of the Financial Internal Rate of Return" is analyzed and judgement is made for evaluation.

FIRRs of the Upper Kihansi Project and the Lower Kihansi Project are 6.49% and 12.74% respectively and that of the combined project is 12.07% as shown in Table 5.

Judging from the FIRR of the combined project, the project is sound from the financial point of view, even though the Upper Kihansi Project itself is not sound based on the unit electric price adopted for the evaluation.

Table 4 Cost and Benefit Flow of Sensitivity Analysis of Kihansi Project (Upper and Lower) (Benefit from Fuel Cost is zero)

Unit:1,000us$

Serial Number	No. after Completion	Cost				Benefit					B - C
		Investment Cost	O&M Cost	Total	Total (N.P.V.)	Investment Cost	O&M Cost	Fuel Cost	Total	Total (N.P.V.)	
0		0.0		0.0	0.0	0.0			0.0	0.0	0.0
1	(92)	13303.0		13303.0	12093.6	0.0			0.0	0.0	-13303.0
2	(93)	13974.0		13974.0	11548.8	0.0			0.0	0.0	-13974.0
3	(94)	17644.0		17644.0	13256.2	19049.4			19049.4	14312.1	1405.4
4	(95)	42252.0		42252.0	28858.7	38098.8			38098.8	26022.0	-4153.2
5	(96)	54784.0		54784.0	34016.6	96791.4			96791.4	60099.8	42007.4
6	1	34506.0	1141.1	35647.1	20121.9	81153.9		0.0	81153.9	45809.3	45506.8
7	2	69225.0	1190.4	70415.4	36134.3	42964.0	4706.3	0.0	47670.3	24462.4	-22745.1
8	3	53950.0	1190.4	55140.4	25723.4	16111.5	4706.3	0.0	20817.8	9711.7	-34322.6
9	4		2211.9	2211.9	938.1		7928.6	0.0	7928.6	3362.5	5716.7
10	5		2211.9	2211.9	852.8		7928.6	0.0	7928.6	3056.8	5716.7
11	6		2211.9	2211.9	775.3		7928.6	0.0	7928.6	2778.9	5716.7
12	7		2211.9	2211.9	704.8		7928.6	0.0	7928.6	2526.3	5716.7
13	8		2211.9	2211.9	640.7		7928.6	0.0	7928.6	2296.6	5716.7
14	9		2211.9	2211.9	582.5		7928.6	0.0	7928.6	2087.9	5716.7
15	10		2211.9	2211.9	529.5		7928.6	0.0	7928.6	1898.0	5716.7
16	11		2211.9	2211.9	481.4		7928.6	0.0	7928.6	1725.5	5716.7
17	12		2211.9	2211.9	437.6		7928.6	0.0	7928.6	1568.6	5716.7
18	13		2211.9	2211.9	397.8		7928.6	0.0	7928.6	1426.0	5716.7
19	14		2211.9	2211.9	361.7		7928.6	0.0	7928.6	1296.4	5716.7
20	15		2211.9	2211.9	328.8		7928.6	0.0	7928.6	1178.5	5716.7
21	16		2211.9	2211.9	298.9		7928.6	0.0	7928.6	1071.4	5716.7
22	17		2211.9	2211.9	271.7		7928.6	0.0	7928.6	974.0	5716.7
