

表 6.3.6 4F13における月平均流量
(高CF計画があり、灌漑への水供給を考慮し2020年の水需要を控除した場合)

(Unit:m³/s)

	Monthly												Daily				
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Min.	Avg.	Max.	Min.	Max.
1957	183.79	173.79	160.66	120.55	169.00	38.00	23.66	121.71	130.51	159.00	102.00	72.00	23.66	121.22	183.79	15.00	211.00
1958	80.16	141.93	136.05	119.00	169.00	78.75	121.10	156.57	147.28	159.11	102.00	72.00	72.00	123.58	169.00	38.00	191.66
1959	74.30	137.22	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	98.88	169.00	15.00	169.00
1960	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1961	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	787.10	758.42	15.00	200.63	787.10	15.00	2069.48
1962	317.25	211.00	131.27	131.27	227.91	141.45	81.65	154.17	150.00	159.27	104.37	72.00	72.00	163.45	317.25	67.23	552.35
1963	38.00	74.80	136.01	119.00	444.50	261.33	103.61	156.81	149.80	159.19	102.00	72.00	38.00	151.42	444.50	23.00	770.32
1964	196.64	211.00	176.58	139.29	405.61	139.61	77.29	156.08	150.54	159.22	102.00	72.00	72.00	165.49	405.61	38.00	677.48
1965	117.25	165.34	166.12	120.73	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	107.45	169.00	15.00	211.00
1966	38.00	23.00	136.00	119.00	169.00	70.05	83.05	152.90	154.82	159.56	181.93	87.17	23.00	114.54	181.93	23.00	211.00
1967	148.49	141.75	136.41	119.00	230.68	290.10	120.74	172.65	162.34	185.79	212.37	271.25	119.00	182.63	290.10	80.69	553.44
1968	209.13	205.78	211.00	208.23	499.78	274.10	155.32	193.45	161.88	171.27	134.59	639.17	134.59	255.31	639.17	102.00	1217.85
1969	223.42	211.00	211.00	175.98	169.00	38.00	15.00	113.00	112.62	159.00	102.00	72.00	15.00	133.50	223.42	15.00	294.57
1970	38.00	133.96	138.89	130.58	169.00	38.00	52.23	147.40	156.23	159.74	103.97	72.00	38.00	111.67	169.00	15.00	211.00
1971	38.00	57.69	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1972	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1973	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1974	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1975	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1976	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1977	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	169.00
1978	38.00	23.00	177.13	436.22	497.36	136.76	92.63	164.06	157.25	169.67	118.79	102.36	23.00	176.10	497.36	23.00	945.70
1979	209.05	211.00	211.00	175.39	343.05	352.32	130.80	167.44	156.34	160.28	104.04	72.00	72.00	191.06	352.32	67.18	693.33
1980	123.33	151.14	136.41	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	104.16	169.00	15.00	172.29
1981	38.00	75.79	176.84	173.75	389.63	193.62	94.40	159.74	158.35	159.40	103.77	72.00	38.00	149.61	389.63	23.00	659.63
1982	38.00	122.85	136.20	119.00	169.00	51.01	94.59	173.47	157.17	182.88	153.92	199.21	38.00	133.11	199.21	23.00	274.91
1983	209.93	204.16	169.77	120.75	169.00	38.08	83.15	151.33	154.53	159.35	102.00	72.00	38.08	136.17	209.93	38.00	211.00
1984	38.00	125.42	136.71	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	94.93	169.00	15.00	170.82
1985	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	109.54	159.00	102.00	72.00	15.00	91.13	169.00	15.00	169.00
1986	38.00	74.28	136.00	119.00	169.00	38.00	15.00	133.58	147.94	159.00	102.00	72.00	15.00	100.32	169.00	15.00	169.14
1987	163.64	155.19	142.74	120.67	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	108.52	169.00	15.00	211.00
1988	38.00	23.00	136.00	119.00	405.55	151.62	79.95	155.22	155.67	173.99	105.89	165.70	23.00	142.47	405.55	23.00	729.28
1989	210.15	199.82	180.65	121.25	169.00	38.00	15.00	113.00	113.35	191.30	177.03	287.23	15.00	151.32	287.23	15.00	462.12
1990	255.09	211.00	211.00	434.04	429.11	177.13	100.84	160.37	153.91	175.21	112.36	195.57	100.84	217.97	434.04	72.00	661.09
Min.	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	211.00
Avg.	101.28	108.00	154.89	146.73	233.21	91.64	51.91	135.23	107.88	163.15	133.59	132.53	35.15	130.01	268.27	15.00	2069.48
Max.	317.25	211.00	211.00	436.22	499.78	352.32	155.32	193.45	162.34	191.30	787.10	758.42	134.59	255.31	787.10	15.00	2069.48
Daily																	
Min.	38.00	23.00	136.00	119.00	169.00	38.00	15.00	113.00	52.00	159.00	102.00	72.00	15.00	86.33	169.00	15.00	211.00
Max.	552.35	211.00	211.00	945.70	870.51	623.46	204.97	211.00	191.07	211.00	2069.48	1431.52	134.59	255.31	787.10	15.00	2069.48

表 6.3.7 灌溉計画リスト

Garissa District					
Name	Area(A)	Name	Area(A)	Name	Area(A)
Dash	20.0	Fort2	20.0	Young2	20.0
Dolal	2.4	Fort3	20.0	Masalani1	20.0
Cymis	10.0	Jar1	20.0	Masalani2	20.0
Kora1	20.0	Jar1	20.0	Gabobey1	20.0
Kora2	20.0	Jar1	20.0	Gabobey2	20.0
Segley1	20.0	Buthaya1	25.0	Gabobey3	20.0
Segley2	20.0	Buthaya2	20.0	Galana	20.0
Wathajir	20.0	Buthaya3	20.0	Saka1	20.0
Qharira	20.0	Chiriki1	20.0	Saka2	20.0
Kora1	15.0	Chiriki2	25.0	Kori	20.0
Aloley1	20.0	Wath1	20.0	Burand1	20.0
Aloley2	20.0	Wath2	15.0	Burand2	20.0
Chiriki	10.0	Wath3	15.0	Marad1	20.0
Kulmis1	20.0	Bar1	20.0	Marad2	20.0
Kulmis2	15.0	Bar2	20.0	Debi1	20.0
Kulmis3	15.0	Bar3	20.0	Debi2	20.0
Banane	20.0	Dekabur1	20.0	Koldere	20.0
Yarabi1	20.0	Dekabur2	22.0	Gabobe	24.0
Yarabi2	20.0	Najar1	20.0	Sigale1	15.0
Degaley	10.0	Najar2	20.0	Sigale2	17.0
Baraka	15.0	Bahbey2	20.0	Nanighi	14.0
Medina1	20.0	Bahbey1	15.0	Bura1	15.0
Medina2	20.0	Ali1	20.0	Masababu	10.0
Medina3	20.0	Ali2	15.0	Bura2	6.0
Asi	4.0	Ali2	15.0	Guyo	20.0
Maridadi	16.0	Ziwani1	15.0	Kamuthe1	20.0
Qabobey1	20.0	Ziwani2	17.0	Kamuthe2	20.0
Qabobey2	20.0	Barwako1	20.0	Jaribu	12.0
Taksoy	10.0	Barwako2	20.0	Hidaya	20.0
Khadi1	20.0	Barwako3	20.0	Abaqdera	24.0
Khadi2	20.0	Bathiya1	20.0	Galbet	20.0
Khadi3	20.0	Bathiya2	20.0		
Fort1	20.0	Young1	20.0		

Tana River District					
Name	Area(A)	Name	Area(A)	Name	Area(A)
Laza1	20.0	Semi2	20.0	Miko1	20.0
Laza2	20.0	Nanighi1	20.0	Miko2	20.0
Laza3	20.0	Nanighi2	20.0	Mnazini1	20.0
Rhoka	20.0	Nanighi3	20.0	Mnazini2	10.0
Madogoi	20.0	Nanighi4	20.0	Korocho1	20.0
Ngao1	20.0	Nanighi5	20.0	Wanje1	20.0
Wema1	20.0	Bangale1	20.0	Wanje2	20.0
Mango	15.0	Bangale2	20.0	Wanje3	20.0
Ghalamani	10.0	Mili1	20.0	Wanje4	20.0
Wayu1	20.0	Mili2	20.0	Wanje5	20.0
Wayu2	20.0	Mbala1	20.0		
Semikaroi	20.0	Mbala2	20.0		

Source : MOALD

表 6.3.8 各灌漑計画におけるポンプの必要エンジン出力

Gwissa District													
Name	Area(A)	Q	H	Pp	P	P	Name	Area(A)	Q	H	Pp	P	P
Dash	20.0	80.8	10.0	13.9	16.9	22.9	Dekaburi	20.0	80.8	10.0	13.9	16.9	22.9
Dola2	2.4	9.7	10.0	1.7	2.0	2.7	Dekabur2	22.0	88.8	10.0	15.3	18.6	25.2
Cymia	10.0	40.4	10.0	6.9	8.5	11.4	Najar1	20.0	80.8	10.0	13.9	16.9	22.9
Kora1	20.0	80.8	10.0	13.9	16.9	22.9	Najar2	20.0	80.8	10.0	13.9	16.9	22.9
Kora2	20.0	80.8	10.0	13.9	16.9	22.9	Bahbey2	20.0	80.8	10.0	13.9	16.9	22.9
Segley1	20.0	80.8	10.0	13.9	16.9	22.9	Bahbey1	15.0	60.6	10.0	10.4	12.7	17.2
Segley2	20.0	80.8	10.0	13.9	16.9	22.9	Asi1	20.0	80.8	10.0	13.9	16.9	22.9
Waibajir	20.0	80.8	10.0	13.9	16.9	22.9	Asi2	15.0	60.6	10.0	10.4	12.7	17.2
Qharira	20.0	80.8	10.0	13.9	16.9	22.9	As2	15.0	60.6	10.0	10.4	12.7	17.2
Kora1	15.0	60.6	10.0	10.4	12.7	17.2	Ziwani1	15.0	60.6	10.0	10.4	12.7	17.2
Aloley1	20.0	80.8	10.0	13.9	16.9	22.9	Ziwani2	17.0	68.6	10.0	11.8	14.4	19.4
Aloley2	20.0	80.8	10.0	13.9	16.9	22.9	Barwako1	20.0	80.8	10.0	13.9	16.9	22.9
Chiriki	10.0	40.4	10.0	6.9	8.5	11.4	Barwako2	20.0	80.8	10.0	13.9	16.9	22.9
Kulmi1	20.0	80.8	10.0	13.9	16.9	22.9	Barwako3	20.0	80.8	10.0	13.9	16.9	22.9
Kulmi2	15.0	60.6	10.0	10.4	12.7	17.2	Bathiya1	20.0	80.8	10.0	13.9	16.9	22.9
Kulmi3	15.0	60.6	10.0	10.4	12.7	17.2	Bathiya2	20.0	80.8	10.0	13.9	16.9	22.9
Bansa	20.0	80.8	10.0	13.9	16.9	22.9	Young1	20.0	80.8	10.0	13.9	16.9	22.9
Yarabi1	20.0	80.8	10.0	13.9	16.9	22.9	Young2	20.0	80.8	10.0	13.9	16.9	22.9
Yarabi2	20.0	80.8	10.0	13.9	16.9	22.9	Masalani1	20.0	80.8	10.0	13.9	16.9	22.9
Degaley	10.0	40.4	10.0	6.9	8.5	11.4	Masalani2	20.0	80.8	10.0	13.9	16.9	22.9
Baraka	15.0	60.6	10.0	10.4	12.7	17.2	Gabobey1	20.0	80.8	10.0	13.9	16.9	22.9
Medina1	20.0	80.8	10.0	13.9	16.9	22.9	Gabobey2	20.0	80.8	10.0	13.9	16.9	22.9
Medina2	20.0	80.8	10.0	13.9	16.9	22.9	Gabobey3	20.0	80.8	10.0	13.9	16.9	22.9
Medina3	20.0	80.8	10.0	13.9	16.9	22.9	Galana	20.0	80.8	10.0	13.9	16.9	22.9
Asi	4.0	16.2	10.0	2.8	3.4	4.6	Sakal	20.0	80.8	10.0	13.9	16.9	22.9
Meridadi	16.0	64.6	10.0	11.1	13.6	18.3	Saka2	20.0	80.8	10.0	13.9	16.9	22.9
Qabobey1	20.0	80.8	10.0	13.9	16.9	22.9	Kori	20.0	80.8	10.0	13.9	16.9	22.9
Qabobey2	20.0	80.8	10.0	13.9	16.9	22.9	Burand1	20.0	80.8	10.0	13.9	16.9	22.9
Taksoy	10.0	40.4	10.0	6.9	8.5	11.4	Burand2	20.0	80.8	10.0	13.9	16.9	22.9
Khadi1	20.0	80.8	10.0	13.9	16.9	22.9	Marad1	20.0	80.8	10.0	13.9	16.9	22.9
Khadi2	20.0	80.8	10.0	13.9	16.9	22.9	Marad2	20.0	80.8	10.0	13.9	16.9	22.9
Khadi3	20.0	80.8	10.0	13.9	16.9	22.9	Debi1	20.0	80.8	10.0	13.9	16.9	22.9
Fort1	20.0	80.8	10.0	13.9	16.9	22.9	Debi2	20.0	80.8	10.0	13.9	16.9	22.9
Fort2	20.0	80.8	10.0	13.9	16.9	22.9	Koldere	20.0	80.8	10.0	13.9	16.9	22.9
Fort3	20.0	80.8	10.0	13.9	16.9	22.9	Gabobe	24.0	96.9	10.0	16.7	20.3	27.5
Jar1	20.0	80.8	10.0	13.9	16.9	22.9	Sigale1	15.0	60.6	10.0	10.4	12.7	17.2
Jar1	20.0	80.8	10.0	13.9	16.9	22.9	Sigale2	17.0	68.6	10.0	11.8	14.4	19.4
Jar1	20.0	80.8	10.0	13.9	16.9	22.9	Nanighi	14.0	56.5	10.0	9.7	11.9	16.0
Buthaya1	25.0	100.9	10.0	17.4	21.2	28.6	Bural	15.0	60.6	10.0	10.4	12.7	17.2
Buthaya2	20.0	80.8	10.0	13.9	16.9	22.9	Masababu	10.0	40.4	10.0	6.9	8.5	11.4
Buthaya3	20.0	80.8	10.0	13.9	16.9	22.9	Bura2	6.0	24.2	10.0	4.2	5.1	6.9
Chiriki1	20.0	80.8	10.0	13.9	16.9	22.9	Guyo	20.0	80.8	10.0	13.9	16.9	22.9
Chiriki2	25.0	100.9	10.0	17.4	21.2	28.6	Kamuthe1	20.0	80.8	10.0	13.9	16.9	22.9
Wath1	20.0	80.8	10.0	13.9	16.9	22.9	Kamuthe2	20.0	80.8	10.0	13.9	16.9	22.9
Wath2	15.0	60.6	10.0	10.4	12.7	17.2	Jaribu	12.0	48.5	10.0	8.3	10.2	13.7
Wath3	15.0	60.6	10.0	10.4	12.7	17.2	Hidaya	20.0	80.8	10.0	13.9	16.9	22.9
Bar1	20.0	80.8	10.0	13.9	16.9	22.9	Abaqdera	24.0	96.9	10.0	16.7	20.3	27.5
Bar2	20.0	80.8	10.0	13.9	16.9	22.9	Galbet	20.0	80.8	10.0	13.9	16.9	22.9
Bar3	20.0	80.8	10.0	13.9	16.9	22.9							

Tana River District													
Name	Area(A)	Q	H	Pp	P	P	Name	Area(A)	Q	H	Pp	P	P
Laza1	20.0	80.8	10.0	13.9	16.9	22.9	Nanighi5	20.0	80.8	10.0	13.9	16.9	22.9
Laza2	20.0	80.8	10.0	13.9	16.9	22.9	Bangale1	20.0	80.8	10.0	13.9	16.9	22.9
Laza3	20.0	80.8	10.0	13.9	16.9	22.9	Bangale2	20.0	80.8	10.0	13.9	16.9	22.9
Rhoka	20.0	80.8	10.0	13.9	16.9	22.9	Mili1	20.0	80.8	10.0	13.9	16.9	22.9
Madogol	20.0	80.8	10.0	13.9	16.9	22.9	Mili2	20.0	80.8	10.0	13.9	16.9	22.9
Ngaol	20.0	80.8	10.0	13.9	16.9	22.9	Mbala1	20.0	80.8	10.0	13.9	16.9	22.9
Wema1	20.0	80.8	10.0	13.9	16.9	22.9	Mbala2	20.0	80.8	10.0	13.9	16.9	22.9
Mango	15.0	60.6	10.0	10.4	12.7	17.2	Mikol	20.0	80.8	10.0	13.9	16.9	22.9
Ghalemani	10.0	40.4	10.0	6.9	8.5	11.4	Miko2	20.0	80.8	10.0	13.9	16.9	22.9
Wayu1	20.0	80.8	10.0	13.9	16.9	22.9	Mnazini1	20.0	80.8	10.0	13.9	16.9	22.9
Wayu2	20.0	80.8	10.0	13.9	16.9	22.9	Mnazini2	10.0	40.4	10.0	6.9	8.5	11.4
Semikaro1	20.0	80.8	10.0	13.9	16.9	22.9	Korocho1	20.0	80.8	10.0	13.9	16.9	22.9
Semi2	20.0	80.8	10.0	13.9	16.9	22.9	Wanjel	20.0	80.8	10.0	13.9	16.9	22.9
Nanighi1	20.0	80.8	10.0	13.9	16.9	22.9	Wanje2	20.0	80.8	10.0	13.9	16.9	22.9
Nanighi2	20.0	80.8	10.0	13.9	16.9	22.9	Wanje3	20.0	80.8	10.0	13.9	16.9	22.9
Nanighi3	20.0	80.8	10.0	13.9	16.9	22.9	Wanje4	20.0	80.8	10.0	13.9	16.9	22.9
Nanighi4	20.0	80.8	10.0	13.9	16.9	22.9	Wanje5	20.0	80.8	10.0	13.9	16.9	22.9

KEY
 Q = SCHEME WATER REQUIREMENT OR DISCHARGE IN L/S.
 H = TOTAL PUMPING HEAD P = ENGINE POWER IN KW
 Pp = PUMP POWER IN KW P = ENGINE POWER IN HP

Source : MOALD

表 6.3.9 小規模ポンプ灌漑計画の費用見積

1. Crop Water Requirement

$$\begin{aligned}
 E_o &= 7.06 \text{ mm/day - (October)} \\
 ET_o &= 0.8 \times 7.06 = 5.65 \text{ mm/day} \\
 K_c &= 1.1 \\
 ET_c &= K_c \times ET_o = 1.1 \times 5.65 = 6.2 \text{ mm/day} = \underline{0.721 \text{ l/s/ha}}
 \end{aligned}$$

2. Scheme Water Requirement (SWR)

$$\begin{aligned}
 \text{Efficiency (Eff)} &= 50\% \text{ for surface irrigation} \\
 \text{Days of irrigation/week (days)} &= 6 \\
 \text{Hours of irrigation/day} &= 10 \text{ (pumping max.)}
 \end{aligned}$$

3. Pumping Head (H)

For pump system along the Tana River, the normal total dynamic head is 10 m.

4. Pump Power (P_p)

$$\begin{aligned}
 \text{where} \quad Q &= \text{discharge (m}^2\text{/s)} = \text{SWR} \\
 H &= \text{Total dynamic head, (m)} \\
 E_p &= \text{pump efficiency} = (0.60), \\
 E_t &= \text{Transmission Efficiency} (=0.95 \text{ for "V" belt})
 \end{aligned}$$

5. Engine Power Requirement

$$\begin{aligned}
 \text{Where} \\
 S_f &= \text{Safety factor} (= 1.20) \\
 A_f &= \text{Altitude derating factor} \\
 &= 1\% \text{ reduction for every 100 m above sea level} \\
 T_f &= \text{Temperature derating factor} \\
 &= 2\% \text{ reduction for every } 5^\circ\text{C above } 70^\circ\text{C}.
 \end{aligned}$$

$$\text{For Garissa, Altitude} = 128 \text{ m}$$

$$\begin{aligned}
 A_f &= 1.028 \\
 T_f &= 1 \text{ (average temperature for October below } 30^\circ\text{C)}.
 \end{aligned}$$

表 6.4.1 ムトンガダム of ダムタイプ比較検討案の建設工事費

(Unit : 1,000 US\$)

Work Item	Alternative Dam Type	
	Rockfill Dam	Concrete Dam
1. Civil Works		
1.1 Preparatory Work	3,270	3,270
1.2 Diversion Tunnel	21,843	15,750
1.3 Main Dam and Cofferdam	13,248	57,663
1.4 Spillway	41,717	13,897
1.5 Power Tunnels/Shafts	4,512	0
1.6 Surge Tank and Penstock	506	254
1.7 Powerhouse	6,581	5,591
1.8 Tailrace and Outlet Channel	1,933	2,000
Total (1)	93,610	98,425
2. Metal Work	30,364	23,269
3. Generating and Substation Equipment	45,498	45,498
4. Transmission Line	1,481	1,481
Total of Direct Construction Cost (1 to 4)	170,953	168,673
5. Eng. Service and Administration	17,095	16,867
6. Land Aquisition/Compensation	4,942	4,942
7. Physical Contingency	17,909	18,276
Project Cost (1 to 7)	210,899	208,758

表 6.4.2 低グラウンドフォールズダムのダム軸とダムタイプの検討案の建設工事費

(Unit: 1,000 US\$)

Work Item	Case 1		Case 2		Case 3		Case 4		Case 5	
	Conc. Facing Dam (Upper Axis)	Rockfill Dam (Middle Axis)	Rockfill Dam (Middle Axis)	Combined Dam (Middle Axis)	Combined Dam (Middle Axis)	Rockfill Dam (Lower Axis)	Rockfill Dam (Lower Axis)	Combined Dam (Lower Axis)	Combined Dam (Lower Axis)	
1. Civil Works										
1.1 Preparatory Work	19,166	19,166	19,166	19,166	19,166	19,166	19,166	19,166	19,166	19,166
1.2 Diversion Tunnel	36,226	39,618	39,618	19,396	19,396	44,005	44,005	19,754	19,754	19,754
1.3 Main Dam and Cofferdam	79,988	82,186	82,186	130,789	130,789	83,764	83,764	129,926	129,926	129,926
1.4 Spillway	34,089	36,708	36,708	20,420	20,420	32,548	32,548	17,426	17,426	17,426
1.5 Power Tunnels/Shafts	8,959	8,683	8,683	642	642	5,910	5,910	643	643	643
1.6 Surge Tank and Penstock	6,340	4,716	4,716	0	0	8,888	8,888	-	-	-
1.7 Powerhouse	14,124	14,124	14,124	13,888	13,888	14,124	14,124	13,888	13,888	13,888
1.8 Tailrace and Outlet Channel	3,675	3,675	3,675	2,957	2,957	3,352	3,352	3,325	3,325	3,325
Total (1)	202,567	208,876	208,876	207,258	207,258	211,757	211,757	204,128	204,128	204,128
2. Metal Work	40,449	40,449	40,449	32,576	32,576	40,449	40,449	32,576	32,576	32,576
3. Generating and Substation Equipment	63,798	63,798	63,798	63,798	63,798	63,798	63,798	63,798	63,798	63,798
4. Transmission Line	9,707	9,707	9,707	9,707	9,707	9,707	9,707	9,707	9,707	9,707
Total (1 to 4)	316,521	322,830	322,830	313,339	313,339	325,711	325,711	310,209	310,209	310,209
5. Eng. Service and Administration	31,652	32,283	32,283	31,334	31,334	32,571	32,571	31,021	31,021	31,021
6. Land Acquisition/Compensation	15,169	15,169	15,169	15,169	15,169	15,169	15,169	15,169	15,169	15,169
7. Physical Contingency	36,083	37,029	37,029	36,393	36,393	37,461	37,461	35,923	35,923	35,923
Total (1 to 7)	399,425	407,311	407,311	396,235	396,235	410,912	410,912	392,322	392,322	392,322

表 6.5.1 ムトンガダム設備容量検討案の建設工事費

(Unit: 1,000 US\$)

Work Items	Alternative Installed Capacity			
	40 MW	60 MW	80 MW	100 MW
1. Civil Works				
1.1 Preparatory Work	3,270	3,270	3,270	3,270
1.2 Diversion Tunnel	15,750	15,750	15,750	15,750
1.3 Main Dam and Cofferdam	57,663	57,663	57,663	57,663
1.4 Spillway	13,897	13,897	13,897	13,897
1.5 Power Tunnels/Shafts	0	0	0	0
1.6 Surge Tank and Penstock	180	254	349	439
1.7 Powerhouse	3,941	5,591	8,105	10,179
1.8 Tailrace and Outlet Channel	1,621	2,000	2,376	2,706
Total (1)	96,322	98,425	101,410	103,904
2. Metal Work	22,715	23,269	24,072	24,961
3. Generating and Substation Equipment	34,263	45,498	53,229	60,646
4. Transmission Line	1,481	1,481	1,481	1,481
Total (1 to 4)	154,781	168,673	180,192	190,992
5. Eng. Service and Administration	15,478	16,867	18,019	19,099
6. Land Aquisition/Compensation	4,942	4,942	4,942	4,942
7. Physical Contingency	17,371	18,276	19,151	19,940
Total (1 to 7)	192,572	208,758	222,304	234,973
Economic Cost (89.0%)	171,389	185,795	197,851	209,126

表 6.5.2 低グランドフォールズダムの設備容量検討案の建設工事費

(Unit: 1,000 US\$)

Work Items	Alternative Installed Capacity			
	100 MW	120 MW	140 MW	160 MW
1. Civil Works				
1.1 Preparatory Work	19,166	19,166	19,166	19,166
1.2 Diversion Tunnel	19,754	19,754	19,754	19,754
1.3 Main Dam and Cofferdam	129,926	129,926	129,926	129,926
1.4 Spillway	17,426	17,426	17,426	17,426
1.5 Power Tunnels/Shafts	553	593	643	684
1.6 Surge Tank and Penstock	0	0	0	0
1.7 Powerhouse	12,286	13,186	13,888	14,679
1.8 Tailrace and Outlet Channel	2,697	3,013	3,325	3,685
Total (1)	201,808	203,064	204,128	205,320
2. Metal Work	30,283	31,400	32,576	33,802
3. Generating and Substation Equipment	53,509	58,837	63,798	68,666
4. Transmission Line	9,707	9,707	9,707	9,707
Total (1 to 4)	295,307	303,008	310,209	317,495
5. Eng. Service and Administration	29,531	30,301	31,021	31,750
6. Land Aquisition/Compensation	15,169	15,169	15,169	15,169
7. Physical Contingency	34,946	35,457	35,923	36,407
Total (1 to 7)	374,953	383,935	392,322	400,821
Economic Cost (89.0%)	333,708	341,702	349,167	356,731

表 8.1 作業可能日 (低グラウンドフォールズおよびムトンガ)

Work Item	Rainfall	Number of Rainy Day												Suspended Day	Total	Days per Month		
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC					
Excavation	0-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.1	26.9		
	2-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	5-10	0.5	0.2	0.6	1.8	1.0	0.1	0.1	0.4	0.2	1.2	1.7	1.0	0.5				
	10-30	0.9	0.1	2.6	6.9	1.3	0.0	0.0	0.1	0.1	2.6	6.4	3.8	1.0				
	30-50	0.1	0.0	0.1	1.9	0.5	0.0	0.0	0.0	0.0	1.1	1.4	0.8	1.0				
	More 50	0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	1.0				
	Total	1.5	0.3	3.7	11.8	2.8	0.1	0.1	0.5	0.3	5.4	10.0	5.6	10.0				
	Calendar	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0				
	Holiday	2.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	2.0	0.0	10.0	18.0				
	Sunday	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	53.0				
	Workable	22.5	23.7	23.3	11.2	23.2	24.9	25.9	26.5	25.7	18.6	16.0	10.4	251.9				
	Earthfill (Core)	0-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			79.7	23.8
		2-5	0.4	0.1	0.9	1.3	1.1	0.3	0.3	0.2	0.3	0.9	1.5	1.0				
5-10		1.0	0.4	1.1	3.5	2.0	0.2	0.1	0.8	0.3	2.3	3.3	1.9	1.0				
10-30		1.4	0.2	3.9	10.4	2.0	0.0	0.0	0.2	0.2	3.9	9.6	5.7	1.5				
30-50		0.2	0.0	0.6	3.8	1.0	0.0	0.0	0.0	0.0	2.2	2.8	1.6	2.0				
More 50		0.0	0.0	0.4	2.4	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	2.0				
Total		3.0	0.7	6.9	21.4	6.1	0.5	0.4	1.2	0.8	10.3	18.2	10.2	10.0				
Calendar		31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0				
Holiday		2.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	2.0	0.0	10.0	18.0				
Sunday		5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	53.0				
Workable		21.0	23.3	20.1	1.6	19.9	24.5	25.6	25.8	25.2	13.7	7.8	5.8	214.3				
Filter		0-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55	25.8		
		2-5	0.4	0.1	0.9	1.3	1.1	0.3	0.3	0.2	0.3	0.9	1.5	1.0				
	5-10	0.5	0.2	0.6	1.8	1.0	0.1	0.1	0.4	0.2	1.2	1.7	1.0	0.5				
	10-30	0.9	0.1	2.6	6.9	1.3	0.0	0.0	0.1	0.1	2.6	6.4	3.8	1.0				
	30-50	0.2	0.0	0.5	2.9	0.8	0.0	0.0	0.0	0.0	1.7	2.1	1.2	1.5				
	More 50	0.0	0.0	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	1.5				
	Total	2.0	0.4	4.9	14.7	4.2	0.4	0.4	0.7	0.6	7.2	12.5	7.0	10.0				
	Calendar	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0				
	Holiday	2.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	2.0	0.0	10.0	18.0				
	Sunday	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	53.0				
	Workable	22.0	23.6	22.1	8.3	21.8	24.6	25.6	25.3	25.4	16.8	13.5	9.0	239.0				
	Rockfill (Inner shell)	0-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			46.7	26.5
		2-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
5-10		0.5	0.2	0.6	1.8	1.0	0.1	0.1	0.4	0.2	1.2	1.7	1.0	0.5				
10-30		0.9	0.1	2.6	6.9	1.3	0.0	0.0	0.1	0.1	2.6	6.4	3.8	1.0				
30-50		0.2	0.0	0.5	2.9	0.8	0.0	0.0	0.0	0.0	1.7	2.1	1.2	1.5				
More 50		0.0	0.0	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	1.5				
Total		1.6	0.3	4.0	13.4	3.1	0.1	0.1	0.5	0.3	6.3	11.0	6.0	10.0				
Calendar		31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0				
Holiday		2.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	2.0	0.0	10.0	18.0				
Sunday		5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	53.0				
Workable		22.4	23.7	23.0	9.6	22.9	24.9	25.9	26.5	25.7	17.7	15.0	10.0	247.3				
Rockfill (Outer shell)		0-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.9	27.3		
		2-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	5-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	10-30	0.9	0.1	2.6	6.9	1.3	0.0	0.0	0.1	0.1	2.6	6.4	3.8	1.0				
	30-50	0.2	0.0	0.5	2.9	0.8	0.0	0.0	0.0	0.0	1.7	2.1	1.2	1.5				
	More 50	0.0	0.0	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	1.5				
	Total	1.1	0.1	3.4	11.6	2.1	0.0	0.0	0.1	0.1	5.1	9.3	5.0	10.0				
	Calendar	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0				
	Holiday	2.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	2.0	0.0	10.0	18.0				
	Sunday	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	53.0				
	Workable	22.9	23.9	23.6	11.4	23.9	25.0	26.0	26.9	25.9	18.9	16.7	11.0	256.1				
	Concrete Grout	0-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			33.3	27.6
		2-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
5-10		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
10-30		0.9	0.1	2.6	6.9	1.3	0.0	0.0	0.1	0.1	2.6	6.4	3.8	1.0				
30-50		0.1	0.0	0.3	1.9	0.5	0.0	0.0	0.0	0.0	1.1	1.4	0.8	1.0				
More 50		0.0	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	1.0				
Total		1.0	0.1	3.1	10.0	1.8	0.0	0.0	0.1	0.1	4.2	8.3	4.6	10.0				
Calendar		31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0				
Holiday		2.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	2.0	0.0	10.0	18.0				
Sunday		5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	53.0				
Workable		23.0	23.9	23.9	13.0	24.2	25.0	26.0	26.9	25.9	19.8	17.7	11.4	260.7				

