The 30% cut in the initial investment costs has also minor effects on the computed value of financial rate of return. This may appear unreasonable, but actually it is not so. Reduction in the initial investment costs decrease depreciation and increase, in turn, the taxable income and the income tax, if the latter are positive to begin with. Since the income tax is included in the cash flow analysis but the depreciation is not, the net cash flow in the last year of production, the only positive flow as seen from Table 9-4, decreases. This negative effect cancels out the positive effect of reduced investment costs. It there were many positive net cash flow in the standard case, the reduction of initial investment costs would certainly improve the financial rate of return considerably.

In the most optimistic case as given in Table 9-5, the financial rate of return becomes positive, but the value is regrettably as low as 5.4% even for Case B.

1--4 Financing Plan

Clearly no financing would help any project with such poor financial viability. It may still be instructive to see how The Project would stand with a realistic financing plan in order to shed another light on the financial performance of The Project.

The amount of capital required for implementing The Project consists of the initial investment costs necessary for constructing the plant and the working capital required for operation of the plant. The latter are determined based on the production costs that include costs of raw materials, power and labor necessary for production and other fixed costs such as overhead and administration costs, sales and freight costs and other marginal expenses.

The following assumptions are made for both Case A and Case B related to capital raising and reimbursement.

(1) The debt/equity ratio is set at 70:30 ; i.e. the internal capital accounts for 30% of the total capital requirements and the rest is to be borrowed.

(2) The internal capital is to be raised in full by the beginning of construction period.

(3) For construction of the plant facilities, preferencially use the internal capital, and the balance is raised by borrowing at the beginning of respective years.

(4) The principal of external capital is to be reimbursed over the 20 year project life starting from the initiation of plant operation.

(5) Interests on the external capital are payable at the end of each year, being assessed at the rate 4% of the total debt outstanding as of the beginning of respective years.

Table 9-5 Sensitivity of Financial Rate of Return for Case B

(a) Electricity rate down by 30%

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	3568.6	50.8	0.0	-3619.4
2.	1984	0.0	8326.8	50.8	0.0	-8377.6
3.	1985	0.0	7137.2	50.8	0.0	-7188.0
4.	1986	0.0	4758.2	50.8	0.0	-4809.0
5.	1987	5157.2	2480.3	5432.0	0.0	-2755.1
6.	1988	6569.2	512.8	6493.4	0.0	-436.9
7.	1989	6569.2	0.0	6493.4	0.0	75.9
8.	1990	6915.0	0.0	6493.4	0.0	421.6
9.	1991	6915.0	0.0	6493.4	0.0	421.6
10.	1992	6915.0	0.0	6493.4	0.0	421.6
11.	1993	6915.0	0.0	6493.4	0.0	421.6
12.	1994	6915.0	0.0	6493.4	0.0	421.6
13.	1995	6915.0	0.0	6493.4	0.0	421.6
14.	1996	6915.0	5701.5	6493.4	0.0	-5279.9
15.	1997	6915.0	0.0	6493.4	0.0	421.6
16.	1998	6915.0	0.0	6493.4	0.0	421.6
17.	1999	6915.0	0.0	6493.4	0.0	421.6
18.	2000	6915.0	0.0	6493.4	0.0	421.6
19.	2001	6915.0	0.0	6493.4	0.0	421.6
20.	2002	6915.0	0.0	6493.4	0.0	421.6
21.	2003	6915.0	0.0	6493.4	0.0	421.6
22.	2004	6915.0	0.0	6493.4	0.0	421.6
23.	2005	6915.0	0.0	6493.4	0.0	421.6
24.	2006	6915.0	-2993.1	6493.4	817.0	7430.5

FINANCIAL ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.052

PRESENT VALUE NET BENEFIT: -22019.1 (DISCOUNT RATE=0.05)
-21859.0 (DISCOUNT RATE=0.10)
-20603.9 (DISCOUNT RATE=0.15)

