water for agricultural use, including irrigation, livestock and fisheries, are described in detail in Sections 3.4 and 3.6. Irrigation demands were calculated for the development projects associated with multi-purpose dams, irrigation only dams and run of river schemes. Livestock and fishpond water requirements were also assessed as future agricultural water demands and the peak water requirement in the dry season calculated. Table 5-9 presents the results of the assessment of the provincial water demands for the categories of irrigation, livestock watering and fishpond development (mainly evaporation losses) necessary to achieve the stated aims of the Zambian government's agricultural expansion policy as set out in ASIP.

Table 5-9 Projection of Agricultural Demands
(Base Scenario - Agricultural Expansion)

(Unit: 1000 m^3/day)

	Lusaka	Copper-belt	Central	North-western	Western	Southern	Luapula	Northern	Eastern	Zambia
1995										
Irrigation	490	803	564	45	0	1,660	185	790	43	4,580
Livestock	5	4	22	3	23	50	1	5	16	129
Fishponds	4	84	1	1	1	7	3	13	4	117
TOTAL	499	891	587	49	24	1,717	189	808	63	4,826
2005										
Irrigation	725	1,178	996	269	303	2,394	457	979	45	7,346
Livestock	7	7	30	9	37	48	4	16	25	183
Fishponds	4	164	97	173	24	7	3	13	329	814
TOTAL	736	1,349	1,123	451	364	2,449	464	1,008	399	8,343
2015										
Irrigation	725	1,678	996	614	604	2,394	1,235	1,411	173	9,830
Livestock	8	9	31	15	45	50	7	26	32	223
Fishponds	4	164	97	246	80	589	276	162	512	2,130
TOTAL	737	1,851	1,124	875	729	3,033	1,518	1,599	717	12,183

5.2.2 Future Water Balance

(1) National Water Balance

The available resources for the target year of 2015 are considered to remain the same as at present, although there is a significant increase in regulated flow (up by 180m^3/sec or 16% to 1330 m^3/sec) caused by the development of the JICA proposed storages and other storages for hydropower generation. On the demand side, there are major increases as described above - urban and industrial use will increase by 10 m^3/s (71%) to 24 m^3/s while agricultural demands, including irrigation, livestock and fishpond uses, are expected to increase by 90 m^3/s (150%) to 150 m^3/s. However, the total demands of around 174 m^3/sec still represent less than 7% of Zambia's total potential water resources for an average year. The major proportion of Zambia's surface water will continue to flow to other countries, although increased hydropower generation will utilise some of this potential. Development of multipurpose dams and groundwater borehole schemes will be able to satisfy the increases in domestic and industrial demands, while run of river irrigation schemes, in conjunction with the proposed multipurpose and irrigation dams, will meet the demands of increased

agricultural production. The national water balance for both the average year and drought year for the Base Scenario - Agricultural Expansion in 2015 is presented in Table 5-10.

Table 5-10 National Water Balance - Future Situation 2015
(Base Scenario - Agricultural Expansion)

Water Resource					Water Use		
Description	Average Year		Drought Year (10-year return period)		Type of Use	Future Projection in 2015	
	million m^3/day	m^3/second	million m^3/day	m^3/second		million m^3/day	m^3/second
Surface Water	237.3	2,747	136.2	1,576	Domestic & Industrial	2.2	25
					(Groundwater)	(0.3)	(4
(Groundwater)	(157.4)	(1,822)			Agricultural	13.0	150
					(Groundwater)	(0.7	(8)
					Flow to other countries	222.1	2,572
					(Hydropower)	(103.7)	(1,200)
< Total >	237.3	2,747	136.2	1,576	< Total >	237.3	2,747

Note: ( ) shows included volume

(2) Water Balance by Province

The balance between available water resources potential and anticipated demands by province for the Base Scenario - Agricultural Expansion for both the average year and drought year conditions is shown in Table 5-11(1). Similarly, the balance for the Base Scenario - Industrialisation and for the Conservative Scenario are shown in Table 5-11(2) and Table 5-11(3) respectively. It is apparent that the available surface water resources in most provinces are more than adequate to satisfy the likely demands even in the most heavily populated provinces of Lusaka, Copperbelt and Central Provinces, even for the high water demands of the industrialisation scenario during a drought year. The one exception is Southern Province where, for the drought year condition, the predicted demands exceed the available surface water resources within the province. As explained previously, these demands can be met from the inflow into Southern Province from Western and North-western Provinces.

However, it is important to remember that this water balance is based on surface water resources calculated from annual mean flows, either for the 30 year average or for the 10 year return period drought conditions. The potential in the dry season is significantly lower if the water resources are not developed by construction of dams and storages. With carefully planned development of surface water resources, supplemented by groundwater development for areas distant from suitable surface supplies, Zambia's water resources are more than adequate to meet the future demands.

Table 5-11(1) Water Balance by Province
(Base Scenario - Agricultural Expansion)

(Unit: 1000 m^3/day)

Demands	Lusaka	Copper-belt	Central	North-western	Western	Southern	Luapula	Northern	Eastern	Zambia
1995										
Domestic Water	192	233	64	22	33	66	31	49	51	741
Industrial Water	98	93	13	6	9	22	4	12	9	266
Losses	70	79	15	4	5	14	4	9	9	209
Sub-Total (PS)	360	405	92	32	47	102	39	70	69	1,216
Irrigation	490	803	564	45	0	1,660	185	790	43	4,580
Livestock	5	4	22	3	23	50	1	5	16	129
Fishponds	4	84	1	1	1	7	3	13	4	117
Sub-Total (Ag)	499	891	587	49	24	1,717	189	808	63	4,826
TOTAL	859	1,296	679	81	71	1,819	228	878	132	6,042
2005										
Domestic Water	291	281	86	27	37	80	35	57	64	958
Industrial Water	137	130	19	8	12	29	5	16	13	369
Losses	103	99	21	5	6	17	5	11	11	278
Sub-Total (PS)	531	510	126	40	55	126	45	84	88	1,605
Irrigation	725	1,178	996	269	303	2,394	457	979	45	7,346
Livestock	7	7	30	9	37	48	4	16	25	183
Fishponds	4	164	97	173	24	7	3	13	329	814
Sub-Total (Ag)	736	1,349	1,123	451	364	2,449	464	1,008	399	8,343
TOTAL	1,267	1,859	1,249	491	419	2,575	509	1,092	487	9,948
2015										
Domestic Water	425	328	110	33	42	93	40	63	76	1,210
Industrial Water	190	141	24	9	13	32	6	17	15	447
Losses	149	113	27	5	7	20	6	12	14	353
Sub-Total (PS)	764	582	161	47	62	145	52	92	105	2,010
Irrigation	725	1,678	996	614	604	2,394	1,235	1,411	173	9,830
Livestock	8	9	31	15	45	50	7	26	32	223
Fishponds	4	164	97	246	80	589	276	162	512	2,130
Sub-Total (Ag)	737	1,851	1,124	875	729	3,033	1,518	1,599	717	12,183
TOTAL	1,501	2,433	1,285	922	791	3,178	1,570	1,691	822	14,193
Surface Water Potential										
Average year	10,800	13,000	33,600	38,900	20,300	5,300	26,300	67,500	21,500	237,200
Drought year	3,700	6,600	11,000	21,500	16,300	1,200	17,700	44,800	13,400	136,200
[Groundwater]	4,100	7,200	21,200	31,300	19,200	15,700	10,600	31,400	16,700	157,400
Balance - Average Year										
1995	9,941	11,704	32,921	38,819	20,229	3,481	26,072	66,622	21,368	231,158
% Not Utilised	92%	90%	98%	100%	100%	66%	99%	99%	98%	98%
2005	9,533	11,141	32,351	38,409	19,881	2,723	25,791	66,408	21,013	227,252
% Not Utilised	88%	86%	96%	99%	98%	51%	98%	98%	98%	96%
2015	9,299	10,567	32,315	37,978	19,509	2,122	24,730	65,809	20,678	223,007
% Not Utilised	86%	81%	96%	98%	96%	40%	94%	97%	96%	94%
Balance - Drought Year										
1995	2,841	5,304	10,321	21,419	16,229	-619	17,472	43,922	13,268	130,158
% Not Utilised	77%	80%	94%	100%	100%	-52%	99%	98%	99%	96%
2005	2,433	4,741	9,751	21,009	15,881	-1,375	17,191	43,708	12,913	126,252
% Not Utilised	66%	72%	89%	98%	97%	-115%	97%	98%	96%	93%
2015	2,199	4,167	9,715	20,578	15,509	-1,978	16,130	43,109	12,578	122,007
% Not Utilised	59%	63%	88%	96%	95%	-165%	91%	96%	94%	90%

Table 5-11(2) Water Balance by Province
(Base Scenario - Industrialisation)

(Unit: 1000 m^3/day)

Demands	Lusaka	Copper-belt	Central	North-western	Western	Southern	Luapula	Northern	Eastern	Zambia
1995										
Domestic Water	195	237	66	24	34	68	29	56	64	773
Industrial Water	125	117	17	7	11	27	4	16	18	342
Losses	76	86	16	4	6	15	4	11	13	231
Sub-Total (PS)	396	440	99	35	51	110	37	83	95	1,346
Irrigation	490	803	564	45	0	1,660	185	790	43	4,580
Livestock	5	4	22	3	23	50	1	5	16	129
Fishponds	4	84	1	1	1	7	3	13	4	117
Sub-Total (Ag)	499	891	587	49	24	1,717	189	808	63	4,826
TOTAL	895	1,331	686	84	75	1,827	226	891	158	6,172
2005										
Domestic Water	314	298	94	34	43	91	37	73	93	1,077
Industrial Water	209	198	29	12	19	44	7	29	32	579
Losses	125	120	24	6	8	22	5	16	20	346
Sub-Total (PS)	648	616	147	52	70	157	49	118	145	2,002
Irrigation	725	1,178	996	269	217	2,394	457	832	45	7,113
Livestock	7	7	30	9	37	48	4	16	25	183
Fishponds	4	164	97	183	35	122	3	13	376	996
Sub-Total (Ag)	736	1,349	1,123	461	289	2,564	464	861	446	8,292
TOTAL	1,384	1,965	1,270	513	359	2,721	513	979	591	10,294
2015										
Domestic Water	501	374	134	50	55	122	46	95	136	1,513
Industrial Water	290	214	36	14	20	48	7	31	36	689
Losses	189	142	34	9	10	28	7	21	28	468
Sub-Total (PS)	980	730	204	73	85	198	60	147	200	2,677
Irrigation	725	1,568	996	355	518	2,394	1,235	1,264	173	9,228
Livestock	9	10	31	19	48	51	9	33	35	245
Fishponds	4	164	97	276	124	1,104	276	162	585	2,793
Sub-Total (Ag)	738	1,742	1,124	650	690	3,549	1,520	1,459	793	12,266
TOTAL	1,718	2,472	1,328	723	775	3,747	1,580	1,606	993	14,943
Surface Water Potential										
Average year	10,800	13,000	33,600	38,900	20,300	5,300	26,300	67,500	21,500	237,200
Drought year	3,700	6,600	11,000	21,500	16,300	1,200	17,700	44,800	13,400	136,200
[Groundwater]	4,100	7,200	21,200	31,300	19,200	15,700	10,600	31,400	16,700	157,400
Balance - Average Year										
1995	9,905	11,669	32,914	38,816	20,225	3,473	26,074	66,609	21,342	231,028
% Not Utilised	92%	90%	98%	100%	100%	66%	99%	99%	99%	97%
2005	9,416	11,035	32,330	38,387	19,941	2,579	25,787	66,521	20,909	226,906
% Not Utilised	87%	85%	96%	99%	98%	49%	98%	99%	97%	96%
2015	9,082	10,528	32,272	38,177	19,525	1,553	24,720	65,894	20,507	222,257
% Not Utilised	84%	81%	96%	98%	96%	29%	94%	98%	95%	94%
Balance - Drought Year										
1995	2,805	5,269	10,314	21,416	16,225	-627	17,474	43,909	13,242	130,028
% Not Utilised	76%	80%	94%	100%	100%	-52%	99%	98%	99%	95%
2005	2,316	4,635	9,730	20,987	15,941	-1,521	17,187	43,821	12,809	125,906
% Not Utilised	63%	70%	89%	98%	98%	-127%	97%	97%	96%	92%
2015	1,982	4,128	9,672	20,777	15,525	-2,547	16,120	43,194	12,407	121,257
% Not Utilised	54%	63%	88%	97%	95%	-212%	91%	96%	93%	89%

Table 5-11(3) Water Balance by Province
(Conservative Scenario)

(Unit: 1000 m^3/day)

Demands	Lusaka	Copper-belt	Central	North-western	Western	Southern	Luapula	Northern	Eastern	Zambia
1995										
Domestic Water	190	232	63	22	32	65	28	52	59	743
Industrial Water	91	86	13	5	8	20	3	13	14	253
Losses	68	77	15	4	5	13	4	10	11	207
Sub-Total (PS)	349	395	91	31	45	98	35	75	84	1,203
Irrigation	490	803	564	45	0	1,660	185	790	43	4,580
Livestock	5	4	22	3	23	50	1	5	16	129
Fishponds	4	84	1	1	1	7	3	13	4	117
Sub-Total (Ag)	499	891	587	49	24	1,717	189	808	63	4,826
TOTAL	848	1,286	678	80	69	1,815	224	883	147	6,029
2005										
Domestic Water	279	270	82	26	36	76	31	59	72	931
Industrial Water	109	103	15	6	10	24	4	15	16	302
Losses	93	90	19	4	6	16	4	11	13	256
Sub-Total (PS)	481	463	116	36	52	116	39	85	101	1,489
Irrigation	725	1,178	564	70	1	2,394	185	832	45	5,994
Livestock	6	6	29	7	33	47	3	13	23	167
Fishponds	4	164	97	166	14	7	3	13	188	656
Sub-Total (Ag)	735	1,348	690	243	48	2,448	191	858	256	6,817
TOTAL	1,216	1,811	806	279	100	2,564	230	943	357	8,306
2015										
Domestic Water	385	299	100	29	38	85	33	62	82	1,113
Industrial Water	151	112	19	7	11	26	4	16	19	365
Losses	130	99	24	5	6	17	4	12	15	312
Sub-Total (PS)	666	510	143	41	55	128	41	90	116	1,790
Irrigation	725	1,727	564	269	303	2,394	457	1,264	173	7,876
Livestock	7	8	31	11	40	49	5	19	28	197
Fishponds	4	164	97	223	48	306	276	162	367	1,648
Sub-Total (Ag)	736	1,899	692	503	391	2,749	738	1,445	568	9,721
TOTAL	1,402	2,409	835	544	446	2,877	779	1,535	684	11,511
Surface Water Potential										
Average year	10,800	13,000	33,600	38,900	20,300	5,300	26,300	67,500	21,500	237,200
Drought year	3,700	6,600	11,000	21,500	16,300	1,200	17,700	44,800	13,400	136,200
[Groundwater]	4,100	7,200	21,200	31,300	19,200	15,700	10,600	31,400	16,700	157,400
Balance - Average Year										
1995	9,952	11,714	32,922	38,820	20,231	3,485	26,076	66,617	21,353	231,171
% Not Utilised	92%	90%	98%	100%	100%	66%	99%	99%	98%	98%
2005	9,584	11,189	32,794	38,621	20,200	2,736	26,070	66,557	21,143	228,894
% Not Utilised	89%	86%	98%	99%	99%	52%	99%	99%	98%	96%
2015	9,398	10,591	32,765	38,356	19,854	2,423	25,521	65,965	20,816	225,689
% Not Utilised	87%	82%	97%	99%	98%	46%	97%	98%	97%	95%
Balance - Drought Year										
1995	2,852	5,314	10,322	21,420	16,231	-615	17,476	43,917	13,253	130,171
% Not Utilised	77%	81%	94%	100%	100%	-31%	99%	98%	99%	96%
2005	2,484	4,789	10,194	21,221	16,200	-1,364	17,470	43,857	13,043	127,894
% Not Utilised	67%	73%	93%	99%	99%	-114%	99%	98%	97%	94%
2015	2,298	4,191	10,165	20,956	15,854	-1,677	16,921	43,265	12,716	124,689
% Not Utilised	62%	64%	92%	98%	98%	-140%	96%	97%	95%	92%

CHAPTER 6 WATER RESOURCES DEVELOPMENT PLAN TOWARD YEAR 2015

6.1 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.

6.1.1 Water Demand Scenarios

Water demands are projected for the three development scenarios outlined below. The corresponding socio-economic and sectoral projections are shown in Table 6-1.

1) Base Scenario - Agricultural Expansion

Water Supply Sector:	Population - Medium Projection, Middle Water Demand
Agricultural Sector:	High Growth in Value Added of Agricultural Sector, Promotion of Export of Agricultural Products

2) Base Scenario - Industrialisation

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

3) Conservative Scenario

Water Supply Sector:	Population - Low Projection, Low Water Demand
AgriculturalSector:	Low Growth in Value Added of Agricultural Sector, Self-supply of Agricultural Products to Moderately Increased Population

6.1.2 Source Development

(1) Surface Water - Level of Compensation Discharge

"Compensation discharge" is the discharge necessary to maintain the normal function of river flow. It is stipulated in the draft of the revised Water Act Section 23.(c) that, in Zambia, "dams should include a low flow pipe to allow low flow releases from the dam". Although the Act mentions the necessity of a flow pipe for flow to downstream of dams, it does not stipulate the requirement or amount of flow to be maintained. In the Manual for River Works in Japan, the "compensation discharge" Qc is defined as the discharge which satisfies the summation of maintenance and water-use discharge.