表 8.2 主要建設機械

Equipment	Spec.	Total Required Number	
		Low Grand Falls Scheme	Mutonga Scheme
Bulldozer with ripper	32 ton	11	8
Bulldozer	32 ton	4	3
Bulldozer	21 ton	3	3
Bulldozer	11 ton	8	5
Wheel loader	5 m3	15	9
Tractor shovel	2.2 m3	6	6
Tractor shovel	1.2 m3	2	2
Backhoe	0.6 m3	2	2
Backhoe	0.2 m3	2	2
Dump truck	32 ton	35	35
Dump truck	11 ton	25	15
Crawler drill	10 m3/min	14	13
Crawler drill	15 m3/min	11	7
Air compressor	13.5 m3/min	14	13
Air compressor	17 m3/min	11	7
Vibrating roller	15 ton	2	2
Vibrating roller	10 ton	2	1
Vibrating roller	4 ton	2	1
Tire roller	20 ton	2	1
Tamping roller	20 ton	2	1
Crushing plant	600ton/h	1	-
Crushing plant	250 ton/h	-	1
Screen/washing plant	100 ton/h	2	1
Concrete plant	3 m3 x 3	2	-
Concrete plant	1.5 m3 x 2	-	2
Agitator truck	4.5 m3	8	8
Concrete pump car	100 m3/hr	2	2
Truck crane	30 ton	2	2
Crawler crane	30 ton/hr	2	2
Motor grader	3.7 m	4	2
Water sprinkler	10 klit	4	2
Boring machine	5.5 kW	7	4
Boring machine	11 kW	11	5
Grout pump	7.5 kW	11	6
Grout pump	11 kW	16	8
Grout mixer	200 lit x 2	27	14
Drill jumbo, truck mount type	6 drills	4	4
Muck loader, side type	1.4 m3	4	4
Air compressor	20 m3/min	4	4
Vent fan	300 m3/min	6	6
Vent fan	100 m3/min	6	6
Shotcrete spray gun	5 - 10 m3/hr	2	2
Full circular sliding form	10.5 m dia, 9 m L	2	-
Full circular sliding form	11 m dia, 9 m L	-	2
Diesel generator	300 kVA	3	2
Diesel generator	500 kVA	6	4
Tower crane, fixed type	13.5 ton x 75m	1	-
Dump truck	20 ton	12	-
Low pressure bulldozer	15 ton	3	-
Vibration roller	7 ton	5	-
Joint cutting machine	0.6m3 backhoe	2	-
Wheel loader	1.2 m3	2	-
Concrete vibrating machine	4 nos. 150 mm	1	-
Tower crane, self propelled type	9.5 ton x 75m	-	2
Transfer car	3 m3	-	2
Concrete vibrating machine	3 nos. 150 mm	-	4
Concrete bucket	3 m3	-	4

表 8.3 勞務費 (勞務賃金)

Description	Unit	Foreign Currency (US\$)	Local Currency (K Shs.)
Foreman,foreign	M.D.	250	-
Tecnician,foreign	M.D.	167	-
Foreman,tunnel	M.D.	.	800
Foreman A	M.D.	-	600
Foreman B	M.D.	-	500
Mechanic	M.D.	-	400
Electrician	M.D.	-	400
Operator,heavy	M.D.	-	400
Operator,light	M.D.	-	300
Assistant operator	M.D.	-	300
Plant operator	M.D.	-	400
Driver,dump truck	M.D.	-	400
Driver,ordinary	M.D.	-	300
Rigger	M.D.	-	300
Carpentor	M.D.	-	300
Formworker	M.D.	-	300
Concrete worker	M.D.	-	300
Driller	M.D.	-	300
Tunnel worker	M.D.	-	300
Pipe fitter	M.D.	-	300
Brick worker	M.D.	-	300
Mason	M.D.	-	300
Plumber	M.D.	-	300
Painter	M.D.	-	300
Welder	M.D.	-	300
Plasterer	M.D.	-	300
Powderman	M.D.	-	400
Reinforcing worker	M.D.	-	300
Boring worker	M.D.	-	400
Grout worker	M.D.	-	400
Pavement worker	M.D.	-	300
Skilled worker	M.D.	-	400
Semi skilled worker	M.D.	-	300
Common labor	M.D.	-	200

表 8.4 建設資材費

Description	Unit	Foreign Currency (US\$)	Local Currency (KShs.)
Gasoline	litre	0.55	11.04
Light oil	litre	0.44	8.85
Lubricant	litre	0.96	19.50
Grease	kg	2.80	56.70
Portland cement(Ordinary,Nairobi)	ton	82.38	4,395.40
Portland cement(Pozzolana,Mombasa)	ton	70.60	5,252.75
Bitumen 80/100	kg	0.35	7.06
Bitumen MC30	litre	0.43	8.81
Emulsion,K170	litre	0.30	6.00
Reinforcement,round	ton	551.85	11,175.00
Reinforcement,deformed	ton	560.74	11,355.00
Annealed iron wire	kg	0.87	17.70
Nail	kg	0.90	18.30
Dynamite	kg	4.20	50.40
ANFO	kg	0.67	8.00
Detonator,delay,open	No	2.43	29.20
Detonator,relay,tunnel	No	3.65	43.80
Timber,square	m3	12.96	7,000.00
Timber,plank	m3	14.81	8,000.00
Timber,log	m3	11.11	6,000.00
Plywood	m3	75.93	41,000.00
H-shape steel	ton	393.75	2,126.25
Channel steel	ton	481.25	2,598.75
Steel plate	ton	437.50	2,362.50
Angle steel	ton	481.25	2,598.75
Bit,75mm	No	426.13	2,301.08
Rod,3m	No	428.75	2,315.25
Shank	No	323.75	1,748.25
Sleeve	No	86.63	467.78
Bit,65mm	No	355.25	1,918.35
Bit,36mm	No	60.38	326.03
Taper rod,1.5m	No	71.40	385.56
Insert bit,36mm,1.7m	No	114.63	618.98
Air entrain agent	kg	2.10	11.34
Water reduced agent	kg	2.80	15.12
Metal form,300*1500	No	22.75	122.85
Metal form,150*1500	No	17.06	92.14
Metal form,100*1500	No	16.19	87.41
Metal bit,56mm	No	32.90	177.66
Diamond bit	carat	96.25	519.75
Boring rod,40mm,1.5m	No	101.50	548.10
Waterstop,200mm,6mm	m	10.94	59.06
Waterstop,300mm,9mm	m	21.35	115.29
Joint filler,20mm	m2	14.70	79.38
PVC pipe,75mm	m	5.16	27.88
Rock bolt,22mm,2m	no.	9.54	51.50
Wire mesh	m2	2.76	14.88

表 8.5 機械費

Equipment	Unit	Foreign Currency (US\$)	Local Currency (KShs.)
Bulldozer with ripper, 32t	Hr	61.67	731
Bulldozer, 32t	Hr	53.74	613
Bulldozer, 21t	Hr	37.59	429
Bulldozer, 11t	Hr	17.08	195
Wheel loader, 5m ³	Hr	84.80	967
Tractor shovel, 2.2m ³	Hr	29.82	340
Tractor shovel, 1.2m ³	Hr	16.54	181
backhoe, 0.6m ³	Hr	24.80	275
Backhoe, 0.2m ³	Hr	24.08	275
Dump truck, 32t	Hr	58.03	634
Dump truck, 11t	Hr	14.35	157
Dump truck, 11t	Hr	14.35	157
Crawler drill, 10m ³ /min	Hr	16.72	164
Crawler drill, 15m ³ /min	Hr	20.95	206
Air compressor, 13.5m ³ /min	Day	109.53	1,044
Air compressor, 17m ³ /min	Day	111.19	1,060
Vibrating roller, 15t	Hr	51.14	546
Vibrating roller, 10t	Hr	32.63	348
Vibrating roller, 4t	Hr	11.40	122
Tire roller, 20t	Hr	13.72	131
Tanmping roller, 20t	Hr	81.88	874
Concrete plant, 3m ³ x 3	Hr	182.33	1,737
Concrete plant, 1.5m ³ x 2	Hr	143.30	1,409
Agitator truck, 4.5m ³	Hr	18.36	201
Concrete pump car, 100m ³ /min	Hr	48.65	532
Truck crane, 30t	Hr	47.54	453
Motor grader, 3.7m	Hr	22.04	241
Water sprinkler, 10m ³	Hr	13.22	144
Boring machine, 5.5kW	Day	39.82	379
Boring machine, 11kW	Day	74.33	708
Grout pump, 7.5kW	Day	31.20	307
Grout pump, 11kW	Day	38.81	382
Grout mixer, 200 lit x 2	Day	16.23	160
Drifter for jumbo	Day	66.68	330
Truck, 8t for jumbo	Hr	10.08	110
Muck loader, side, 1.4m ³	Hr	26.48	289
Air compressor, 20m ³ /min	Hr	9.69	86
Vent fan, 300m ³ /min	Hr	28.15	230
Vent fan, 100m ³ /min	Hr	2.16	18
Shotcrete spray gun, 5-10m ³ /hr	Hr	41.47	408
Diesel generator, 300kVA	Day	90.05	768
Tower crane, fixed, 13.5t x 75m	Hr	423.20	3,289
Dump truck, 20t	Hr	37.67	412
Low pressure bulldozer, 15t	Hr	22.68	259
Vibration roller, 7t	Hr	32.63	348
Joint cutting machine, 0.4m ³ backhoe	Hr	52.54	501
Wheel loader, 1.2m ³	Hr	26.85	293
Concrete vibrating machine, 4nos, 150m	Hr	34.51	398
Tower crane, self propell, 9.5t x 75m	Hr	421.48	3,104
Transfer car, 3m ³	Hr	26.93	239
Concrete vibrating machine, 3nos, 150m	Hr	27.11	312

表 8.6 低グランドフォールズ及びムトンガ計画の工事費概要

Description	Foreign Currency (1000 US\$)	Local Currency (1000 kShs)	Total (1000 KShs)	Total (1000 US\$)
1. Low Grand Falls Scheme				
Direct construction cost	228,738.46	4,248,173	16,600,050	307,408.33
Land acquisition and compensation	0.00	407,220	407,220	7,541.11
Administration expenses	0.00	83,000	83,000	1,537.04
Engineering services	29,624.00	282,300	1,881,996	34,851.78
Physical contingency	21,708.79	463,959	1,636,234	30,300.62
Price escalation	62,848.74	0	3,393,832	62,848.74
Total (Low Grand Falls Scheme)	342,919.99	5,484,652	24,002,331	444,487.62
2. Mutonga Scheme				
Direct construction cost	119,374.48	1,970,450	8,416,672	155,864.29
Land acquisition and compensation	0.00	89,402	89,402	1,655.59
Administration expenses	0.00	42,083	42,083	779.31
Engineering services	10,312.00	98,264	655,112	12,131.70
Physical contingency	10,177.80	199,836	749,437	13,878.47
Price escalation	50,575.55	0	2,731,080	50,575.55
Total (Mutonga Scheme)	190,439.83	2,400,035	12,683,786	234,884.92
Grand Total	533,359.82	7,884,687	36,686,117	679,372.54

Remarks : Price escalation is expressed in US\$.
FC escalation rate is applied for both currencies.

表 8.7 低グラッドフォールズ計画の工事費概要

Description	Foreign Currency (1000 US\$)	Local Currency (1000 kShs)	Total (1000 KShs)	Total (1000 US\$)
1. Civil work	146,189.25	3,485,976	11,380,196	210,744.36
2. Metal work	26,384.84	259,866	1,684,647	31,197.17
3. Generating equipment	43,213.23	244,036	2,577,550	47,732.42
4. Transmission line and substation equipment	12,951.14	258,295	957,657	17,734.38
Total(1 to 4)	228,738.46	4,248,173	16,600,050	307,408.33
5. Land acquisition and compensation	0.00	407,220	407,220	7,541.11
6. Administration expenses	0.00	83,000	83,000	1,537.04
7. Engineering services	29,624.00	282,300	1,881,996	34,851.78
Total(1 to 7)	258,362.46	5,020,693	18,972,266	351,338.26
8. Physical contingency	21,708.79	463,959	1,636,234	30,300.62
Total(1 to 8)	280,071.25	5,484,652	20,608,500	381,638.88
9. Price escalation	62,848.74	0	3,393,832	62,848.74
Grand total	342,919.99	5,484,652	24,002,331	444,487.62

Remarks : Price escalation is expressed in US\$.
FC escalation rate is applied for both currencies.

表 8.8 ムトンガ計画の工事費概要

Description	Foreign Currency (1000 US\$)	Local Currency (1000 kShs)	Total (1000 KShs.)	Total (1000 US\$)
1. Civil work	63,557.53	1,566,767	4,998,874	92,571.73
2. Metal work	18,050.16	156,141	1,130,850	20,941.66
3. Generating equipment	30,538.08	174,230	1,823,286	33,764.56
4. Transmission line and substation equipment	7,228.71	73,312	463,662	8,586.34
Total(1 to 4)	119,374.48	1,970,450	8,416,672	155,864.29
5. Land aquisition and compensation	0.00	89,402	89,402	1,655.59
6. Administration expenses	0.00	42,083	42,083	779.31
7. Engineering services	10,312.00	98,264	655,112	12,131.70
Total(1 to 7)	129,686.48	2,200,199	9,203,269	170,430.91
8. Physical contengency	10,177.80	199,836	749,437	13,878.47
Total(1 to 8)	139,864.28	2,400,035	9,952,706	184,309.37
9. Price escalation	50,575.55	0	2,731,080	50,575.55
Grand total	190,439.83	2,400,035	12,683,786	234,884.92

Remarks : Price escalation is expressed in US\$.
FC escalation rate is applied for both currencies.

表 8.9 低グランドフォールズ計画の工事費

Description	Foreign Currency (1000 US\$)	Local Currency (1000 KSh)	Total (1000 KSh)	Total (1000 US\$)
1. Civil work				
1.1 Preparatory works	6,961.39	165,999	541,914	10,035.45
1.2 Diversion tunnel	8,234.32	170,388	615,041	11,389.65
1.3 Cofferdam	2,175.96	34,389	151,891	2,812.79
1.4 Main dam	111,933.69	2,677,835	8,722,254	161,523.23
1.5 Flip bucket	774.89	10,615	52,459	971.46
1.6 Intake	168.23	7,029	16,113	298.40
1.7 Power station	3,278.82	103,944	281,000	5,203.71
1.8 Tailrace and outlet channel	3,217.48	94,416	268,160	4,965.92
1.9 Switchyard	458.69	11,067	35,836	663.63
1.10 Access road and base camp	8,985.78	210,294	695,526	12,880.11
Total(1)	146,189.25	3,485,976	11,380,196	210,744.36
2. Metal work				
Diversion tunnel closing gate	1,820.70	17,350	115,668	2,142.00
Sand flush gate	7,776.00	46,656	466,560	8,640.00
Spillway radial gate,hoist,stoplogs	9,253.06	88,176	587,841	10,885.95
Intake gate and intake trashracks	2,662.20	25,369	169,128	3,132.00
Penstock	4,235.63	76,242	304,966	5,647.52
Powerhouse tailrace gate,hoist	637.25	6,073	40,485	749.71
Total(2)	26,384.84	259,866	1,684,647	31,197.17
3. Generating equipment				
Turbines	14,533.74	82,075	866,897	16,053.65
Generators	12,338.91	69,681	735,982	13,629.30
Transformers	3,821.85	21,583	227,963	4,221.54
Indoor switchgear	7,817.58	44,149	466,298	8,635.15
Ancillary equipment	1,671.66	9,440	99,710	1,846.47
Miscellaneous materials	2,518.11	14,220	150,198	2,781.44
Transmission line protective relays	270.36	1,527	16,126	298.64
PLC communication	241.02	1,361	14,376	266.22
Total(3)	43,213.23	244,036	2,577,550	47,732.42
4. Transmission line and substation equipment				
Transmission line	4,184.87	208,789	434,772	8,051.33
Low Grand Falls outdoor switchgear	4,247.37	23,986	253,344	4,691.56
Extension of Kiambere substation	4,518.90	25,520	269,541	4,991.49
Total(4)	12,951.14	258,295	957,657	17,734.38
Total(1 to 4)	228,738.46	4,248,173	16,600,050	307,408.33
5. Land acquisition and compensation				
	0.00	407,220	407,220	7,541.11
6. Administration expenses				
	0.00	83,000	83,000	1,537.04
7. Engineering services				
7.1 Detailed design	11,333.00	108,000	719,982	13,333.00
7.2 Construction supervision	18,291.00	174,300	1,162,014	21,518.78
Total(7)	29,624.00	282,300	1,881,996	34,851.78
Total(1 to 7)	258,362.46	5,020,693	18,972,266	351,338.26
8. Physical contingency				
	21,708.79	463,959	1,636,234	30,300.62
Total(1 to 8)	280,071.25	5,484,652	20,608,500	381,638.88
10. Price escalation				
	62,848.74	0	3,393,832	62,848.74
Total (Low Grand Falls Scheme)	342,919.99	5,484,652	24,002,331	444,487.62

Remarks : Price escalation is expressed in US\$.
FC escalation rate is applied for both currencies.

表 8.10 ムトンガ計画の工事費

Description	Foreign Currency (1000 US\$)	Local Currency (1000 KSh)	Total (1000 KSh)	Total (1000 US\$)
1. Civil work				
1.1 Preparatory works	5,777.96	142,433	454,443	8,415.61
1.2 Diversion tunnel	7,456.39	150,073	552,718	10,235.52
1.3 Cofferdam	1,918.55	31,129	134,731	2,495.01
1.4 Main dam	36,654.22	913,703	2,893,031	53,574.65
1.5 Stilling Basin	5,399.92	150,701	442,297	8,190.68
1.6 Intake	277.15	10,112	25,078	464.41
1.7 Power station	2,825.21	91,402	243,963	4,517.84
1.8 Tailrace and outlet channel	1,555.76	32,826	116,837	2,163.65
1.9 Switchyard	498.52	13,437	40,357	747.35
1.10 Access road and base camp	1,193.85	30,951	95,419	1,767.02
Total(1)	63,557.53	1,566,767	4,998,874	92,571.73
2. Metal work				
Diversion tunnel closing gate	1,170.45	11,154	74,358	1,377.01
Sand flush gate	6,480.00	38,880	388,800	7,200.00
Spillway radial gate,hoist,stoplogs	8,193.15	78,075	520,505	9,638.98
Intake gate and intake trashracks	918.00	8,748	58,320	1,080.00
Penstock	826.88	14,884	59,536	1,102.51
Powerhouse tailrace gate,hoist	461.68	4,400	29,331	543.16
Total(2)	18,050.16	156,141	1,130,850	20,941.66
3. Generating equipment				
Turbines	9,160.38	52,215	546,876	10,127.32
Generators	7,526.07	43,061	449,469	8,323.50
Transformers	2,382.12	13,578	142,212	2,633.56
Indoor switchgear	7,818.84	44,567	466,784	8,644.15
Ancillary equipment	1,125.18	6,414	67,174	1,243.96
Miscellaneous materials	1,743.66	9,939	104,097	1,927.72
Transmission line protective relays	540.81	3,083	32,287	597.90
PLC communication	241.02	1,373	14,388	266.45
Total(3)	30,538.08	174,230	1,823,286	33,764.56
4. Transmission line and substation equipment				
Transmission line	793.80	36,632	79,497	1,472.17
Mutonga outdoor switchgear	6,434.91	36,680	384,165	7,114.17
Total(4)	7,228.71	73,312	463,662	8,586.34
Total(1 to 4)	119,374.48	1,970,450	8,416,672	155,864.29
5. Land aquisition and compensation				
	0.00	89,402	89,402	1,655.59
6. Administration expenses				
	0.00	42,083	42,083	779.31
7. Engineering services				
7.1 Detailed design	0.00	0	0	0.00
7.1 Construction supervision	10,312.00	98,264	655,112	12,131.70
Total(7)	10,312.00	98,264	655,112	12,131.70
Total(1 to 7)	129,686.48	2,200,199	9,203,269	170,430.91
8. Physical contingency				
	10,177.80	199,836	749,437	13,878.47
Total(1 to 8)	139,864.28	2,400,035	9,952,706	184,309.37
9. Price escalation				
	50,575.55	0	2,731,080	50,575.55
Total (Mutonga Scheme)	190,439.83	2,400,035	12,683,786	234,884.92

Remarks: Price escalation is expressed in US\$.
FC escalation rate is applied for both currencies.

表 8.11 低グラウンドフォールズ計画の工事費の年次別支出

Unit:1,000 US\$,1,000 KSh.s.

Description	Total		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Civil works	146,189.25	3,485,976	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	32,811.36	778,720	18,978.23	399,470	34,422.49	874,314	38,899.56	943,245	21,077.61	490,228	0.00	0
2. Metal work	26,384.84	259,866	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	5,276.97	0	0.00	0	9,234.70	116,940	9,234.70	116,940	2,638.48	25,986
3. Generating equipment	43,213.23	244,035	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	8,642.65	0	0.00	0	4,321.32	24,404	25,927.94	170,825	4,321.32	48,607
4. Transmission line and substation equipment	12,951.14	258,295	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	2,590.23	0	4,532.90	77,488	4,532.90	154,977	1,295.11	25,830
Total(1 to 4)	228,738.46	4,248,172	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	32,811.36	778,720	32,897.85	399,470	37,012.72	874,314	56,988.48	1,162,077	60,773.15	932,970	8,254.91	100,623
5. Land aquisition and compensation	0.00	407,220	0.00	0	0.00	0	0.00	0	0.00	101,805	0.00	203,610	0.00	101,805	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
6. Administration expenses	0.00	83,000	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	12,753	0.00	10,880	0.00	14,365	0.00	21,197	0.00	21,074	0.00	2,731
7. Engineering services																								
Detailed design	11,333.00	108,000	0.00	0	0.00	0	2,266.60	21,600	6,799.80	64,800	2,266.60	21,600	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Supervision	18,291.00	174,301	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	2,810.00	26,781	2,398.00	22,848	3,166.00	30,167	4,671.00	44,514	4,644.00	44,255	602.00	5,736
Subtotal	29,624.00	282,301	0.00	0	0.00	0	2,266.60	21,600	6,799.80	64,800	2,266.60	21,600	2,810.00	26,781	2,398.00	22,848	3,166.00	30,167	4,671.00	44,514	4,644.00	44,255	602.00	5,736
Total(1 to 7)	258,362.46	5,020,693	0.00	0	0.00	0	2,266.60	21,600	6,799.80	166,605	2,266.60	225,210	35,621.36	920,059	35,295.85	433,198	40,178.72	918,846	61,659.48	1,227,788	65,417.15	998,299	8,856.91	109,090
8. Physical contingency	21,708.79	463,960	0.00	0	0.00	0	226.66	2,160	679.98	16,661	226.66	22,521	3,562.14	92,006	2,833.60	43,320	3,888.36	91,885	5,261.50	111,837	4,556.94	77,693	472.95	5,877
Total(1 to 8)	280,071.25	5,484,653	0.00	0	0.00	0	2,493.26	23,760	7,479.78	183,266	2,493.26	247,731	39,183.50	1,012,065	38,129.45	476,518	44,067.08	1,010,731	66,920.98	1,339,625	69,974.09	1,075,992	9,329.86	114,967
9. Price escalation	62,848.74	0	0.00	0	0.00	0	149.01	0	780.72	0	660.65	0	6,667.22	0	6,451.46	0	10,058.05	0	16,823.07	0	18,609.27	0	2,649.29	0
Grand total	342,919.99	5,484,653	0.00	0	0.00	0	2,642.27	23,760	8,260.50	183,266	3,153.91	247,731	45,850.72	1,012,065	44,580.91	476,518	54,125.13	1,010,731	83,744.05	1,339,625	88,583.36	1,075,992	11,979.15	114,967

表 8.12 ムトンガ計画の工事費の年次別支出

Unit: 1,000 US\$, 1,000 KSh.

Description	Total		2006		2007		2008		2009		2010		2011		2012	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Civil works	63,557.53	1,566,767	0.00	0	0.00	0	21,787.37	502,784	12,361.49	268,000	20,109.77	546,363	9,296.23	249,573	2.67	48
2. Metal work	18,050.16	156,141	0.00	0	0.00	0	3,610.04	0	0.00	0	6,317.56	70,264	6,317.56	70,264	1,805.00	15,613
3. Generating equipment	30,538.08	174,230	0.00	0	0.00	0	6,107.62	0	0.00	0	3,053.81	17,423	18,322.85	121,961	3,053.81	34,846
4. Transmission line and substation equipment	7,228.71	73,312	0.00	0	0.00	0	0.00	0	1,445.74	0	0.00	0	5,060.10	51,318	722.87	21,994
Total (1 to 4)	119,374.48	1,970,450	0.00	0	0.00	0	31,505.03	502,784	13,807.23	268,000	29,481.14	634,050	38,996.74	493,116	5,584.35	72,501
5. Land acquisition and compensation	0.00	89,402	0.00	44,701	0.00	44,701	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
6. Administration expenses	0.00	42,083	0.00	0	0.00	0	0.00	11,020	0.00	5,068	0.00	11,130	0.00	12,995	0.00	1,870
7. Engineering services	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Detailed design	10,312.00	98,264	0.00	0	0.00	0	2,429.00	23,143	1,117.00	10,643	2,453.00	23,373	2,864.00	27,289	1,449.00	13,816
Supervision	10,312.00	98,264	0.00	0	0.00	0	2,429.00	23,143	1,117.00	10,643	2,453.00	23,373	2,864.00	27,289	1,449.00	13,816
Subtotal	129,686.48	2,200,199	0.00	44,701	0.00	44,701	33,934.03	536,947	14,924.23	283,711	31,934.14	668,553	41,860.74	533,400	7,033.35	88,187
Total (1 to 7)	10,177.80	199,836	0.00	4,470	0.00	4,470	2,907.52	53,695	1,420.14	28,371	2,724.85	62,471	2,701.05	41,163	424.24	5,196
8. Physical contingency	139,864.28	2,400,035	0.00	49,171	0.00	49,171	56,841.55	590,642	16,344.37	312,082	34,658.99	731,024	44,561.79	574,563	7,457.59	93,383
Total (1 to 8)	50,575.55	0	167.00	0	188.49	0	11,046.59	0	5,659.23	0	13,538.39	0	16,919.37	0	3,056.48	0
9. Price escalation	190,439.83	2,400,035	167.00	49,171	188.49	49,171	47,888.14	590,642	22,003.60	312,082	48,197.38	731,024	61,481.16	574,563	10,514.07	93,383
Grand total																

表 8.13 低グラントフォールズ計画の工事費の詳細 (1/3)