23	18		2211.9	2211.9	247.0		7928.6	0.0	7928.6	885.5	5716.7
24	19		2211.9	2211.9	224.6		7928.6	0.0	7928.6	805.0	5716.7
25	20		2211.9	2211.9	204.1		7928.6	0.0	7928.6	731.8	5716.7
26	21		2211.9	2211.9	185.6		7928.6	0.0	7928.6	665.3	5716.7
27	22		2211.9	2211.9	168.7		7928.6	0.0	7928.6	604.8	5716.7
28	23		2211.9	2211.9	153.4	19049.4	7928.6	0.0	26978.0	1870.7	24766.1
29	24		2211.9	2211.9	139.4	38098.8	7928.6	0.0	46027.4	2901.5	43815.5
30	25		2211.9	2211.9	126.8	66909.9	7928.6	0.0	74838.5	4288.9	72626.6
31	26		2211.9	2211.9	115.2	51272.4	7928.6	0.0	59201.0	3084.3	56989.1
32	27		2211.9	2211.9	104.8	42964.0	7928.6	0.0	50892.6	2410.4	48680.7
33	28		2211.9	2211.9	95.2	16111.5	7928.6	0.0	24040.1	1035.1	21828.2
34	29		2211.9	2211.9	86.6		7928.6	0.0	7928.6	310.3	5716.7
35	30		2211.9	2211.9	78.7		7928.6	0.0	7928.6	282.1	5716.7
36	31		2211.9	2211.9	71.6		7928.6	0.0	7928.6	256.5	5716.7
37	32		2211.9	2211.9	65.0		7928.6	0.0	7928.6	233.2	5716.7
38	33		2211.9	2211.9	59.1		7928.6	0.0	7928.6	212.0	5716.7
39	34	18261.0	2211.9	20472.9	497.6		7928.6	0.0	7928.6	192.7	-12544.3
40	35	34810.0	2211.9	37021.9	818.0	29881.5	7928.6	0.0	37810.1	835.4	788.2
41	36	3289.0	2211.9	5500.9	110.5	29881.5	7928.6	0.0	37810.1	759.5	32309.2
42	37	5184.0	2211.9	7395.9	135.1		7928.6	0.0	7928.6	144.8	532.7
43	38	9824.0	2211.9	12035.9	199.8		7928.6	0.0	7928.6	131.6	-4107.3
44	39		2211.9	2211.9	33.4		7928.6	0.0	7928.6	119.7	5716.7
45	40		2211.9	2211.9	30.3		7928.6	0.0	7928.6	108.8	5716.7
46	41		2211.9	2211.9	27.6		7928.6	0.0	7928.6	98.9	5716.7
47	42		2211.9	2211.9	25.1		7928.6	0.0	7928.6	89.9	5716.7
48	43		2211.9	2211.9	22.8		7928.6	0.0	7928.6	81.7	5716.7
49	44		2211.9	2211.9	20.7		7928.6	0.0	7928.6	74.3	5716.7
50	45		2211.9	2211.9	18.8		7928.6	0.0	7928.6	67.5	5716.7
51	46		2211.9	2211.9	17.1		7928.6	0.0	7928.6	61.4	5716.7
52	47		2211.9	2211.9	15.6		7928.6	0.0	7928.6	55.8	5716.7
53	48		2211.9	2211.9	14.2		7928.6	0.0	7928.6	50.7	5716.7
54	49		2211.9	2211.9	12.9		7928.6	0.0	7928.6	46.1	5716.7
55	50		2211.9	2211.9	11.7		7928.6	0.0	7928.6	41.9	5716.7
56											
		371006.0	107481.3	478487.3	193491.8	588338.0	382058.0	0.0	970396.0	231203.0	491908.7