Table 6-1 Economic and Population Projection for Each Scenario

	Base Scenario - Agricultural Expansion	Base Scenario - Industrialisation	Conservative Scenario
Economic Growth	Growth Rate in GDP is assumed to grow around 5% (GDP per capita: 2.5% per annum) to 2000. Afterwords the growth rate of GDP wil reduce to 3.2% (GDP per capita: 1.25% per annum) by 2015. Growth Rate in VA of Agricultural Sector: 6% per annum to 2000 (based on ASIP), 3% per annum afterwards	Growth Rate inGDP is assumed to grow around 5% (GDP per capita:2.5% per annum) to 2000, afterwords GDP will reduce 4% (GDP per capita:1.25%) by 2015. Growth Rate in VA of Agricultural Sector: 3% per annum to 2015, the rest of VA to be covered by Manufacturing Sector	Growth Rate in GDP is assumed to grow around 2.5% (GDP per capita: 0.3% per annum) to 2000, GDP will reduce to 1.5% (GDP per capita: 0.15% per annum) by 2015 afterwards Growth Rate in VA of Agricultural Sector: 2.6% per annum to 1.5% in 2015
	<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% (2.7% → 1.9%)	Population Growth Rate in 1980's to continue after 1990, Annual Population Growth Rate to be 2.7% (2.7% → 2.7%)	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% (2.7% → 1.4%)
	< 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

Maintenance discharge has been stipulated to be maintained even at times of low flow, upon overall consideration of the following : boat transportation, fishing, scenery, maintenance of groundwater level, preservation of plants and animals, preservation of cleanliness of river flow. Water-use discharge is the flow necessary for the consumptive use of river water at all points downstream.

In detailed planning, the maintenance discharge should be studied, taking account of the items mentioned above, and water-use discharge should be investigated from a survey of the river water rights. However in framework planning, "drought discharge" (discharge which river flow exceeds for 355 days a year) is often applied as the compensation discharge at the possible dam sites, because the maintenance and water use discharge are yet to be investigated in detail. In this Master Plan Study, the average ten year "drought discharge", is estimated and applied as compensation discharge for proposed dam development projects.

(2) Groundwater Development

The required number of boreholes to meet the regional demands has been estimated for formulation of the groundwater development plan. Boreholes provide a more stable source of

water with better quantity and quality. Shallow wells are affected by droughts and provide lower quality water and are not a reliable source for sustainable development. The following criteria are applied for the development plans :

- Urban Water Supply : Water supply in urban areas requires large volume of water. Pumped water from one borehole is determined based on the assessment of safe yield according to the hydrogeological characteristics of the area. Standard size of boreholes is 20 - 30cm in diameter and 60 - 100m in depth.
- Rural Water Supply : Standard pumped water is assumed to be 7.5 m^3/day for rural water supply. Hand pumps are to be used and the design safe yield is to be the standard pumping capacity of the hand pump. Standard size of boreholes is 10 - 15cm in diameter and 60m in depth.

Groundwater development is carried out by drilling boreholes. Yields of boreholes are limited and over pumping causes adverse effects, not only to groundwater environment around the borehole, but also to the borehole itself. Therefore, the safe yield should be determined for each borehole for sustainable groundwater use. Safe yields of boreholes depend on the lithology of the aquifer, groundwater recharge and allowable groundwater draw down of borehole. Using those parameters, safe yield of each aquifer lithology has been calculated by computer simulation model. In the calculation, 24 hours continuous pumping over 20 years is assumed and the calculated safe yields are applicable to the whole of Zambia. Drilling of boreholes should be planned based on the yields shown in Table 6-2.

Table 6-2 Safe Yield of Aquifer Lithology

Allowable Draw Down	Safe Yield of Aquifer Lithology (m^3/day)							
	Limestone & Dolomite	Sand & Gravel	Sandstone	Granite	Quartzite	Shist	Gneiss	Shale & Others
20 - 30 m	550-630	310-470	120-200	60-110	60-110	45-75	28-43	20-35

6.1.3 Sector Policy and Strategy

(1) Water Supply Projects

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) Agricultural Projects

Policies of water resources development for the agricultural sector have been based on ASIP, whose target year is the Year 2000. Since the Master Plan covers the period upto 2015, agricultural development plan up to 2015 has been formulated in Section 3.4 of this Report, and is outlined as follows:

1) Domestic consumption of crops, livestock and fish is to be met, in principle, from the domestic production.
2) To assure stable production resistant to drought, production of irrigated wheat is to be promoted.
3) Contribution to the national economy is to be enlarged through an increase of products suitable for export

Policies of water resources development for agricultural sector are as follows:

1) Water sources for irrigation and aquaculture are to be mainly surface water. Although ground water is abstracted for some irrigation projects, the scale of abstraction is quite small. On the other hand, the sources for livestock breeding are mainly to be groundwater, because regional distribution of demand is scattered and volume of individual demand is small.
2) Low flow security in the case of diversion weir or direct intake has been set to ensure the abstraction and compensation discharge even in the occurrence of the worst drought in five years. In the case of dam development, both for single purpose for

irrigation and multi-purpose dams, low flow security is set against the worst drought in ten years as determined for water supply projects for domestic and industrial use.

3) Irrigation projects are classified as follows :

< Project Type >

- ASIP Rehabilitation Projects : Rehabilitation of existing irrigation schemes for smallholder farmers by the Government
- Expansion Projects : Expansion of existing irrigation by commercial farmers
- New Projects : Newly developed projects in potential areas for irrigation

< Scale of Projects >

- Large Scale Projects : Projects for an area of over 1000 ha
- Middle Scale Projects : Projects for an area of between 100 ha and 1,000 ha
- Small Scale Projects : Projects targeted for an area of less than 100 ha

< Source Type >

- Dam Development Project : Projects using developed water from either single or multi-purpose dam development
- Run-of-River Development Project : Projects using river water abstraction, either with or without a weir

4) Majority of proposed projects are furrow irrigation schemes. Irrigation efficiency is assumed as follows :

- Conveyance Efficiency : 80%
- Application Efficiency : 60%
- Overall Efficiency : 50%
- Efficiency for aquaculture : 100% application efficiency, 80% overall efficiency

(3) Water Resources Development for Other Sectors

< Hydroelectric Power Generation >

Most of Zambia's electricity is supplied from hydroelectric power generation. Current generation has already harnessed 28% of the potential available. Construction of two major hydro-power generation plants, namely Kafue Gorge Lower Power Station with capacity of 450MW and Batoka Gorge Power Station with Zambian share of capacity of 400MW, are planned and have been evaluated as feasible. Hydroelectricity is the most advanced sector in the development and utilisation of water resources in Zambia. The objectives of these projects are promotion of export of electric power and contribution to stable economic development. Negotiations and agreements should be encouraged with the electricity importing countries and the countries which need to jointly invest in these two projects.

Stabilisation of power supply to the northern parts of Zambia is necessary because of disruptions caused by problems with the long transmission lines. Extension of the existing Musonda Falls hydropower station is proposed, including multi-purpose utilisation of the water developed. To improve rural electrification, and to replace expensive and unreliable diesel powered generators, small scale hydropower stations are proposed as part of multi-purpose dam development projects.

In addition, development projects which utilise the water of the Kafue River, such as water supply to Lusaka City and irrigation for sugarcane production, are proposed in the Master Plan. These projects will also contribute to social and economic development of the country and are necessary in the future. Co-ordination and re-adjustment of water rights and review of

electricity generation plans for the existing and new Kafue Gorge Power Stations will be necessary.

< Navigation >

Inland navigation development plan should be studied in accordance with the national transportation policy. Existing navigation on slow flowing rivers and lakes will decrease with the development of alternative road networks. Demands for navigation will, however, remain until alternative roads or bridges are completed. The continuation of dredging of waterways which are affected by low flows and sedimentation is necessary.

< Flood Control >

No major flood control projects are necessary because flooding is not a major issue in Zambia. Flood control measures, which aim to encourage intensive land use through protection of lives and properties, are generally included in multi-purpose dam development because of the cost involved. Some of the dams proposed in the Master Plan will result in higher safety against floods and encourage agricultural floodplain land use.

< Forestry >

Forests have an important role from the viewpoint of water resources development by protecting watersheds against soil erosion and in maintaining stable water flow. Forest occupies 14% of the territory of Zambia, and has been decreasing by 1.3%/year caused by forest fires, shifting cultivation, and increasing demand for building poles and firewood. Although the Zambia Forestry and Forest Industries Corporation conducted major forest plantations, further afforestation should be promoted taking account of the future increase in demand for forestry products such as building materials. Encouragement of permanent cultivation rather than shifting cultivation will also benefit forest preservation.

< Water Quality >

The abundant resources, combined with the low level of consumptive use (3% of the resources) and the beneficial effect of large hydro releases, mean that water quality is not a major issue when considering the development of rivers in Zambia. Even though consumptive use will grow to almost 7% of the resources by 2015, the increased use will not cause major problems in general. Degradation of water quality in rivers and contamination of groundwater caused by domestic or industrial effluent will occur in certain urban areas, imposing additional constraints for water use in the area. Construction and expansion of sewer system and treatment facilities will be required in the future. The following are necessary for water quality management.

1) adoption of aquatic ecosystem guidelines for instream river water quality
2) regular water quality monitoring at designated points
3) periodical effluent monitoring of factories and sewage treatment works

6.2 Domestic and Industrial Water

6.2.1 Water Demand and Present Supply Capacity

(1) 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 6-3. 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 6-3 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	-1011	-224	-89	-186	-500
(%)	29	40	82	38	42	64	82	51	22	39	81	34
Shortage in 2015	-655	-127	-237	-1020	-1056	-400	-233	-1689	-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 6-4. 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 6-4 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 6-5. 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 6-5 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 6-6. 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.

(2) Balance of Water Source Demand and Present Supply Capacity

The overall balance between water demand at intake site and present supply capacity for 3 cities and 9 municipalities was calculated in Table 6-4. Lusaka city is the most serious condition in terms of water source shortage. The volume of shortage will reach to more than 0.3 million m³/day by 2005 and more than 0.5 million m³/day by 2015, if the present supply conditions are not improved in the near future. This situation is illustrated in the water supply plan for Lusaka shown in Table 6-7. In addition to Lusaka, the following towns will have similar shortage problems in the future : Ndola, Kitwe, Mufulira, Kalulushi, Luanshya, Kabwe, Livingstone, Kasama, Chipata.

Table 6-6 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

The balance for the 80 smaller townships was calculated in Table 6-5, which shows the total, not by individual town, but by province. The balance is illustrated in Table 6-8. The present supply capacity is estimated referring to the results of the "Current Water Use Survey". As shown in the table, the following three provinces will have serious shortage problems (more than 15,000 m³/day in 2015) in the future: Lusaka, Northern, Southern and Western. In addition to these provinces, another four provinces will also have shortage problems (more than 10,000 m³/day in 2015): Luapula, North-western, Eastern and Central.

In rural areas, the water shortage problem seem to be more serious than in urban areas. Even Lusaka province, the least deficient of the 9 provinces in 2015, will be in short supply of more than 10,000 m³/day if the present capacity is not augmented in the future, as shown in Table 6-6 and illustrated in Table 6-9. Even if the supply target is set as 55% in 2005 and 75% in 2015, the shortage would reach to around 5,000 m³/day in 2005 and around 9,000 m³/day in 2015, as far as the present capacity will not increased until the target year. In other provinces, the shortage problems would be more serious than in Lusaka province, as shown in the table.

The national situation was illustrated in Table 6-3. In 1995 for the Base Scenario - Agricultural Expansion, the total supply capacity almost meets the total requirement for large and small urban areas, although the source water is not evenly distributed as discussed above. However, as shown in the table, the situation in rural areas is already serious, and by 2005 and 2015, it is clear that the total supply capacity will become inadequate. In 2015 the deficiency of source water is estimated at 1.02 million m³/day for the Base Scenario - Agricultural Expansion. For the Base Scenario - Industrialisation, the deficiency sums to 1.69 million m³/day as shown in the table, although for the Conservative Scenario, it is limited to 0.80 million m³/day.

6.2.2 Water Supply Plans

(1) Large Urban Areas

As seen from Table 6-4, 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 6-7 as an example. The plans for the other cities and municipalities are included in the Supporting Report. 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>Kalulushi</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)

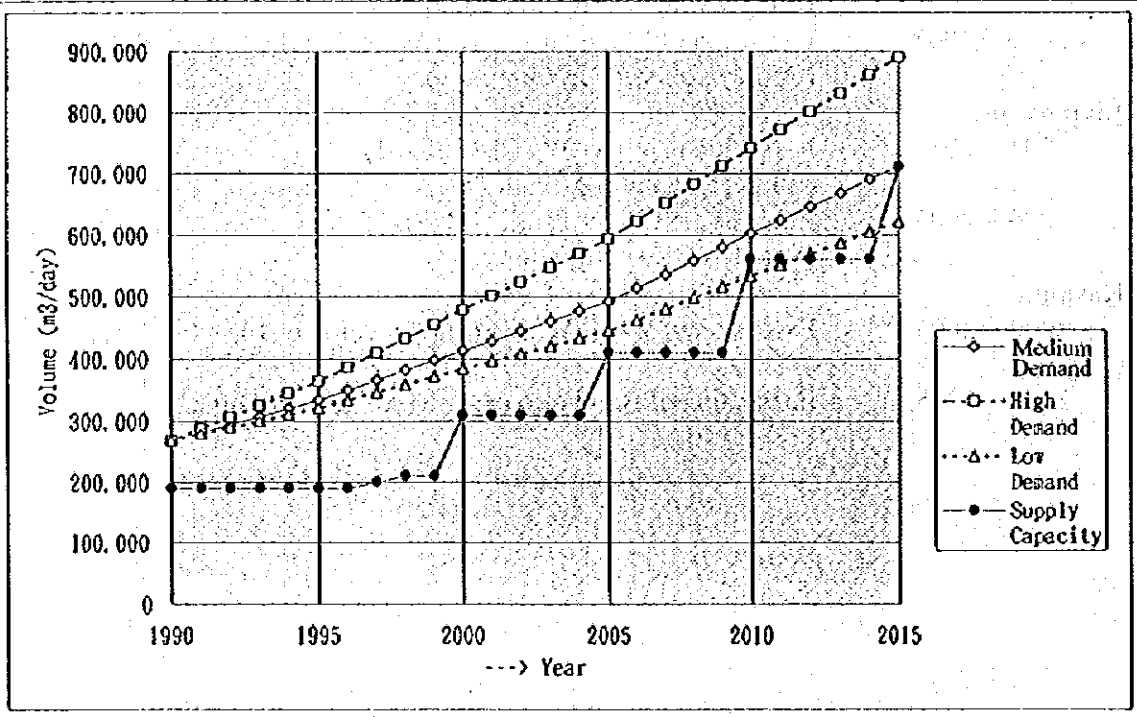
Table 6-7 Water Demand and Supply Plan (Lusaka Urban)

Township		DISTRICT		PROVINCE	
111	Lusaka	11	Lusaka Urban	10	Lusaka

1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Population Projection	1995	2005	2015
- Population	769,353	(1) Medium 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)	(Medium)	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)	(Medium)	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)	(Medium)	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)	(Medium)	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/s)		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



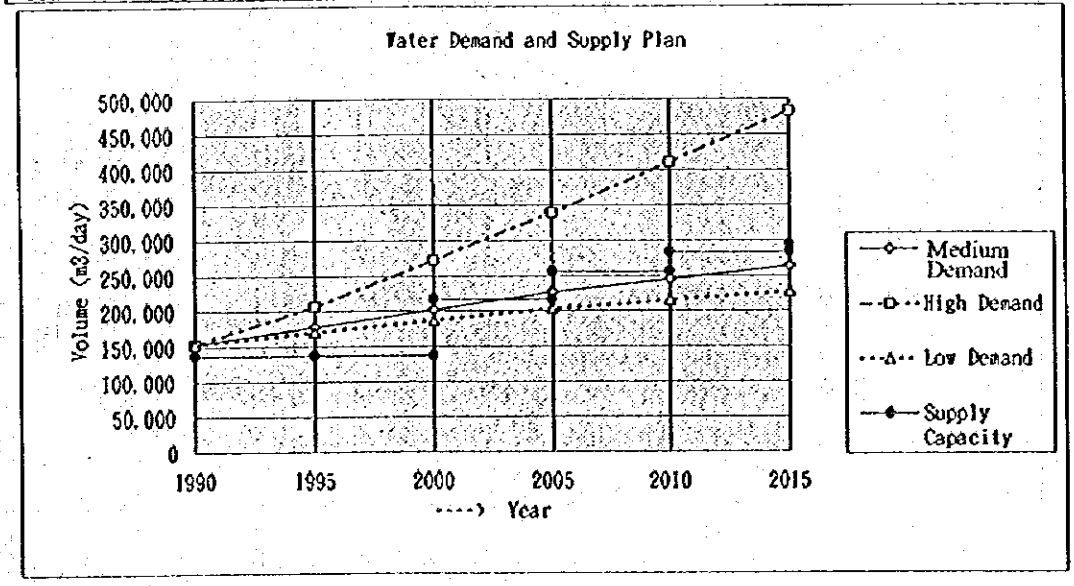
(2) Small Urban Areas

The water demand and supply plan for small urban areas (Zambia total) is summarised in Table 6-8. The province level plans are included in the Supporting Report.