(b) Ferrochrome price up by 20%

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	3568.6	50.8	0.0	-3619.4
2.	1984	0.0	8326.8	50.8	0.0	-8377.6
3.	1985	0.0	7137.2	50.8	0.0	-7188.0
4.	1986	0.0	4758.2	50.8	0.0	-4809.0
5.	1987	6186.4	2480.3	6021.0	0.0	-2314.8
6.	1988	7880.2	512.8	7204.1	0.0	163.4
7.	1989	7880.2	0.0	7204.1	0.0	676.2
8.	1990	8295.0	0.0	7204.1	0.0	1090.9
9.	1991	8295.0	0.0	7204.1	0.0	1090.9
10.	1992	8295.0	0.0	7204.1	0.0	1090.9
11.	1993	8295.0	0.0	7204.1	0.0	1090.9
12.	1994	8295.0	0.0	7204.1	0.0	1090.9
13.	1995	8295.0	0.0	7204.1	0.0	1090.9
14.	1996	8295.0	5701.5	7204.1	0.0	-4610.6
15.	1997	8295.0	0.0	7204.1	0.0	1090.9
16.	1998	8295.0	0.0	7204.1	0.0	1090.9
17.	1999	8295.0	0.0	7204.1	0.0	1090.9
18.	2000	8295.0	0.0	7204.1	0.0	1090.9
19.	2001	8295.0	0.0	7204.1	0.0	1090.9
20.	2002	8295.0	0.0	7204.1	0.0	1090.9
21.	2003	8295.0	0.0	7204.1	0.0	1090.9
22.	2004	8295.0	0.0	7204.1	0.0	1090.9
23.	2005	8295.0	0.0	7204.1	0.0	1090.9
24.	2006	8295.0	-2993.1	7204.1	1218.5	7698.3

FINANCIAL ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.014

PRESENT VALUE NET BENEFIT: -15238.5 (DISCOUNT RATE=0.05)
-17860.9 (DISCOUNT RATE=0.10)
-18260.6 (DISCOUNT RATE=0.15)

Table 9-5 (continued)

(c) Initial investment costs down by 30%

UNIT: 1000$L

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	2498.0	50.8	0.0	-2548.8
2.	[illegible]	0.0	5828.8	50.8	0.0	-5879.6
3.	[illegible]	0.0	4996.0	50.8	0.0	-5046.8
4.	[illegible]	0.0	3330.7	50.8	0.0	-3381.5
5.	1987	5157.2	2460.3	6021.0	0.0	-3344.1
6.	1988	6569.2	512.8	7204.1	0.0	-1147.6
7.	1989	6569.2	0.0	7204.1	0.0	-634.8
8.	1990	6915.0	0.0	7204.1	0.0	-289.1
9.	1991	6915.0	0.0	7204.1	0.0	-289.1
10.	1992	6915.0	0.0	7204.1	0.0	-289.1
11.	1993	6915.0	0.0	7204.1	0.0	-289.1
12.	1994	6915.0	0.0	7204.1	0.0	-289.1
13.	1995	6915.0	0.0	7204.1	0.0	-289.1
14.	1996	6915.0	3991.0	7204.1	0.0	-4260.1
15.	1997	6915.0	0.0	7204.1	0.0	-289.1
16.	1998	6915.0	0.0	7204.1	0.0	-289.1
17.	1999	6915.0	0.0	7204.1	0.0	-289.1
18.	2000	6915.0	0.0	7204.1	0.0	-289.1
19.	2001	6915.0	0.0	7204.1	0.0	-289.1
20.	2002	6915.0	0.0	7204.1	0.0	-289.1
21.	2003	6915.0	0.0	7204.1	0.0	-289.1
22.	2004	6915.0	0.0	7204.1	0.0	-289.1
23.	2005	6915.0	0.0	7204.1	0.0	-289.1
24.	2006	6915.0	-2993.1	7204.1	760.1	6776.7

FINANCIAL ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.091

PRESENT VALUE NET BENEFIT: -22019.5 (DISCOUNT RATE=0.05)
-19636.4 (DISCOUNT RATE=0.10)
-17570.6 (DISCOUNT RATE=0.15)