B - C 37711.147
B / C 1.1948978
E D R 0.2328895

Table 5 Cost Flow and Flow of Revenue of Kihansi Project (Upper and Lower)

Unit:1,000us$

Serial Number	Year	Cost			Revenue	B - C
		Investment Cost	O&M Cost	Total		
0	1991	0.0		0.0		0.0
1	1992	17493.0		17493.0		-17493.0
2	1993	20438.0		20438.0		-20438.0
3	1994	27808.0		27808.0		-27808.0
4	1995	64030.0		64030.0		-64030.0
5	1996	86701.0		86701.0		-86701.0
6	1997	64921.0	1575.9	66496.9	20742.1	-45754.8
7	1998	99160.0	1869.0	101029.0	33941.6	-67087.4
8	1999	86449.0	1869.0	88318.0	33941.6	-54376.4
9	2000		3384.0	3384.0	68992.0	65608.0
10	2001		3384.0	3384.0	68992.0	65608.0
11	2002		3384.0	3384.0	68992.0	65608.0
12	2003		3384.0	3384.0	68992.0	65608.0
13	2004		3384.0	3384.0	68992.0	65608.0
14	2005		3384.0	3384.0	68992.0	65608.0
15	2006		3384.0	3384.0	68992.0	65608.0
16	2007		3384.0	3384.0	68992.0	65608.0
17	2008		3384.0	3384.0	68992.0	65608.0
18	2009		3384.0	3384.0	68992.0	65608.0
19	2010		3384.0	3384.0	68992.0	65608.0
20	2011		3384.0	3384.0	68992.0	65608.0
21	2012		3384.0	3384.0	68992.0	65608.0
22	2013		3384.0	3384.0	68992.0	65608.0
23	2014		3384.0	3384.0	68992.0	65608.0
24	2015		3384.0	3384.0	68992.0	65608.0
25	2016		3384.0	3384.0	68992.0	65608.0
26	2017		3384.0	3384.0	68992.0	65608.0
27	2018		3384.0	3384.0	68992.0	65608.0
28	2019		3384.0	3384.0	68992.0	65608.0
29	2020		3384.0	3384.0	68992.0	65608.0
30	2021		3384.0	3384.0	68992.0	65608.0
31	2022		3384.0	3384.0	68992.0	65608.0
32	2023		3384.0	3384.0	68992.0	65608.0
33	2024		3384.0	3384.0	68992.0	65608.0
34	2025		3384.0	3384.0	68992.0	65608.0
35	2026		3384.0	3384.0	68992.0	65608.0
36	2027		3384.0	3384.0	68992.0	65608.0
37	2028		3384.0	3384.0	68992.0	65608.0
38	2029		3384.0	3384.0	68992.0	65608.0
39	2030	24849.8	3384.0	28233.8	68992.0	40758.3
40	2031	49151.8	3384.0	52535.8	68992.0	16456.3
41	2032	10003.0	3384.0	13387.0	68992.0	55605.0
42	2033	7010.8	3384.0	10394.8	68992.0	58597.3
43	2034	13824.3	3384.0	17208.3	68992.0	51783.8
44	2035		3384.0	3384.0	68992.0	65608.0
45	2036		3384.0	3384.0	68992.0	65608.0
46	2037		3384.0	3384.0	68992.0	65608.0
47	2038		3384.0	3384.0	68992.0	65608.0
48	2039		3384.0	3384.0	68992.0	65608.0
49	2040		3384.0	3384.0	68992.0	65608.0
50	2041		3384.0	3384.0	68992.0	65608.0
51	2042		3384.0	3384.0	68992.0	65608.0
52	2043		3384.0	3384.0	68992.0	65608.0
53	2044		3384.0	3384.0	68992.0	65608.0
54	2045		3384.0	3384.0	68992.0	65608.0
55	2046		3384.0	3384.0	68992.0	65608.0
		671839.5	164361.9	736201.4	3331249.3	2595047.9

F I R R 0.120664

Chapter 6 CONCLUSIONS

This Project is situated in the central southern part of the Republic of Tanzania, and is the Kihansi Hydroelectric Power Development Project to be constructed on the Kihansi River, a tributary of the Rufiji River, the largest river in the country, which empties into the Indian Ocean. With regard to this hydroelectric power development project, the JICA Study Team has carried out a prefeasibility study of the Upper Kihansi Project located on the upstream part, and a feasibility study of the Lower Kihansi Project located on the downstream part. As a result of these studies, it is concluded that the two projects are amply feasible from engineering, economic, and environmental points of view. An outline of the conclusions are given below.

(1) Power demand in the Republic of Tanzania, reflecting stagnation of the economy up to 1985, had shown an annual growth rate of 5.9 percent, but as a result of the economy turning around favorably with an economic plan receiving aid from the World Bank in 1986-1988, the growth rate rose sharply to 10.3 percent. Hereafter, from 1990 to 2005, the annual growth rate in power demand is estimated as 6.2 percent. Accordingly, the peak demand of 285 MW in 1990 is anticipated to become 707 MW in 2005, and when the capacities of thermal power plants to be discarded during that time are taken into account, new facilities of more than 520 MW will be required.