Table 6-8 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		Population Projection	1995	2005	2015
- Population	585,668	(1) Medium 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
CURRENT DOMESTIC WATER SUPPLY PROJECT					
Name of Water Supply Project		Type of Managing Body	Water Supply Volume (m3/day)		
Total					
Surface Water Source :					
Groundwater Source :					
WATER RESOURCES POTENTIAL					
Surface Water Potential					
Groundwater Potential					

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)	(Medium)	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)	(Medium)	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)	(Medium)	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)	(Medium)	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
				79,801	79,801	79,801	79,801
					38,493	38,493	38,493
						27,923	27,923
							9,661
- Total Water Supply (m3/day)		137,203	137,203	217,004	255,497	283,420	293,081



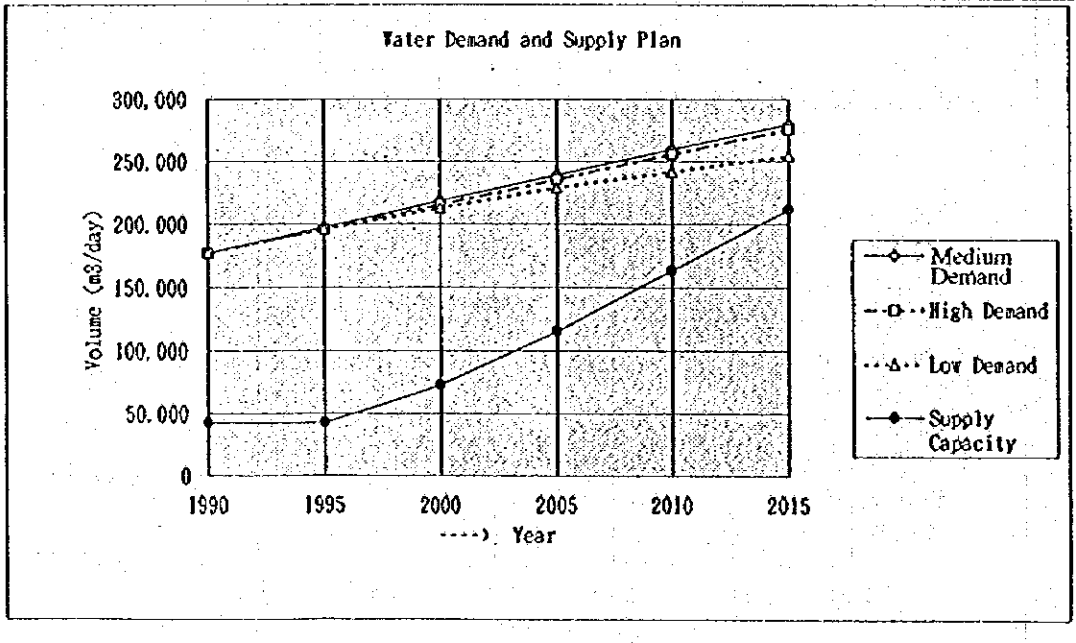
(3) Rural Areas

Water demand and supply plan for rural areas (Zambia total) is summarised in Table 6-9. The province level plans are included in the Supporting Report.

Table 6-9 Water Demand and Supply Plan for Rural Areas (Zambia Total)

RURAL			ZAMBIA TOTAL		
1990 CENSUS POPULATION AND FUTURE PROJECTION					
1990 Census Data		Population Projection	1995	2005	2015
- Population	4,601,554	(1) Medium 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
CURRENT DOMESTIC WATER SUPPLY PROJECT					
Name of Water Supply Project		Type of Managing Body	Water Supply Volume (m3/day)		
Total					
Surface Water Source :					
Groundwater Source :			42,594		
WATER RESOURCES POTENTIAL					
Surface Water Potential					
Groundwater Potential					

WATER DEMAND AND SUPPLY							
Items		1990	1995	2000	2005	2010	2015
< Domestic Water >							
Consumption Rate (lit/cap./day)		35	35	35	35	35	35
Rural Water Demand (m3/day)	(Medium)	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)	(Medium)	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



6.2.3 Facility Plans

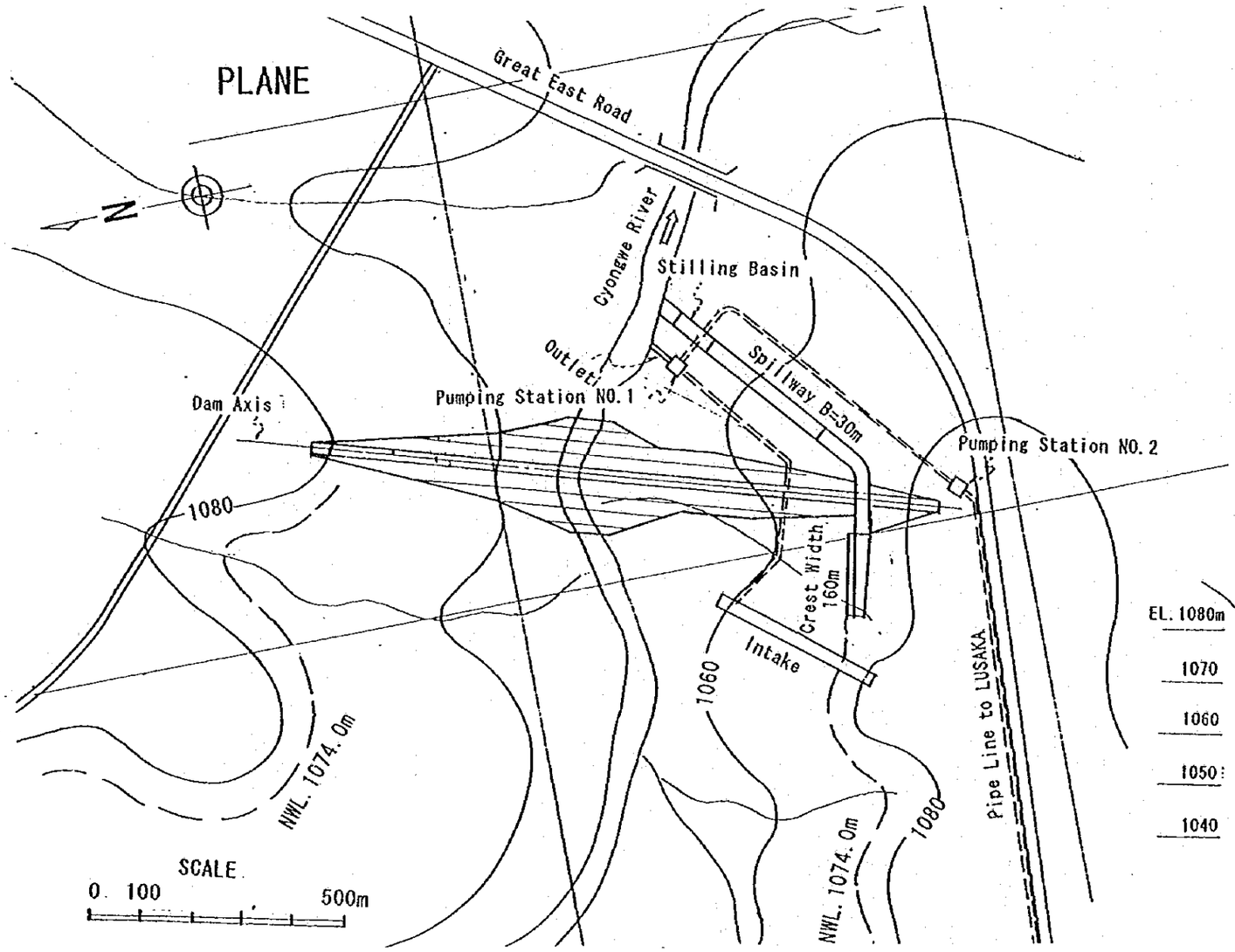
(1) Multi-purpose Dams

Table 6-10 Outline of Proposed Multi-purpose Dams

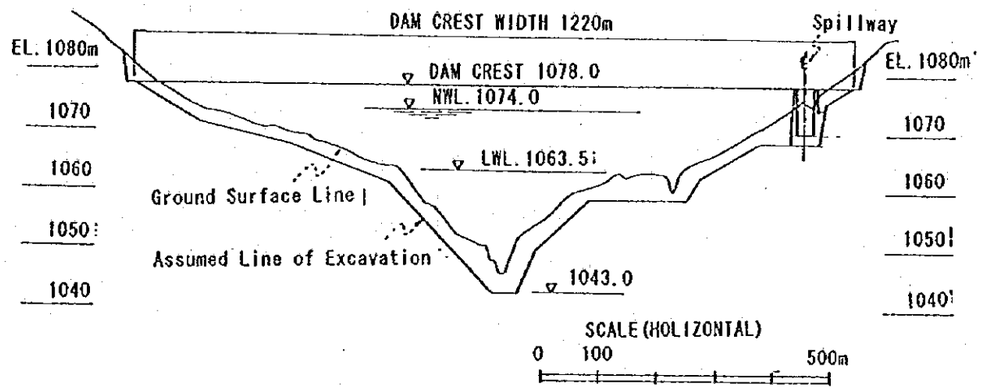
	Chongwe Dam	Kafubu Dam	Mutundu Dam
(1) Dam Site	- 45 km east of Lusaka, - 1 km east of Chongwe	- 30km south-west of Ndola, - 15km south-east of Luanshya	- 15km north of Kitwe, - 15km south of Mufulira
(2) Dam Type	Fill Type	Fill Type	Fill Type
(3) Dam Height	37.0 m	27.0 m	30.0 m
(4) Dam Volume	1,315,000 m^3	795,000 m^3	981,000 m^3
(5) Maximum Volume of Water Developed	173,000 m^3/day (2.002 m^3/sec)	430,000 m^3/day (4.977 m^3/sec)	170,000 m^3/day (1.968 m^3/sec)
(6) Purpose (volume of water to be developed as in Base Scenario - Agricultural Expansion)	- Water Supply:103,000m^3/day (Lusaka, Chongwe) - Irrigation: 70,000 m^3/day (810ha near to Chongwe)	- Water Supply: 65,000m^3/day (Ndola, Luanshya) - Irrigation: 365,000m^3/day (4,220ha along Kafubu River)	- Water Supply: 35,000m^3/day (Kitwe, Kalulushi, Mufulira) - Irrigation: 135,000m^3/day (1,560ha near to Kitwe)

Preliminary layout drawings, including plans, longitudinal sections and typical cross sections, are shown for Chongwe, Kafubu and Mutundu Dams in Figures 6-1, 6-2 and 6-3. The standard designs for pumping wells for Lusaka water supply, township water and rural supplies are shown in Figure 6-4.

PLANE



LONGITUDINAL CROSS SECTION



TYPICAL CROSS SECTION

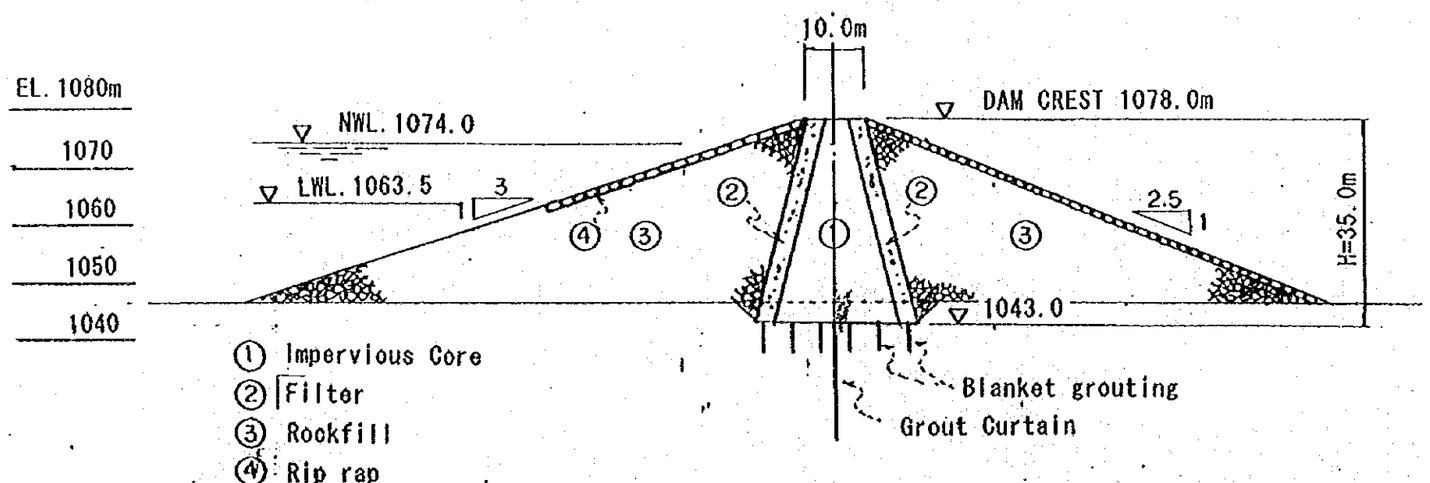
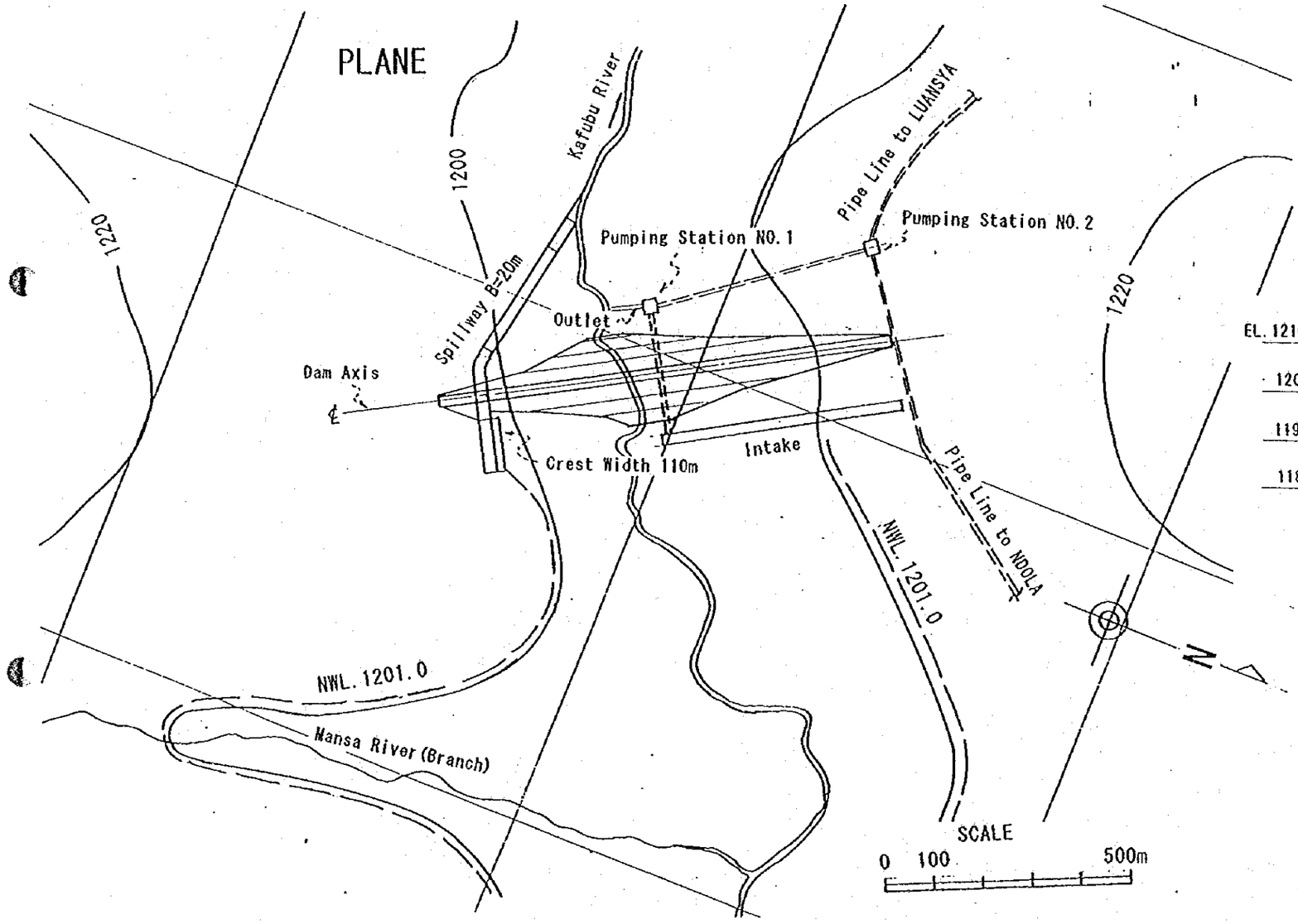
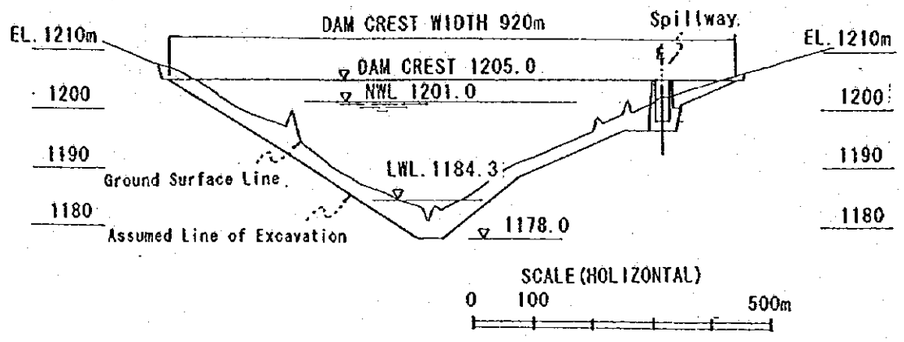