Description	Unit	Quantity	Foreign Currency (US\$)		Local Currency (KSh)	
			Unit Price	Amount	Unit Price	Amount
1 Civil Works						
1.1 Preparatory Works (General Item 10%)	L.S.			6,961,393.06		165,993,878
1.2 Diversion Tunnel						
Site clearance	m2	1,600	0.05	80.00	0.80	1,280
Excavation, common	m3	7,960	2.89	23,004.40	51.85	412,726
Excavation, weathered rock	m3	18,570	4.14	76,879.80	72.05	1,337,969
Excavation, rock	m3	1,000	10.16	10,160.00	143.38	143,380
Excavation, tunnel	m3	95,280	53.48	5,095,574.40	820.15	78,143,892
Rock bolt	m	18,080	16.41	296,692.80	279.34	5,050,467
Shotcrete for tunnel	m2	13,240	16.13	213,561.20	330.22	5,034,113
Shotcrete for slope protection	m2	2,110	15.22	32,114.20	423.14	892,825
Concrete, structure	m3	2,240	56.44	126,425.60	2,008.07	4,498,077
Concrete, tunnel	m3	24,050	57.83	1,390,811.50	2,065.19	49,667,820
Concrete, plug	m3	770	57.83	44,529.10	2,065.19	1,590,196
Formwork, structure	m2	3,290	2.60	8,554.00	540.90	1,779,561
Formwork, tunnel	m3	770	15.74	12,119.80	65.55	50,474
Reinforcement	ton	430	686.48	295,186.40	19,845.68	8,533,642
Consolidation grout	m	580	86.89	50,396.20	2,004.09	1,162,372
Curtain grout	m	600	108.39	65,034.00	2,475.34	1,485,204
Backfill grout	m3	1,680	60.17	101,085.60	1,479.30	2,485,224
Others (5%)	L.S.			392,110.45		8,113,711
Subtotal				8,234,319.45		170,387,933
1.3 Cofferdam						
Upstream cofferdam						
Site clearance	m2	18,100	0.05	905.00	0.80	14,480
Excavation, common	m3	40,720	3.56	144,963.20	44.39	1,807,561
Excavation, weathered rock	m3	10,180	5.12	52,121.60	74.73	760,751
Excavation, rock	m3	500	10.28	5,140.00	136.10	68,050
Embankment, core	m3	33,640	5.38	180,983.20	96.00	3,229,440
Embankment, filter	m3	21,240	9.50	201,780.00	193.91	4,118,648
Embankment, rock	m3	116,460	9.23	1,074,925.80	129.12	15,037,315
Embankment, riprap	m3	14,440	10.85	156,674.00	245.58	3,546,175
Downstream cofferdam						
Site clearance	m2	3,920	0.05	196.00	0.80	3,136
Excavation, common	m3	11,330	3.56	40,334.80	44.39	502,939
Excavation, weathered rock	m3	2,840	5.12	14,540.80	74.73	212,233
Excavation, rock	m3	500	10.28	5,140.00	136.10	68,050
Embankment, core	m3	5,510	5.38	29,643.80	96.00	528,960
Embankment, filter	m3	4,180	9.50	39,710.00	193.91	810,544
Embankment, rock	m3	9,930	9.23	91,653.90	129.12	1,282,162
Embankment, riprap	m3	3,100	10.85	33,635.00	245.58	761,298
Others (5%)	L.S.			103,617.36		1,637,587
Subtotal				2,175,964.46		34,389,329
1.4 Main Dam						
Reservoir clearance	ha	3,000	450.00	1,350,000.00	8,010.00	24,030,000
Rockfill dam						
Site clearance	m2	181,000	0.05	9,050.00	0.80	144,800
Excavation, common	m3	284,640	3.56	1,013,318.40	44.39	12,635,170
Excavation, weathered rock	m3	160,200	5.12	820,224.00	74.73	11,971,746
Excavation, rock	m3	32,550	10.28	334,614.00	136.10	4,430,055
Embankment, core	m3	597,090	5.38	3,212,344.20	96.00	57,320,640
Embankment, filter	m3	438,660	9.50	4,167,270.00	193.91	85,060,561
Embankment, shell	m3	1,632,420	9.23	15,067,236.60	129.12	210,778,070
Embankment, riprap	m3	216,640	10.85	2,350,544.00	245.58	53,202,451
Concrete dam						
Site clearance	m2	44,000	0.05	2,200.00	0.80	35,200
Excavation, common	m3	138,630	3.56	493,522.80	44.39	6,153,786
Excavation, weathered rock	m3	462,100	5.12	2,365,952.00	74.73	34,532,733
Excavation, rock	m3	323,470	10.28	3,325,271.60	136.10	44,024,267
Fill and backfill	m3	24,640	3.46	85,254.40	62.21	1,532,854
Mass concrete (RCC)						
Interior concrete, RCC	m3	770,340	51.56	39,718,730.40	1,326.11	1,021,555,577
External concrete and structural concrete	m3	404,330	60.71	24,546,874.30	1,927.40	779,305,642
Reinforcement	ton	670	686.48	459,941.60	19,845.68	13,296,606
Formwork, upstream and downstream	m2	94,750	10.07	954,132.50	293.51	27,810,073
Formwork for structural portion	m2	31,450	2.60	81,770.00	540.90	17,011,305
Formwork for joint portion	m2	62,270	10.07	627,058.90	293.51	18,276,868
Steel plate for joint	m2	36,770	3.31	121,708.70	18.00	661,860
Waterstop, drain pipe, etc for joint	m	1,860	98.92	183,991.20	801.90	1,491,534
Crest bridge, 5.0m wide, 16m long	nos.	6	15,300.00	91,800.00	900,000.00	5,400,000
Crest asphalt pavement	m2	7,320	5.72	41,870.40	117.95	863,394
Drilling and grouting						
Consolidation grout	m	16,200	86.89	1,407,618.00	2,004.09	32,466,258
Curtain grout	m	23,300	108.39	2,525,487.00	2,475.34	57,675,422
Measuring apparatus (1%)	L.S.			1,053,577.85		25,216,669

表 8.13 低グランドフォールズ計画の工事費の詳細 (2/3)

Description	Unit	Quantity	Foreign Currency (US\$)		Local Currency (KShs)	
			Unit Price	Amount	Unit Price	Amount
Borrow area						
Clearance	ha	100	450.00	45,000.00	8,010.00	801,000
Spoil overburden	m ³	30,000	2.68	80,400.00	48.22	1,446,600
Quarry site						
Clearance	ha	50	450.00	22,500.00	8,010.00	400,500
Spoil overburden	m ³	15,000	2.95	44,250.00	52.50	787,500
Others (5%)	L.S.			5,330,175.64		127,515,957
Subtotal				111,933,688.49		2,677,835,097
1.5 Flip Bucket						
Site clearance	m ²	13,760	0.05	688.00	0.80	11,008
Excavation, common	m ³	16,530	3.56	58,846.80	44.39	733,267
Excavation, weathered rock	m ³	55,090	5.12	282,060.80	74.73	4,116,876
Excavation, rock	m ³	38,560	10.28	396,396.80	136.10	5,248,016
Others (5%)	L.S.			36,899.62		505,483
Subtotal				774,892.02		10,615,150
1.6 Intake						
Concrete, structure	m ³	1,880	59.04	110,995.20	2,038.59	3,832,549
Formwork, structure	m ²	3,090	2.60	8,034.00	540.90	1,671,381
Reinforcement	ton	60	686.48	41,188.80	19,845.68	1,190,741
Others (5%)	L.S.			8,010.90		334,734
Subtotal				168,228.90		7,029,405
1.7 Power Station						
Powerhouse						
Site clearance	m ²	20,000	0.05	1,000.00	0.80	16,000
Excavation, common	m ³	11,620	2.89	33,581.80	51.85	602,497
Excavation, weathered rock	m ³	38,720	4.14	160,300.80	72.05	2,782,776
Excavation, rock	m ³	27,100	10.16	275,336.00	148.38	4,021,098
Fill and backfill	m ³	12,260	3.46	42,419.60	62.21	762,695
Anchor bar	m	50	12.66	633.00	146.21	7,311
Concrete, superstructure	m ³	1,680	58.36	98,044.80	2,109.10	3,543,288
Concrete, substructure	m ³	12,960	59.04	765,158.40	2,038.59	26,420,126
Secondary concrete around equipment	m ³	1,440	58.36	84,038.40	2,109.10	3,037,104
Reinforcement	ton	810	686.48	556,048.80	19,845.68	16,075,001
Formwork, structure	m ²	22,000	2.60	57,200.00	540.90	11,899,800
Road pavement	m ²	4,480	12.18	54,566.40	233.69	1,046,931
Fence	m	1,120	31.50	35,280.00	1,701.00	1,905,120
Gate	L.S.			3,000.00		162,000
Earthing for powerhouse	m	3,050	11.48	35,014.00	109.35	333,518
Architectural building						
Powerhouse building	L.S.			933,075.00		27,130,950
Diesel generator house	L.S.			42,705.00		1,241,730
Guard house, dam site	L.S.			25,038.00		728,028
Guard house, powerhouse	L.S.			25,038.00		728,028
Others (5%)	L.S.			51,340.47		1,492,895
Subtotal				3,278,818.47		103,943,895
1.8 Tailrace and Outlet Channel						
Excavation, common	m ³	21,340	2.89	61,672.60	51.85	1,106,479
Excavation, weathered rock	m ³	71,110	4.14	294,395.40	72.05	5,123,476
Excavation, rock	m ³	49,780	10.16	505,764.80	148.38	7,386,356
Fill and backfill	m ³	500	3.46	1,730.00	62.21	31,105
Anchor bar	m ³	4,340	12.66	54,944.40	146.21	634,551
Concrete, structure	m ³	26,590	59.04	1,569,873.60	2,038.59	54,206,108
Formwork, structure	m ²	10,270	2.60	26,702.00	540.90	5,555,043
Reinforcement	ton	800	686.48	549,184.00	19,845.68	15,876,544
Others (5%)	L.S.			153,213.34		4,495,983
Subtotal				3,217,480.14		94,415,646
1.9 Switchyard						
Site clearance	m ²	8,160	0.05	408.00	0.80	6,528
Excavation, common	m ³	8,250	2.89	23,842.50	51.85	427,763
Excavation, weathered rock	m ³	27,480	4.14	113,767.20	72.05	1,979,934
Excavation, rock	m ³	19,240	10.16	195,478.40	148.38	2,854,831
Fill and backfill	m ³	1,000	3.46	3,460.00	62.21	62,210
Concrete, structure	m ³	1,100	59.04	64,944.00	2,038.59	2,242,449
Formwork, structure	m ²	4,200	2.60	10,920.00	540.90	2,271,780
Reinforcement	ton	35	686.48	24,026.80	19,845.68	694,599
Others (5%)	L.S.			21,842.35		527,005
Subtotal				458,689.25		11,067,098

表 8.13 低グランドフォールズ計画の工事費の詳細 (3/3)

Description	Unit	Quantity	Foreign Currency (US\$)		Local Currency (KShs)	
			Unit Price	Amount	Unit Price	Amount
1.10 Access Road and Base Camp						
Access road						
Access road, new permanent road Kiambere to Low Grand Falls	km	52.2	108,900.00	5,684,530.00	2,070,000.00	108,054,060
Bridge construction						
Massa River bridge, 20m	L.S.			106,200.00		3,438,000
Dhuo River bridge, 20m	L.S.			106,200.00		3,438,000
Ngeukya River bridge, 20m	L.S.			50,400.00		1,872,000
Ukeni River bridge, 20m	L.S.			50,400.00		1,872,000
Mukinda River bridge, 20m	L.S.			50,400.00		1,872,000
Kanyaka River bridge, 40m	L.S.			100,800.00		3,744,000
Konyu River bridge, 100m	L.S.			252,000.00		9,360,000
Kamura River bridge, 80m	L.S.			201,600.00		7,438,000
Kabange River bridge, 60m	L.S.			151,200.00		5,616,000
Upgrading existing road for construction use	km	20	48,600.00	972,000.00	909,000.00	18,180,000
Base camp construction at Low Grand Falls	L.S.			1,260,000.00		45,360,000
Subtotal				8,985,780.00		210,294,000
Total (Civil Works)				146,189,254.23		3,485,976,430
2 Metal Work						
Diversion tunnel closing gate	ton	280	6,502.50	1,820,700.00	61,965.00	17,350,200
Sand flush gate	ton	960	8,100.00	7,776,000.00	48,600.00	46,656,000
Spillway radial gate, hoist, stoplogs	ton	1,423	6,502.50	9,253,057.50	61,965.00	88,176,195
Intake gate, intake trashracks	ton	580	4,590.00	2,662,200.00	43,740.00	25,369,200
Penstock	ton	1,255	3,375.00	4,235,625.00	60,750.00	76,241,250
Powerhouse tailrace gate, hoist	ton	98	6,502.50	637,245.00	61,965.00	6,072,570
Total (Metal Work)				26,384,827.50		259,865,415
3 Generating Equipment						
Turbine	L.S.			14,533,740.00		82,074,600
Generator	L.S.			12,338,910.00		69,680,700
Transformer	L.S.			3,821,850.00		21,582,900
Indoor switchgear	L.S.			7,817,580.00		44,148,600
Ancillary equipment	L.S.			1,671,660.00		9,440,100
Miscellaneous materials	L.S.			2,518,110.00		14,220,000
Transmission line protective relays	U.S.			270,360.00		1,527,300
PLC communication	L.S.			241,020.00		1,360,800
Total (Generating Equipment)				43,213,230.00		244,035,000
4 Transmission Line and Substation						
Transmission line	km	45	92,997.00	4,184,865.00	4,639,761.00	208,789,245
Low Grand Falls outdoor switchgear	L.S.			4,247,370.00		23,985,900
Extension of Kiambere substation	L.S.			4,518,900.00		25,519,500
Total (Transmission Line and Substation)				12,951,135.00		258,294,645
Total (1 to 4)				228,738,446.73		4,248,171,490
5 Land Acquisition and Compensation						
Land acquisition for construction area, reservoir area and buffer zone	L.S.			0.00		134,760,000
Compensation for resettlement	L.S.			0.00		137,460,000
Infrastructure	L.S.			0.00		108,000,000
Water supply facilities for resettlement area	L.S.			0.00		27,000,000
Total (Land acquisition and compensation)				0.00		407,220,000
6 Administration Expenses						
	L.S.			0.00		83,000,000
7 Engineering Services						
Detailed design	L.S.			11,333,000.00		108,000,000
Construction supervision	L.S.			18,291,000.00		174,300,000
Total (Engineering Services)				29,624,000.00		282,300,000
Total (1 to 7)				258,362,446.73		5,020,691,490
8 Physical Contingency						
Total (1 to 8)	L.S.			21,708,785.05		463,959,396
Excluding price escalation.				280,071,231.78		5,484,650,886
Remarks:						
Engineering services for detail design Low Grand Falls : 220 M/M Muronga : 180 M/M Detail design				11,333,000.00		108,000,000

表 8.14 ムトンガ計画の工事費の詳細 (1/3)

Description	Unit	Quantity	Foreign Currency (US\$)		Local Currency (N\$T)	
			Unit Price	Amount	Unit Price	Amount
I Civil Works						
1.1 Preparatory Works (General Item 10%)	L.S.			5,777,956.48		142,433,457
1.2 Diversion Tunnel						
Site clearance	m2	2,590	0.05	129.50	0.80	2,072
Excavation, common	m3	7,460	2.89	21,559.40	51.85	386,801
Excavation, weathered rock	m3	17,410	4.14	72,077.40	72.65	1,254,391
Excavation, rock	m3	1,000	10.16	10,160.00	148.38	148,380
Excavation, tunnel	m3	83,610	53.48	4,471,462.80	870.15	68,572,742
Fill and backfill	m3	3,600	3.46	12,456.00	62.21	223,956
Rock bolt	m	9,270	16.41	152,120.70	279.34	2,589,482
Shotcrete for tunnel	m2	6,660	16.13	107,425.80	380.21	2,532,265
Shotcrete for slope protection	m2	1,100	15.22	16,742.00	423.14	465,454
Concrete, structure	m3	3,160	56.44	178,350.40	2,008.07	6,345,501
Concrete, tunnel	m3	20,890	57.83	1,208,068.70	2,065.19	43,141,819
Concrete, plug	m3	1,620	57.83	93,684.60	2,065.19	3,345,608
Formwork, structure	m2	3,180	2.60	8,268.00	540.90	1,720,062
Formwork, tunnel	m3	22,810	15.74	359,029.40	65.55	1,495,196
Reinforcement	ton	410	686.48	281,456.80	19,845.68	8,136,729
Consolidation grout	m	216	86.89	18,768.24	2,004.09	432,883
Curtain grout	m	360	108.39	39,020.40	2,475.34	891,122
Backfill grout	m3	840	60.17	50,542.80	1,479.50	1,242,612
Others (5%)	L.S.			355,066.15		7,146,354
Subtotal				7,456,389.09		150,073,428
1.3 Cofferdam						
Upstream cofferdam						
Site clearance	m2	19,300	0.05	965.00	0.80	15,440
Excavation, common	m3	50,770	3.56	180,741.20	44.39	2,253,680
Excavation, weathered rock	m3	12,700	5.12	65,024.00	74.73	949,071
Excavation, rock	m3	500	10.28	5,140.00	136.10	68,050
Embankment, core	m3	39,289	4.96	194,873.44	88.35	3,471,183
Embankment, filter	m3	22,625	9.50	214,937.50	193.91	4,387,214
Embankment, rock	m3	108,542	7.58	822,748.36	107.46	11,663,923
Embankment, riprap	m3	15,640	9.20	143,888.00	223.92	3,502,109
Downstream cofferdam						
Site clearance	m2	4,200	0.05	210.00	0.80	3,360
Excavation, common	m3	10,460	3.56	37,237.60	44.39	464,319
Excavation, weathered rock	m3	2,620	5.12	13,414.40	74.73	195,793
Excavation, rock	m3	500	10.28	5,140.00	136.10	68,050
Embankment, core	m3	5,740	4.96	28,470.40	88.35	507,129
Embankment, filter	m3	3,780	9.50	35,910.00	193.91	732,580
Embankment, rock	m3	7,090	7.58	53,742.20	107.46	761,891
Embankment, riprap	m3	2,690	9.20	24,748.00	223.92	602,345
Others (5%)	L.S.			91,359.51		1,482,327
Subtotal				1,918,549.61		31,128,864
1.4 Main Dam						
Reservoir clearance	ha	1,300	450.00	585,000.00	8,010.00	10,413,000
Concrete dam						
Site clearance	m2	24,200	0.05	1,210.00	0.80	19,360
Excavation, common	m3	66,960	3.56	238,377.60	44.39	2,972,354
Excavation, weathered rock	m3	223,180	5.12	1,142,681.60	74.73	16,678,241
Excavation, rock	m3	156,230	10.28	1,606,044.40	136.10	21,262,903
Fill and backfill	m3	27,550	3.46	95,323.00	62.21	1,713,866
Mass concrete (Concrete dam)						
Interior concrete	m3	217,300	63.38	13,772,474.00	1,523.67	331,093,491
External concrete and structural concrete	m3	198,360	69.01	13,688,823.60	1,966.37	390,049,153
Reinforcement	ton	830	686.48	569,778.40	19,845.68	16,471,914
Formwork, upstream and downstream	m2	44,170	10.07	444,291.90	293.51	12,964,337
Formwork for joint portion	m2	18,130	10.07	182,569.10	293.51	5,321,336
Formwork for structural portion	m2	5,780	10.07	58,204.60	293.51	1,696,488
Waterstop, drain pipe, etc for joint	m	950	74.82	71,079.00	605.20	575,415
Crest bridge, 5.0 m wide and 17.5 m long	cos	4	15,200.00	64,800.00	990,000.00	3,960,000
Crest asphalt pavement	m2	5,620	5.72	32,146.40	117.55	662,879
Drilling and grouting						
Consolidation grout	m	7,900	86.89	686,431.00	2,004.09	13,832,311
Curtain grout	m	11,600	168.39	1,953,324.00	2,475.34	28,713,944
Measuring apparatus (1%)	L.S.			344,970.59		8,604,010
Quarry site						
Clearance	ha	50	450.00	22,500.00	8,010.00	400,500
Spoil overburden	m3	15,000	2.95	44,250.00	52.50	787,500
Others (5%)	L.S.			1,745,438.96		43,509,651
Subtotal				36,654,218.15		913,702,674
1.5 Stilling Basin						
Site clearance	m2	13,300	0.05	665.00	0.80	10,640
Excavation, common	m3	36,400	2.89	105,196.00	51.85	1,887,340
Excavation, weathered rock	m3	121,320	4.14	502,264.80	72.65	8,741,166
Excavation, rock	m3	84,930	10.16	862,787.20	148.38	12,600,430
Fill and backfill	m3	15,620	3.46	54,045.20	62.21	971,220
Concrete, wall in stilling basin	m3	26,260	59.04	1,550,390.40	2,038.59	33,533,373
Concrete, stilling basin base	m3	18,000	54.53	1,000,617.00	1,788.90	33,810,210
Formwork, structure	m2	17,640	2.60	45,864.00	540.90	6,836,976
Reinforcement	ton	1,200	686.48	823,776.00	19,845.68	23,814,816
Anchor bar, 1 - 5m	m	10,500	17.16	180,180.00	125.51	1,317,855
Others (5%)	L.S.			357,139.28		7,176,223
Subtotal				5,399,924.88		150,700,690

表 8.14 ムトンガ計画の工事費の詳細 (2/3)

Description	Unit	Quantity	Foreign Currency (US\$)		Local Currency (KShs)	
			Unit Price	Amount	Unit Price	Amount
1.6 Intake						
Concrete structure	m3	3,220	59.04	190,108.80	2,038.59	6,564,260
Formwork structure	m2	2,000	2.60	5,200.00	540.90	1,081,800
Reinforcement	ton	100	686.48	68,648.00	19,845.68	1,984,568
Others (5%)	L.S.			13,197.84		481,531
Subtotal				277,154.64		10,112,159
1.7 Power Station						
Powerhouse						
Site clearance	m2	14,400	0.05	720.00	0.80	11,520
Excavation, common	m3	7,940	2.89	22,946.60	51.85	411,689
Excavation, weathered rock	m3	26,450	4.14	109,503.00	72.05	1,905,723
Excavation, rock	m3	18,520	10.16	188,153.20	148.38	2,747,999
Fill and backfill	m3	1,490	3.46	5,155.40	62.21	92,693
Anchor bar	m	50	12.66	633.00	146.21	7,311
Concrete superstructure	m3	1,400	58.36	81,704.00	2,109.10	2,932,740
Concrete substructure	m3	10,800	59.04	637,632.00	2,038.59	21,016,772
Secondary concrete around equipment	m3	1,200	58.36	70,032.00	2,109.10	2,530,920
Reinforcement	ton	670	686.48	459,941.60	19,845.68	13,296,606
Formwork, structure	m2	20,000	2.60	52,000.00	540.90	10,818,000
Road pavement	m2	3,800	12.18	46,284.00	233.69	888,022
Fence	m	1,120	31.50	35,280.00	1,701.00	1,905,120
Gate, 2 nos.	L.S.			3,000.00		162,000
Earthing for powerhouse	m	3,050	11.48	35,014.00	109.35	333,518
Architectural building						
Powerhouse building	L.S.			933,075.00		27,130,950
Diesel generator house	L.S.			42,705.00		1,241,730
Guard house, dam site	L.S.			25,038.00		728,028
Guard house, powerhouse	L.S.			25,038.00		728,028
Others (5%)	L.S.			51,340.47		1,492,895
Subtotal				2,825,205.27		91,402,260.85
1.8 Tailrace and Outlet Channel						
Excavation, common	m3	27,130	2.89	78,405.70	51.85	1,406,691
Excavation, weathered rock	m3	90,440	4.14	374,421.60	72.05	6,516,202
Excavation, rock	m3	63,310	10.16	643,270.60	148.38	9,393,938
Fill and backfill	m3	500	3.46	1,730.00	62.21	31,105
Anchor bar	m3	1,100	12.66	13,926.00	146.21	160,831
Concrete structure	m3	4,400	59.04	260,089.60	2,038.59	9,153,269
Formwork, structure	m2	3,370	2.60	8,762.00	540.90	1,822,833
Reinforcement	ton	140	686.48	96,107.20	19,845.68	2,778,395
Others (5%)	L.S.			74,083.59		1,563,163
Subtotal				1,555,755.29		32,826,427
1.9 Switchyard						
Site clearance	m2	8,160	0.05	408.00	0.80	6,528
Excavation, common	m3	8,250	2.89	23,842.50	51.85	427,763
Excavation, weathered rock	m3	27,480	4.14	113,767.20	72.05	1,979,934
Excavation, rock	m3	19,240	10.16	195,478.40	148.38	2,854,831
Fill and backfill	m3	1,000	3.46	3,460.00	62.21	62,210
Concrete structure	m3	1,650	59.04	97,416.00	2,038.59	3,363,674
Formwork, structure	m2	6,300	2.60	16,380.00	540.90	3,407,670
Reinforcement	ton	35	686.48	24,026.80	19,845.68	694,599
Others (5%)	L.S.			23,738.95		639,860
Subtotal				408,517.85		13,437,068
1.10 Access Road and Base Camp						
Access road						
Access road branched from new permanent road to Mutonga dam	km	6.5	108,900.00	707,850.00	2,070,000.00	13,455,000
Base camp construction at Mutonga site	L.S.			480,000.00		17,496,000
Subtotal				1,187,850.00		30,951,000
Total (Civil Works)						
				63,557,521.24		1,566,768,028
2 Metal Work						
Diversion tunnel closing gate	ton	180	6,502.50	1,170,450.00	61,965.00	11,153,700
Sand flush gate	ton	800	8,100.00	6,480,000.00	48,600.00	38,880,000
Spillway radial gate, hoist, stoplogs	ton	1,260	6,502.50	8,193,150.00	61,965.00	78,075,900
Intake gate, trashracks	ton	200	4,590.00	918,000.00	43,740.00	8,748,000
Penstock	ton	245	3,375.00	826,875.00	60,750.00	14,883,750
Powerhouse tailrace gate, hoist	ton	71	6,502.50	461,677.50	61,965.00	4,399,515
Total (Metal Work)				18,050,152.50		156,140,865
3 Generating Equipment						
Turbine	L.S.			9,160,380.00		52,215,300
Generator	L.S.			7,325,070.00		43,060,500
Transformer	L.S.			2,382,120.00		13,578,300
Indoor switchgear	L.S.			7,818,840.00		44,567,100
Auxiliary equipment	L.S.			1,125,180.00		6,414,300
Miscellaneous materials	L.S.			1,743,660.00		9,938,700
Transmission line protective relays	L.S.			540,810.00		3,082,500
PLC communication	L.S.			241,020.00		1,373,400
Total (Generating Equipment)				30,538,080.00		174,230,100
4 Transmission Line and Substation						
Transmission line (Tapping-off section)	km	4.5	176,400.00	793,800.00	8,140,500.00	36,632,250
Mutonga outdoor switchgear	L.S.			6,434,910.00		36,680,400
Total (Transmission Line and Substation)				7,228,710.00		73,312,650
Total (1 to 4)				119,374,463.74		1,970,451,643

表 8.14 ムトンガ計画の工事費の詳細 (3/3)

Description	Unit	Quantity	Foreign Currency (US\$)		Local Currency (KSh)	
			Unit Price	Amount	Unit Price	Amount
5 Land Acquisition and Compensation						
Land acquisition for construction area, reservoir area and buffer zone	L.S.		0.00			37,260,000
Compensation for resettlement	L.S.		0.00			25,122,000
Water supply facilities for resettlement area	L.S.		0.00			27,000,000
Total (land acquisition and compensation)			0.00			89,402,000
6 Administration Expenses						
	L.S.			0.00		42,083,000
7 Engineering Services						
Detailed design (incl. Low Grand Falls)	L.S.			0.00		0
Construction supervision	L.S.			10,312,000.00		98,264,000
Total (Engineering Services)				10,312,000.00		98,264,000
Total (1 to 7)				129,686,463.74		2,200,200,643
8 Physical Contingency						
	L.S.			10,177,799.25		199,835,884
Total (1 to 8)				139,864,262.99		2,400,036,527
Excluding price escalation.						