(2) Coal and natural gas have been confirmed as energy resources in the Republic of Tanzania, but these will require great expense for development and transportation. On the other hand, the hydroelectric potential of the country is estimated at 38 million kilowatts with the portion already developed being not even 1 percent, and hydro power is recognized as being an important energy resource in the future.

(3) The development scheme for the Kihansi River proposed in the Master Plan was reviewed, and appropriate selections were made of timings of development, development scale and layouts. For the sequence of development, the conclusion was drawn that development should be in two stages, commissioning of the Lower Kihansi Project as Phase I, and commissioning of the Upper Kihansi Project as Phase II. With regard to the starts of operation of the two projects, it was concluded as a result of load forecasting that it is appropriate for start-up of the Lower Kihansi Project to be in 1996, and that of the Upper Kihansi Project in 1999.

(4) For the construction costs of the two projects, estimating was done assuming that design and construction methods, and materials and products according to the technological levels that could be expected as of June 1989 were applied, with the geological conditions and regional conditions of the project sites, construction scales, etc. taken into consideration in the construction unit prices, and with import duties and interest during construction included.

The construction costs, including both local and foreign currency requirements, are US$261 million for the Upper Kihansi Project and US$206 million for the Lower Kihansi Project, for a total of US$467 million.

(5) The economical natures of the two projects are that, even independently, they are economically superior compared with an alternative thermal facility and, particularly, the unit construction cost per kilowatt-hour of the Lower Kihansi Project is 0.37 US$ to comprise the cheapest power source in the Republic of Tanzania.

The expenses and revenues of the two projects were calculated and the economic internal rate of return (EIRR) on discounting to present worth was 39.3 percent. This value far exceeds the marginal rate of return set by

international financing institutions, indicating that this Project is feasible from the standpoint of the national economy.

(6) For the dam of the Upper Kihansi Project, a rockfill dam is adopted taking into consideration of topography, geology, construction materials, construction costs, etc., while for the Lower Kihansi Project, a concrete gravity dam is adopted. It is possible for both sites to be provided with economical semi-underground powerhouses and, especially, since Lower Kihansi Power Station has a high head, Pelton type turbines are adopted and design of the waterway is simplified. Both projects involve no problems that will cause hindrances to realization of construction and are technically feasible.

(7) The Slash-and-burn farmland to be submerged in the reservoir area as a result of this Project is a few and no habitant exists, while there are no items at all requiring compensation such as roads, public buildings, etc.

(8) The water quality of the Kihansi River has strong acidity due to the influences of the topsoils and slash-and-burn farming, while because of oligotrophication and the swift flow where rock is exposed at the river bed, there are almost no aquatic organisms such as fishes to be seen. As for the areas planned for water impoundment, since they consist of slash-and-burn farmland or land lying fallow and are cleared away, the existence of large wild animals has not been confirmed. However, it will be necessary to be careful about outbreaks of harmful plants and insects in the reservoir areas or dewatered areas, and a reasonable amount of environmental protection funds, including monitoring device, are calculated in the construction cost.

(9) It is assessed that the effects on the natural and social environments of the surroundings will be small, and it is

expected that this power development project will contribute greatly to the regional society, at the same time making possible stable supply of electric power.

Chapter 7 RECOMMENDATION

Hydroelectric power development project on the Kihansi River is judged to be technically and economically feasible and the commissioning programs in the power system in accordance with the electric power development program in the Republic of Tanzania are planned for the Lower Kihansi Project in the year 1996 and for the Upper Kihansi Project in the year 1999. Consequently, the necessary preparations for the development are recommended to be executed under the development scheme.

For realization of this Project, the following items are necessary to be performed;

(1) The feasibility study should be performed on the Upper Kihansi Project.

(2) The necessary preparatory works for the construction such as the definite design, the preparation of tender document and so on should be implemented on the Lower Kihansi Project.

(3) The additional investigations and tests described in Chapter 14 "Future Investigation Works" of the Final Report should be executed for the definite design on the Lower Kihansi Project and the results should be thoroughly reflected in the definite design.