Figure 6-1 Layout of Chongwe Dam

CHONGWE DAM (NO. 16)





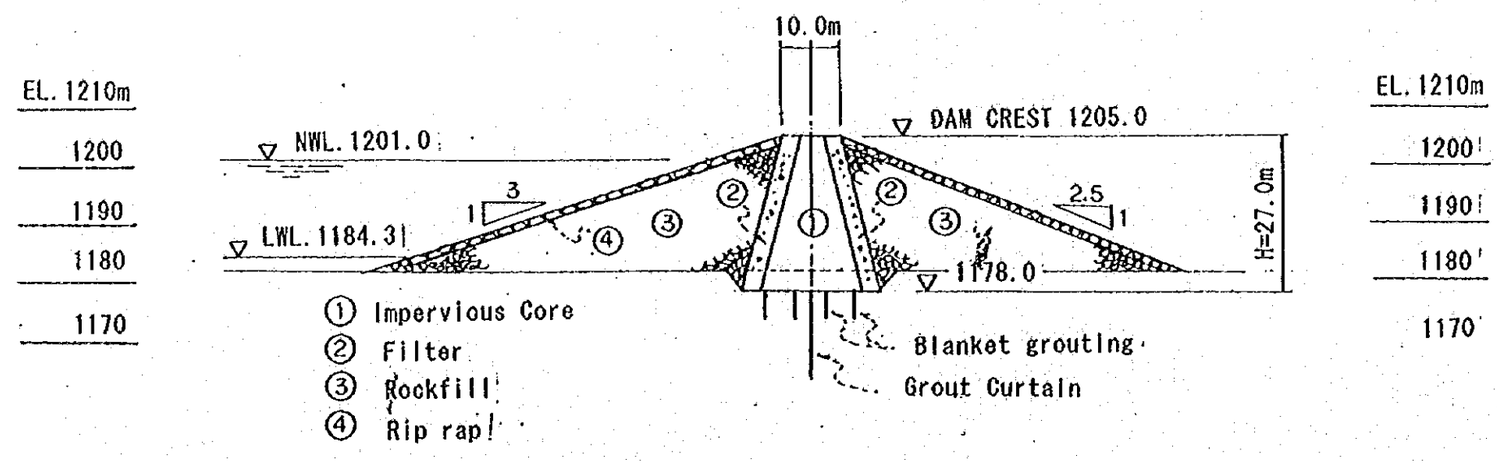
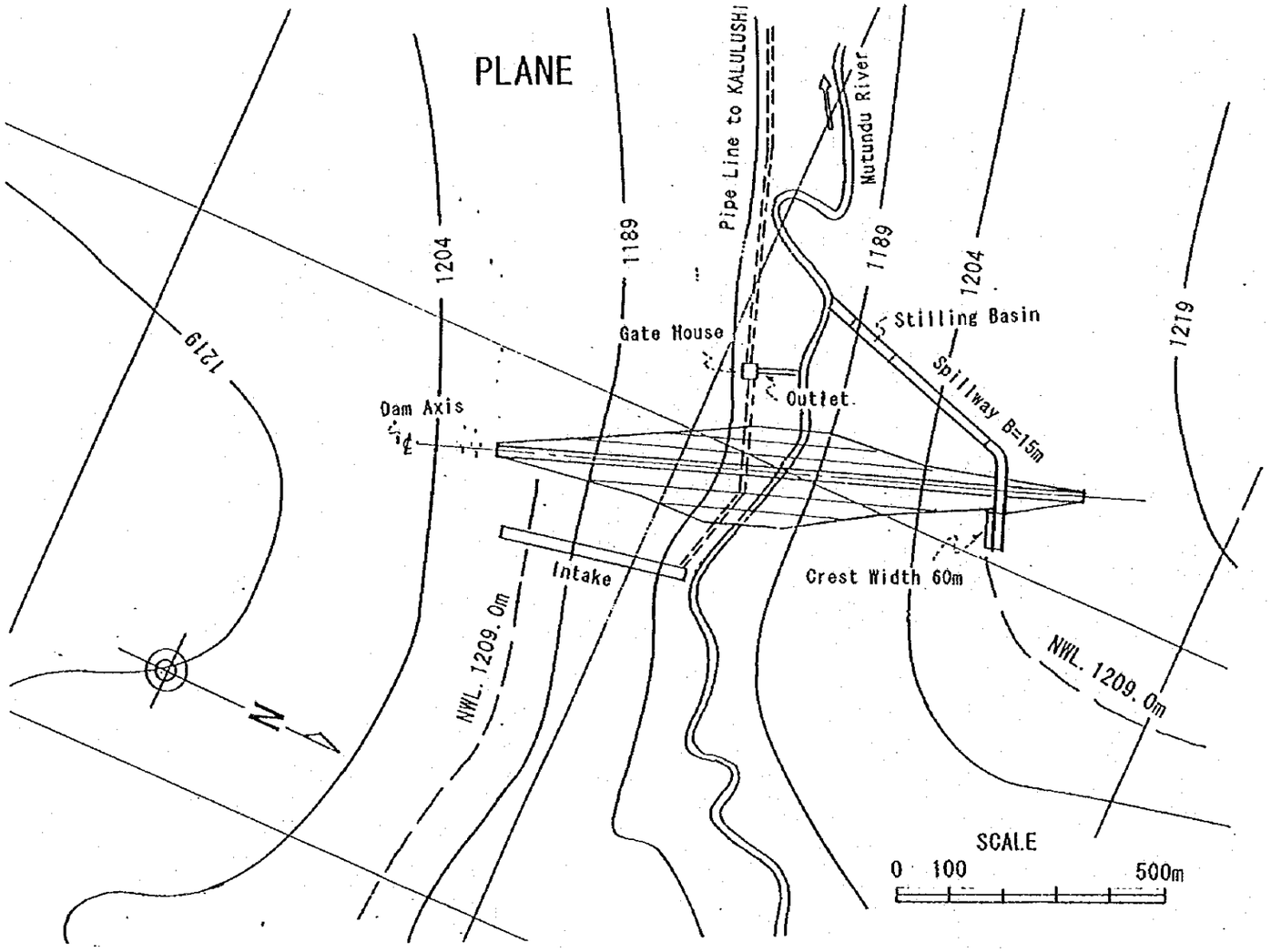


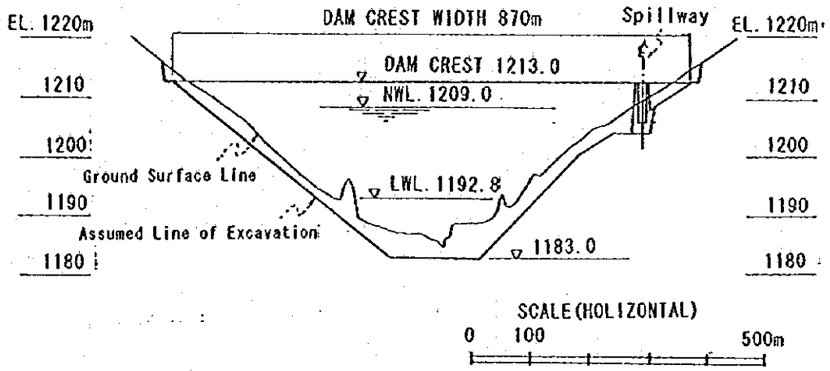
Figure 6-2 Layout of Kafubu Dam

KAFUBU DAM (NO. 10)

PLANE



LONGITUDINAL SECTION OF DAM AXIS



TYPICAL CROSS SECTION

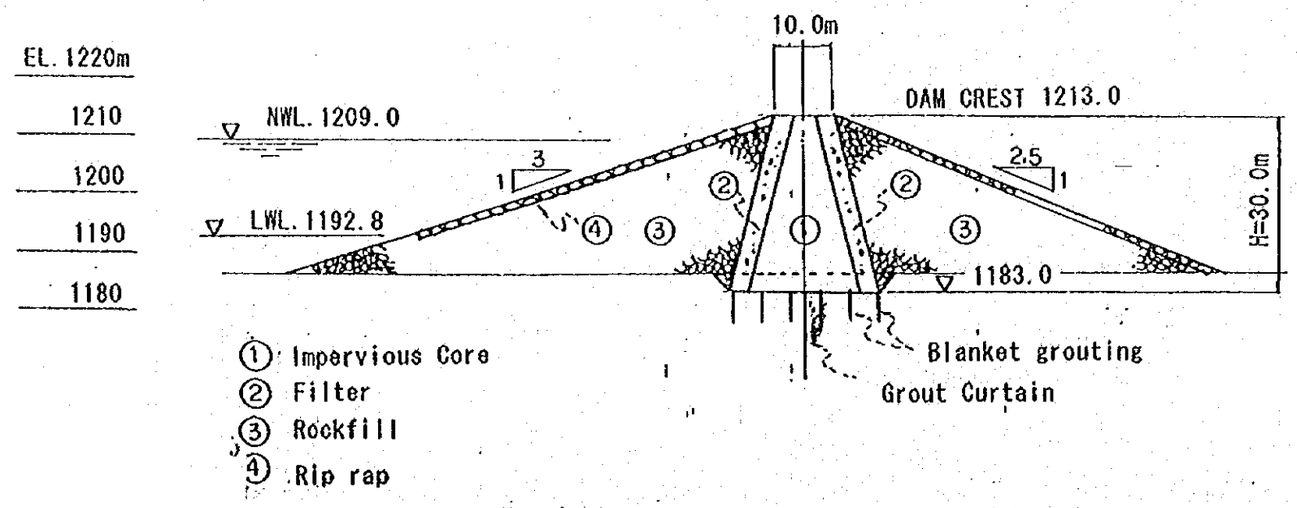


Figure 6-3 Layout of Mutundu Dam

MUTUNDU DAM (NO. 7)

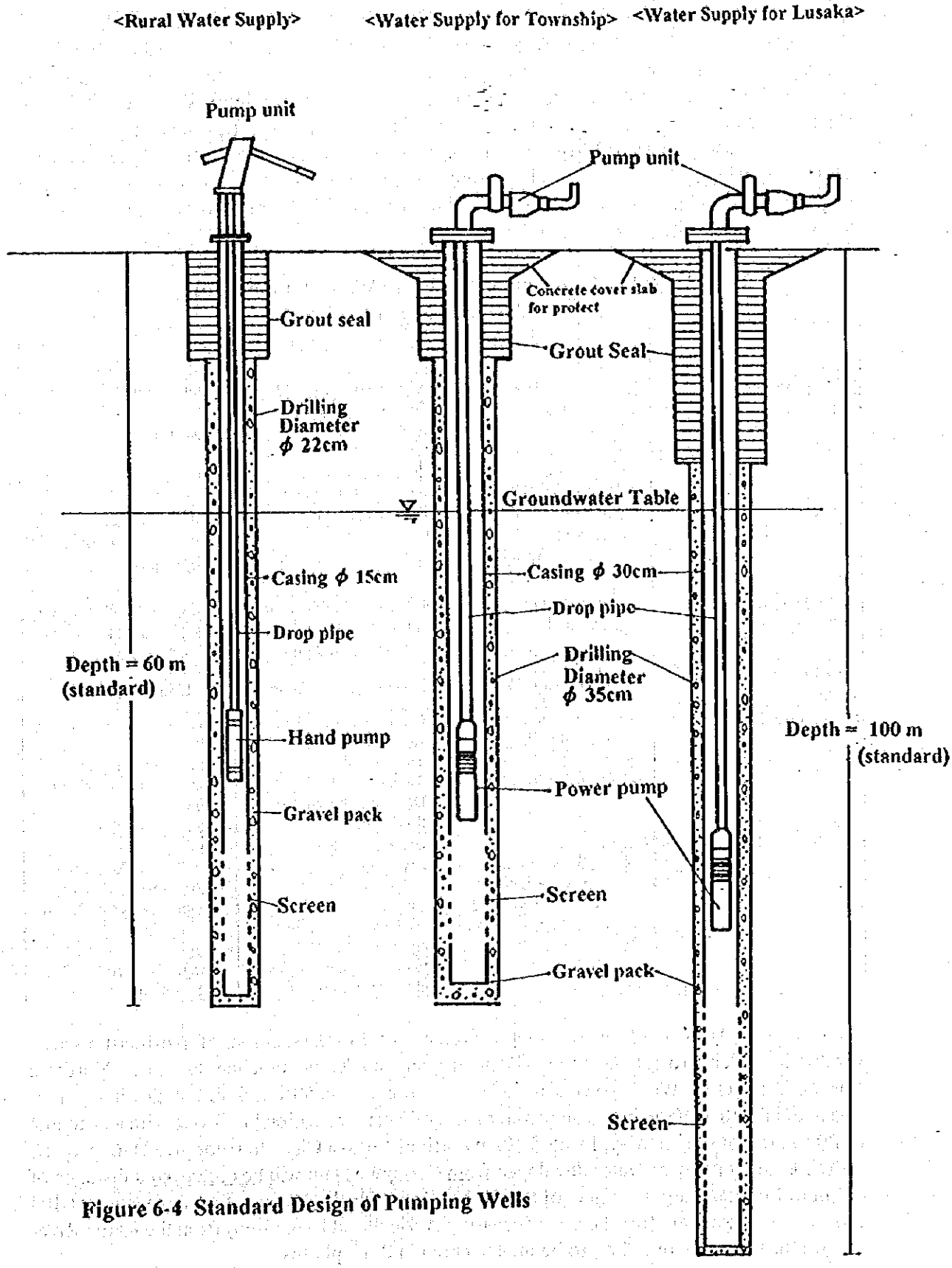


Figure 6-4 Standard Design of Pumping Wells

(2) Water Supply Projects for Large Urban Areas

Source of water supply to the Capital City of Lusaka relies on groundwater in the Lusaka Dolomite Aquifer (90,000 m^3/day abstracted) and on the Kafue River (100,000 m^3/day conveyed). For the future source of supply, large volume of abstraction cannot be expected from the Lusaka Dolomite Aquifer. An alternative aquifer for additional source will be the Cheta Limestone Aquifer located 10km north of Lusaka. The most promising source near Lusaka City will be obtained from the Chongwe River with dam and reservoir development. The Kafue River will remain as an important source. However, there is no surplus water in respect to water rights as most of the amount has been granted for hydro-electric generation. Re-allocation of water rights would be necessary.

Table 6-11 Development Policy of Water Supply Projects for Lusaka Urban Area by Source

	Source of Water Supply in Lusaka Urban Area		
	Groundwater	Chongwe River	Kafue River
Site of Source	10 km north from Lusaka	45 km east of Lusaka	50 km south of Lusaka
Type of Source	50 Boreholes Diameter: 30 cm Depth: 100m Amount of Developed Water: 400m^3/day/bore	Chongwe Dam Fill Type Dam Height: 37m Reservoir Storage: 92 million m^3	Direct Intake
Potential	Maximum Amount of Development 38,000 m^3/day (0.440 m^3/sec)	Maximum Amount of Development 173,000 m^3/day (2.002 m^3/sec)	Mean Discharge: (295.6 m^3/sec) Drought Discharge: (123.3 m^3/sec)
Feasible Scale of Development	20,000~30,000 m^3/day (0.231~0.347 m^3/sec) < Small Scale >	100,000~150,000 m^3/day (1.157~1.736 m^3/sec) < Medium Scale >	300,000~600,000 m^3/day (3.427~6.944 m^3/sec) < Large Scale >
Unit Price of Developed Water	US$ 788 m^3/day	US$ 1,099 m^3/day	US$ 805 m^3/day
Characteristics of Source	- Cheta Limestone Aquifer, - No current abstraction because of the location (10km north from Lusaka)	- Current source of water supply for Chongwe Township - New source for Lusaka - Developed by storage of flood water	- Abundant water at intake point, - 180m^3 of water rights attached to hydro-electric generation - No surplus water
Priority and Reasons	<First Priority> - No conflicts with the existing water rights - Small capital investment - Short term implementation - Highest priority	<Second Priority> - new source providing an alternative for stable supply - a joint venture project with agricultural sector - to be implemented after the groundwater project	<Third Priority> - possible conflicts with existing water rights granted for hydro-electric generation - Large capital investment - Longest term required for preparation

As shown in Table 6-11, water supply projects of Lusaka consist of Northern Lusaka Production Well Project, Chongwe Dam Project and Kafue Pipeline Project. Northern Lusaka Production Well Projects includes construction of 50 boreholes with diameter of 30cm and depth of 100m in a groundwater basin of Cheta formation limestone with a potential of 20 to 30 thousand m^3/day, located 10km north of Lusaka City. In Chongwe Dam project, 100 thousand m^3/day of water developed from Chongwe Dam will be conveyed a distance of 45km to Lusaka. Largest project of the three is Kafue Pipeline Project for conveyance of 400 thousand m^3/day water (for the Base Scenario - Agricultural Expansion) from the Kafue River to Lusaka a distance of 50km, to be implemented in three phases.