表 9.2.1 工事費の年次別支出

Cost component	Construction cost																	Total
	Low Grand Falls Scheme																	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012					
1. Civil works	0	0	0	47,232	26,376	50,613	56,367	30,156	0	0	0	0	0	0	0	0	210,744	
2. Metal work	0	0	0	0	5,277	0	11,400	11,400	3,120	0	0	0	0	0	0	0	31,197	
3. Generating equipment	0	0	0	0	8,643	0	4,773	29,091	5,225	0	0	0	0	0	0	0	47,732	
4. Transmission line & substation equipment	0	0	0	0	0	0	2,590	5,968	7,403	1,773	0	0	0	0	0	0	17,734	
5. Sub-total (1 + 4)	0	0	0	47,232	40,295	53,204	78,508	78,030	10,118	0	0	0	0	0	0	0	307,408	
6. Land acquisition & compensation	0	1,885	3,771	1,885	0	0	0	0	0	0	0	0	0	0	0	0	7,541	
7. Administration expenses	0	0	0	236	201	266	393	390	51	0	0	0	0	0	0	0	1,537	
8. Engineering services	2,667	8,000	2,667	3,306	2,821	3,725	5,495	5,464	708	0	0	0	0	0	0	0	34,852	
9. Detailed design	2,667	8,000	2,667	0	0	0	0	0	0	0	0	0	0	0	0	0	13,333	
10. Supervision	0	0	0	3,306	2,821	3,725	5,495	5,464	708	0	0	0	0	0	0	0	21,519	
11. Sub-total (5 + 8)	2,667	9,885	6,437	52,659	43,318	57,194	84,396	83,904	10,877	0	0	0	0	0	0	0	351,338	
12. Physical contingency	267	989	644	5,266	3,636	5,590	7,333	5,996	582	0	0	0	0	0	0	0	30,301	
13. Sub-total ((11 + 12)	2,933	10,874	7,081	57,925	46,954	62,784	91,729	89,900	11,459	0	0	0	0	0	0	0	381,639	
14. Price escalation	149	781	661	6,667	6,451	10,058	16,823	18,609	2,649	0	0	0	0	0	0	0	62,849	
15. Total financial cost (Incl. price escalation)	3,082	11,654	7,742	64,593	53,405	72,842	108,552	108,509	14,108	0	0	0	0	0	0	0	444,488	
16. Total financial cost (Excl. price escalation)	2,933	10,874	7,081	57,925	46,954	62,784	91,729	89,900	11,459	0	0	0	0	0	0	0	381,639	
17. Total economic cost (Excl. price escalation)	2,611	9,677	6,302	51,554	41,789	55,878	81,639	80,011	10,198	0	0	0	0	0	0	0	339,659	

Cost component	Mutonga										Total
	2006										
	2006	2007	2008	2009	2010	2011	2012				
1. Civil works	0	0	31,098	17,324	30,228	13,918	4	92,572			
2. Metal work	0	0	3,610	0	7,619	7,619	2,094	20,942			
3. Generating equipment	0	0	6,108	0	3,376	20,581	3,699	33,765			
4. Transmission line & substation equipment	0	0	0	1,446	0	6,010	1,130	8,586			
5. Sub-total (1 + 4)	0	0	40,816	18,770	41,223	48,129	6,927	155,864			
6. Land acquisition & compensation	828	828	0	0	0	0	0	1,656			
7. Administration expenses	0	0	204	94	206	241	35	779			
8. Engineering services	0	0	2,858	1,314	2,886	3,369	1,705	12,132			
9. Detailed design	0	0	0	0	0	0	0	0			
10. Supervision	0	0	2,858	1,314	2,886	3,369	1,705	12,132			
11. Sub-total (5 + 8)	828	828	43,877	20,178	44,315	51,739	8,666	170,431			
12. Physical contingency	83	83	3,902	1,946	3,882	3,463	520	13,878			
13. Sub-total ((11 + 12)	911	911	47,779	22,124	48,196	55,202	9,187	184,309			
14. Price escalation	167	188	11,047	5,659	13,538	16,919	3,056	50,576			
15. Total financial cost (Incl. price escalation)	1,078	1,099	58,826	27,783	61,735	72,121	12,243	234,885			
16. Total financial cost (Excl. price escalation)	911	911	47,779	22,124	48,196	55,202	9,187	184,309			
17. Total economic cost (Excl. price escalation)	810	810	42,524	19,690	42,895	49,130	8,176	164,035			

表 0.2.2 経済的内部収益率の計算

(US\$1,000)

Year in order	Year	Economic cost					Total	Economic benefit					Total of benefit	Cash balance
		Low Grand Falls S.		Mutonga Scheme		Low Grand Falls Scheme			Mutonga scheme					
		Const ruction cost	O/M and replace- ment cost	Const ruction cost	O/M and replace- ment cost	Power value		Energy value	O/M cost	Power value	Energy value	O/M cost		
1	2000	2,611				2,611							0	-2,611
2	2001	9,677				9,677							0	-9,677
3	2002	6,302				6,302							0	-6,302
4	2003	51,554				51,554							0	-51,554
5	2004	41,789				41,789							0	-41,789
6	2005	55,878				55,878							0	-55,878
7	2006	81,639		810		82,449	37,533						37,533	-44,916
8	2007	80,011		810		80,821	62,555						62,555	-18,265
9	2008	10,198	906	42,524		53,628	25,022	25,204	1,230				51,456	-2,172
10	2009		1,811	19,690		21,501	0	50,408	2,459		0		52,867	31,366
11	2010		1,811	42,895		44,706	0	50,408	2,459		16,246		69,113	24,406
12	2011		1,811	49,130		50,941	0	50,408	2,459		27,076		79,943	29,002
13	2012		1,811	8,176	478	10,466	0	50,408	2,459	10,830	11,880	532	76,109	65,644
14	2013		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
15	2014		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
16	2015		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
17	2016		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
18	2017		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
19	2018		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
20	2019		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
21	2020		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
22	2021		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
23	2022		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
24	2023		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
25	2024		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
26	2025		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
27	2026		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
28	2027		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
29	2028		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
30	2029		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
31	2030		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
32	2031		1,811		956	2,768	33,780	50,408	2,459	0	23,759	1,064	111,470	108,703
33	2032		1,811		956	2,768	56,300	50,408	2,459	0	23,759	1,064	133,990	131,222
34	2033		1,811		956	2,768	22,520	50,408	2,459	0	23,759	1,064	100,210	97,443
35	2034		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
36	2035		1,811		956	2,768	0	50,408	2,459	14,621	23,759	1,064	92,312	89,544
37	2036		1,811		956	2,768	0	50,408	2,459	24,368	23,759	1,064	102,059	99,291
38	2037		1,811		956	2,768	0	50,408	2,459	9,747	23,759	1,064	87,438	84,670
39	2038		44,293		956	45,249	0	50,408	2,459	0	23,759	1,064	77,691	32,441
40	2039		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
41	2040		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
42	2041		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
43	2042		1,811		31,007	32,819	0	50,408	2,459	0	23,759	1,064	77,691	44,872
44	2043		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
45	2044		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
46	2045		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
47	2046		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
48	2047		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
49	2048		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
50	2049		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
51	2050		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
52	2051		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
53	2052		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
54	2053		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
55	2054		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
56	2055		1,811		956	2,768	0	50,408	2,459	0	23,759	1,064	77,691	74,923
57	2056		1,811		956	2,768	33,780	50,408	2,459	0	23,759	1,064	111,470	108,703
58	2057		1,926		956	2,882	56,300	50,408	2,459	0	23,759	1,064	133,990	131,108
Total		339,659	132,265	164,035	73,563	709,521	327,789	2,495,196	121,729	102,889	1,081,035	48,431	4,177,068	3,467,547

In the condition of discount rate at 12 %:

Present value:	229,837	286,710	56,873
Internal rate of return (EIRR):			14.98%
B/C			1.25

表 9.2.3 経済的内部収益率の計算 (人工洪水放流を考慮した場合)

		Economic cost				Economic benefit					(US\$1,000)			
Year in order	Year	Low Grand Falls S.		Mutonga Scheme		Low Grand Falls Scheme			IGF + Mutonga		Total of benefit	Cash balance		
		Const ruction cost	O/M and replace-ment cost	Const ruction cost	O/M and replace-ment cost	Power value	Energy value	O/M cost	Power value	Energy value			O/M cost	
1	2000	2,611									0	-2,611		
2	2001	9,677									0	-9,677		
3	2002	6,302									0	-6,302		
4	2003	51,554									0	-51,554		
5	2004	41,789									0	-41,789		
6	2005	55,878									0	-55,878		
7	2006	81,639		810		82,449	21,638				21,638	-60,811		
8	2007	80,011		810		80,821	36,063				36,063	-44,758		
9	2008	10,198	963	47,309		58,470	14,425	18,803	709		33,937	-24,533		
10	2009		1,926	21,932		23,858	0	37,606	1,418	0	39,024	15,166		
11	2010		1,926	47,721		49,647	0	37,606	1,418	16,562	55,586	5,939		
12	2011		1,926	54,581		56,507	0	37,606	1,418	27,604	66,627	10,120		
13	2012		1,926	7,722	509	10,157	0	37,606	1,418	11,041	11,905	540	62,510	52,354
14	2013		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
15	2014		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
16	2015		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
17	2016		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
18	2017		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
19	2018		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
20	2019		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
21	2020		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
22	2021		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
23	2022		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
24	2023		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
25	2024		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
26	2025		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
27	2026		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
28	2027		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
29	2028		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
30	2029		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
31	2030		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
32	2031		1,926		1,017	2,943	19,474	37,606	1,418	0	23,810	1,081	83,388	80,445
33	2032		1,926		1,017	2,943	32,456	37,606	1,418	0	23,810	1,081	96,371	93,427
34	2033		1,926		1,017	2,943	12,983	37,606	1,418	0	23,810	1,081	76,897	73,953
35	2034		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
36	2035		1,926		1,017	2,943	0	37,606	1,418	14,912	23,810	1,081	78,827	75,883
37	2036		1,926		1,017	2,943	0	37,606	1,418	24,843	23,810	1,081	88,757	85,814
38	2037		1,926		1,017	2,943	0	37,606	1,418	9,937	23,810	1,081	73,852	70,908
39	2038		49,128		1,017	50,145	0	37,606	1,418	0	23,810	1,081	63,914	13,769
40	2039		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
41	2040		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
42	2041		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
43	2042		1,926		34,406	36,333	0	37,606	1,418	0	23,810	1,081	63,914	27,582
44	2043		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
45	2044		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
46	2045		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
47	2046		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
48	2047		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
49	2048		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
50	2049		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
51	2050		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
52	2051		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
53	2052		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
54	2053		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
55	2054		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
56	2055		1,926		1,017	2,943	0	37,606	1,418	0	23,810	1,081	63,914	60,971
57	2056		1,926		1,017	2,943	19,474	37,606	1,418	0	23,810	1,081	83,388	80,445
58	2057		1,926		1,017	2,943	32,456	37,606	1,418	0	23,810	1,081	96,371	93,427
Total		339,659	142,543	180,885	79,673	742,760	188,968	1,861,497	70,176	104,900	1,083,355	49,166	3,358,061	2,615,301

In the condition of discount rate at 12 %:

Present value:	235,535	220,282	-15,253
Internal rate of return (EIRR):			11.23%
B/C			0.94

表 9.2.4 発電の季節変化 (1)

(Unit : MW)	Masinga (Rule 3, Qfirm=70)						Kamburu						Gituru						Kiandaruma						Kiambere (Rule 1, Qfirm=90)												
	Jan-Mar		Apr-Jun		Jul-Sep		Oct-Dec		Jan-Mar		Apr-Jun		Jul-Sep		Oct-Dec		Jan-Mar		Apr-Jun		Jul-Sep		Oct-Dec		Jan-Mar		Apr-Jun		Jul-Sep		Oct-Dec						
	Jan	Mar	Apr	Jun	Jul	Sep	Oct	Dec	Jan	Mar	Apr	Jun	Jul	Sep	Oct	Dec	Jan	Mar	Apr	Jun	Jul	Sep	Oct	Dec	Jan	Mar	Apr	Jun	Jul	Sep	Oct	Dec					
1966	37.58	38.81	38.81	38.81	32.61	31.78	31.78	58.73	58.73	78.36	78.36	54.36	54.36	68.14	68.14	116.09	116.09	135.47	135.47	110.31	110.31	127.84	127.84	31.23	31.23	42.27	42.27	28.41	28.41	36.23	36.23	135.92	135.92	149.24	149.24	118.98	140.77
1967	30.15	35.26	35.26	36.64	36.64	39.71	39.71	52.99	52.99	79.83	79.83	68.36	68.36	81.61	81.61	99.94	99.94	128.99	128.99	133.35	133.35	135.47	135.47	27.76	27.76	40.07	40.07	35.89	35.89	43.65	43.65	119.53	119.53	149.11	149.11	146.26	149.24
1968	38.76	39.95	39.95	38.92	38.92	38.32	38.32	66.25	66.25	82.36	82.36	71.24	71.24	77.84	77.84	129.71	129.71	135.47	135.47	134.35	134.35	135.47	135.47	35.15	35.15	44.82	44.82	37.40	37.40	41.99	41.99	146.37	146.37	149.24	149.24	147.13	149.24
1969	38.88	33.14	33.14	29.64	29.64	29.13	29.13	67.81	67.81	59.25	59.25	51.28	51.28	53.65	53.65	135.47	135.47	120.43	120.43	103.42	103.42	108.89	108.89	35.69	35.69	31.24	31.24	26.66	26.66	28.30	28.30	146.82	146.82	134.84	134.84	117.76	121.30
1970	27.13	35.65	35.65	33.64	33.64	30.07	30.07	52.96	52.96	76.92	76.92	59.74	59.74	55.05	55.05	103.08	103.08	135.47	135.47	121.80	121.80	111.43	111.43	27.76	27.76	40.80	40.80	31.40	31.40	28.90	28.90	117.85	117.85	149.24	149.24	132.32	127.66
1971	23.98	25.51	25.51	26.07	26.07	23.92	23.92	44.70	44.70	62.44	62.44	52.11	52.11	48.75	48.75	92.37	92.37	124.81	124.81	105.32	105.32	97.66	97.66	23.64	23.64	33.48	33.48	27.21	27.21	25.97	25.97	117.06	117.06	141.06	141.06	119.77	129.63
1972	20.67	20.66	20.66	20.06	20.06	23.72	23.72	48.29	48.29	58.95	58.95	49.30	49.30	71.41	71.41	97.06	97.06	119.97	119.97	98.93	98.93	134.08	134.08	25.09	25.09	31.31	31.31	25.56	25.56	38.09	38.09	117.77	117.77	133.86	133.86	118.04	139.15
1973	25.09	25.40	25.40	24.52	24.52	23.64	23.64	52.81	52.81	61.88	61.88	52.60	52.60	57.76	57.76	122.87	122.87	125.42	125.42	106.43	106.43	115.63	115.63	27.68	27.68	32.66	32.66	27.42	27.42	30.42	30.42	125.97	125.97	135.58	135.58	119.65	128.79
1974	19.25	22.35	22.35	24.58	24.58	24.29	24.29	52.18	52.18	57.99	57.99	55.38	55.38	49.89	49.89	105.24	105.24	118.48	118.48	112.86	112.86	100.41	100.41	27.32	27.32	30.87	30.87	29.08	29.08	26.08	26.08	117.97	117.97	137.41	137.41	126.08	118.29
1975	23.15	25.45	25.45	27.06	27.06	29.22	29.22	48.75	48.75	62.72	62.72	52.21	52.21	50.93	50.93	92.99	92.99	124.57	124.57	105.56	105.56	102.62	102.62	25.36	25.36	33.26	33.26	27.26	27.26	26.74	26.74	116.06	116.06	130.21	130.21	120.16	119.47
1976	32.19	28.32	28.32	28.89	28.89	31.18	31.18	52.23	52.23	55.45	55.45	48.00	48.00	53.46	53.46	93.13	93.13	113.03	113.03	96.29	96.29	108.46	108.46	27.35	27.35	29.37	29.37	24.84	24.84	28.14	28.14	117.88	117.88	127.52	127.52	117.14	117.31
1977	31.73	39.70	39.70	36.15	36.15	39.14	39.14	61.08	61.08	82.29	82.29	58.05	58.05	74.90	74.90	98.63	98.63	135.47	135.47	118.09	118.09	134.42	134.42	32.18	32.18	44.30	44.30	30.52	30.52	40.03	40.03	128.00	128.00	149.24	149.24	130.99	147.33
1978	39.62	39.74	39.74	35.93	35.93	36.73	36.73	77.08	77.08	76.19	76.19	58.51	58.51	66.98	66.98	134.85	134.85	133.66	133.66	119.03	119.03	131.16	131.16	41.62	41.62	41.07	41.07	30.70	30.70	35.30	35.30	149.24	149.24	146.59	146.59	129.69	142.94
1979	38.75	39.95	39.95	38.62	38.62	37.78	37.78	61.90	61.90	82.36	82.36	63.48	63.48	62.16	62.16	130.49	130.49	135.47	135.47	129.38	129.38	125.36	125.36	32.82	32.82	44.82	44.82	33.48	33.48	33.28	33.28	143.68	143.68	149.24	149.24	142.81	143.80
1980	32.10	27.29	27.29	26.49	26.49	25.74	25.74	69.12	69.12	75.19	75.19	46.71	46.71	53.01	53.01	96.66	96.66	133.84	133.84	94.50	94.50	107.24	107.24	36.59	36.59	39.95	39.95	24.35	24.35	28.10	28.10	139.95	139.95	149.24	149.24	117.01	117.60
1981	24.17	38.90	38.90	38.42	38.42	32.29	32.29	49.16	49.16	82.36	82.36	65.69	65.69	56.35	56.35	96.01	96.01	135.47	135.47	128.68	128.68	114.39	114.39	25.82	25.82	44.82	44.82	34.58	34.58	29.94	29.94	117.45	117.45	149.24	149.24	140.61	137.47
1982	32.82	36.87	36.87	39.27	39.27	39.95	39.95	53.41	53.41	75.39	75.39	64.66	64.66	81.89	81.89	96.26	96.26	132.21	132.21	129.80	129.80	135.47	135.47	28.08	28.08	40.92	40.92	34.02	34.02	44.37	44.37	122.37	122.37	149.24	149.24	142.45	149.24
1983	38.48	39.72	39.72	39.29	39.29	33.12	33.12	59.60	59.60	79.07	79.07	63.38	63.38	56.81	56.81	128.06	128.06	135.47	135.47	127.72	127.72	115.43	115.43	31.46	31.46	42.98	42.98	33.36	33.36	29.92	29.92	134.77	134.77	149.24	149.24	139.27	131.10
1984	36.29	25.38	25.38	21.41	21.41	25.30	25.30	57.13	57.13	47.09	47.09	43.38	43.38	58.02	58.02	97.46	97.46	135.47	135.47	127.62	127.62	116.26	116.26	30.17	30.17	24.67	24.67	22.94	22.94	31.09	31.09	131.61	131.61	120.59	120.59	113.56	117.73
1985	28.53	39.70	39.70	38.96	38.96	32.98	32.98	51.71	51.71	79.68	79.68	62.50	62.50	57.30	57.30	117.28	117.28	135.47	135.47	125.24	125.24	120.22	120.22	27.24	27.24	43.18	43.18	32.93	32.93	30.31	30.31	123.84	123.84	149.24	149.24	138.82	136.65
1986	36.72	39.81	39.81	39.20	39.20	32.67	32.67	55.66	55.66	78.91	78.91	62.77	62.77	59.44	59.44	123.14	123.14	135.47	135.47	113.02	113.02	105.11	105.11	30.01	30.01	31.40	31.40	29.11	29.11	27.16	27.16	127.25	127.25	139.82	139.82	123.41	125.97
1987	37.16	32.47	32.47	34.29	34.29	32.61	32.61	57.03	57.03	58.79	58.79	55.43	55.43	51.32	51.32	112.65	112.65	135.47	135.47	132.21	132.21	135.47	135.47	28.92	28.92	44.82	44.82	34.76	34.76	44.82	44.82	118.39	118.39	149.24	149.24	144.84	149.24
1988	35.92	39.95	39.95	38.37	38.37	39.95	39.95	54.99	54.99	82.36	82.36	66.13	66.13	82.36	82.36	135.47	135.47	135.47	135.47	135.47	135.47	135.47	135.47	44.19	44.19	44.82	44.82	39.17	39.17	44.36	44.36	149.24	149.24	149.24	149.24	149.09	149.24
1989	39.95	39.95	39.95	39.51	39.51	39.95	39.95	82.04	82.04	82.36	82.36	73.66	73.66	82.15	82.15	135.47	135.47	135.47	135.47	135.47	135.47	135.47	135.47	39.29	39.29	44.82	44.82	30.40	30.40	37.85	37.85	148.06	148.06	149.24	149.24	128.93	149.24
1990	39.44	39.95	39.95	35.03	35.03	36.65	36.65	73.33	73.33	82.36	82.36	57.75	57.75	71.33	71.33	135.47	135.47	135.47	135.47	118.10	118.10	135.47	135.47	30.87	30.87	38.62	38.62	30.58	30.58	33.71	33.71	129.59	129.59	143.44	143.44	150.47	134.93
Avg. Ratio	32.34	33.99	33.99	32.94	32.94	32.19	32.19	58.44	58.44	71.79	71.79	58.27	58.27	63.30	63.30	112.57	112.57	128.64	128.64	116.67	116.67	120.30	120.30	0.231	0.231	0.289	0.289	0.229	0.229	0.252	0.252	0.241	0.241	0.266	0.266	0.242	0.251

表 9.2.4 発電の季節変化 (3)

	Mizu											
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
1966	24.97	49.11	40.10	26.96								
1967	5.27	43.31	48.03	34.85								
1968	32.32	50.96	50.96	38.68								
1969	44.45	41.17	30.46	13.63								
1970	34.11	50.96	50.96	34.78								
1971	9.08	39.11	50.96	29.64								
1972	11.67	34.90	46.08	43.26								
1973	41.24	37.87	48.29	36.39								
1974	6.54	50.96	50.96	33.02								
1975	5.93	45.25	50.96	40.27								
1976	8.21	31.02	50.96	19.21								
1977	22.78	50.96	50.96	45.80								
1978	44.09	50.96	50.96	47.00								
1979	43.83	50.96	49.99	14.92								
1980	7.27	40.96	46.87	17.45								
1981	10.34	49.15	50.96	33.25								
1982	5.55	35.68	50.51	50.13								
1983	20.60	41.98	50.96	45.08								
1984	13.56	16.70	32.86	30.40								
1985	12.79	50.96	50.96	27.99								
1986	9.44	40.06	41.79	22.47								
1987	17.10	45.99	37.87	35.57								
1988	22.06	50.96	50.96	43.79								
1989	18.67	50.96	48.59	50.75								
1990	45.55	50.96	47.45	34.32								
Avg.	20.70	44.07	47.22	33.99								
Ratio	0.142	0.302	0.323	0.233								

表 9.2.5 既存及び計画中の水力発電所のデータ

Name	Status	Commissioning Year	Retirement Year	Installed Capacity (MW)	Firm Output (MW)	Annual Average Energy (GWh/y)	Forced Outage Rate (%)	Schedule Maintenance (week)
Small Hydro	Existing	1952	2002	28.3	28.3	153.0	2.0	2
Masinga	Existing	1981	2031	40.0	17.7	248.0	2.0	2
Kambru	Existing	1975	2025	84.0	29.3	475.9	2.0	2
Gitaru	Existing	1978	2028	145.0	64.8	961.8	2.0	2
Gitaru 3rd Unit	Committed	1999	2049	72.5	72.5	46.0	2.0	2
Kindaruma	Existing	1968	2018	44.0	16.1	253.2	2.0	2
Kiambere	Existing	1988	2038	140.0	134.4	1004.6	2.0	2
Low Grand Falls	Committed	2008	2058	140.0	135.3	715.5	2.0	2
Mutonga	Committed	2012	2062	60.0	58.1	337.5	2.0	2
Turkwele	Existing	1991	2041	106.0	88.7	372.0	2.0	2
Sondu/Miriu (Import)	Committed Existing	2002	2052	60.0	59.4	337.0	2.0	2
Total		-	-	949.8	734.5	5048.4	-	-

表 9.2.6 既存及び計画中の火力および地熱発電所のデータ

Name	Status	Commissioning Year	Retirement Year	Installed Capacity (MW)	Firm Output (MW)	Annual Average Energy (GWh/y)	Forced Outage Rate (%)	Schedule Maintenance (week)	Fuel Type	Fuel Cost (US\$/BTU)	Heat Rate (BTU/kWh)	Fixed O&M Cost (\$/kW-y)	Variable O&M Cost (\$/MWh)
Kipevu NO.6	Existing	1992	2001	25.0	25.0	-	0.15	11	RES	2.313	16115	32.0	3.2
Kipevu NO.7	Existing	1992	2004	30.0	30.0	-	0.15	11	RES	2.313	16115	32.0	3.2
Kipevu CT	Existing	1992	2010	31.0	31.0	-	0.15	3	IDO	3.220	16115	21.0	6.9
NAIROBI CT	Existing	1992	2003	13.5	13.5	-	0.15	3	AGO	5.452	14361	14.5	5.8
Stop-gap 1x44.5	Committed	1997	2004	44.5	44.5	-	0.05	4	RES	2.313	8341	16.0	9.0
Stop-gap 1x43	Committed	1997	2004	43.0	43.0	-	0.06	4	RES	2.313	8341	16.0	9.0
Kipevu I	Committed	1999	2014	75.0	75.0	-	0.06	4	RES	2.313	8341	16.0	9.0
Kipevu II	Committed	1999	2014	75.0	75.0	-	0.06	4	RES	2.313	8341	16.0	9.0
LS DIESEL 1x50	Committed	2000	2020	50.0	50.0	-	0.05	4	HFO	2.026	7868	16.0	4.5
OLKARIA	Existing	1985	2010	45.0	45.0	392.8	0.05	4	-	-	-	-	6.4
OLKARIA II	Committed	2001	2026	61.4	61.4	472.0	0.05	4	-	-	-	-	6.4
OLKARIA III	Committed	2002	2027	61.4	61.4	472.0	0.05	4	-	-	-	-	6.4

表 9.2.7 候補の火力および地熱発電所のデータ

Name	Operating Life (Year)	Installed Capacity (MW)	Firm Output (MW)	Annual Average Energy (GWh/y)	Forced Outage Rate (%)	Schedule Maintenance (week)	Fuel Type	Fuel Cost (US\$/BTU)	Heat Rate (BTU/kWh)	Fixed O&M Cost (\$/kW-y)	Variable O&M Cost (\$/MWh)	Installation Cost (\$/kW)
Geothermal 2x32	25	64	61.4	472	0.05	4	-	-	-	-	6.4	1883
LS DIESEL 1x50	20	50.0	50.0	-	0.05	4	HFO	2.026	7868	16.0	4.5	1050
MS DIESEL 1x60	15.0	60.0	60.0	-	0.06	4	LRF0	2.313	8341	16.0	9.0	805

表 9.2.8 最適投入時期検討結果による投入計画

YEAR	Hydro (MW)	Geo-THERM (MW)	LS Diesel (MW)	MS Diesel (MW)	Stop-Gap (MW)
1995		2x32			
1996					
1997					1x44.5 1x43
1998					
1999	1x72.5(Gi 3rd)			6x12.5 6x12.5	
2000			1x50		
2001		2x32(01k II)			
2002	2x30(Miriu)	2x32(01k III)			
2003					
2004			3x50		-1x44.5 -1x43
2005			1x50		
2006			2x50		
2007			2x50		
2008	1x140(LGF)				
2009			1x50		
2010			4x50		
2011			2x50		
2012	1x60(Muto)		1x50		
2013		2x32	1x50		
2014			6x50		
2015			3x50		
2016			4x50		
2017			3x50		
2018			4x50		
2019		4x32	1x50		

表 9.3.1 価格変動を含む財務費用の年次別支出

Cost component	Construction cost															Total
	Low Grand Falls Scheme															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	13	14	
1. Year after base year	3	4	5	6	7	8	9	10	11	12	13	14	15			
2. Construction cost for FC	2,493	7,480	2,493	39,184	38,129	44,067	66,921	69,974	9,330							280,071
3. Construction cost for FC incl. escalation	2,620	8,017	2,726	43,694	43,368	51,127	79,194	84,459	11,487							326,692
4. Construction cost for LC in Kshs.1,000	23,760	183,266	247,731	1,012,065	476,518	1,010,731	1,339,625	1,075,992	114,967							5,484,655
5. Construction cost for LC in US\$1,000	440	3,394	4,588	18,742	8,824	18,717	24,808	19,926	2,129							101,568
6. Construction cost for LC incl. escalation	462	3,637	5,016	20,899	10,037	21,716	29,358	24,050	2,621							117,796
7. Total financial cost (3+6)	3,082	11,654	7,742	64,593	53,405	72,843	108,552	108,509	14,108							444,438

Cost component	Construction cost															Total
	Mutonga Scheme															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	13	14	
1. Construction cost for FC							0	0	36,842	16,344	34,659	44,562	7,458			139,864
2. Construction cost for FC incl. escalation							0	0	45,359	20,525	44,395	58,220	9,939			178,438
3. Construction cost for LC in Kshs.1,000						49,171	49,171	590,642	312,082	731,024	574,563	93,283	2,400,036			
4. Construction cost for LC in US\$1,000						911	911	10,938	5,779	13,537	10,640	1,729	44,445			
5. Construction cost for LC incl. escalation						1,078	1,099	13,467	7,258	17,340	13,901	2,304	56,447			
6. Total financial cost (2+5)						1,078	1,099	58,826	27,783	61,735	72,121	12,243	234,885			

Source : JICA Study Team.
 (Note) Exchange rate : US\$ 1.00 = KSh.54 = Japanese Yen 120, as of June 1997.

表 9.3.2 財務分析のパラメータ

Item	Unit	Value		
		Low Grand Falls	Mutonga	Full operation (After 2013)
OM Cost				
Total financial construction cost	US\$1,000	444,488	234,885	679,373
Cost for civil, metal & transmission line	US\$1,000	259,675	122,100	381,775
OM cost for civil, metal & transmission line (0.5% of construction cost for civil, metal & transmission line)	US\$1,000	1,298	611	1,909
OM cost for generating equipment (5.5 US\$/kW for Low Grand Falls & 8.0 US\$/kW for Mutonga)	US\$1,000	737	464	1,201
OM cost	US\$1,000	2,035	1,075	3,110
Subtransmission and Distribution Cost				
Assumed subtransmission and distribution cost in 1997 (70% of construction cost for transmission line/kWh/year)	US\$/KWh	0.0175	0.0175	
Assumed subtransmission and distribution cost in 2008	US\$/KWh	0.03	0.03	
Annual subtransmission and distribution cost in 2008	US\$1,000	18,018	8,492	26,510
Electricity Tariff				
Average electricity tariff in 1999	Ksh/KWh	6.720	6.720	6.720
Estimated electricity tariff in 2008	Ksh/KWh	10.420	10.420	10.420
Estimation of Annual Revenue				
Annual generated energy	GWh	715	337	1,052
Transmission and distribution loss	%	16.00%	16.00%	16.00%
Energy received at customers	GWh	600.60	283.08	883.68
Annual revenue in Ksh.	Ksh.million	6,258	2,950	9,208
Exchange rate as of June 1997	Ksh/US\$	54.0	54.0	54.0
Annual revenue in US\$ in 2008	US\$1,000	115,894	54,624	170,518

表 9.3.3 財務的内部収益率の計算

(US\$1,000)

Year in order	Year	Financial cost				Subtransmission and Distribution Cost	Total	Benefit	Cash balance
		Low Grand Falls Scheme		Mutonga Scheme					
		Cost	OMR	Cost	OMR				
1	2000	3,082					3,082	0	-3,082
2	2001	11,654					11,654	0	-11,654
3	2002	7,742					7,742	0	-7,742
4	2003	64,593					64,593	0	-64,593
5	2004	53,405					53,405	0	-53,405
6	2005	72,842					72,842	0	-72,842
7	2006	108,552		1,078			109,630	0	-109,630
8	2007	108,509		1,099			109,608	0	-109,608
9	2008	14,108	1,018	58,826		9,009	82,961	57,947	-25,014
10	2009		2,035	27,783		18,018	47,836	115,894	68,058
11	2010		2,035	61,735		18,018	81,788	115,894	34,106
12	2011		2,035	72,121		18,018	92,174	115,894	23,720
13	2012		2,035	12,243	538	22,264	37,080	143,206	106,126
14	2013		2,035		1,075	26,510	29,620	170,518	140,898
15	2014		2,035		1,075	26,510	29,620	170,518	140,898
16	2015		2,035		1,075	26,510	29,620	170,518	140,898
17	2016		2,035		1,075	26,510	29,620	170,518	140,898
18	2017		2,035		1,075	26,510	29,620	170,518	140,898
19	2018		2,035		1,075	26,510	29,620	170,518	140,898
20	2019		2,035		1,075	26,510	29,620	170,518	140,898
21	2020		2,035		1,075	26,510	29,620	170,518	140,898
22	2021		2,035		1,075	26,510	29,620	170,518	140,898
23	2022		2,035		1,075	26,510	29,620	170,518	140,898
24	2023		2,035		1,075	26,510	29,620	170,518	140,898
25	2024		2,035		1,075	26,510	29,620	170,518	140,898
26	2025		2,035		1,075	26,510	29,620	170,518	140,898
27	2026		2,035		1,075	26,510	29,620	170,518	140,898
28	2027		2,035		1,075	26,510	29,620	170,518	140,898
29	2028		2,035		1,075	26,510	29,620	170,518	140,898
30	2029		2,035		1,075	26,510	29,620	170,518	140,898
31	2030		2,035		1,075	26,510	29,620	170,518	140,898
32	2031		2,035		1,075	26,510	29,620	170,518	140,898
33	2032		2,035		1,075	26,510	29,620	170,518	140,898
34	2033		2,035		1,075	26,510	29,620	170,518	140,898
35	2034		2,035		1,075	26,510	29,620	170,518	140,898
36	2035		2,035		1,075	26,510	29,620	170,518	140,898
37	2036		2,035		1,075	26,510	29,620	170,518	140,898
38	2037		2,035		1,075	26,510	29,620	170,518	140,898
39	2038		49,767		1,075	26,510	77,352	170,518	93,166
40	2039		2,035		1,075	26,510	29,620	170,518	140,898
41	2040		2,035		1,075	26,510	29,620	170,518	140,898
42	2041		2,035		1,075	26,510	29,620	170,518	140,898
43	2042		2,035		34,840	26,510	63,385	170,518	107,134
44	2043		2,035		1,075	26,510	29,620	170,518	140,898
45	2044		2,035		1,075	26,510	29,620	170,518	140,898
46	2045		2,035		1,075	26,510	29,620	170,518	140,898
47	2046		2,035		1,075	26,510	29,620	170,518	140,898
48	2047		2,035		1,075	26,510	29,620	170,518	140,898
49	2048		2,035		1,075	26,510	29,620	170,518	140,898
50	2049		2,035		1,075	26,510	29,620	170,518	140,898
51	2050		2,035		1,075	26,510	29,620	170,518	140,898
52	2051		2,035		1,075	26,510	29,620	170,518	140,898
53	2052		2,035		1,075	26,510	29,620	170,518	140,898
54	2053		2,035		1,075	26,510	29,620	170,518	140,898
55	2054		2,035		1,075	26,510	29,620	170,518	140,898
56	2055		2,035		1,075	26,510	29,620	170,518	140,898
57	2056		2,035		1,075	26,510	29,620	170,518	140,898
58	2057		2,035		1,075	26,510	29,620	170,518	140,898
Total		444,487	148,465	234,885	82,678	1,278,277	2,188,792	8,222,145	6,033,353

In the condition of discount rate at 12 %:

Tariff applied : KShs.10.42/kWh as of 2008 resulted from 1999 tariff provided by KPC applying an annual price escalation of 5%.