Water supply projects to the other large urban areas are shown in Table 6-12. Sources of urban water supply in the five large urban areas in Copperbelt Province are to be obtained from two multi-purpose dams, namely Kafubu and Mutundu Dams. In the Base Scenario-Agricultural Expansion, a volume of 60 thousand m^3/day of water to Ndola and 5 thousand m^3/day to Luanshya will be conveyed from Kafubu Dam. In the same scenario, 20 thousand m^3/day to Kitwe, 10 thousand m^3/day to Kalulushi, and 5 thousand m^3/day to Mufulira will be conveyed from Mutundu Dam.

Water to Kabwe urban area will be supplied by an expansion of conveyance, implemented in two phases, of 57 thousand m^3/day in the Base Scenario-Agricultural Expansion from Kabwe Dam completed in 1990. Water supply to Livingstone and Kasama will be attained with water conveyance projects without dam development. Volumes of developed water will be 20 thousand m^3/day for Livingstone and 14 thousand m^3/day for Kasama in the Base Scenario-Agricultural Expansion. Water to Chipata is to be supplied with construction of 120 boreholes, with diameter of 30cm and depth of 60m, for a volume of 12 thousand m^3/day of developed water in the same scenario.

Adjustments of water supply projects to demand increase for the Base Scenario - Industrialisation or decrease for the Conservative Scenario are to be made as follows, as shown in Table 6-13:

- In Lusaka urban area, Northern Lusaka Production Well Project and Chongwe Dam Project are to be implemented as planned in any case. Water supply is adjusted in Kafue Pipeline Project.
- In Kafubu and Mutundu Multi-purpose Dams Projects, for five urban areas in Copperbelt Province, the priority in allocation of developed water is given to municipal water supply and remaining water is used for irrigation.
- In projects for expansion of conveyance or borehole construction projects, volume of conveyed water or number of boreholes to be constructed is to be adjusted in accordance with the volume of water demand.

Table 6-12 Outline of Water Supply Projects for Large Urban Areas

Projects	Water Supply Volume (m^3/day)	Source Development	Water Treatment	Water Conveyance	Distribution (1000 pop)
(1) Lusaka W/S from Northern Wells	20,000	50 wells	Chlorination	Distance = 10km Head = 30m Pipe = 350mm Pump = 1 station	107.0
(2) Lusaka W/S from Chongwe Dam	100,000	Dam Height=37m Dam Volume =1,315,000m^3	Sedimentation Rapid filter Chlorination	Distance = 45km Head = 270m Pipe = 800mm Pump =2 stations	400.0
(3) Lusaka W/S from Kafue River	400,000		Sedimentation Rapid filter	Distance = 50km Head = 310m	1,777.8
Phase-1:	100,000	Intake Facilities	Chlorination	Pipe = 800mm Pump =2 stations	444.4
Phase-2:	150,000	Intake Facilities		Pipe = 1000mm Pump =2 stations	666.7
Phase-3:	150,000	Intake Facilities		Pipe = 1000mm Pump =2 stations	666.7
(4) Ndola W/S from Kafubu Dam	60,000	Dam Height=27m Dam Volume =795,000m^3	Sedimentation Rapid filter Chlorination	Distance = 40km Head = 110m Pipe = 600mm Pump = 1 station	266.7
(5) Luanshya W/S from Kafubu Dam	5,000	do.	Sedimentation Rapid filter Chlorination	Distance = 15km Head = 60m Pipe = 200mm Pump = 1 station	22.2
(6) Kitwe W/S from Mutundu Dam	20,000	Dam Height=30m Dam Volume =981,000m^3	Sedimentation Rapid filter Chlorination	Distance = 20km Head = 20m Pipe = 350mm Pump = 1 station	88.9
(7) Kalulushi W/S from Mutundu Dam	10,000	do.	Sedimentation Rapid filter Chlorination	Distance = 30km Head = 100m Pipe = 250mm Pump = 1 station	44.4
(8) Mufulira W/S from Mutundu Dam	5,000	do.	Sedimentation Rapid filter Chlorination	Distance = 15km Head = 80m Pipe = 200mm Pump = 1 station	22.2
(9) Kabwe W/Works Extension	57,000		Rapid filter Clari-	Distance = 15km Head = 130m	253.4
Phase-1:	19,500	Existing Facilities	-flocculation Chlorination	Pipe = 350mm Pump = 1 station	86.7
Phase-2:	37,500	Existing Facilities		Pipe = 500mm Pump = 1 station	166.7
(10) Livingstone W/W Extension	20,000		Sedimentation Rapid filter	Distance = 10km Head = 30m	88.8
Phase-1:	10,000	Existing Facilities	Chlorination	Pipe = 250mm Pump = 1 station	44.4
Phase-2:	10,000	Existing Facilities		Pipe = 250mm Pump = 1 station	44.4
(11) Kasama W/ S from Lukupa River	14,000	Existing Facilities	Rapid filter Slow filter Chlorination	Distance = 10km Head = 150m Pipe = 300mm Pump = 1 station	62.2
(12) Chipata W/S from Production Wells	12,000	120 wells	Chlorination	Distance = 5km Head = 30m Pipe = 300mm Pump = 1 station	53.3

Table 6-13 Water Supply Projects for Large Urban Areas by Scenarios

City	Base Scenario- Agricultural Expansion (medium population projection)	Base Scenario- Industrialisation (high population projection)	Conservative Scenario (low population projection)
Lusaka	Northern Lusaka Production Well Project Q = 20,000 m³/day N = 50 wells L = 10 km	Same as Base Scenario- Agricultural Expansion	Same as Base Scenario- Agricultural Expansion
	Lusaka Water Supply Project (Chongwe Dam Project) Q = 100,000 m³/day L = 45 km	Same as Base Scenario- Agricultural Expansion	Same as Base Scenario- Agricultural Expansion
	Lusaka Water Supply Project (Kafue Pipeline Project) Q = 400,000 m³/day L = 45 km Phase-1 : 100,000 m³/day Phase-2 : 150,000 m³/day Phase-3 : 150,000 m³/day	Q = 600,000 m3/day Phase-1 : 150,000 m3/day Phase-2 : 150,000 m3/day Phase-3 : 200,000 m3/day	Q = 300,000 m3/day Phase-1 : 100,000 m3/day Phase-2 : 100,000 m3/day Phase-3 : 100,000 m3/day
Sub Total	Q = 520,000 m³/day	Q = 720,000 m³/day	Q = 420,000 m³/day
Ndola	Ndola Water Supply Project (Kafubu Dam) Q = 60,000 m³/day L = 40 km	Q = 110,000 m³/day	Q = 45,000 m³/day
Luanshya	Luanshya Water Supply Project (Kafubu Dam) Q = 5,000 m³/day L = 15 km	Q = 20,000 m³/day	No New Demand
Kitwe	Kitwe Water Supply Project (Mutundu Dam) Q = 20,000 m³/day L = 20 km	Q = 50,000 m³/day	No New Demand
Kalulushi	Kalulushi Water Supply Project (Mutundu Dam) Q = 10,000 m³/day L = 30km	Q = 15,000 m³/day	Q = 6,000 m³/day
Mufulira	Mufulira Water Supply Project (Mutundu Dam) Q = 5,000 m³/day L = 15 km	Q = 15,000 m³/day	No New Demand
Kabwe	Kabwe Water Supply Expansion Project Q = 57,000 m³/day L = 15 km Phase-1 : 19,500 m³/day Phase-2 : 37,500 m³/day	Q = 80,000 m3/day Phase-1 : 27,000 m³/day Phase-2 : 53,000 m³/day	Q = 45,000 m3/day Phase-1 : 15,000 m³/day Phase-2 : 30,000 m³/day
Livingstone	Livingstone Water Supply Expansion Project Q = 20,000 m³/day L = 10 km Phase-1 : 10,000 m³/day Phase-2 : 10,000 m³/day	Q = 30,000 m³/day Phase-1 : 15,000 m³/day Phase-2 : 15,000 m³/day	Q = 16,000 m³/day Phase-1 : 8,000 m³/day Phase-2 : 8,000 m³/day
Kasama	Kasama Water Supply Expansion Project Q = 14,000 m³/day L = 5 km	Q = 35,000 m³/day	Q = 10,000 m³/day
Chipata	Chipata Production Well Project Q = 12,000 m³/day N = 120 wells	Q = 20,000 m³/day N = 200 wells	Q = 9,000 m³/day N = 90 wells
<Total>	No. of Cities : 10 cities Q = 723,000 m³/day N = 170 wells	No. of Cities : 10 cities Q = 1,095,000 m³/day N = 250 wells	No. of Cities : 7 cities Q = 551,000 m³/day N = 140 wells

[Note] (1) Of the twelve large urban areas, Chililabombwe and Chingola are excluded, where new development is not necessary because the current supply capacity is sufficient to meet the future demands

(2) Of the boreholes included in Northern Lusaka Production well projects, 8 boreholes (5,200 m³/day) will be drilled through a grant aid project of the Government of Japan

(3) Q : Water Volume Developed N : Number of Wells L : Length of Water Conveyance

(3) Water Supply Projects for Small Urban Areas

In the Base Scenario-Agricultural Expansion, sources of water supply to 80 small urban areas are divided between surface water in 17 towns and groundwater in 63 towns. Volume of surface water to be developed in the same scenario, amounts to 49.3 thousand m^3/day, and the average for each town is 2.9 thousand m^3/day. Since demand for each town is small compared to a large urban area, intakes from natural flows, not from reservoirs developed by dam construction, are planned for small towns. Total volume of groundwater developed in small towns in the scenario, will reach 106.6 thousand m^3/day with 1,281 boreholes, and the average for each town is 1.7 thousand m^3/day, equivalent to 20 boreholes.

Table 6-14 Water Supply Projects for Small Urban Areas

Province	Base Scenario-Agricultural Expansion			Base Scenario- Industrialisation			Conservative Scenario		
	No. of Towns	Volume (m^3/day)	Facility	No. of Towns	Volume (m^3/day)	Facility	No. of Towns	Volume (m^3/day)	Facility
Lusaka	5			5			5		
Surface	4	23,600	L=40km	4	62,300	L=40km	4	13,700	L=40km
Groundwater	1	960	W=5	1	1,728	W=9	1	576	W=3
Copperbelt	4			4			4		
Surface	-	-		-	-		-	-	
Groundwater	4	5,818	W=17	4	15,512	W=60	4	3,542	W=7
Central	7			7			7		
Surface	-			-			-		
Groundwater	7	13,590	W=230	7	31,390	W=594	7	9,390	W=156
Northwestern	7			7			7		
Surface	5	11,600	L=12km	5	38,200	L=12km	4	7,700	L=10km
Groundwater	2	3,220	W=92	2	6,020	W=172	3	2,520	W=72
Western	12			12			12		
Surface	3	5,700	L=6km	2	9,400	L=6km	3	4,100	L=6km
Groundwater	9	16,878	W=36	9	31,356	W=67	9	10,764	W=23
Southern	21			21			21		
Surface	2	1,400	L=6km	2	2,500	L=6km	2	1,100	L=6km
Groundwater	19	25,660	W=315	19	59,573	W=764	19	13,070	W=144
Luapula	7			7			7		
Surface	3	7,000	L=6km	3	13,600	L=6km	3	5,900	L=6km
Groundwater	4	8,374	W=79	4	20,760	W=185	4	5,936	W=56
Northern	10			10			10		
Surface	-			-			-		
Groundwater	10	19,326	W=221	10	36,988	W=445	10	14,850	W=162
Eastern	7			7			7		
Surface	-	-		-	-		-	-	
Groundwater	7	12,782	W=286	7	24,030	W=531	7	9,878	W=223
TOTAL	80	155,906		80	353,267		80	103,026	
Surface	17	49,300	L=70km	17	126,000	L=70km	16	32,500	L=68km
Groundwater	63	106,606	W=1,281	63	227,267	W=2,837	64	70,526	W=846

[Note] : L = length of conveyance (km), W = number of wells

(4) Water Supply Projects for Rural Areas

Rural water supply projects are planned using boreholes, 15cm in diameter and 60m in depth, fitted with hand pumps. In order to cover 75% of the demands in rural areas by 2015, rural water supply projects will require construction of 22,528 boreholes with developed water of 169 thousand m^3/day in the Base Scenario-Agricultural Expansion.

Table 6-15 Water Supply Projects for Rural Areas

Province	Base Scenario-Agricultural Expansion		Base Scenario- Industrialisation		Conservative Scenario	
	Volume (m^3/day)	Number of Wells	Volume (m^3/day)	Number of Wells	Volume (m^3/day)	Number of Wells
Lusaka	8,176	1,090	3,892	519	7,275	970
Copperbelt	12,780	1,704	13,470	1,796	11,100	1,480
Central	21,256	2,834	21,923	2,923	18,975	2,530
Northwestern	13,066	1,742	11,460	1,528	11,693	1,559
Western	7,936	1,058	7,298	973	4,958	661
Southern	26,372	3,516	25,935	3,458	23,130	3,084
Luapula	15,512	2,068	15,188	2,025	13,860	1,848
Northern	26,596	3,546	26,603	3,547	23,888	3,185
Eastern	37,276	4,970	38,565	5,142	33,390	4,452
TOTAL	168,970	22,528	164,334	21,911	148,269	19,769

(Note) Of the above wells to be developed, 65 boreholes, 150 boreholes and 105 boreholes are being drilled in Lusaka, Copperbelt and Central Provinces, respectively, through grant aid projects of the Government of Japan.

(5) Promotion Projects for Groundwater Development

Refer to Table 6-16 and 6-17.

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. Before constructing the provincial drilling centres, a Groundwater Development Training 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.

Table 6-16 Drilling Centre Projects

Province	Number of Rigs	Number of New Boreholes 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 training centre and drilling centre. 2 drilling teams.
Copperbelt	2		17	1,704	1,721	6.46	Drilling centre to be newly constructed in Ndola. 3 drilling teams.
Central	(3)*		230	2,834	3,064	-	Existing drilling centre in Kabwe to be utilised. 5 drilling teams.
Northwestern	2		92	1,742	1,834	6.46	Drilling centre to be newly constructed in Solwezi. 3 drilling teams.
Western	(1)*		36	1,058	1,094	-	Existing drilling centre in Mongu to be utilised. 2 drilling teams.
Southern	(2)*		315	3,516	3,831	-	Existing drilling centre in Monze to be utilised. 5 drilling teams.
Luapula	2		79	2,068	2,147	6.46	Drilling centre to be newly constructed in Mansa. 3 drilling teams.
Northern	3		221	3,546	3,767	.57	Drilling centre to be newly constructed in Kasama. 5 drilling teams.
Eastern	4	120	286	4,970	5,376	12.69	Drilling centre to be newly constructed in Chipata. 6 drilling teams.
<Total>	13 (8)*	170	1,281	22,528	23,979	55.04	

(Note) * : Number of existing drilling rigs

Table 6-17 Groundwater Development Training Centre Project

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
Location	Lusaka City - Groundwater Development Training Centre and Drilling Centre of Lusaka Province should be located in the same place
Size	Total Land Area: 10,000 m^2 Total Building Area: 3,000 m^2, 2 rigs
Main Facilities	Training Rooms, Auditorium, Conference Room, Audio-visual Room, Computer Room, Dormitory, Workshop
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)
Project Cost	Phase 1: - Construction: US$ 13.40 million - Initial Training: US$ 3.00 million - Operation and Maintenance: US$ 100,000/year After Phase 2 - Operation and Maintenance: US$ 264,000/year

6.3 Agriculture, Livestock and Fishery

6.3.1 Sector Development Plan and Water Demand

(1) Total Water Requirement

Of the three scenarios, the largest amount of agricultural water requirement is projected in the Base Scenario-Industrialisation, resulting in newly developed water demand of 7.45 million m^3/day. This is caused by the largest increase in water requirement for fishery to meet the demand of fish products for the largest population increase projected in this scenario. Irrigation water shares the largest proportion of 72 % of the total agricultural water requirement in Base Scenario - Agricultural Expansion.

Table 6-18 Total Water Requirement (Unit : 1,000 m^3/day)

Terms	Base Scenario-Agricultural Expansion				Base Scenario- Industrialisation				Conservative Scenario			
	Irri.	Fish.	Lvst.	Total	Irri.	Fish.	Lvst.	Total	Irri.	Fish.	Lvst.	Total
Present (1993)	4,581	117	129	4,827	4,581	117	129	4,827	4,581	117	129	4,827
Demand (2005)	7,266	798	183	8,247	7,119	962	192	8,273	6,228	641	175	7,044
Newly Develop	2,684	681	54	3,419	2,537	845	63	3,445	1,646	524	46	2,216
Demand(2015)	9,835	2,131	224	12,190	9,232	2,793	250	12,275	7,881	1,648	202	9,731
Newly Develop	5,254	2,014	95	7,363	4,652	2,676	121	7,449	3,300	1,531	73	4,904
Ratio	72 %	27 %	1 %	100 %	62 %	36 %	2 %	100 %	67 %	32 %	1 %	100 %

(2) Necessary Area and Water Requirement for Irrigation

The irrigation area and water requirement necessary to be developed by the year 2015 for the Base Scenario - Agricultural Development are 60,820 ha and 5,254,000 m^3/day, respectively. This area and water requirement are the maximum of the three scenarios. Water requirement for the Conservative Scenario of 3,300,000 m^3/day is the lowest of the three scenarios and corresponds to about 63 % of the Base Scenario - Agricultural Development.

Table 6-19 Requirement of Irrigation Area and Water in 2015

Province	Present Situation (1993)	Base Scenario - AgriculturalExpansion		Base Scenario - Industrialisation		Conservative Scenario	
		Developed	Total	Developed	Total	Developed	Total
Irrigation Area (Unit : ha)							
Lusaka	5,670	2,720	8,390	2,720	8,390	2,720	8,390
Copperbelt	9,290	10,120	19,410	8,850	18,140	10,700	19,990
Central	6,530	5,000	11,530	5,000	11,530	0	6,530
N/Western	520	6,590	7,110	3,590	4,110	2,590	3,110
Western	0	7,010	7,010	6,010	6,010	3,510	3,510
Southern	19,230	8,540	27,770	8,540	27,770	8,540	27,770
Luapula	2,140	12,140	14,280	12,140	14,280	3,140	5,280
Northern	9,140	7,190	16,330	5,490	14,630	5,490	14,630
Eastern	500	1,510	2,010	1,510	2,010	1,510	2,010
Total	53,020	60,820	113,840	53,850	106,870	38,200	91,220
Irrigation Water Requirement (Unit : 1000m^3/day)							
Lusaka	490	235	725	235	725	235	725
Copperbelt	803	874	1,677	765	1,567	924	1,727
Central	564	432	996	432	996	0	564
N/Western	45	569	614	310	355	224	269
Western	0	606	606	519	519	303	303
Southern	1,661	738	2,399	738	2,399	738	2,399
Luapula	185	1,049	1,234	1,049	1,234	272	456
Northern	790	621	1,411	474	1,264	474	1,264
Eastern	43	130	173	130	173	130	173
Total	4,581	5,254	9,835	4,652	9,232	3,300	7,881

(3) Necessary Area and Water Requirement for Fish Ponds

Fish pond requirement is maximum for the Base Scenario - Industrialisation with the highest population growth, because fish pond development is planned based on a target for per capita fish consumption of 12 kg/person/year. Fish pond area of 38,760 ha is necessary to be newly developed by the year 2015. Then the total necessary fish pond area will reach 40,500 ha and the total water requirement will become 2,793,000 m^3/day.

Table 6-20 Necessary Area and Water Requirement for Fish Ponds

Province	Present Situation	Base Scenario - Agricultural Development		Base Scenario - Industrialisation		Conservative Scenario	
	(1993)	(2005)	(2015)	(2005)	(2015)	(2005)	(2015)
Fish Pond Area necessary to be newly development (ha)							
Lusaka	-	0	0	0	0	0	0
Copperbelt	-	1,200	1,200	1,200	1,200	1,200	1,200
Central	-	0	1,400	0	1,400	0	1,400
N/Western	-	2,590	3,690	2,740	4,140	2,490	3,340
Western	-	340	1,140	490	1,790	190	690
Southern	-	0	8,425	1,825	15,875	0	4,325
Luapula	-	4,105	4,105	4,105	4,105	2,000	4,105
Northern	-	2,000	2,250	2,250	2,250	2,000	2,250
Eastern	-	0	7,000	0	8,000	0	5,000
Total	-	10,235	29,210	12,610	38,760	7,880	22,310
Total Fish Pond Area (ha)							
Lusaka	60	60	60	60	60	60	60
Copperbelt	1,260	2,460	2,460	2,460	2,460	2,460	2,460
Central	10	10	1,410	10	1,410	10	1,410
N/Western	10	2,600	3,700	2,750	4,150	2,500	3,350
Western	10	350	1,150	500	1,800	200	700
Southern	100	100	8,525	1,925	15,975	100	4,425
Luapula	40	4,145	4,145	4,145	4,145	2,040	4,145
Northern	190	2,190	2,440	2,440	2,440	2,190	2,440
Eastern	60	60	7,060	60	8,060	60	5,060
Total	1,740	11,975	30,950	14,350	40,500	9,620	24,050
Total Water Requirement (m^3/day)							
Lusaka	4,147	4,147	4,147	4,147	4,147	4,147	4,147
Copperbelt	83,825	163,659	163,659	163,659	163,659	163,659	163,659
Central	691	691	97,459	691	97,459	691	97,459
N/Western	665	172,973	246,154	182,952	276,091	166,320	222,869
Western	691	24,192	79,488	34,560	124,416	13,824	48,384
Southern	6,912	6,912	589,248	133,056	1,104,192	6,912	305,856
Luapula	2,661	275,759	275,759	275,759	275,759	135,717	275,759
Northern	12,640	145,696	162,328	162,328	162,328	145,696	162,328
Eastern	4,355	4,355	512,387	4,355	584,963	4,355	367,235
Total	116,587	798,384	2,130,629	961,507	2,793,014	641,321	1,647,696

(4) Water Requirement for Livestock

Livestock requirement is also maximum for the Base Scenario - Industrialisation with the highest population growth, because livestock development is planned based on current per capita consumption of meat products. The total water requirement by the year 2015 will reach over 250,000 m^3/day.

Table 6-21 Water Requirement for Livestock (Unit : m^3/day)

Province	Present Situation	Base Scenario - Agricultural Expansion		Base Scenario - Industrialisation		Conservative Scenario	
	(1993)	(2005)	(2015)	(2005)	(2015)	(2005)	(2015)
Lusaka	4,451	6,921	8,367	7,332	9,000	6,610	7,691
Copperbelt	4,300	7,002	8,830	7,494	9,872	6,648	7,935
Central	22,331	30,391	30,962	30,552	31,373	30,305	30,687
N/Western	2,752	9,029	15,187	10,354	20,629	8,009	11,925
Western	22,599	36,713	44,937	38,876	48,636	34,837	41,141
Southern	50,224	47,738	50,007	48,247	51,619	47,293	48,862
Luapula	1,220	3,903	6,666	4,497	9,141	3,513	5,213
Northern	5,382	15,777	25,802	17,948	34,490	14,077	20,484
Eastern	15,678	25,138	31,637	26,711	35,625	23,810	28,469
Total	128,937	182,612	222,395	192,011	250,385	175,102	202,407

6.3.2 Water Development Plans

(1) Irrigation Development Plan

Irrigation projects in this Study can be divided into ASIP rehabilitation projects, expansion projects of existing irrigation and new development projects, as shown in Table 6-22.

Table 6-22 Outline of Irrigation Projects

ASIP Rehabilitation Projects	Expansion Projects of Existing Irrigation	New Development Projects
- Contents: rehabilitation of existing irrigation scheme for smallholding farmers proposed in ASIP, simple rehabilitation, such as that of damaged pumps or pipelines, through which the whole function of disordered irrigation schemes will be recovered at low cost - No. of Projects: 9 (267 ha) - Project Scale: all small - Target Crop: vegetable	- Contents: expansion of existing irrigation mainly managed by commercial farmers. Large scale projects are concentrated in Kafue Flood Plain, such as sugarcane estates and upstream areas of the Kafue River -No. of Projects: 21 (16,484 ha) - Project Scale: 5 large projects (13,340 ha) 5 medium projects (2,869 ha) 11 small projects (275 ha) - Target Crops: sugarcane, coffee and wheat, etc., large scale plantation of each crop	- Contents: projects in selected areas from potential areas, vegetable cultivation in suburbs using water from dam reservoir, or cropping of wheat, ground nuts, and fruits with direct water intake. Vegetable production is planned at the extent to meet the local demand - No. of Projects: 18 (44,070) direct intake; 13 (29,000 ha) multi-purpose dams; 3 (6,590 ha) (Chongwe, Kafubu, Mutundu) (Refer to Table 6-10) irrigation dams; 2 (8,480 ha) (Refer to Table 6-23)

Dam development projects for the single purpose of irrigation are outlined in Table 6-23. These irrigation dam sites were selected for the potential to irrigate by gravity and to be economical. Irrigation farms would be developed downstream of all the proposed dams. Although pipelines are necessary to be set for some areas downstream of Lufubu and Lundazi Dams, most of the other irrigation areas were planned to be easily irrigated by gravity. In the case of the area downstream of Lufubu Dam, the irrigation area could be expanded to 14,000 ha from 7,000 ha if pumping facilities were employed.

Table 6-23 Outline of Irrigation Dams

Items	Lufubu Dam	Lundazi Dam
(1) Dam Site	50 km north-north-east of Mansa, 60 km south-east of Mwense (Luapula Province)	30 km north-west of Lundazi, 100 km south-south-east of Chipata (Eastern Province)
(2) Dam Type	Fill type	Fill type
(3) Dam Height	28.4 m	35.0 m
(4) Dam Volume	410,000 m^3	428,000 m^3
(5) Irrigation Plan - Area Developed - Irrigation Method - Irrigation Water	7,000 ha Gravitational Irrigation 7.00 m^3/s	1,480 ha Gravitational Irrigation 1.48 m^3/s

The distribution of irrigation projects by province is given in Table 6-24. The largest irrigated area of 60,821 ha requiring 5.25 million m^3/day of developed water is planned for the Base Scenario-Agricultural Expansion by the year 2015.

(2) Fish Pond Development Plan

Since aqua-cultural development is planned to attain the production to meet the target per capita fish consumption of 12 kg/capita/year in all of the three scenarios, the largest amount of developed water will be required in Base Scenario-Industrialisation. In that scenario, 38,760 ha of fish ponds are planned to be constructed by 2015. In the Base Scenario-Agricultural Expansion, fish pond development will amount to 29,210 ha. Large scale fish ponds are planned to be developed in the Kafue Flood Plain in Southern Province and along the Luangwa River in Eastern Province. Required areas in the Base Scenario-Industrialisation are 15,875 ha and 8,000 ha, respectively, as shown in Table 6-25. These large scale projects will enable effective and efficient use of water which uselessly evaporates from Kafue Flood Plains, and of lands with heavy clayey soil unsuitable for cultivation along the Luangwa River.

Table 6-24 Irrigation Development Projects

Project	Base Scenario- Agricultural Expansion		Base Scenario- Industrialisation		Conservative Scenario	
	Irrigation Area (ha)		Irrigation Area (ha)		Irrigation Area (ha)	
	(2005)	(2015)	(2005)	(2015)	(2005)	(2015)
Lusaka Prov.	**2,720**	**2,720**	**2,720**	**2,720**	**2,720**	**2,720**
Chongwe Dam	810	810	810	810	810	810
ASIP Rehabilitation	10	10	10	10	10	10
Expansion Project	1,900	1,900	1,900	1,900	1,900	1,900
Copperbelt Prov.	**4,340**	**10,120**	**4,340**	**8,850**	**4,340**	**10,700**
Kafubu Dam	–	4,220	–	3,470	–	4460
Mutundu Dam	–	1,560	–	1,040	–	1900
ASIP Rehabilitation	140	140	140	140	140	140
Expansion Project	4,200	4,200	4,200	4,200	4,200	4,200
Central Prov.	**5,000**	**5,000**	**5,000**	**5,000**	**0**	**0**
New Project : P-1	5,000	5,000	5,000	5,000	0	0
Northwest Prov.	**2,590**	**6,590**	**2,590**	**3,590**	**290**	**2,590**
Expansion Project	290	290	290	290	290	290
New Project : P-79	–	1,000	–	1,000	0	0
New Project : P-80	2,300	2,300	2,300	2,300	0	2,300
New Project : P-82	–	3,000	–	0	0	0
Western Prov.	**2,510**	**7,010**	**2,510**	**6,010**	**10**	**3,510**
Expansion Project	10	10	10	10	10	10
New Project : P-16	1,000	1,000	1,000	1,000	0	1,000
New Project : P-23	1,500	3,000	1,500	3,000	0	2,500
New Project : P-84	–	1,000	–	1,000	0	0
New Project : P-86	–	1,000	–	0	0	0
New Project : P-88	–	1,000	–	1,000	0	0
Southern Prov.	**8,539**	**8,539**	**8,539**	**8,539**	**8,539**	**8,539**
ASIP Rehabilitation	89	89	89	89	89	89
Expansion Project	8,450	8,450	8,450	8,450	8,450	8,450
Luapula Prov.	**3,144**	**12,144**	**3,144**	**12,144**	**0**	**3,144**
Lufubu Dam		7,000		7,000	0	0
Expansion Project	1,144	1,144	1,144	1,144	0	1,144
New Project : P-37	2,000	2,000	2,000	2,000	0	2,000
New Project : P-45		2,000		2,000	0	0
Northern Prov.	**2,190**	**7,190**	**490**	**5,490**	**490**	**5,490**
Expansion Project	490	490	490	490	490	490
New Project : P-52	1,700	1,700	0	0	0	0
New Project : P-65	–	5,000	–	5,000	0	5,000
Eastern Prov.	**28**	**1,508**	**28**	**1,508**	**28**	**1,508**
Lundazi Dam	–	1,480	–	1,480	–	1,480
ASIP Rehabilitation	28	28	28	28	28	28
Total	**32,061**	**60,821**	**29,361**	**53,851**	**16,417**	**38,201**

Table 6-25 Fish Pond Development Projects

Project	Base Scenario- Agricultural Expansion	Base Scenario- Industrialisation	Conservative Scenario
Lusaka Prov.	no project	no project	no project
Copperbelt Prov. P-2 : Luswishi	-Area developed : 1,200 ha -Source : Luswishi R. -Inlet : head works, pump -Water developed: 80,000 m^3/day	same as Base Scenario- Agricultural Expansion	same as Base Scenario- Agricultural Expansion
Central Prov. P-1 Machiya	-Area developed : 1,400 ha -Source : Kafue R. -Inlet : head works, pump -Water developed: 97,000 m^3/day	same as Base Scenario- Agricultural Expansion	same as Base Scenario- Agricultural Expansion
North-western Prov. Dispersed Small Scale Development	-Area developed : 3,690 ha -Source : tributary of Kabompo R. -Inlet : small diversion weir, small pump -Water developed: 245,000 m^3/day (36 locations)	-Area developed : 4,140 ha -Source : tributary of Kabompo R. -Inlet : small diversion weir, small pump -Water developed: 275,000 m^3/day (42 locations)	-Area developed : 3,340 ha -Source : tributary of Kabompo R -Inlet : small diversion weir, small pump -Water developed: 222,000 m^3/day (34 locations)
Western Prov. Dispersed Small Scale Development (Sushanjo : the plateau along the Barotse Flood Plain)	-Area developed : 1,140 ha -Source : seepage water from Plateau -Water developed: 79,000 m^3/day (114 locations)	-Area developed : 1,790 ha -Source : seepage water from Plateau -Water developed: 124,000 m^3/day (179 locations)	-Area developed : 690 ha -Source : seepage water from Plateau -Water developed: 48,000 m^3/day (69 locations)
Southern Prov. Large Scale Project at Kafue Flood Plain	-Area developed : 8,425 ha -Source : evaporation from Kafue Flood Plain -Inlet : Gravity -Water developed: 582,000 m^3/day	-Area developed : 15,875 ha -Source : evaporation from Kafue Flood Plain -Inlet : Gravity -Water developed: 1,097,000 m^3/day	-Area developed : 4,325 ha -Source : evaporation from Kafue Flood Plain -Inlet : Gravity -Water developed: 299,000 m^3/day
Luapula Prov. P-43 Samfya P-44 Lake Bangweulu	-Area developed : 4,105 ha -Source : evaporation from Lake Bangweulu -Inlet : Gravity -Water developed: 273,000 m^3/day	same as Base Scenario- Agricultural Expansion	same as Base Scenario- Agricultural Expansion
Northern Prov. P-64 Mutale Mokonge P-66 Chamdamali	-Area developed : 250 ha 2,000 ha -Source : Lubansenshi R., upstream of Chambeshi R. -Inlet : head works , pump -Water developed: 150,000 m^3/day	same as Base Scenario- Agricultural Expansion	same as Base Scenario- Agricultural Expansion
Eastern Prov. P-70 Luangwa River	-Area developed : 7,000 ha -Source : Luangwa R. -Inlet : head works , pump -Water developed: 508,000 m^3/day	-Area developed : 8,000 ha -Source : Luangwa R. -Inlet : head works , pump -Water developed: 581,000 m^3/day	-Area developed : 5,000 ha -Source : Luangwa R. -Inlet : head works , pump -Water developed: 363,000 m^3/day
Area developed Water developed	29,210 ha 2,014,000 m^3/day (23.3 m^3/s)	38,760 ha 2,677,000 m^3/day (30.0 m^3/s)	22,310 ha 1,532,000 m^3/day (17.7 m^3/s)

(3) Livestock Development Plan

Livestock projects in all the scenarios are planned to maintain the present consumption level of livestock products, such as 14.2 kg/capita/year of meat. While Southern Province has already resulted in over-grazing, the northern region such as Chambeshi Flood Plain still

remains suitable for grazing and is not fully used. Thus the target of livestock-breeding is set as the expansion in the northern region in order to attain stable and sustainable development. Each project is proposed based on the cattle distribution plan, according to the potential of available lands, as shown in Table 6-26.