Cost : Included the price escalation of 2% per annum since 1997.

Internal rate of return (FIRR):

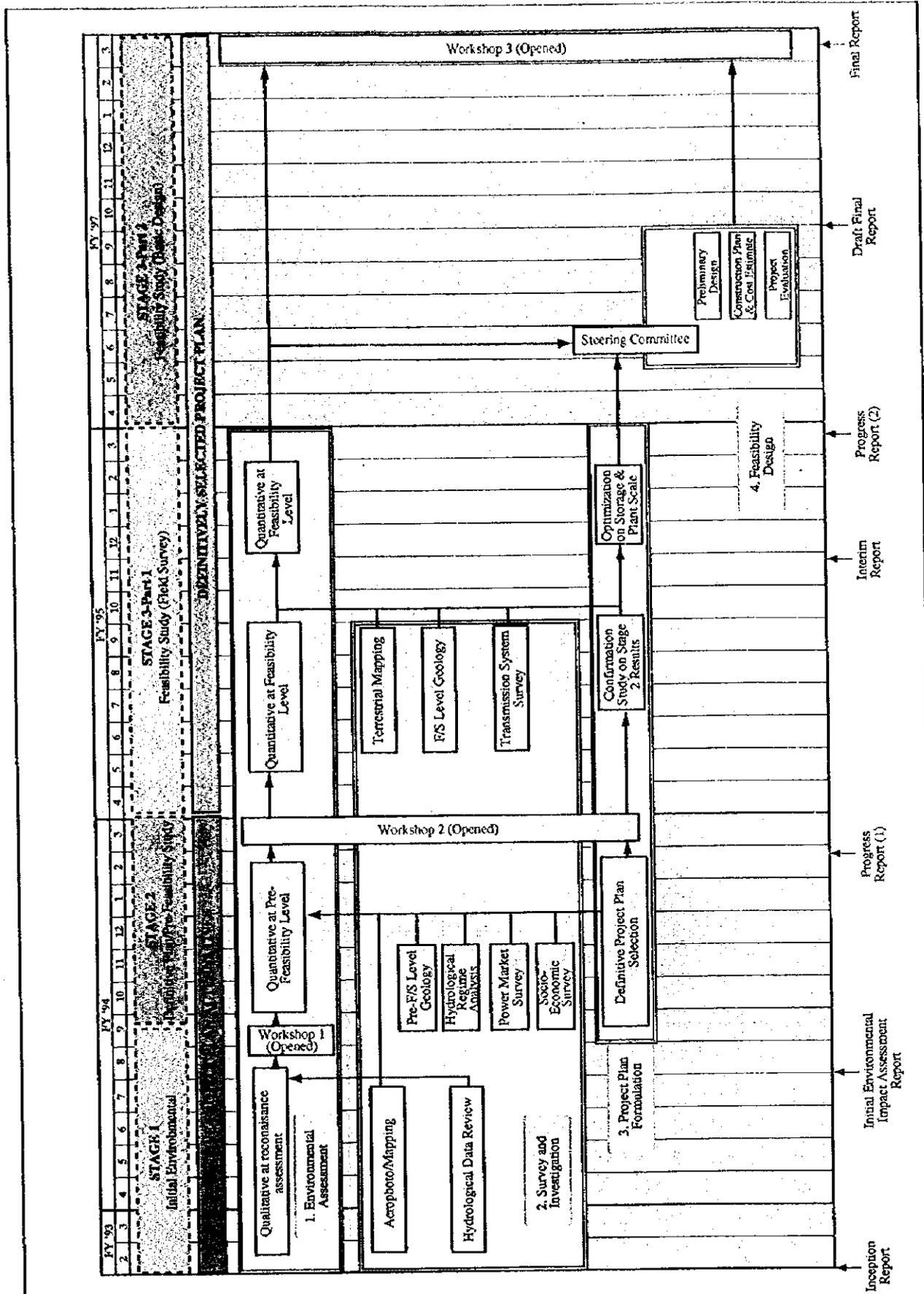
15.10%

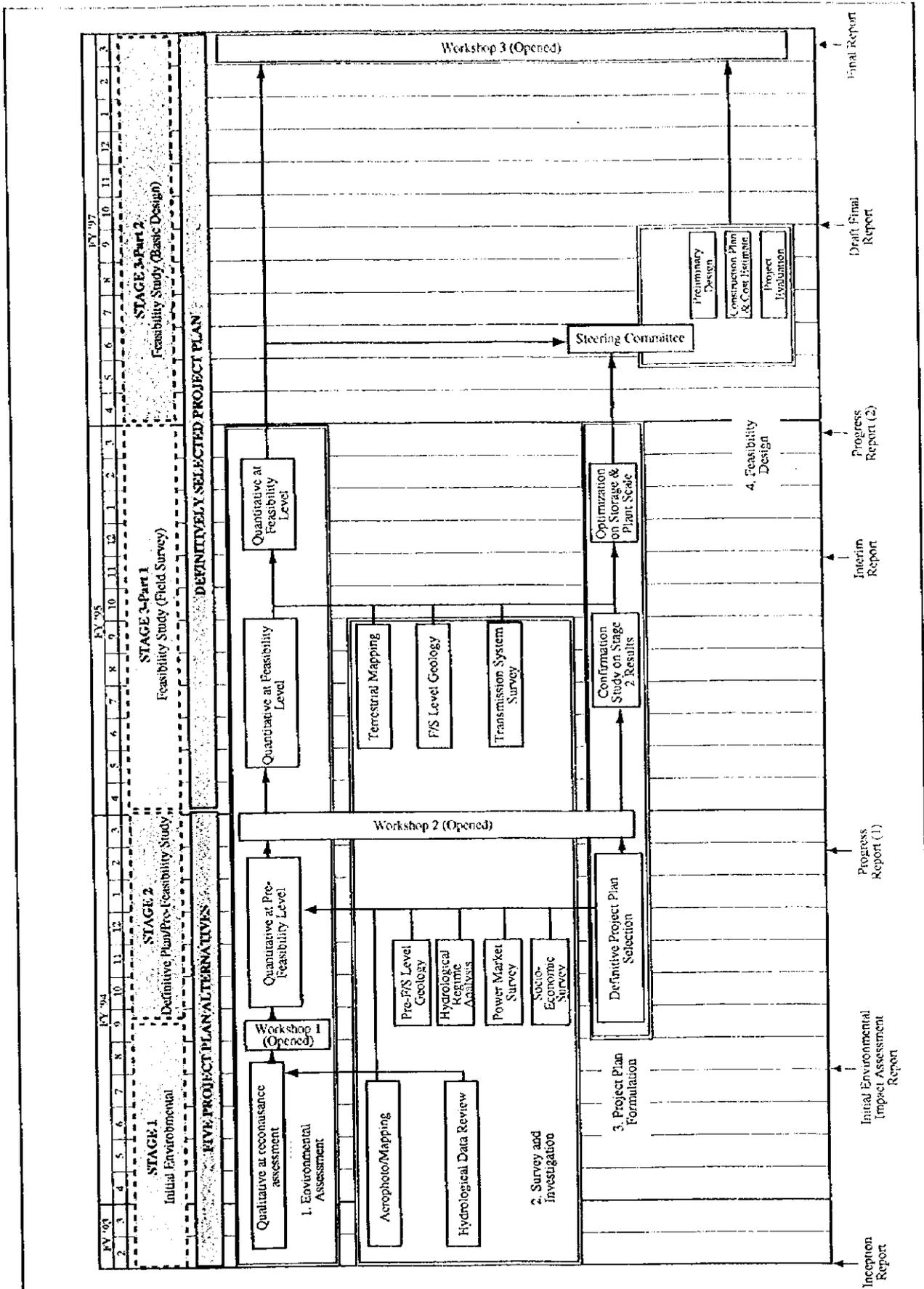
表 9.3.4 ムトンガ/グランドフォールズ水力発電プロジェクトのローン償還計画

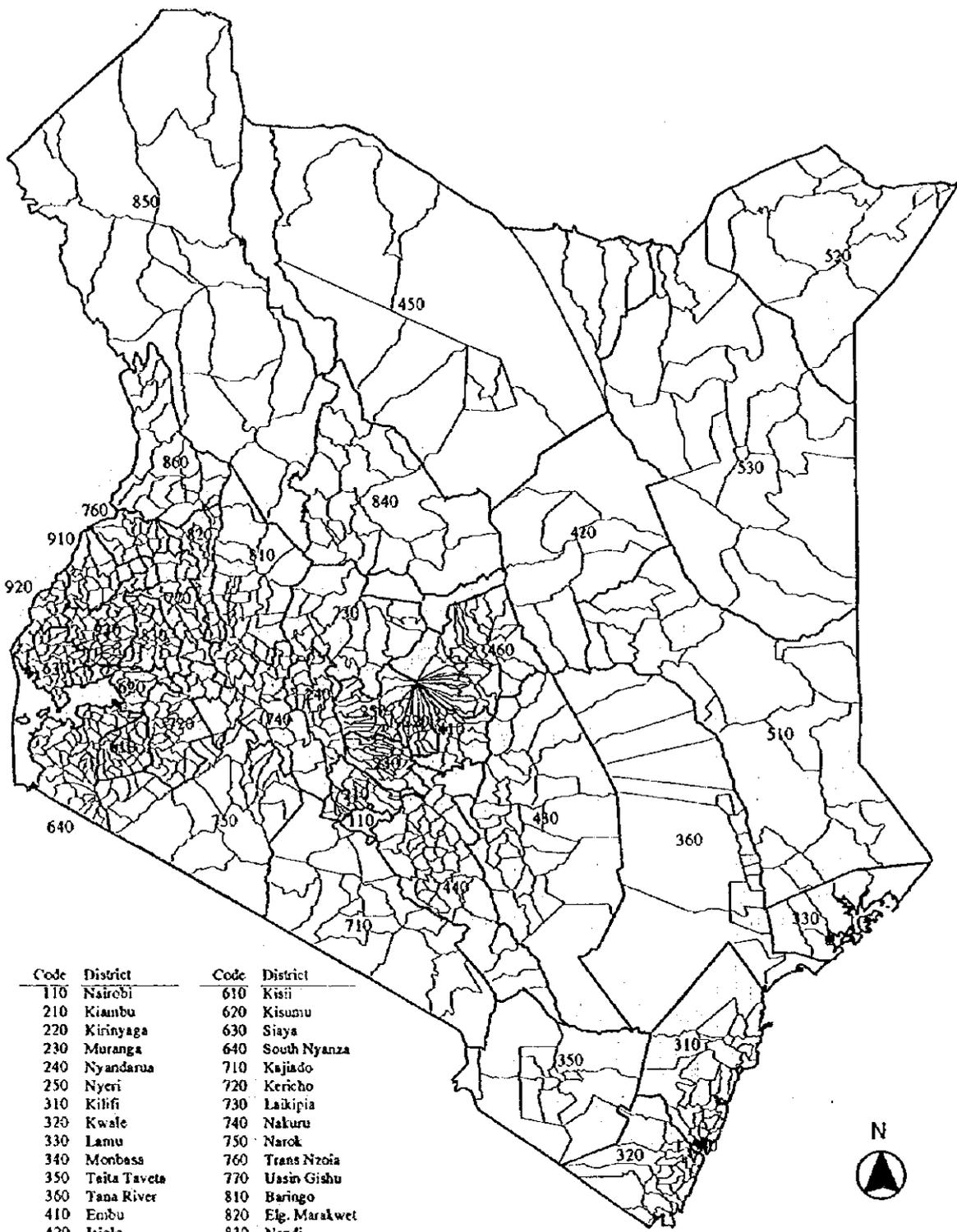
Interest rate of Loan: 2.30%
 Capital recovery factor: 0.06294
 (US\$1,000)

Year in order	Year	Initial Investment Cost		Loan Disbursement (MTC)	Expenditure (incl. Loan Disbursement)			Amount to be expended by the Government			Subsidi. and Distri. Cost		Total outflow		Revenue		Cash balance	Accumulated cash balance	
		(LGF)	(MTC)		Low Grand Falls	Interest	Mutonga Scheme	OM cost	OM cost	Distri. Cost	OM cost	OM cost	Low Grand Falls Scheme	Mutonga Scheme	OM cost	OM cost			Annual revenue
1	2000	3,082	0	2,620	0	0	0	0	0	0	0	0	462	0	0	0	-462	-462	
2	2001	11,654	0	9,906	0	0	0	0	0	0	0	0	1,748	0	0	0	-1,748	-2,210	
3	2002	7,742	0	6,581	0	0	0	0	0	0	0	0	1,161	0	0	0	-1,161	-3,372	
4	2003	64,593	0	54,904	0	0	0	0	0	0	0	0	9,689	0	0	0	-9,689	-13,061	
5	2004	53,405	0	45,394	0	0	0	0	0	0	0	0	8,011	0	0	0	-8,011	-21,071	
6	2005	72,842	0	61,916	0	0	0	0	0	0	0	0	10,926	0	0	0	-10,926	-31,998	
7	2006	108,552	1078	92,269	916	0	0	0	0	0	0	0	16,445	162	0	0	-16,445	-48,442	
8	2007	108,509	1,099	92,233	934	0	0	0	0	0	0	0	16,276	165	0	0	-16,441	-64,883	
9	2008	14,108	58,826	11,992	-50,002	0	0	0	0	0	0	0	2,116	8,824	1,018	0	9,009	-20,967	
10	2009	27,783	0	23,616	0	0	0	0	0	0	0	0	4,167	8,274	1,018	0	18,018	20,967	
11	2010	61,735	0	52,475	10,754	15,090	25,845	0	0	0	0	0	9,260	4,167	2,035	0	18,018	24,220	
12	2011	72,121	0	61,303	10,407	15,438	25,845	0	0	0	0	0	10,818	9,260	2,035	0	18,018	55,138	
13	2012	12,243	0	10,407	10,052	15,793	25,845	0	0	0	0	0	1,836	10,818	2,035	538	22,264	56,716	
14	2013				9,689	16,156	25,845	0	0	0	0	0	0	1,836	2,035	1,075	55,465	52,518	
15	2014				9,317	16,527	25,845	0	0	0	0	0	0	0	2,035	1,075	55,465	329,929	
16	2015				8,937	16,908	25,845	0	0	0	0	0	0	0	2,035	1,075	55,465	329,929	
17	2016				8,548	17,296	25,845	6,107	7,974	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
18	2017				8,151	17,684	25,845	5,923	8,158	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
19	2018				7,744	18,101	25,845	5,544	8,345	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
20	2019				7,327	18,518	25,845	5,146	8,537	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
21	2020				6,901	18,943	25,845	5,347	8,734	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
22	2021				6,466	19,379	25,845	5,146	8,935	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
23	2022				6,020	19,825	25,845	4,941	9,140	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
24	2023				5,564	20,281	25,845	4,731	9,350	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
25	2024				5,098	20,747	25,845	4,516	9,565	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
26	2025				4,620	21,224	25,845	4,296	9,785	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
27	2026				4,152	21,713	25,845	4,071	10,010	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
28	2027				3,633	22,212	25,845	3,840	10,241	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
29	2028				3,122	22,723	25,845	3,605	10,476	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
30	2029				2,599	23,246	25,845	3,364	10,717	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
31	2030				2,075	23,784	25,845	3,117	10,964	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
32	2031				1,551	24,333	25,845	2,865	11,216	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
33	2032				1,026	24,893	25,845	2,607	11,474	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
34	2033				501	25,463	25,845	2,343	11,738	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
35	2034				0	26,043	25,845	2,075	12,008	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
36	2035				0	26,633	25,845	1,797	12,284	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
37	2036				0	27,233	25,845	0	0	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
38	2037				0	27,843	25,845	0	0	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
39	2038				0	28,463	25,845	0	0	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
40	2039				0	29,093	25,845	0	0	14,081	0	0	0	0	2,035	1,075	55,465	170,518	
Total		444,447	234,885	377,814	199,652	199,683	377,814	516,897	81,968	199,652	281,620	296,517	66,073	35,233	111,775	29,563	801,108	1,842,869	3,109,952

付 図





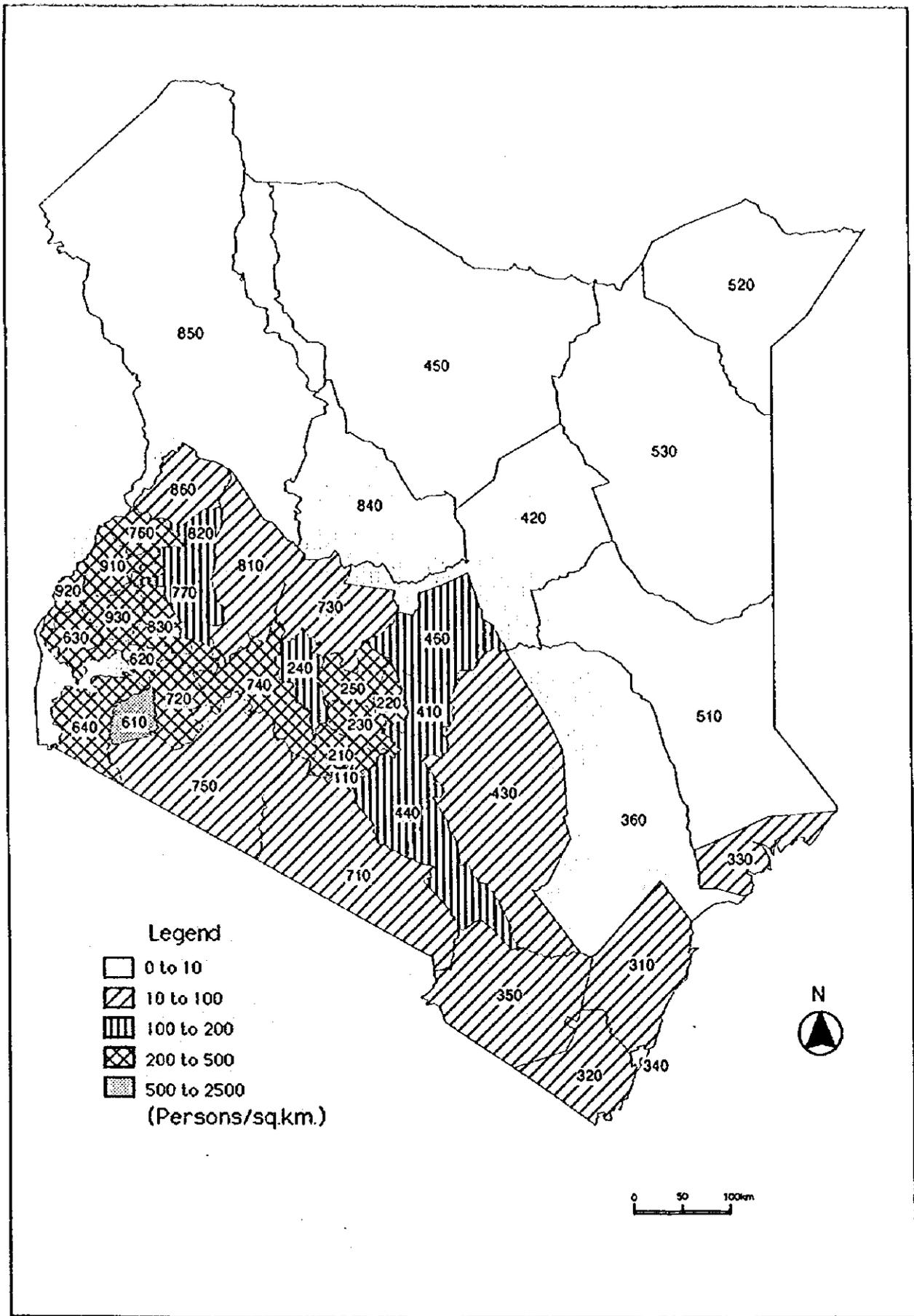


Code	District	Code	District
110	Nairobi	610	Kisii
210	Kiambu	620	Kisumu
220	Kirinyaga	630	Siaya
230	Muranga	640	South Nyanza
240	Nyandarua	710	Kajiado
250	Nyeri	720	Kericho
310	Kilifi	730	Lakipia
320	Kwale	740	Nakuru
330	Lamu	750	Narok
340	Monbasa	760	Trans Nzoia
350	Taita Taveta	770	Uasin Gishu
360	Tana River	810	Baringo
410	Embu	820	Elg. Marakwet
420	Isiolo	830	Nandi
430	Kitui	840	Samburu
440	Machakos	850	Turkana
450	Marsabit	860	West Pokot
460	Meru	910	Bungoma
510	Garissa	920	Busia
520	Mandera	930	Kakamega
530	Wajir		

JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

1986年における行政区分

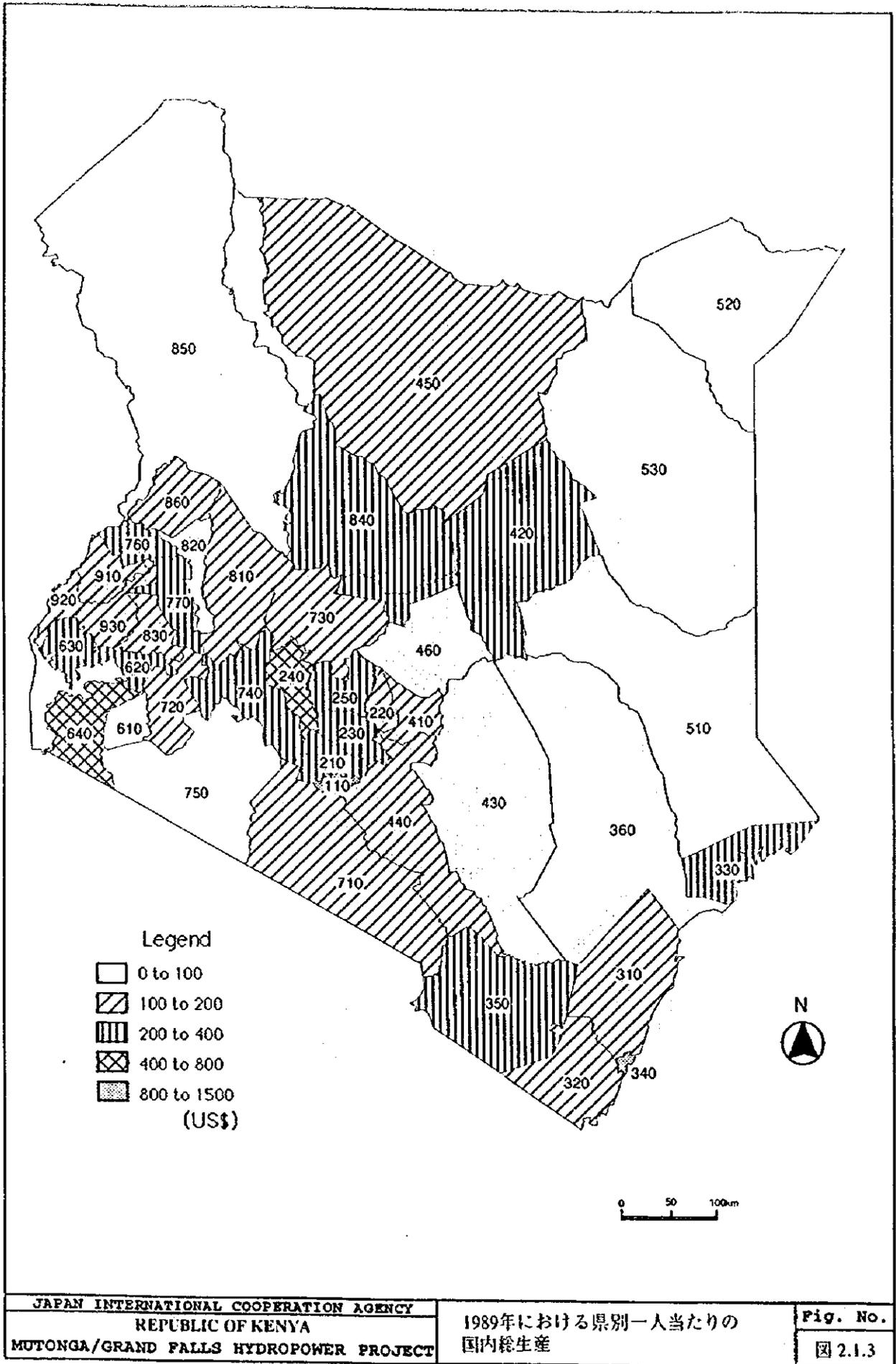
Fig. No.
 図 2.1.1

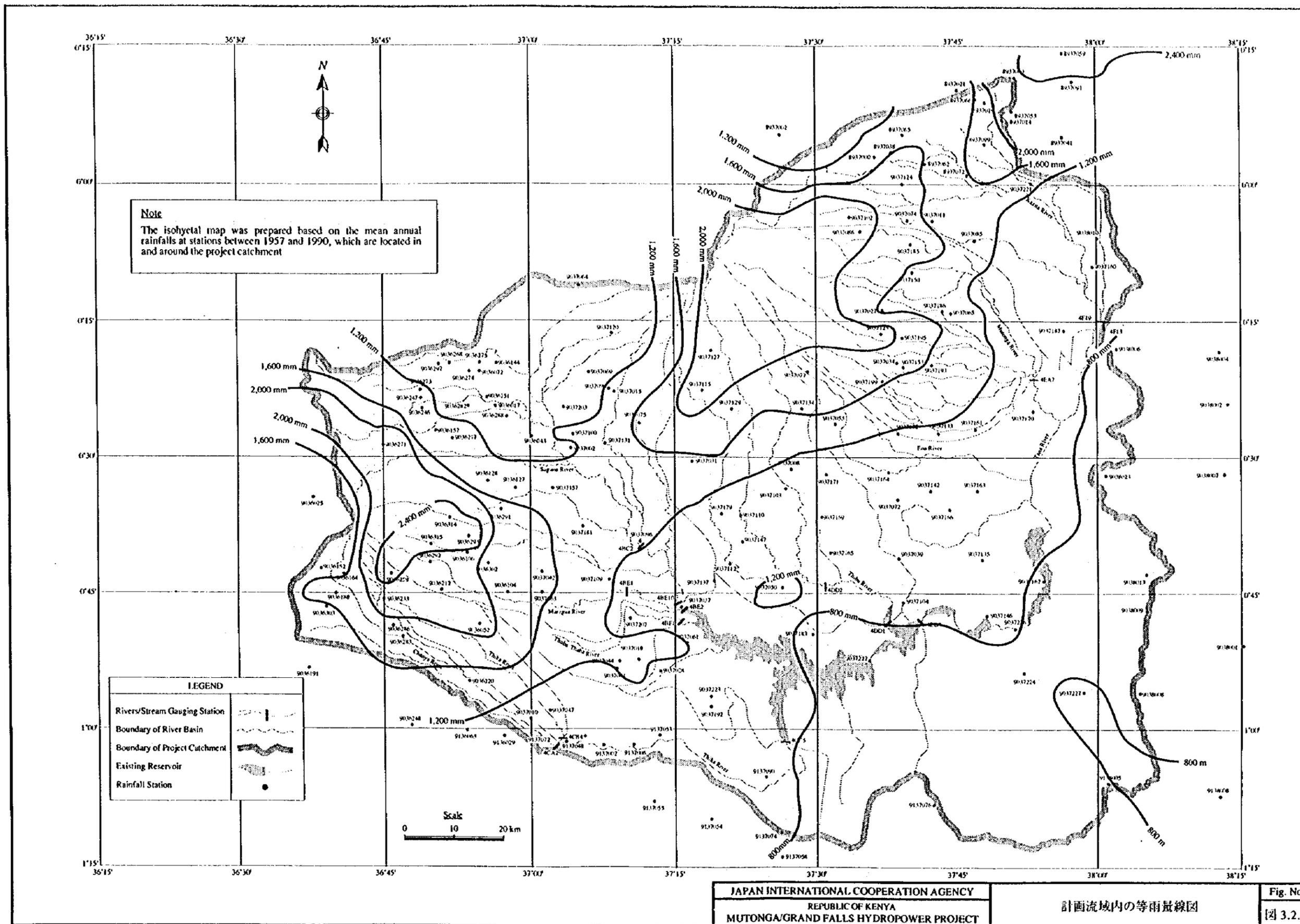


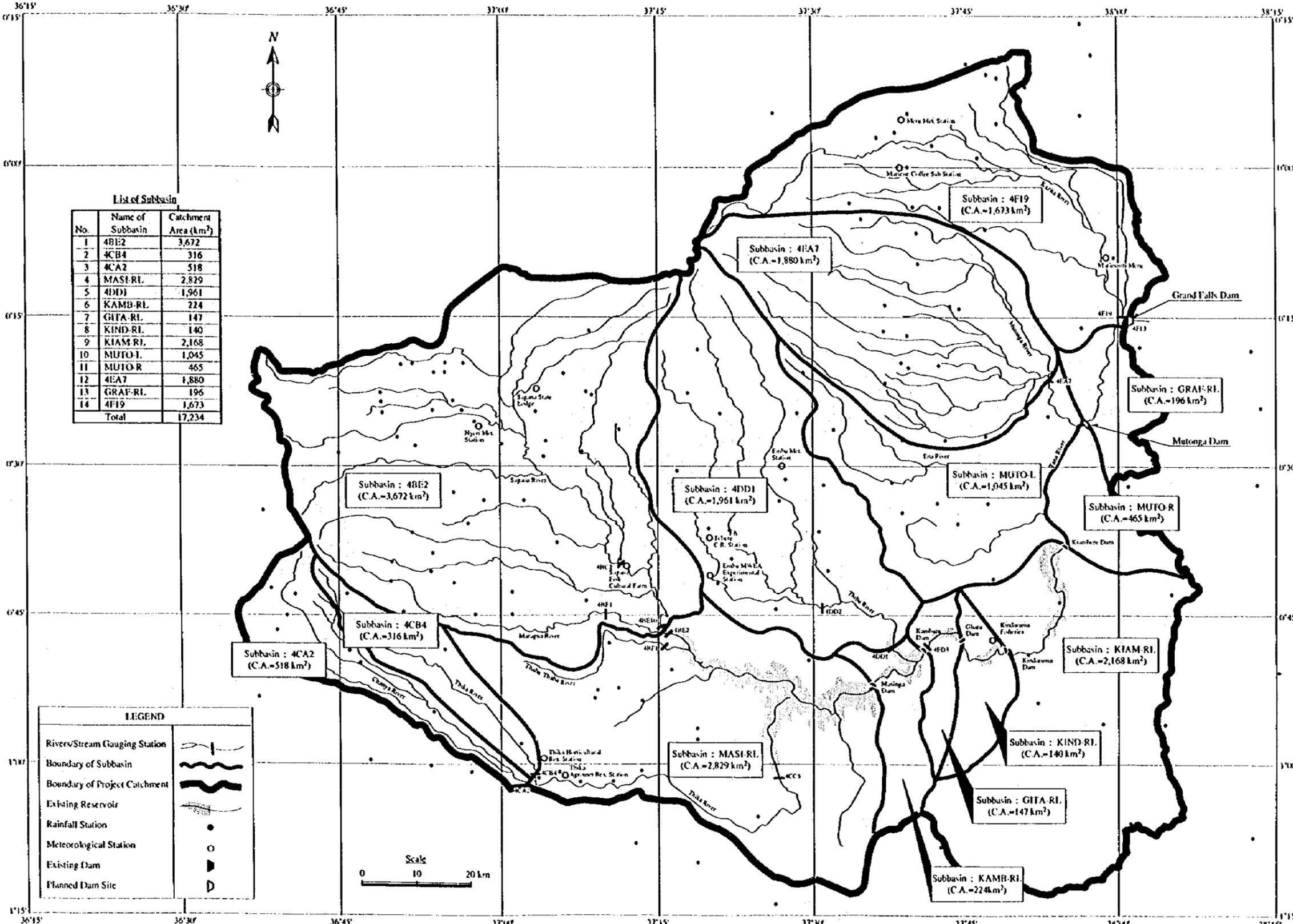
JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