Table 6-26 Water to be Developed for Livestock by 2015

Province	Present (1990)		Base Scenario-Agricultural Expansion		Base Scenario-Industrialisation		Conservative Scenario	
	Head of Cattle (1,000)	Water Developed (m^3/day)	Head of Cattle (1,000)	Water Developed (m^3/day)	Head of Cattle (1,000)	Water Developed (m^3/day)	Head of Cattle (1,000)	Water Developed (m^3/day)
Lusaka	88	4,451	170	8,367	179	9,000	155	7,691
Copperbelt	74	4,300	164	8,830	182	9,872	146	7,935
Central	504	22,331	695	30,962	683	31,373	683	30,687
N/Western	59	2,752	330	15,187	491	20,629	280	11,925
Western	547	22,599	1,078	44,937	1,182	48,636	998	41,141
Southern	1,053	50,224	932	50,007	916	51,619	916	48,862
Luapula	12	1,220	135	6,666	190	9,141	100	5,213
Northern	108	5,382	574	25,802	798	34,490	465	20,484
Eastern	224	15,678	525	31,637	561	35,625	446	28,469
Total	2,669	128,937	4,603	222,395	5,182	250,385	4,189	202,407

6.3.3 Facility Plans

(1) Irrigation Facilities

Irrigation facilities are classified into water resource, intake, conveyance, and terminal irrigation facilities. Each facility is composed of following works:

Water Resources Facility:	Dam or Diversion Weir
Intake Facility:	Pump or Gravity Intake
Conveyance Facility:	Canal or Pipeline
Terminal Irrigation Facility:	Furrow/ Basin or Overhead Irrigation

Required irrigation facilities are summarised in Table 6-27, and major projects are illustrated in Figure 6-5 and 6-6. The basic considerations for irrigation facilities are as follows:

(a) Dams

Dams are selected considering the economical viewpoint, based on following criteria:

- Multi-purpose : all multi-purpose dams are selected for irrigation development, taking scale and possibility of advanced peri-urban agriculture into consideration.

- Irrigation only : only the dams whose cost corresponds to an equivalent unit cost of less than US$20,000/ha of irrigable area, and where water can be conveyed by gravity, are selected. Two dams, namely Lufubu dam (D-1) and Lundazi dam (D-18) are selected as irrigation development dams.

(b) Diversion Weirs

Diversion weirs have been considered for abstracting water where the river water depth becomes shallower than 1.7 metres during drought flow conditions. Standard size of weir is assumed to be 50 metres width for 1,000 ha of irrigation area. However, where river depth is adequate for water abstraction, construction of a weir is not necessary. Such development sites are as follows:

<Possible Projects not premising Diversion Weirs>

- Luapula :	River is assumed to be deeper than 1.7 metres during drought flow. (P-45 Luapula)
- Kabompo :	30 small pumps are to be provided along the river. Each intake is small compared to the river flow. (P-82 Kabompo)
- Zambezi :	There are many rapids and the river is confined in a narrow channel below Senanga. These rapids are able to act as natural weirs. (P-16 Katima Mulilo, P-84 Ngambwe Rapid, P-86 Manto Rapid, P-88 Sioma Rapid)
- Zambezi Floodplain :	There are many artificial or natural channels running in the floodplain and it is possible to intake water at several suitable locations. (P-23 Zambezi Left Bank Floodplain)
- Kafue Floodplain :	Kafue River is fully controlled by Kafue Gorge Dam. Water can be abstracted without weirs. (O-13 Kaleya Small-holders Irrigation Scheme, O-18 Nakambala Sugar Estates, O-20 Nanga Irrigation Scheme)

(c) Pumps and Pipelines

Pump capacity has been considered to be 1.0 lit./sec/ha when provided in conjunction with night storage reservoir. Standard pump for 1,000 ha of irrigation is considered to have a capacity of 1.0m3/sec, static head of 100m and serves a single 5km length of steel pipe. This standard is applied for potential irrigation projects and operational large scale irrigation projects.

(d) Terminal Irrigation Systems

Terminal irrigation systems are assumed to be furrow irrigation or basin irrigation. However, soils are excessively drained along the Zambezi and Kabompo rivers and, therefore, sprinkler irrigation has been proposed in the following projects - P-16 Katima Mulilo, P-82 Kabompo, P-84 Ngambwe Rapid, P-86 Manto Rapid, P-88 Sioma Rapid. For existing operational irrigation projects, present terminal systems are assumed to continue.

(2) Aquacultural Projects

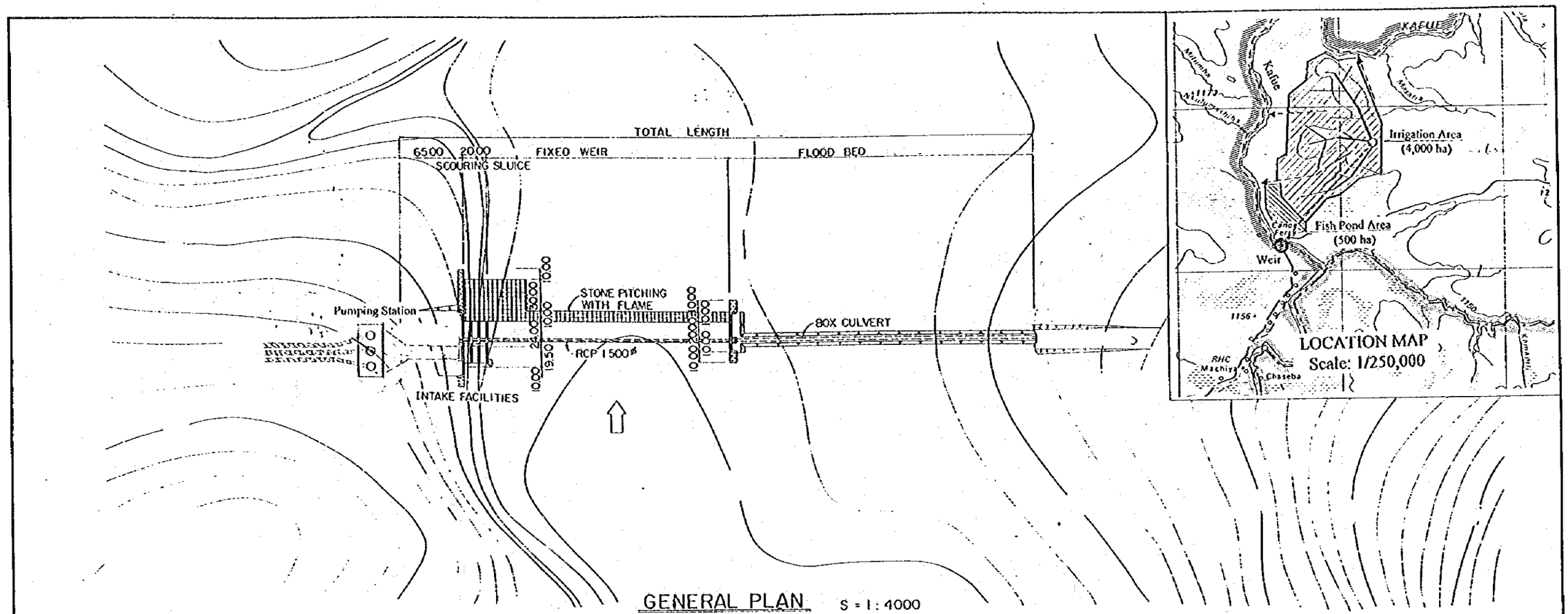
For aquacultural projects, similar criteria to the irrigation projects described above have been applied for planning. However, pumps are considered to be low lift pumps because fish ponds are generally provided along the rivers.

(3) Livestock Projects

Water source for livestock is assumed to be groundwater, because cattle herds are widely dispersed to ensure adequate grazing space. Boreholes are proposed for such water demand.

Table 6-27 Major Facilities for Irrigation Projects for Base Scenario - Agricultural Expansion

Project Category/ Project Name		Irrigable Area (ha)			Major Facilities for the Project					
		Gravity	Pump	Total	Dam	Weir	Canal	Pump (m^3/s)	Pipeline	Irrigation Method
ASIP Rehabilitation Project		**10**	**257**	**267**						
N-1	Chipepa	10		10	Small dam		open	0		Furrow
N-2	Ipafu		80	80		Fixed Type	pipeline	0.080	PVC,2km	Furrow
O-9	Chapula		60	60		Fixed Type	pipeline	0.060	PVC,2km	Furrow
O-14	Buleya Malima		57	57		Fixed Type	pipeline	0.034	PVC,2km	Furrow
O-15	Siatwinda		22	22		Fixed Type	pipeline	0.004	PVC,2km	Furrow
O-21	Nakandabwe		10	10	Small dam		pipeline	0.010	PVC,2km	Furrow
O-28	Makungwa		5	5	Small dam		pipeline	0.004	PVC,2km	Furrow
O-30	Vuu		13	13	Small dam		pipeline	0.010	PVC,2km	Furrow
O-31	Lusowe		10	10	Small dam		pipeline	0.010	PVC,2km	Furrow
Expansion of Existing Projects		**3,427**	**13,057**	**16,484**						
I-1	Nakatoya	0	10	10		Fixed Type		0.010	PVC,2km	Furrow
I-2	Mansa Pilot Scheme	0	10	10		Fixed Type		0.010	PVC,2km	Furrow
N-4	Chiyabi	0	10	10		Fixed Type		0.010	PVC,2km	Furrow
N-5	Kenani Vegetable Scheme	8	0	8		Fixed Type	open	0	PVC,2km	Furrow
N-6	Chiposa Mubende Scheme	0	10	10		Fixed Type		0.010	PVC,2km	Furrow
N-7	Chembe Vegetable Scheme	0	10	10		Fixed Type		0.010	PVC,2km	Furrow
N-8	Chama Vegetable Scheme	0	10	10		Fixed Type		0.010	PVC,2km	Furrow
O-1	Chiawa	0	20	20		Fixed Type		0.020	PVC,2km	Furrow
O-2	Chanyanya	0	800	800		no weir		0.800	SP,4km	Furrow
O-3	Masstock	0	1,000	1,000		no weir		1.000	SP,5km	Overhead
O-5	Kaunga	80	0	80		Fixed Type			ACP,5km	Furrow
O-6	Mpongwe (G/W)	0	2,200	2,200		sinkhole		2.200	SP,11km	Overhead
O-7	Munkumpu	2,000	0	2,000		Gate Type	open			Overhead
O-11	Ikelenge Pineapple	290	0	290		Gate Type	open			Furrow
O-13	Kaleya Small Holders	0	300	300		no weir		0.300	SP,1.5km	Furrow
O-18	Nakambala Sugar Estates	0	7,000	7,000		no weir		7.000	SP,35km	Furrow
O-20	Nanga	0	1,140	1,140		no weir		1.140	SP,5.7km	Overhead
O-22	Kawambwa Tea	0	47	47		Fixed Type		0.047	SP,0.25km	Overhead
O-24	Mulumbi Coffee	60	0	60		Fixed Type	open			Furrow
O-25	Lukulu North	989	0	989		Gate Type	open			Furrow
O-27	Kateshi Coffee	0	490	490		Fixed Type		2.5	2.94	Overhead
Potential Irrigation Project										
Dam Project		**8,480**	**6,590**	**15,070**						
D-1	Lufubu	7,000		7,000	Irrigation		open, syphon			Furrow
D-7	Mutundu		1,560	1,560	Multi-Pur.			1.560	SP,10km	Furrow
D-10	Kafubu		4,220	4,220	Multi-Pur.			4.220	SP,20km	Furrow
D-16	Chongwe	0	810	810	Multi-Pur.			0.810	SP,10km	Fur,Drip
D-18	Lundazi	1,480		1,480	Irrigation		open, syphon			Furrow
Run-of-River Project		**3,500**	**25,500**	**29,000**						
P-1	Machiya		5,000	5,000		Gate Type	pipeline	5.000	SP,25km	Furrow
P-79	Mwombeshi	500	500	1,000		Gate Type	pipeline	0.500	SP,2.5km	Furrow
P-80	Mwinilunga	1,150	1,150	2,300		Gate Type	pipeline	1.150	SP,5.75km	Furrow
P-82	Kabompo		3,000	3,000		no weir	pipeline	3.000	SP,15km	sprinkler
P-16	Katima Mulilo		1,000	1,000		no weir	pipeline	1.000	SP,5km	sprinkler
P-23	Zambezi F.plain (Left Bank)		3,000	3,000		no weir	75 km	3.105		Basin
P-84	Ngambwe Rapid		1,000	1,000		no weir	pipeline	1.000	SP,5km	sprinkler
P-86	Manto Rapid		1,000	1,000		no weir	pipeline	1.000	SP,5km	sprinkler
P-88	Sioma Rapid		1,000	1,000		no weir	pipeline	1.000	SP,5km	sprinkler
P-37	Mushota Island	1,000	1,000	2,000		Gate Type	pipeline	1.000	SP,5km	Furrow
P-45	Luapula		2,000	2,000		no weir	pipeline	2.000	SP,10km	Furrow
P-52	Chinakila	850	850	1,700		Gate Type	pipeline	0.850	SP,4.25km	Furrow
P-65	Chilbula South		5,000	5,000		Gate Type	pipeline	5.000	SP,15km	Furrow
Total		**15,417**	**45,404**	**60,821**						



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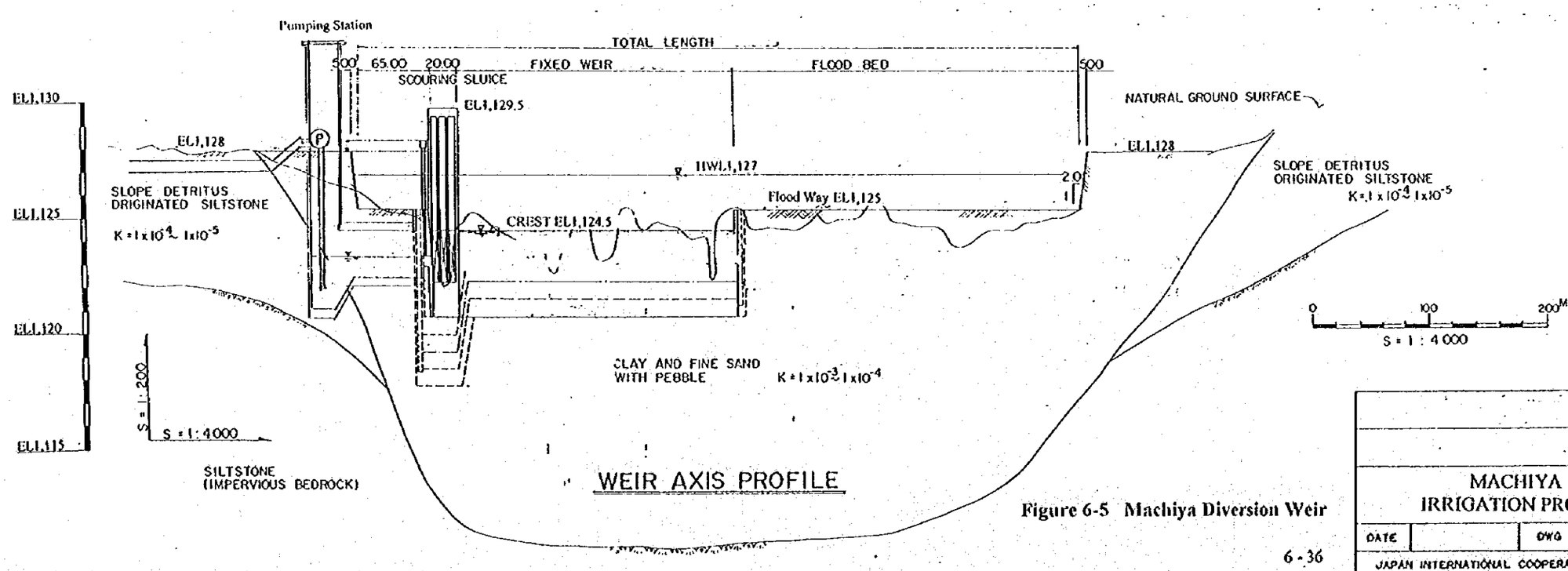