1990年における県別人口密度

Fig. No.
 図 2.1.2





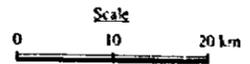


List of Subbasin

No.	Name of Subbasin	Catchment Area (km ²)
1	4BE2	3,672
2	4CB4	316
3	4CA2	518
4	MA SI-RI	2,829
5	4DD1	1,961
6	KAMB-RI	224
7	GIFA-RI	147
8	KIND-RI	140
9	KIAM-RI	2,168
10	MUFO-L	1,045
11	MUFO-R	465
12	4EA7	1,880
13	GRAF-RI	196
14	4F19	1,673
Total		17,234

LEGEND

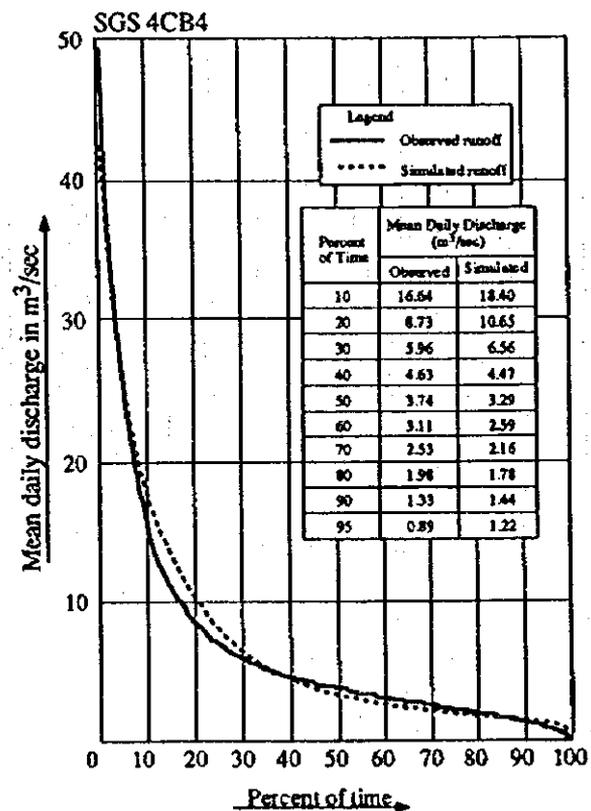
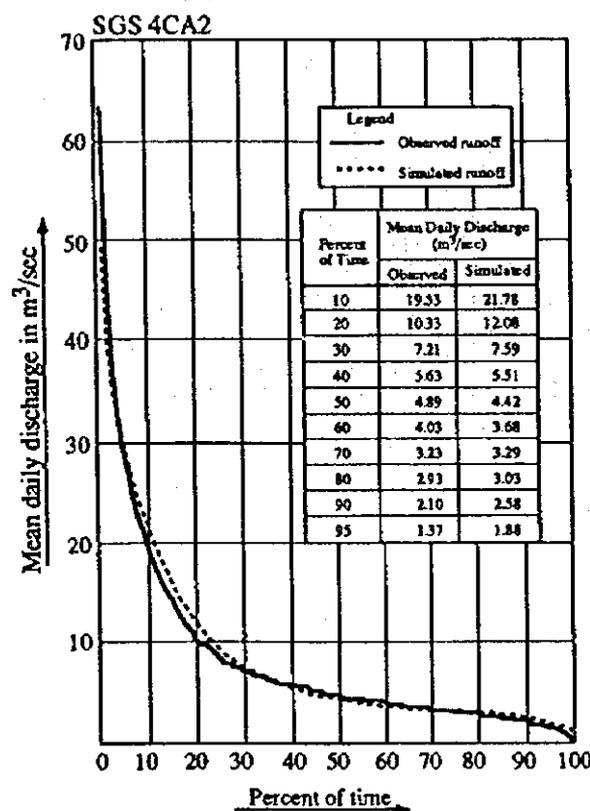
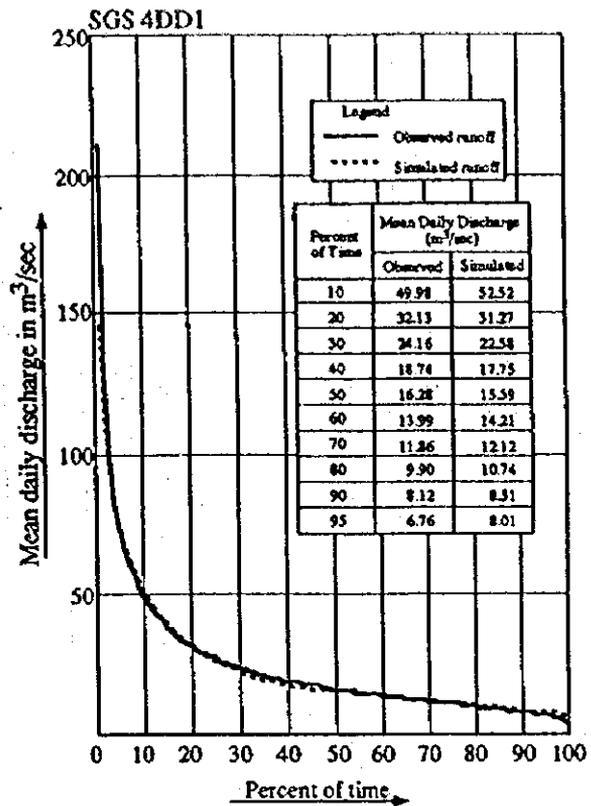
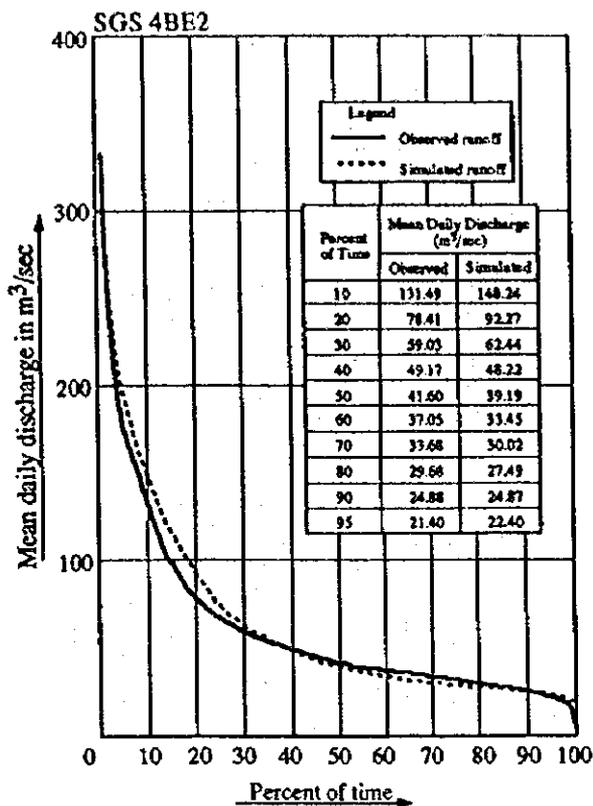
Rivers/Stream Gauging Station	
Boundary of Subbasin	
Boundary of Project Catchment	
Existing Reservoir	
Rainfall Station	
Meteorological Station	
Existing Dam	
Planned Dam Site	



JAPAN INTERNATIONAL COOPERATION AGENCY
REPUBLIC OF KENYA
MUTONGA/GRAND FALLS HYDROPOWER PROJECT

流出解析のための分割流域

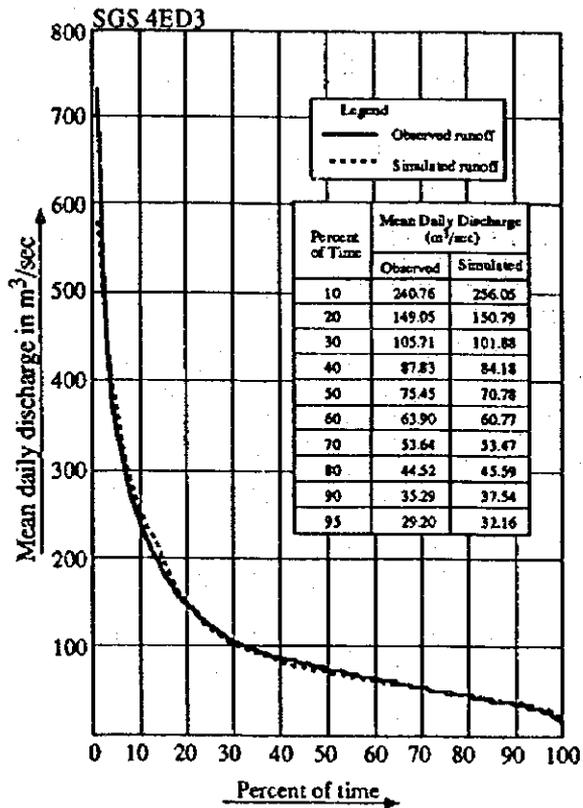
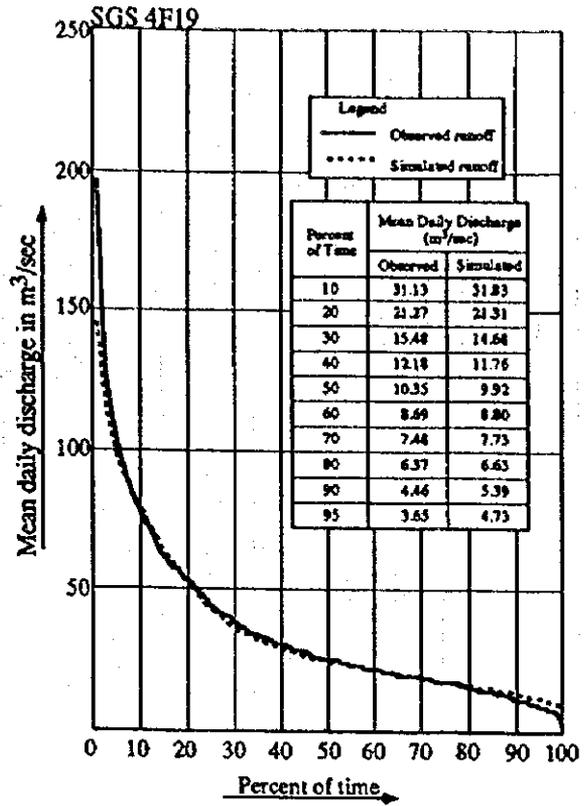
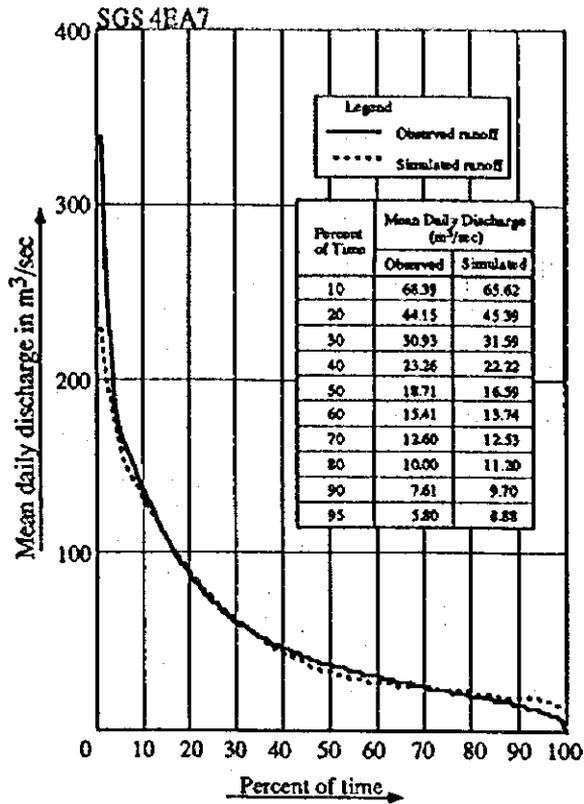
Fig. No.
図 3.2.2



JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

日流量流況図の観測値と計算値の比較
 (1/2)

Fig. No.
 図 3.2.3



JAPAN INTERNATIONAL COOPERATION AGENCY

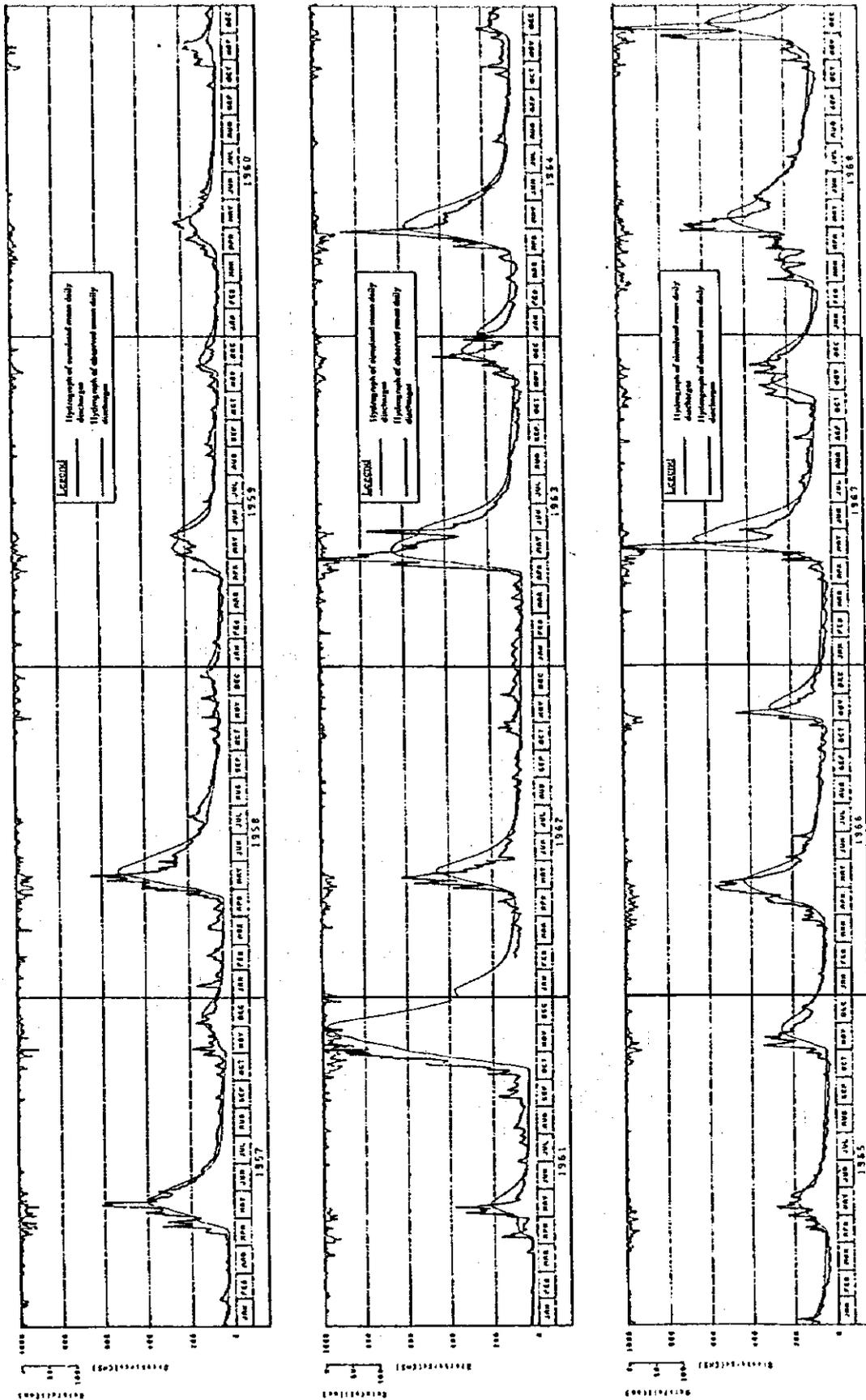
REPUBLIC OF KENYA

MUTONGA/GRAND FALLS HYDROPOWER PROJECT

日流量流況図の観測値と計算値の比較
(2/2)

Fig. No.

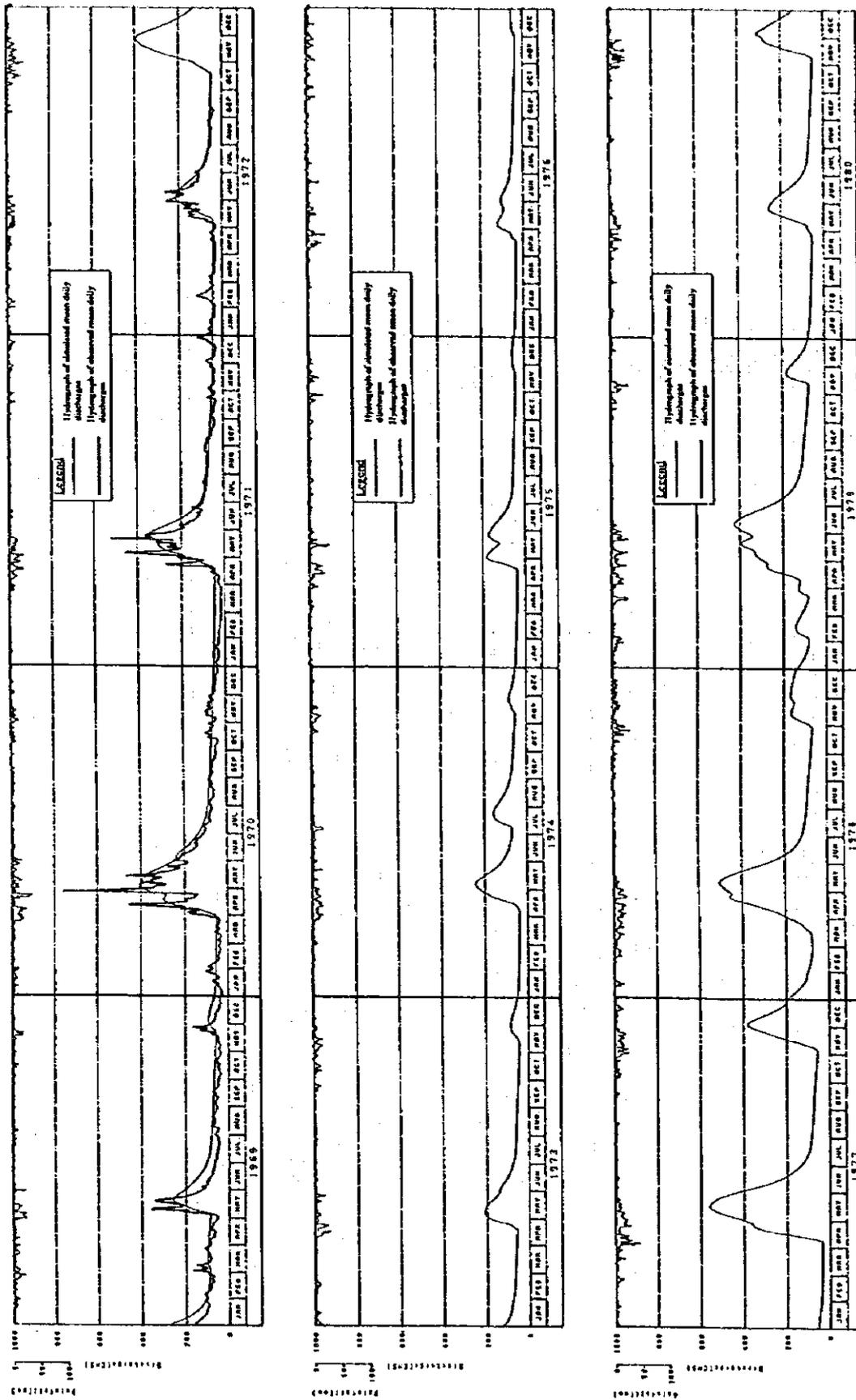
図3.2.3



JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

SGS 4ED3における日流量ハイドログラフ
 (1/3)

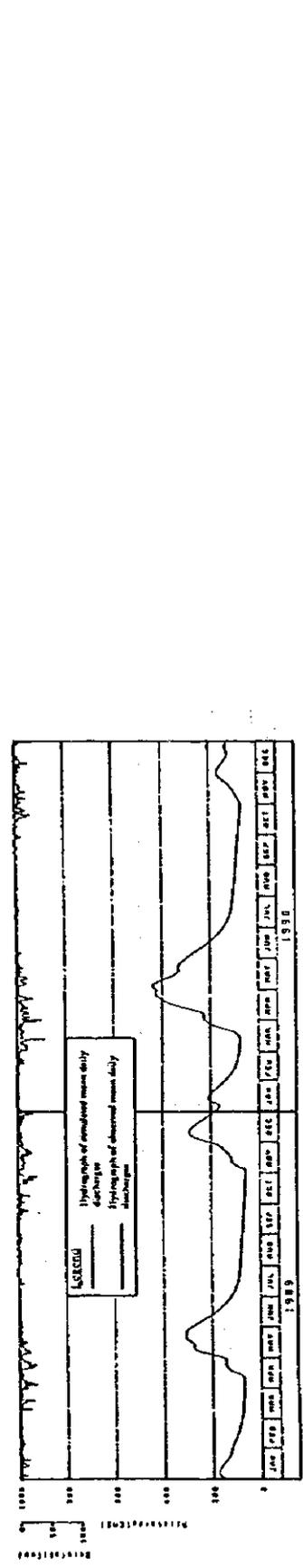
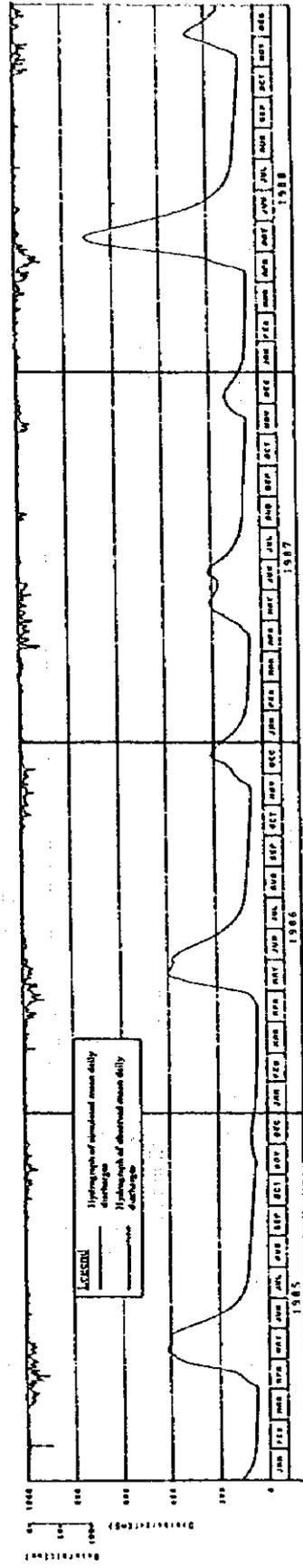
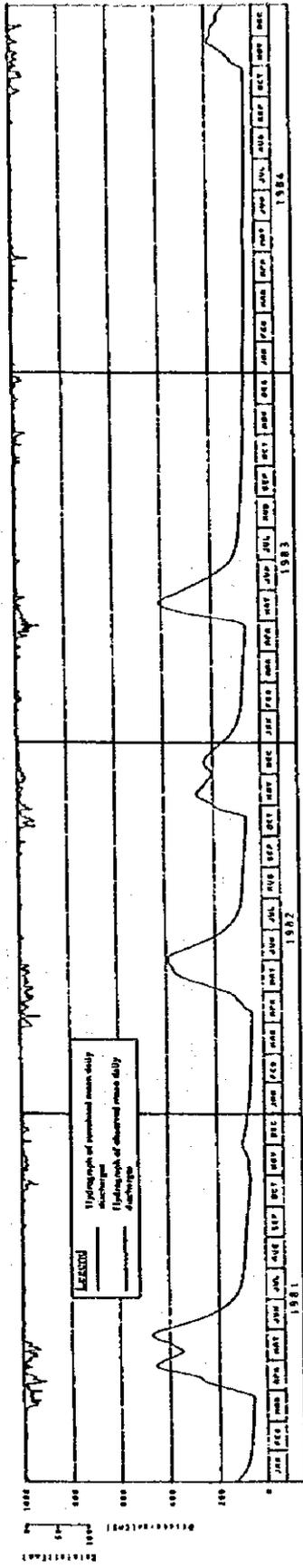
Fig. No.
 3.2.4

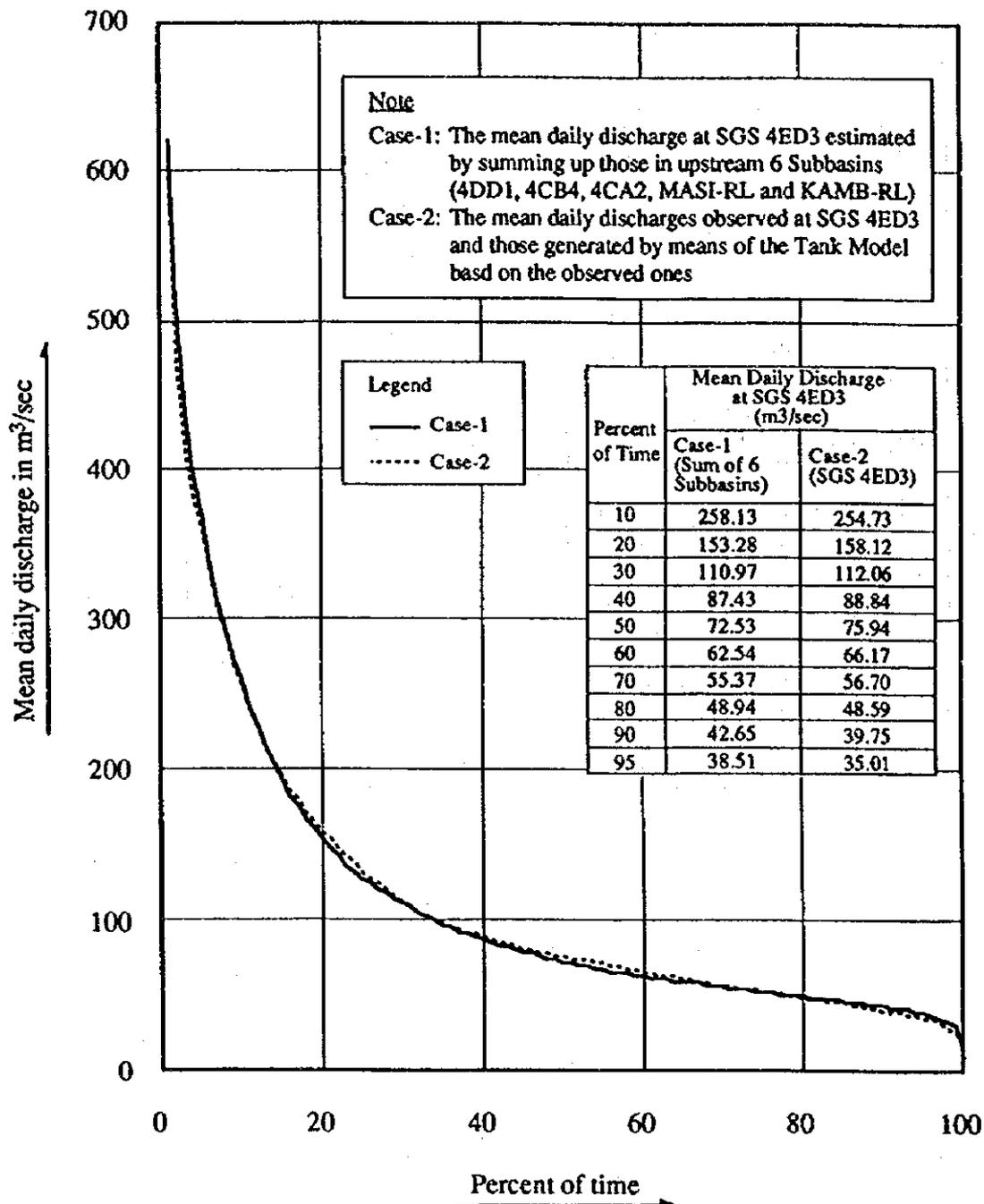


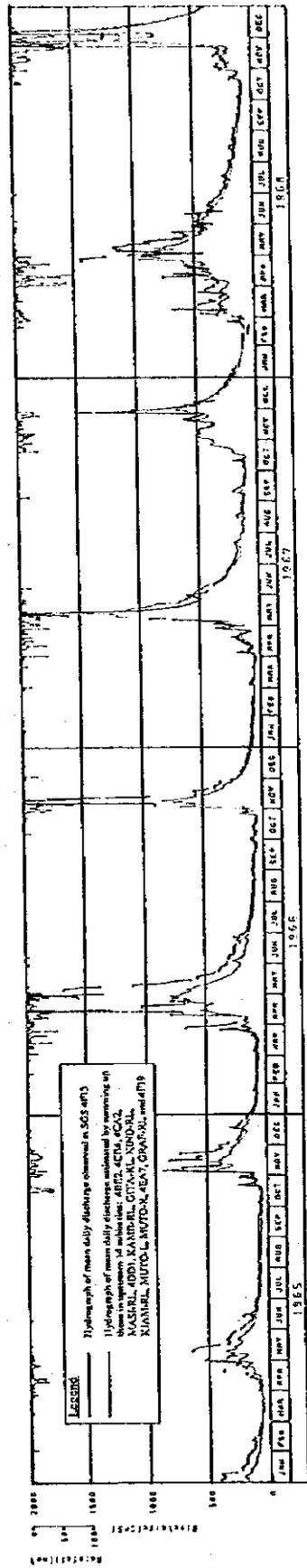
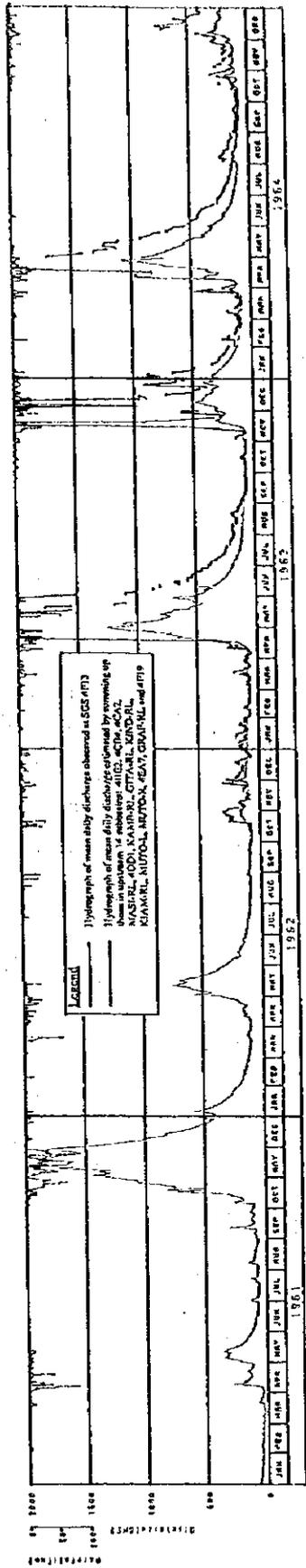
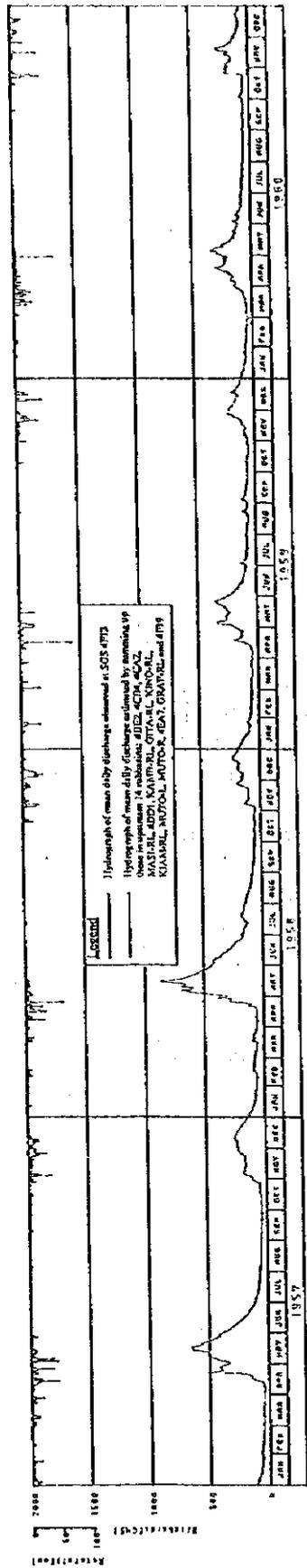
JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

SGS 4ED3における日流量ハイログラフ (2/3)

Fig. No.
 図 3.2.4



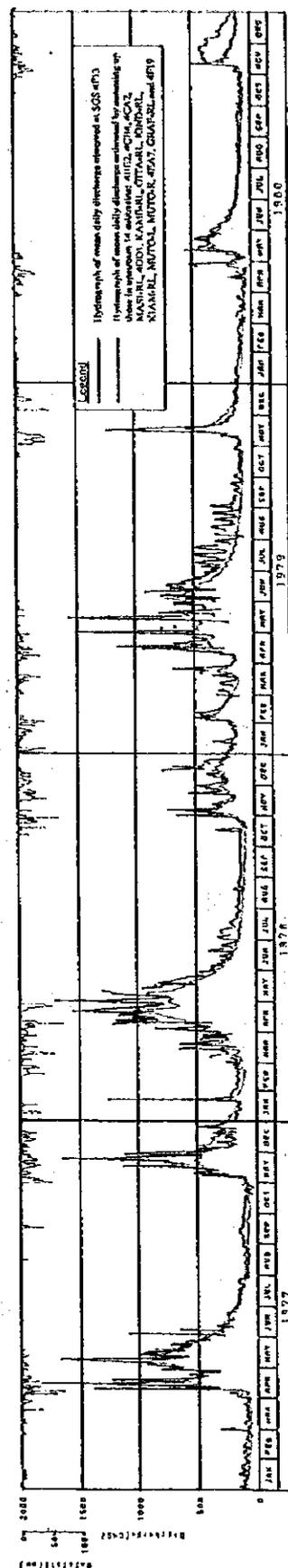
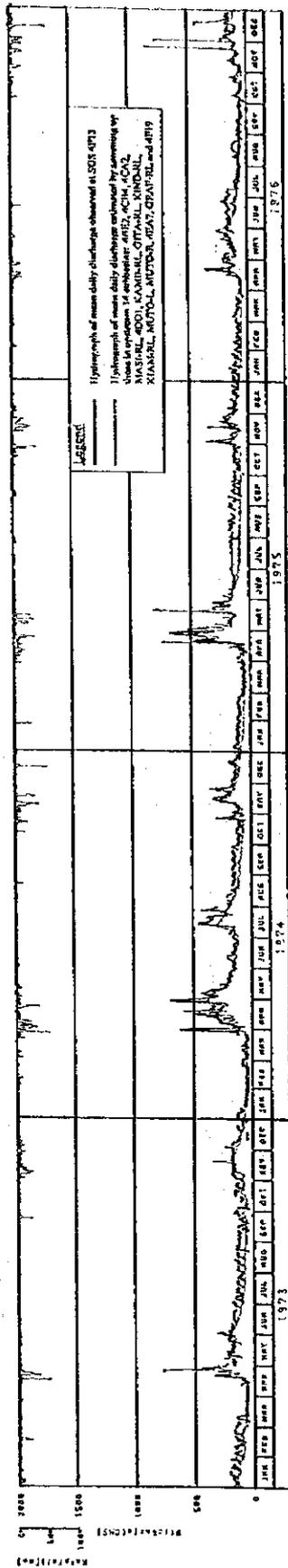
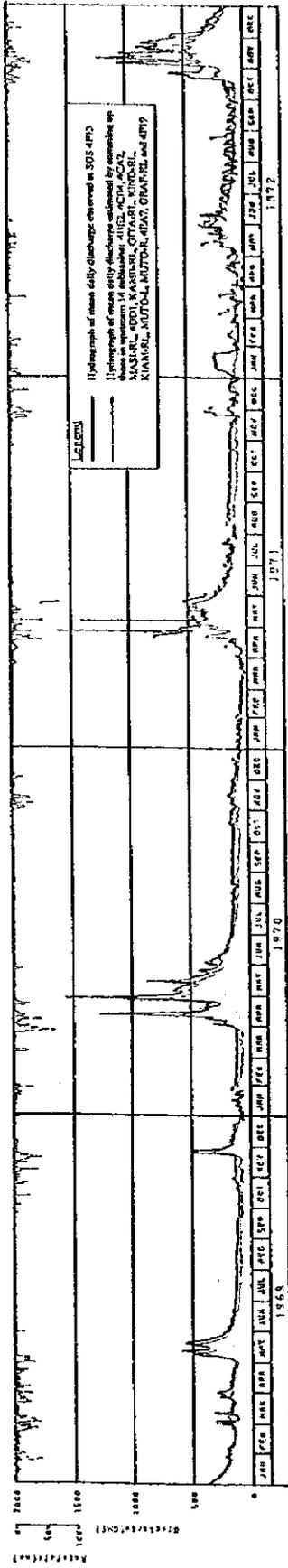


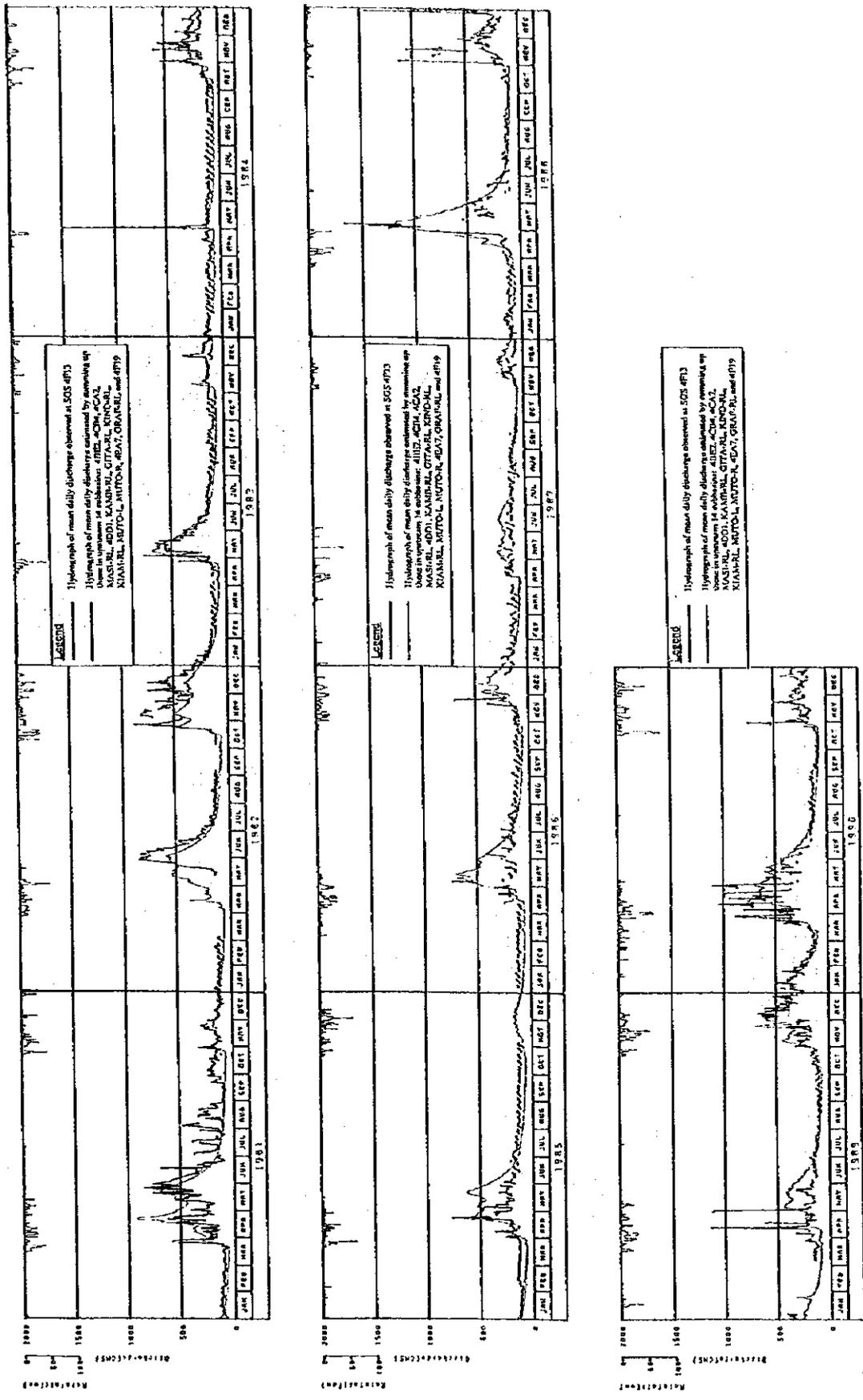


JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

SGS 4F13における日流量ハイドログラフ
 の観測値と計算値の比較 (1/3)

Fig. No.
 3.2.6

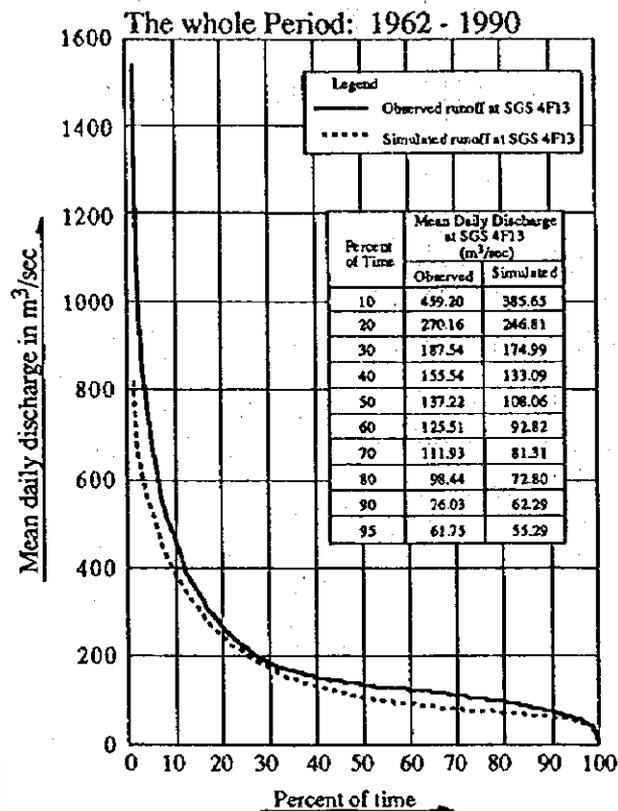
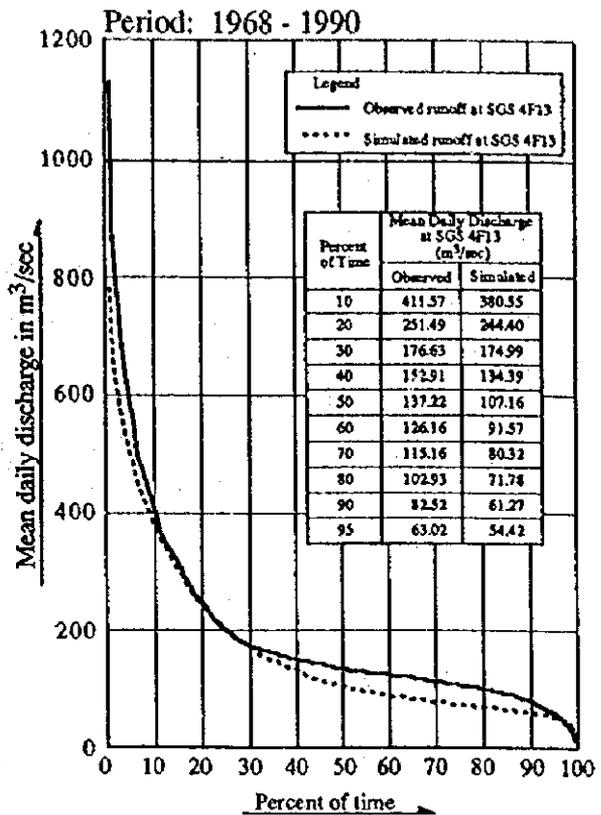
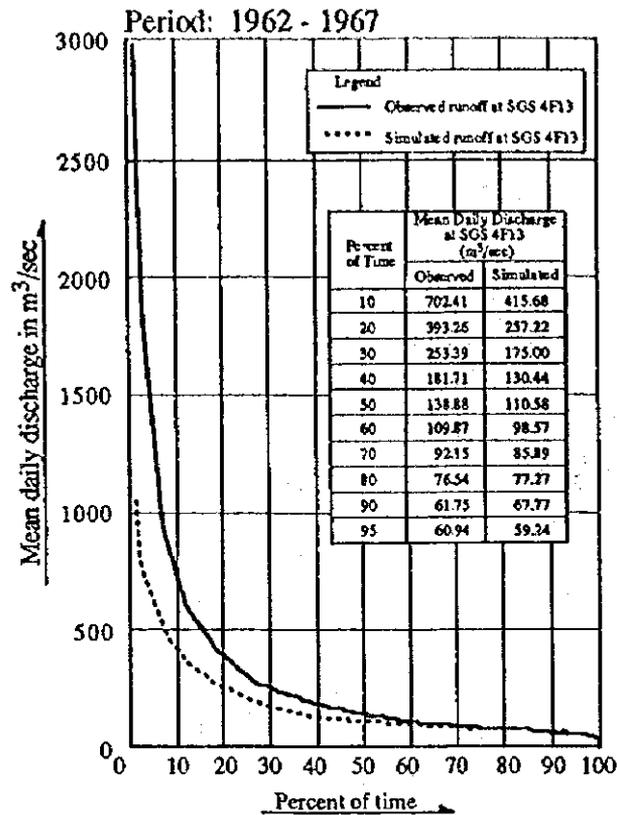




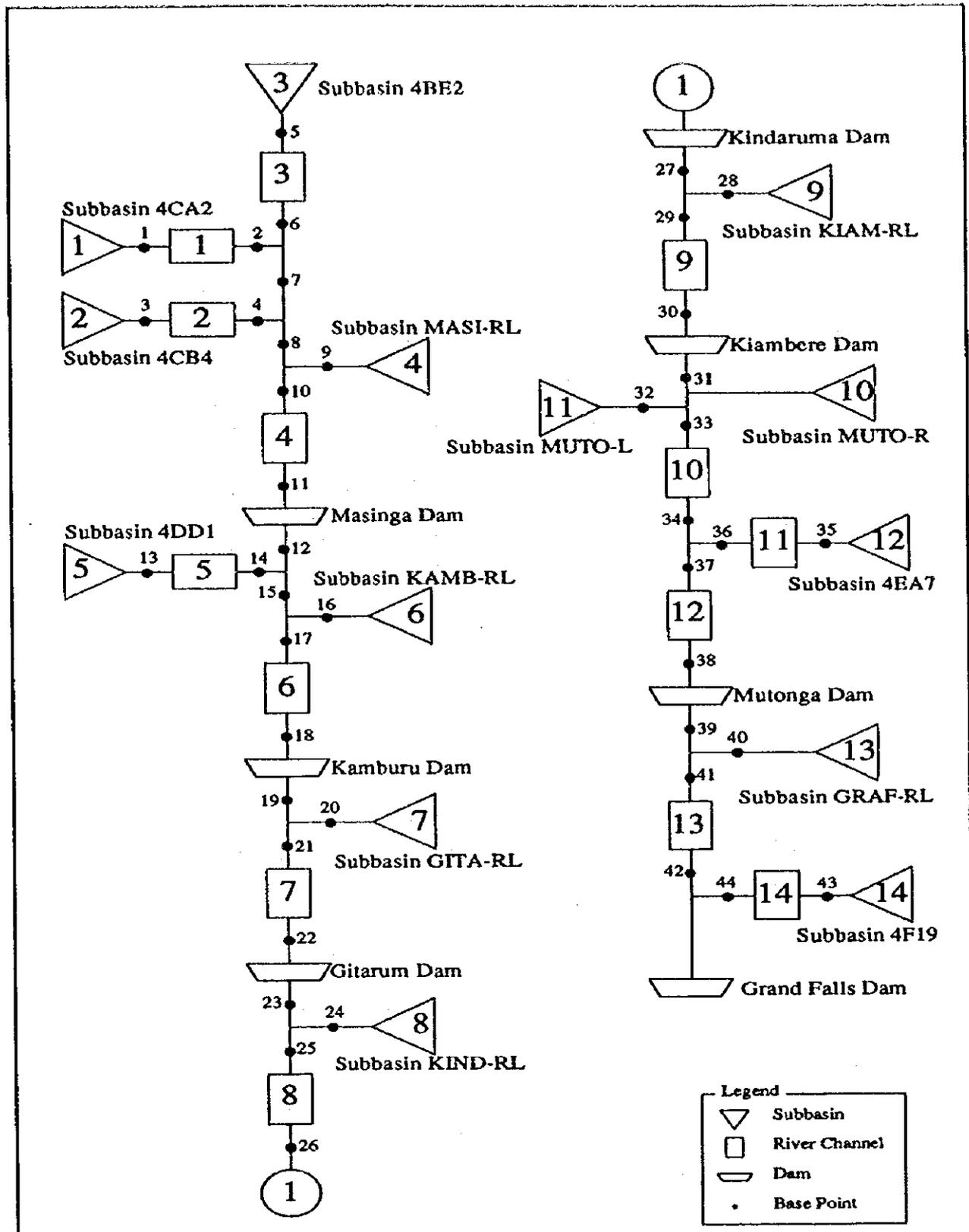
JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

SGS 4F13における日流量ハイドログラフの観測値と計算値の比較 (3/3)

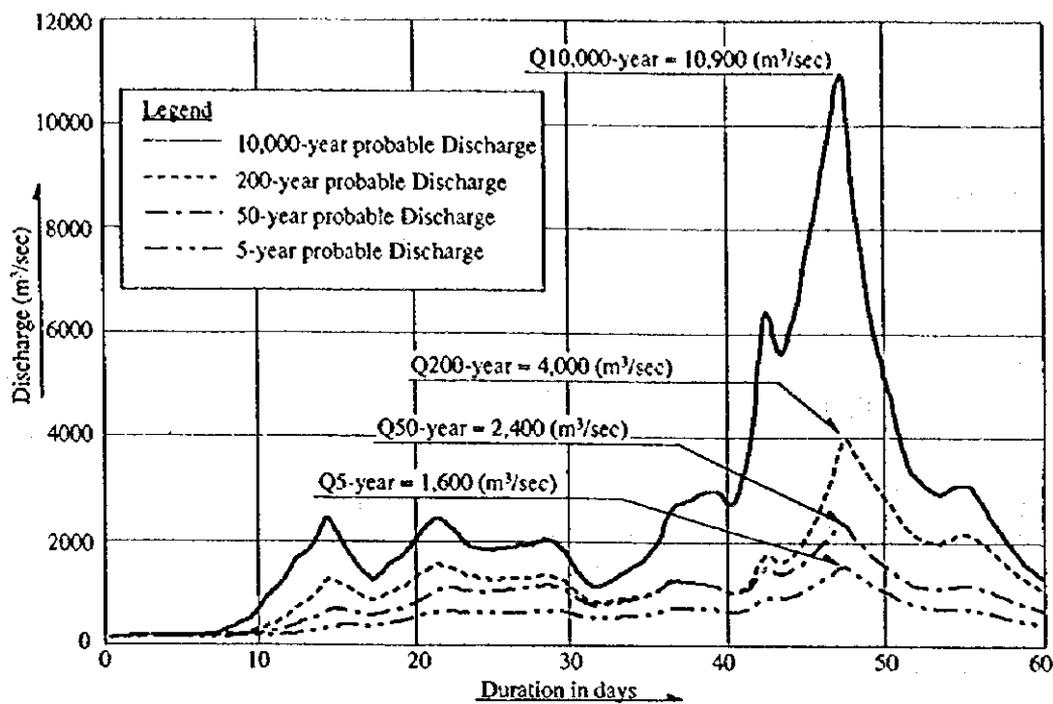
Fig. No.
 図 3.2.6



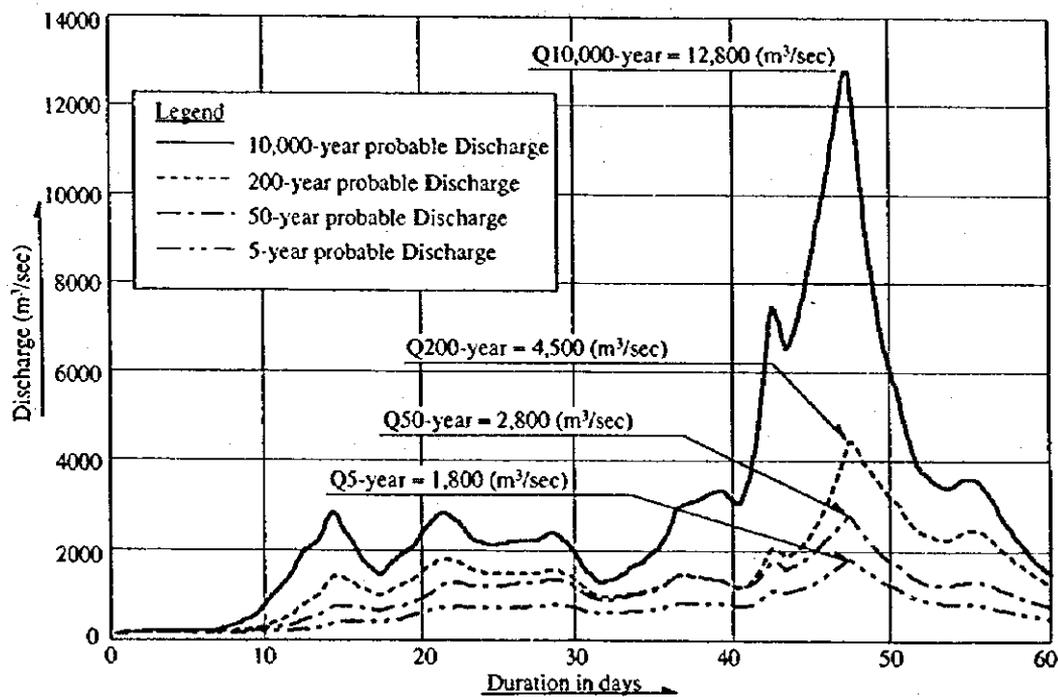
Note
 The "Simulated" and "Simulated runoff" are the mean daily discharges derived by summing up those in the upstream 14 subbasins, which were estimated by means of the Tank Model Method.