WEIR AXIS PROFILE

Figure 6-5 Machiya Diversion Weir

MACHIYA IRRIGATION PROJECT

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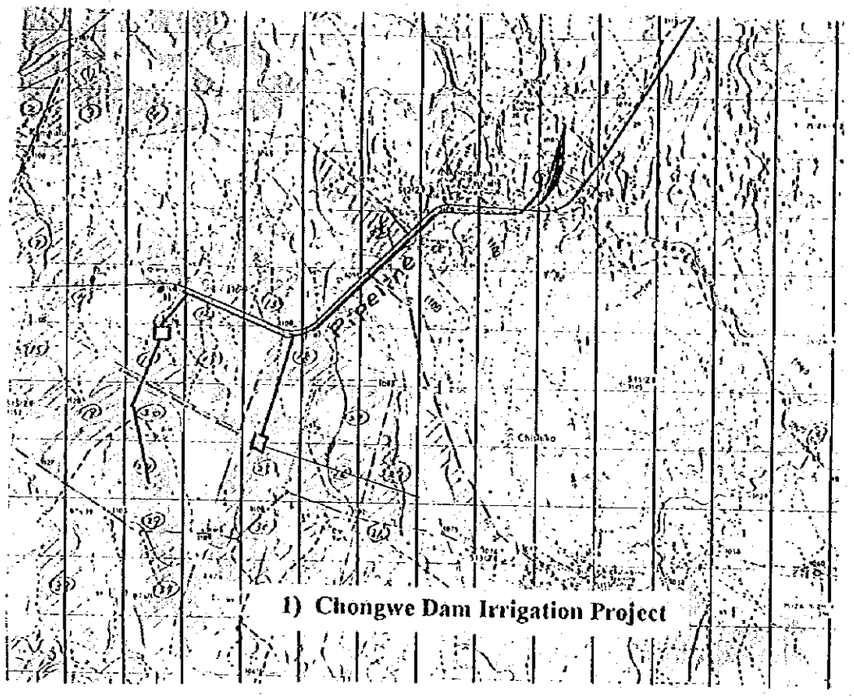
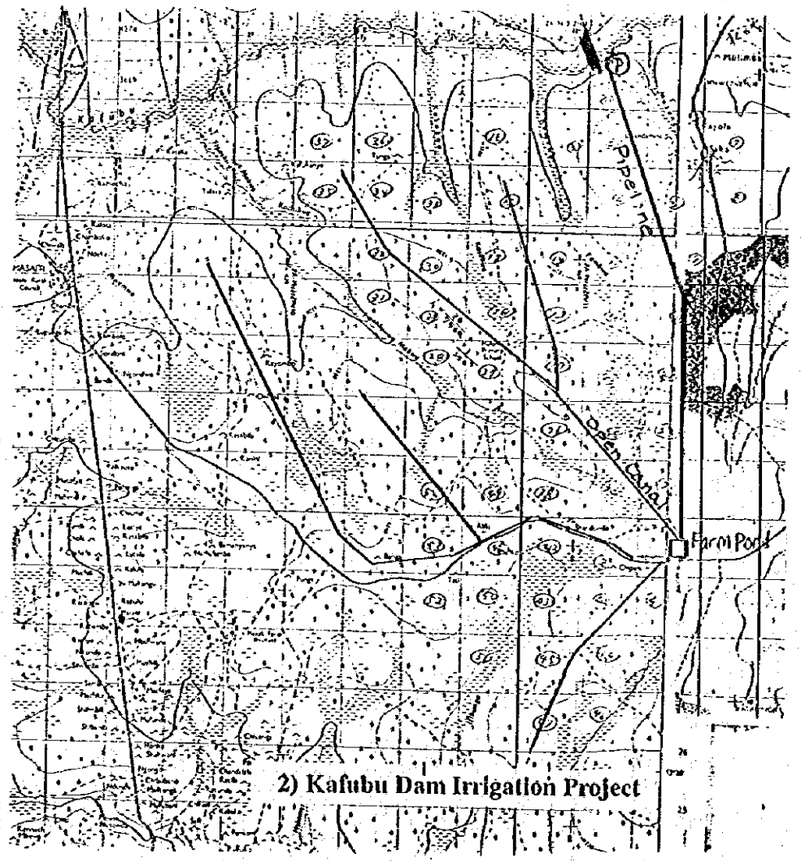
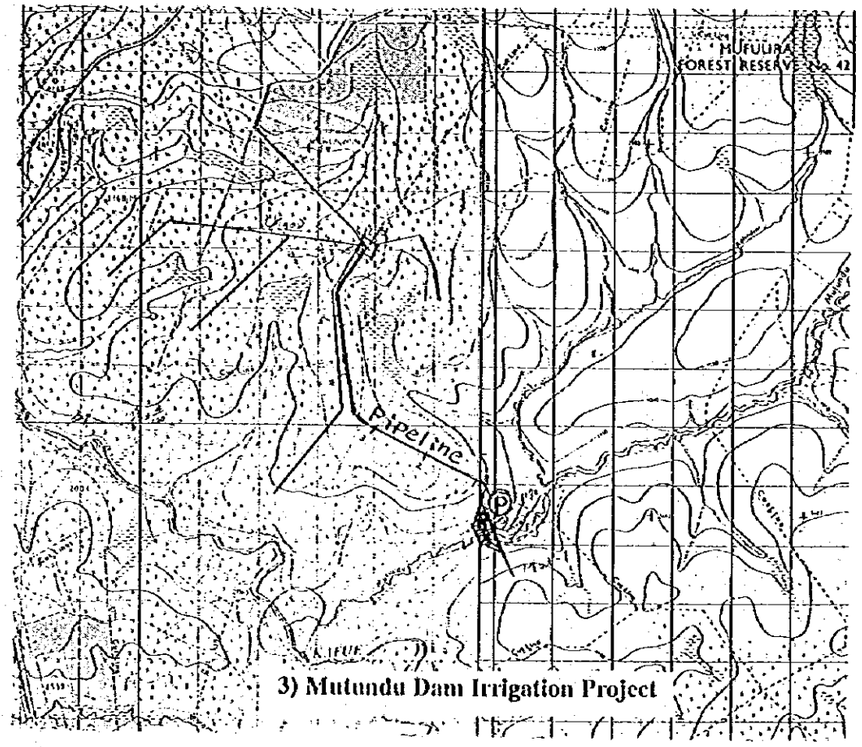
JAPAN INTERNATIONAL COOPERATION AGENCY







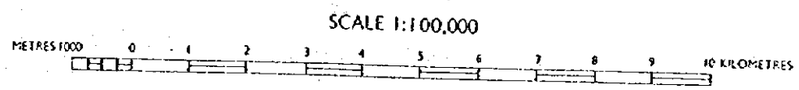


Figure 6-6 Plan of Irrigation Projects from Multipurpose Dam Development

6.4 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.

6.4.1 Water Supply Projects for Domestic and Industrial Water

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 6-28 and 6-29.

Table 6-28 Construction Cost of Water Supply Projects

Province	Lusaka	Copperbelt	Central	NWestern	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	21,250	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	91,840	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	61.89	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.	14,270	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	33,396	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	417.21	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 6-29 Construction Cost for Large Urban Water Supply Projects

	Base Scenario-Agricultural Expansion			Base Scenario- Industrialisation			Conservative Scenario		
	Water Dslp. (m^3/day)	Cost (US$million)	Unit Price (US$/$m^3$/day)	Water Dslp. (m^3/day)	Cost (US$million)	Unit Price (US$/$m^3$/day)	Water Dslp. (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

6.4.2 Agriculture Projects

Total construction cost of agricultural projects amounts to US$ 1,516 million in the Base Scenario-Agricultural Expansion, comprising US$ 1,190 million (79%) for irrigation, US$ 290 million (19%) for aqua-culture and US$ 36 million (2%) for livestock breeding. Total construction cost in the Base Scenario-Industrialisation and in the Conservative Scenario are US$ 1,375 million and US$ 1,022 million, respectively, or 91% and 68%, compared to that in the Base Scenario-Agricultural Expansion.

Direct construction cost of irrigation projects includes those for source development (dam or diversion weir), conveyance facility (pump, pipeline), land consolidation (new reclamation or improvement of existing farm) and terminal irrigation facility (furrow or sprinkler). That for aqua-culture comprises costs for source development (diversion weir), conveyance facility (pump), and fish pond construction.

Unit costs of irrigation projects for land area and water are US$ 19,600 /ha and US$ 226 /m^3/day in the Base Scenario-Agricultural Expansion. Those for aqua-cultural projects in the same case are US$ 9,930 /ha and US$ 144 /m^3/day, respectively.

Table 6-30 Construction Cost of Agricultural Projects

(Unit: US$ million)

Province	Base Scenario-Agricultural Expansion			Base Scenario- Industrialisation			Conservative Scenario		
	Irigation	Aqua-culture	Livestock	Irigation	Aqua-culture	Livestock	Irigation	Aqua-culture	Livestock
Lusaka	73.47	0.00	1.35	73.47	0.00	1.45	73.47	0.00	1.24
Copperbelt	230.67	14.04	1.42	190.42	14.04	1.59	247.00	14.04	1.28
Central	103.40	16.38	4.98	103.40	16.38	5.04	0.0	16.38	4.93
N/Western	203.36	43.17	2.44	50.57	48.44	3.32	35.99	39.08	1.92
Western	103.39	10.49	7.22	87.33	16.47	7.82	48.72	6.35	6.61
Southern	177.54	77.51	8.04	177.54	146.05	8.30	177.54	39.79	7.86
Luapula	132.77	37.77	1.07	132.77	37.77	1.47	39.95	37.77	0.84
Northern	138.49	26.32	4.15	113.71	26.32	5.54	113.71	26.33	3.29
Eastern	26.90	64.40	5.09	26.90	73.60	5.73	26.90	46.00	4.58
Total	1,189.98	290.08	35.75	956.10	379.07	40.25	763.27	225.74	32.54
	1,515.81			1,375.42			1,021.55		

Table 6-31 Unit Construction and Water Cost of Agricultural Projects

	Base Scenario-Agricultural Expansion	Base Scenario-Industrialisation	Conservative Scenario
(1) Irigation Projects			
- Irrigated Area (ha)	60,821	53,851	38,201
- Irrigated Water (1000m^3/day)	5,256	4,654	3,300
- Const. Cost (US$ million)	1,189.98	956.10	763.27
- Unit Const. Cost (US$/ha)	19,600	17,700	20,000
- Unit Water Cost (US$/m3/day)	226	205	231
(2) Aqua-cultural Projects			
- Fish Pond Development (ha)	29,210	38,760	22,310
- Water Developed (1000m3/day)	2,014	2,677	1,532
- Const. Cost (US$ million)	290.08	390.07	225.74
- Unit Const. Cost (US$/ha)	9,930	10,060	10,120
- Unit Water Cost (US$/m3/day)	144	146	147
(3) Livestock Projects			
- Water Developed (1000m3/day)	222	250	202
- Const. Cost (US$ million)	35.75	40.25	32.54
- Unit Water Cost (US$/m3/day)	161	161	161

(1) Construction Costs for Irrigation Projects

Construction costs for irrigation projects are shown in Table 6-32.

Table 6-32 Construction Cost for Irrigation Projects

Province	Base Scenario-Agricultural Expansion			Base Scenario- Industrialisation			Conservative Scenario		
	Developed Water ($1000m^3$ /day)	Const. Cost (US$ million)	Unit Price (US$/ m3/day)	Developed Water ($1000m^3$ /day)	Const. Cost (US$ million)	Unit Price (US$/ m3/day)	Developed Water ($1000m^3$ /day)	Const. Cost (US$ million)	Unit Price (US$/ m3/day)
Lusaka	235	73.47	312.64	235	73.47	312.64	235	73.47	312.64
Chongwe Dam	70	34.74	496.29	70	34.74	496.29	70	34.74	496.29
ASIP Rehabilitation	1	0.09	90.00	1	0.09	90.00	1	0.09	90.00
Extension Project	164	38.64	235.61	164	38.64	235.61	164	38.64	235.61
Copperbelt	874	230.67	263.92	765	190.42	248.92	924	247.00	267.32
Kafubu Dam	365	103.49	283.53	300	83.85	279.50	385	107.78	279.95
Mutundu Dam	135	60.09	445.11	90	39.48	438.67	164	72.13	439.82
ASIP Rehabilitation	12	3.27	272.50	12	3.27	272.50	12	3.27	272.50
Extension Project	363	63.82	175.81	363	63.82	175.81	363	63.82	175.81
Central	432	103.40	239.35	432	103.40	239.35	0	0.00	0.00
New Project P-1	432	103.40	239.35	432	103.40	239.35	0	0.00	0.00
Northwestern	569	203.36	357.40	310	50.57	163.13	224	35.99	160.67
Extension Project	25	2.46	98.40	25	2.46	98.40	25	2.46	98.40
New Project P-79	86	14.58	169.53	86	14.58	169.53	0	0.00	0.00
P-80	199	33.53	168.49	199	33.53	168.49	199	33.53	168.49
P-82	259	152.79	589.92	0	0.00	0.00	0	0.00	0.00
Western	606	103.39	170.61	519	87.33	168.27	303	48.72	160.79
Extension Project	1	0.21	210.00	1	0.21	210.00	1	0.21	210.00
New Project P-16	86	16.06	186.74	86	16.06	186.74	86	16.06	186.74
P-23	261	38.94	149.20	261	38.94	149.20	216	32.45	150.23
P-84	86	16.06	186.74	86	16.06	186.74	0	0.00	0.00
P-86	86	16.06	186.74	0	0.00	0.00	0	0.00	0.00
P-88	86	16.06	186.74	86	16.06	186.74	0	0.00	0.00
Southern	738	177.54	240.57	738	177.54	240.57	738	177.54	240.57
ASIP Rehabilitation	8	2.42	302.50	8	2.42	302.50	8	2.42	302.50
Extension Project	730	175.12	239.89	730	175.12	239.89	730	175.12	239.89
Luapula	1,050	132.77	126.45	1,050	132.77	126.45	272	39.95	146.88
Lufubu Dam	605	56.96	94.15	605	56.96	94.15	0	0.00	0.00
Extension Project	99	10.80	109.09	99	10.80	109.09	99	10.80	109.09
New Project P-37	173	29.15	168.50	173	29.15	168.50	173	29.15	168.50
P-45	173	35.86	207.28	173	35.86	207.28	0	0.00	0.00
Northern	621	138.49	223.01	474	113.71	239.89	474	113.71	239.89
Extension Project	42	10.305	245.36	42	10.305	245.36	42	10.31	245.48
New Project P-52	147	24.78	168.57	0	0.00	0.00	0	0.00	0.00
P-65	432	103.40	239.35	432	103.40	239.35	432	103.40	239.35
Eastern	130	26.90	206.92	130	26.90	206.92	130	26.90	206.92
Lundazi Dam	128	26.13	204.14	128	26.13	204.14	128	26.13	204.14
ASIP Rehabilitation	2	0.77	385.00	2	0.77	385.00	2	0.77	385.00
Total	5,256	1,189.98	226.40	4,654	956.10	205.44	3,300	763.28	231.30

(2) Construction Costs for Aquaculture Projects

Construction costs for aquaculture projects are shown in Table 6-33.

Table 6-33 Implementation and O/M Costs for Fishery Projects

(Unit : mil. US$)

Province	Project Number	Base Scenario-Agricultural Expansion				Base Scenario-Industrialisation				Conservative Scenario			
		2005		2015		2005		2015		2005		2015	
		PIC	O/M	PIC	O/M	PIC	O/M	PIC	O/M	PIC	O/M	PIC	O/M
Lusaka	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copperbelt	1	14.04	0.78	14.04	0.78	14.04	0.78	14.04	0.78	14.04	0.78	14.04	0.78
Central	1	0.00	0.00	16.38	0.91	0.00	0.00	16.38	0.91	0.00	0.00	16.38	0.91
N/Western	41	30.30	1.69	43.17	2.41	32.06	1.79	48.44	2.70	29.13	1.63	39.08	2.18
Western	18	3.13	0.22	10.49	0.74	4.51	0.32	16.47	1.17	1.75	0.12	6.35	0.45
Southern	1	0.00	0.00	77.51	5.50	16.79	1.19	146.05	10.37	0.00	0.00	39.79	2.82
Luapula	2	37.77	2.68	37.77	2.68	37.77	2.68	37.77	2.68	18.40	1.31	37.77	2.68
Northern	2	23.40	1.31	26.33	1.47	26.33	1.47	26.33	1.47	23.40	1.31	26.33	1.47
Eastern	1	0.00	0.00	64.40	4.57	0.00	0.00	73.60	5.22	0.00	0.00	46.00	3.27
Total	67	108.64	6.68	290.09	19.06	131.50	8.23	379.08	25.30	86.72	5.15	225.74	14.56

(Note) PIC: Project Implementation Cost, O/M: Operation and Maintenace Cost

(3) Costs for Livestock Projects

Livestock breeding requires stable good quality water supply in the dry season. Dispersed water demand occurs because herds of cattle are widely distributed. For this reason, groundwater is the most suitable source. Water supply for cattle breeding is planned using borehole construction, and the unit cost amounts to US$ 161 /m^3/day. Costs for bore holes needed for livestock breeding were estimated based on the projected number of cattle in 2005 and 2015. The results are shown inTable 6-34.

Table 6-34 Costs for Livestock Projects

(unit : mil.US$)

Province	Base Scenario - Agricultural Expansion		Base Scenario - Industrialisation		Conservative Scenario	
	2005	2015	2005	2015	2005	2015
Lusaka	1.11	1.35	1.18	1.45	1.06	1.24
Copperbelt	1.13	1.42	1.21	1.59	1.07	1.28
Central	4.89	4.98	4.91	5.04	4.87	4.93
Northwestern	1.45	2.44	1.66	3.32	1.29	1.92
Western	5.9	7.22	6.25	7.82	5.6	6.61
Southern	7.68	8.04	7.76	8.30	7.6	7.86
Luapula	0.63	1.07	0.72	1.47	0.56	0.84
Northern	2.54	4.15	2.89	5.54	2.26	3.29
Eastern	4.04	5.09	4.3	5.73	3.83	4.58
Total	29.37	35.75	30.88	40.25	28.14	32.54

(Note) Cost estimated on the assumption that water will be supplied from boreholes of yield 158m3/day and construction cost US$25,400.