Note
The locations of subbasins are shown in Fig. B3.1

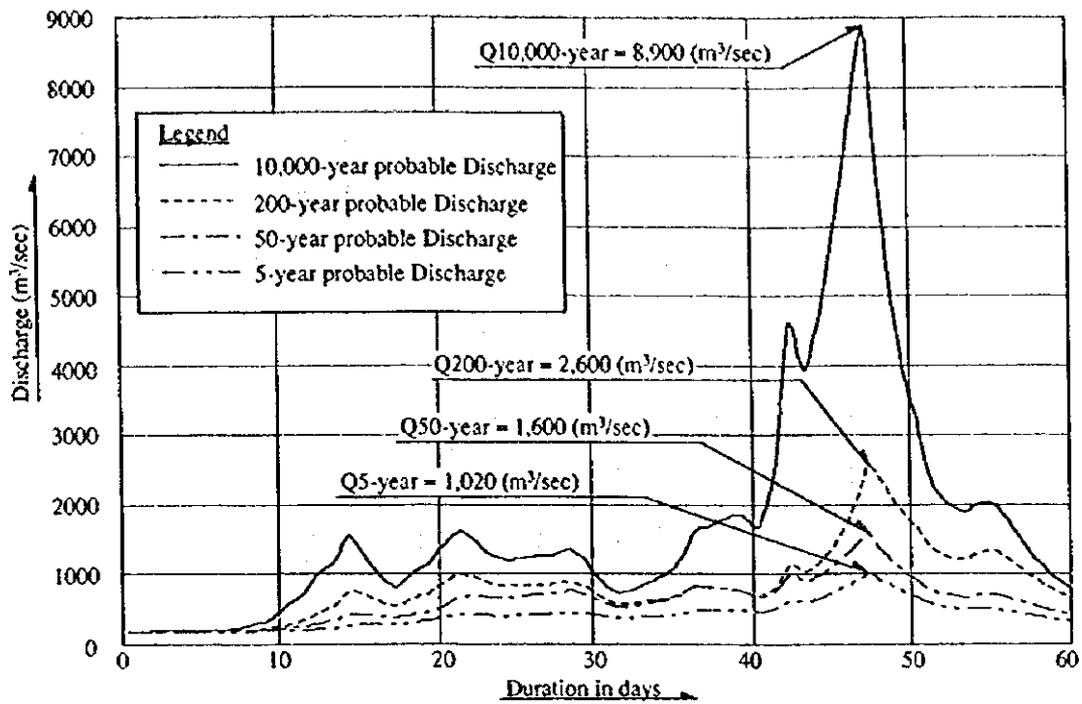


Hydrographs of Probable Floods at Mutonga Dam Site

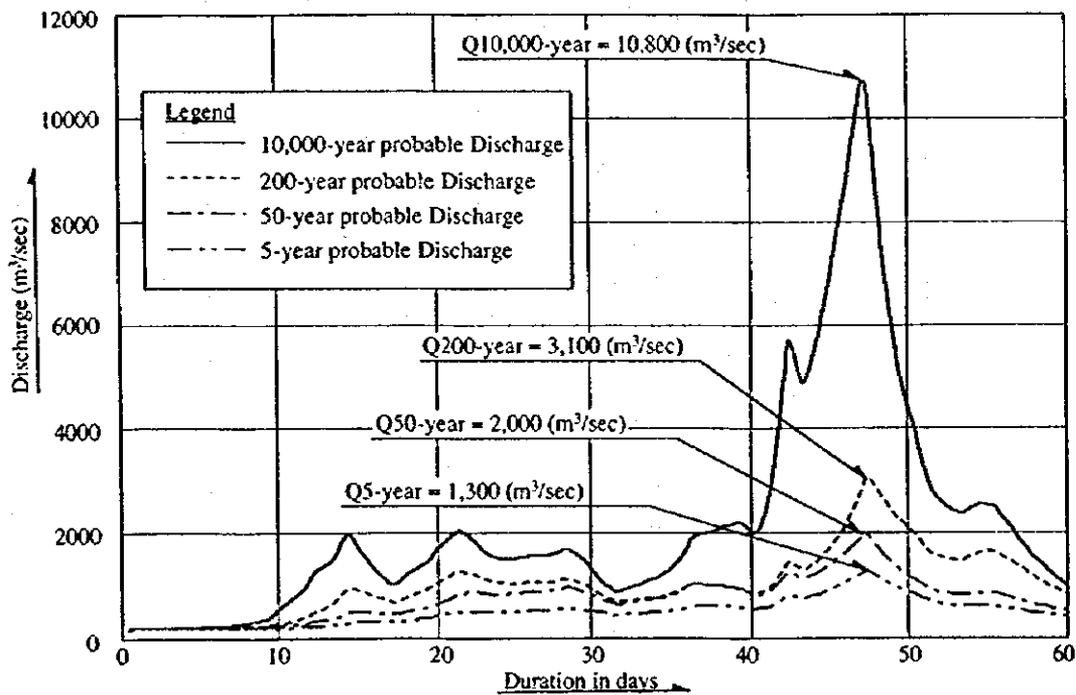


Hydrographs of Probable Floods at Grand Falls Site

JAPAN INTERNATIONAL COOPERATION AGENCY REPUBLIC OF KENYA MUTONGA/GRAND FALLS HYDROPOWER PROJECT	ムトンガとグランドフォールズダム地点 の洪水ハイドログラフ (上流の貯水池がない場合)	Fig. No. 図 3.2.9
---	---	---------------------



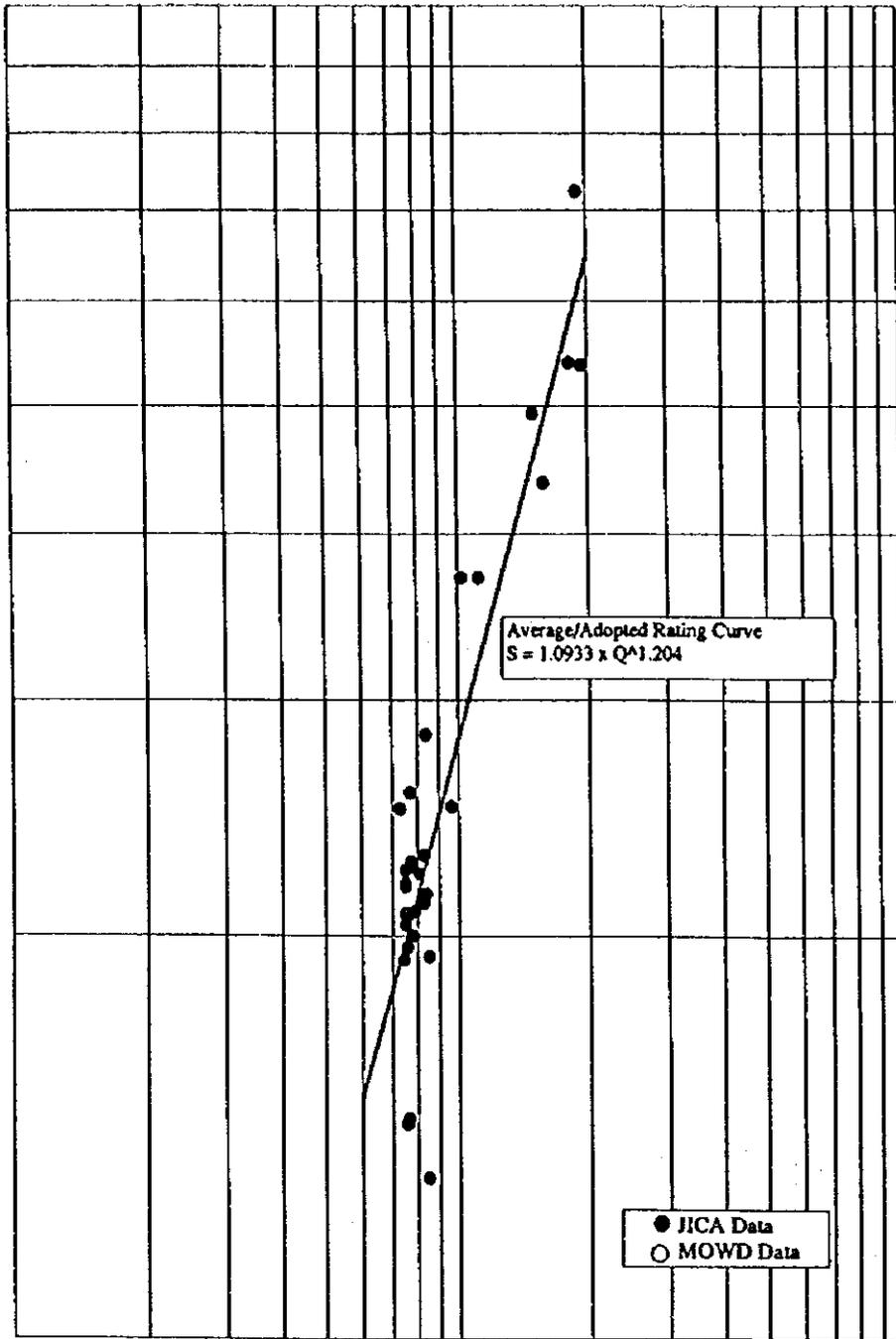
Hydrographs of Probable Floods at Mutonga Dam Site



Hydrographs of Probable Floods at Grand Falls Site

Suspended Load
Yield (t/day)

1,000



100

10

100

1,000
Discharge (m³/s)

JAPAN INTERNATIONAL COOPERATION AGENCY
REPUBLIC OF KENYA

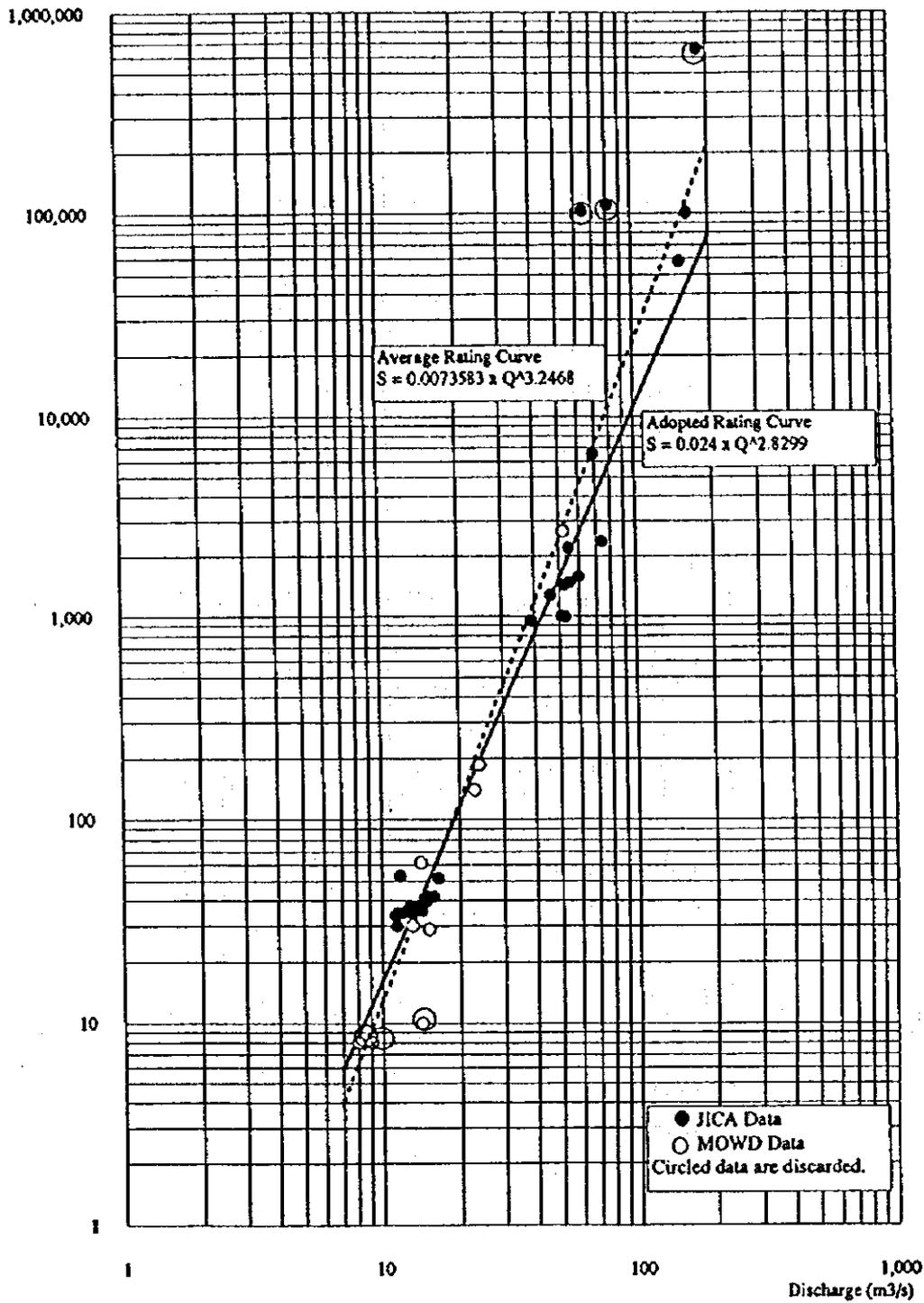
MUTONGA/GRAND FALLS HYDROPOWER PROJECT

キャンベレダム下流地点における
浮遊砂量-流量曲線

Fig. No.

図 3.2.11

Suspended Load
Yield (t/day)



JAPAN INTERNATIONAL COOPERATION AGENCY
REPUBLIC OF KENYA
MUTONGA/GRAND FALLS HYDROPOWER PROJECT

ムトンガ川のSGS4EA7における
浮遊砂量-流量曲線

Fig. No.
図 3.2.12

Suspended Load
Yield (t/day)

1,000,000

100,000

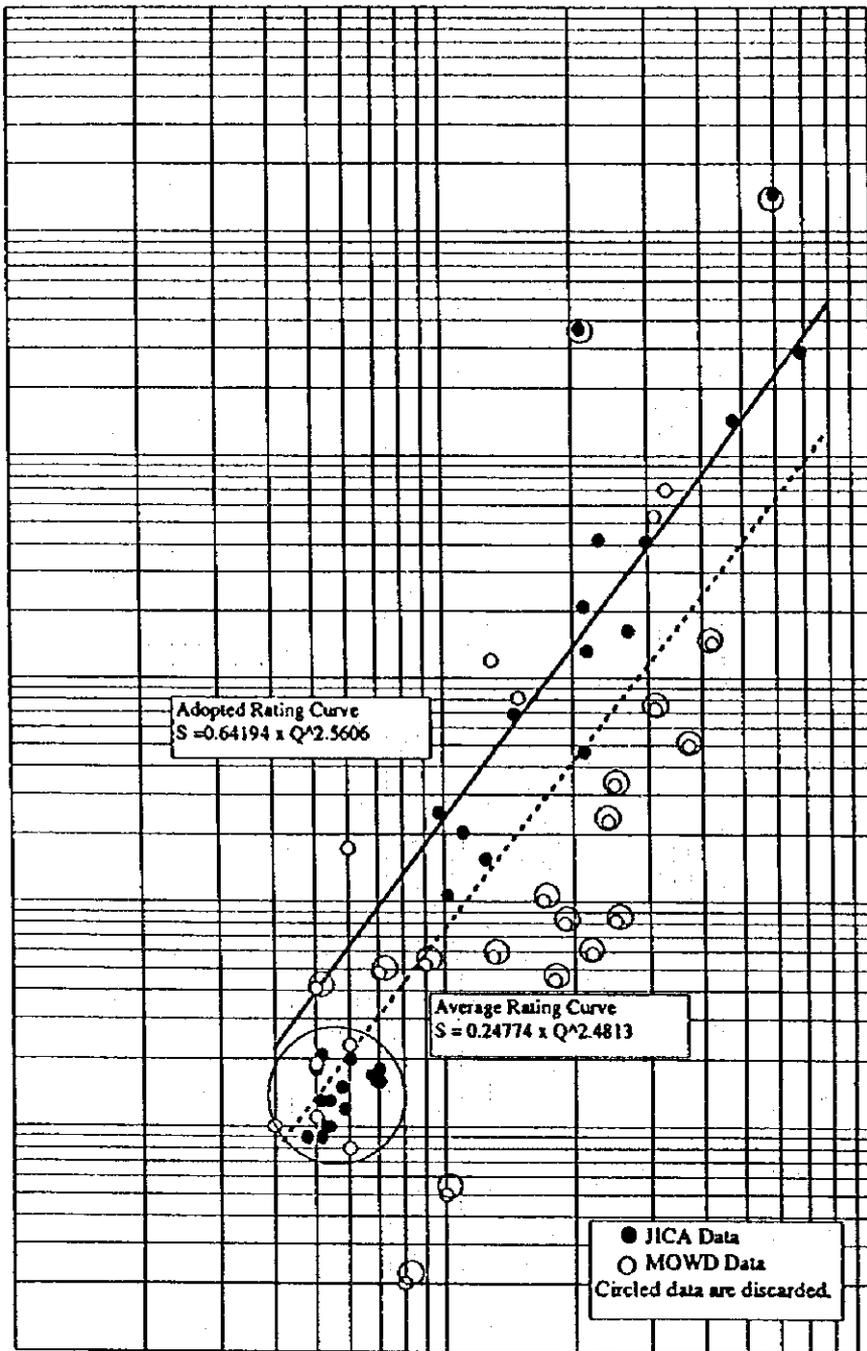
10,000

1,000

100

10

1



Adopted Rating Curve
 $S = 0.64194 \times Q^{2.5606}$

Average Rating Curve
 $S = 0.24774 \times Q^{2.4813}$

● JICA Data
○ MOWD Data
Circled data are discarded.

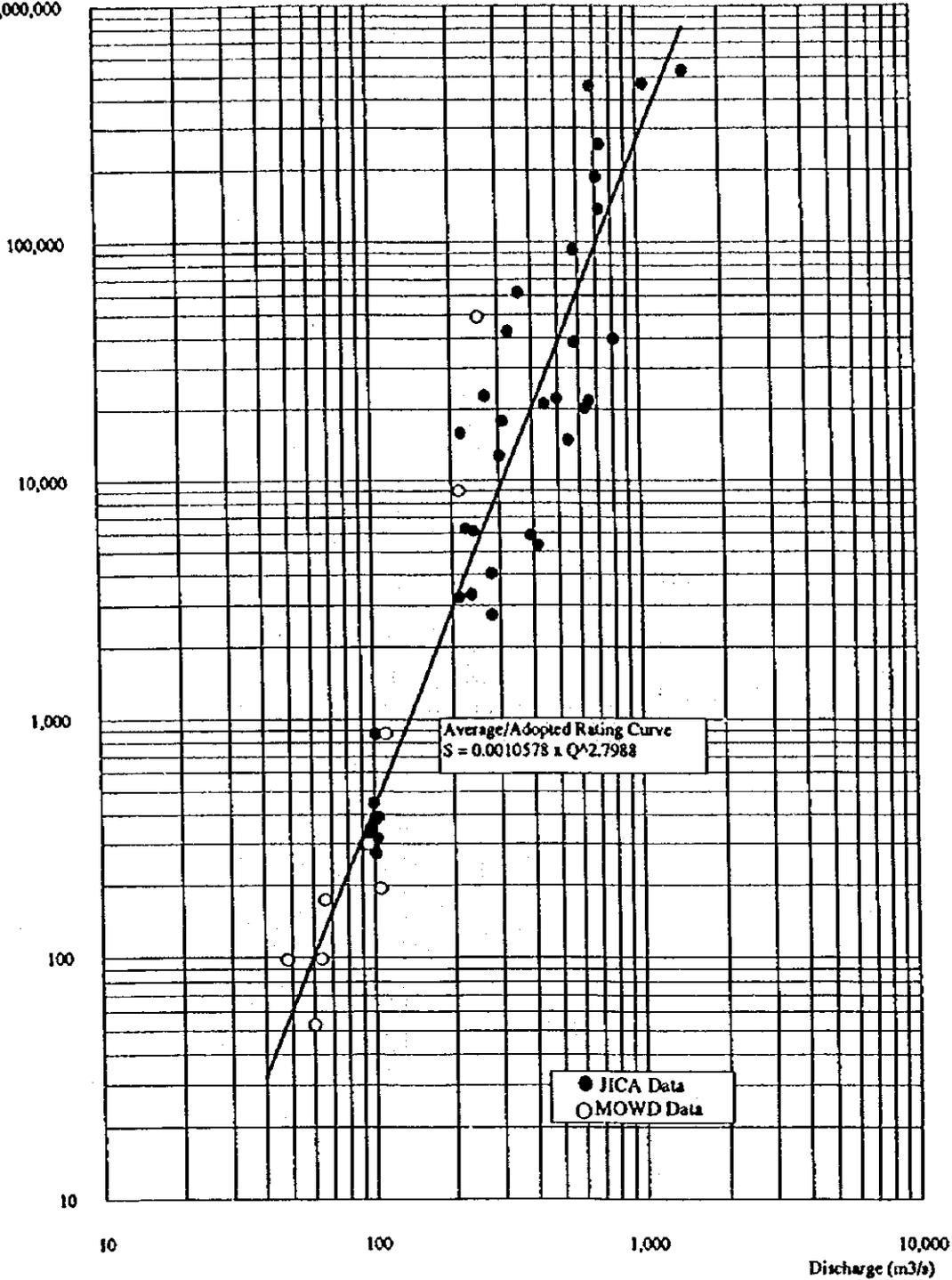
Discharge (m3/s)

JAPAN INTERNATIONAL COOPERATION AGENCY
REPUBLIC OF KENYA
MUTONGA/GRAND FALLS HYDROPOWER PROJECT

カジタ川のSGS4F19における
浮遊砂量-流量曲線

Fig. No.
図 3.2.13

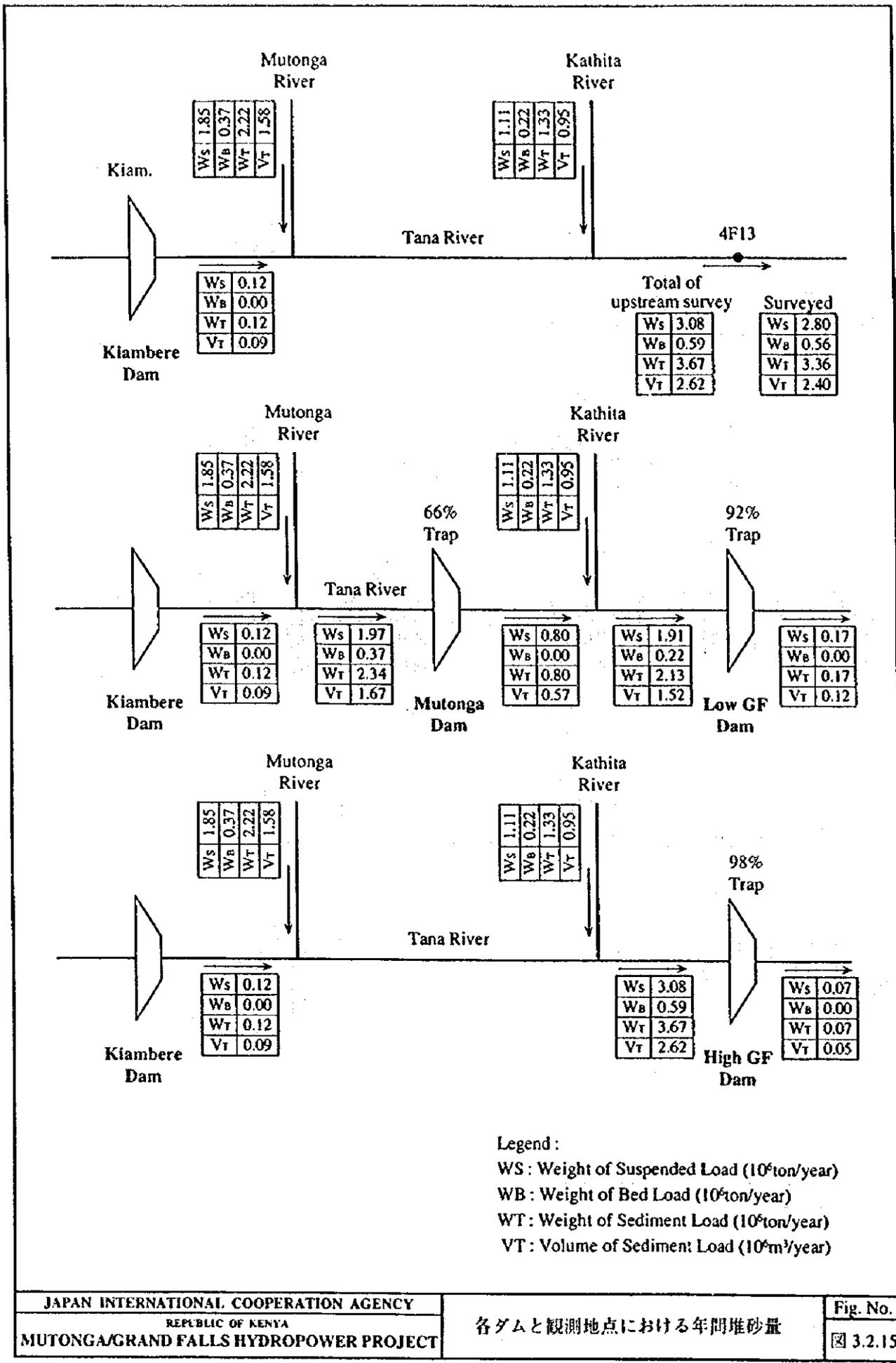
Suspended Load
Yield (t/day)
3,000,000



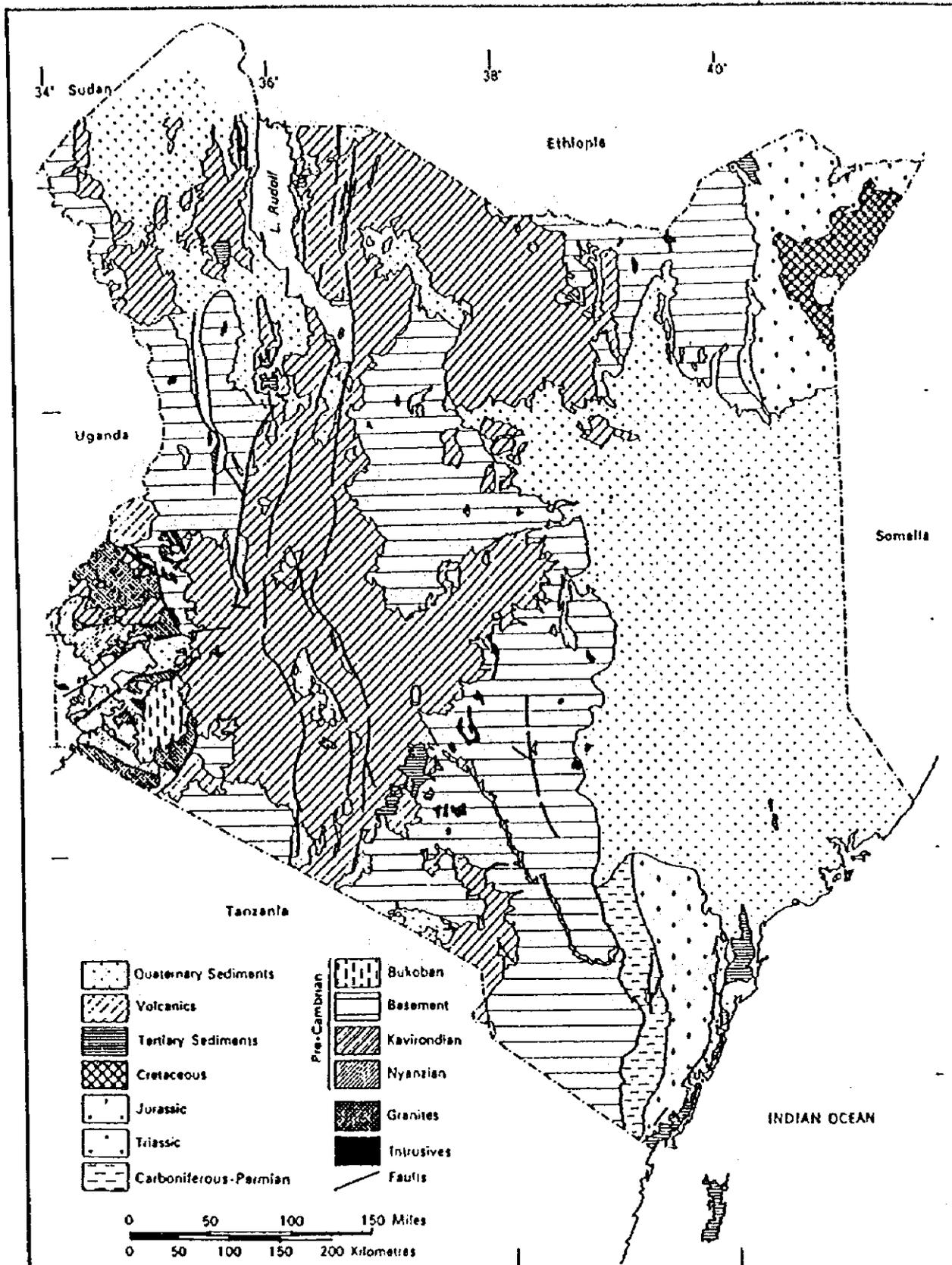
JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

グランドフォールズ地点SGS 4F13
 における浮遊砂量-流量曲線

Fig. No.
 図 3.2.14

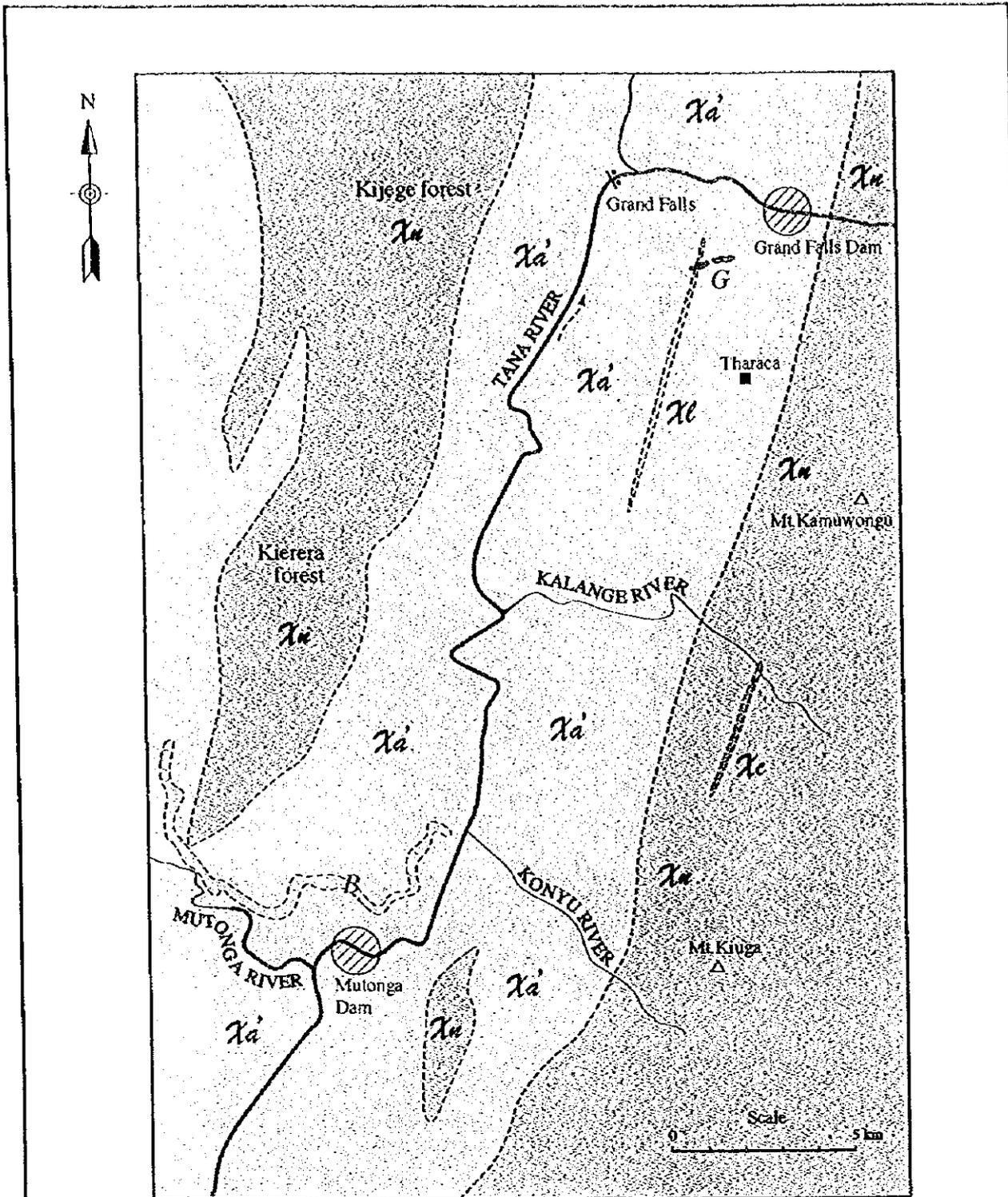


Legend:
 WS : Weight of Suspended Load (10^6 ton/year)
 WB : Weight of Bed Load (10^6 ton/year)
 WT : Weight of Sediment Load (10^6 ton/year)
 VT : Volume of Sediment Load (10^6 m³/year)



Source: Mines and Geological Department(1967)

JAPAN INTERNATIONAL COOPERATION AGENCY		Fig. No.
REPUBLIC OF KENYA	ケニアの地質	
MUTONGA/GRAND FALLS HYDROPOWER PROJECT		図 3.3.1



From * Geology of the North Kitui Area.
 Geological Survey of Kenya.
 Report No.33, 1/125,000.
 * A Geological Reconnaissance of the
 country between Embu and Meru.
 Geological Survey of Kenya
 Report No.17, 1/125,000.

LEGEND

- B**: Basalt (Pleistocene?)
- G**: Granite (Archaean?)
- Xa**: Granitic gneiss
- Xa'**: Semi-pelitic gneiss
- Xu**: Crystalline limestone
- Xc**: Calc-silicate gneiss
- Geological boundary

Kenya
 Basement
 System
 (Archaean)

JAPAN INTERNATIONAL COOPERATION AGENCY
 REPUBLIC OF KENYA
 MUTONGA/GRAND FALLS HYDROPOWER PROJECT

貯水池内地質

Fig. No.

図 3.3.2