(d) Exemption of taxes and duties

UNIT: 1000$L

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	3568.6	50.8	0.0	-3619.4
2.	1984	0.0	8326.8	50.8	0.0	-8377.6
3.	1985	0.0	7137.2	50.8	0.0	-7188.0
4.	1986	0.0	4758.2	50.8	0.0	-4809.0
5.	1987	5157.2	2232.3	6021.0	0.0	-3096.0
6.	1988	6569.2	461.5	7204.1	0.0	-1096.4
7.	1989	6569.2	0.0	7204.1	0.0	-634.8
8.	1990	6915.0	0.0	7204.1	0.0	-289.1
9.	1991	6915.0	0.0	7204.1	0.0	-289.1
10.	1992	6915.0	0.0	7204.1	0.0	-289.1
11.	1993	6915.0	0.0	7204.1	0.0	-289.1
12.	1994	6915.0	0.0	7204.1	0.0	-289.1
13.	1995	6915.0	0.0	7204.1	0.0	-289.1
14.	1996	6915.0	4333.1	7204.1	0.0	-4622.2
15.	1997	6915.0	0.0	7204.1	0.0	-289.1
16.	1998	6915.0	0.0	7204.1	0.0	-289.1
17.	1999	6915.0	0.0	7204.1	0.0	-289.1
18.	2000	6915.0	0.0	7204.1	0.0	-289.1
19.	2001	6915.0	0.0	7204.1	0.0	-289.1
20.	2002	6915.0	0.0	7204.1	0.0	-289.1
21.	2003	6915.0	0.0	7204.1	0.0	-289.1
22.	2004	6915.0	0.0	7204.1	0.0	-289.1
23.	2005	6915.0	0.0	7204.1	0.0	-289.1
24.	2006	6915.0	-2693.8	7204.1	0.0	7237.5

FINANCIAL ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.096

PRESENT VALUE NET BENEFIT: -20431.5 (DISCOUNT RATE=0.05)
-25666.3 (DISCOUNT RATE=0.10)
-23248.8 (DISCOUNT RATE=0.15)

Table 9-5 (continued)

(e) Most optimistic case

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	2498.0	50.8	0.0	-2548.8
2.	1984	0.0	5828.6	50.8	0.0	-5879.6
3.	1985	0.0	4996.0	50.8	0.0	-5046.8
4.	1986	0.0	3330.7	50.8	0.0	-3381.5
5.	1987	6186.4	2232.3	5432.0	0.0	-1477.9
6.	1988	7880.2	461.5	6493.4	0.0	925.3
7.	1989	7880.2	0.0	6493.4	0.0	1386.9
8.	1990	8295.0	0.0	6493.4	0.0	1801.6
9.	1991	8295.0	0.0	6493.4	0.0	1801.6
10.	1992	8295.0	0.0	6493.4	0.0	1801.6
11.	1993	8295.0	0.0	6493.4	0.0	1801.6
12.	1994	8295.0	0.0	6493.4	0.0	1801.6
13.	1995	8295.0	0.0	6493.4	0.0	1801.6
14.	1996	8295.0	3033.2	6493.4	0.0	-1231.6
15.	1997	8295.0	0.0	6493.4	0.0	1801.6
16.	1998	8295.0	0.0	6493.4	0.0	1801.6
17.	1999	8295.0	0.0	6493.4	0.0	1801.6
18.	2000	8295.0	0.0	6493.4	0.0	1801.6
19.	2001	8295.0	0.0	6493.4	0.0	1801.6
20.	2002	8295.0	0.0	6493.4	0.0	1801.6
21.	2003	8295.0	0.0	6493.4	0.0	1801.6
22.	2004	8295.0	0.0	6493.4	0.0	1801.6
23.	2005	8295.0	0.0	6493.4	0.0	1801.6
24.	2006	8295.0	-2693.8	6493.4	0.0	9328.2

FINANCIAL ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: 0.054

PRESENT VALUE NET BENEFIT: 895.7 (DISCOUNT RATE=0.05)
-6137.8 (DISCOUNT RATE=0.10)
-8956.9 (DISCOUNT RATE=0.15)

(6) Grace is allowed to the payments during the construction period, and interests during this period are computed at the same compound rate of interest and added to the debt outstanding at the beginning of plant operation.

(7) The working capital requirements are met by borrowing in full when the plant operation is initiated.

(8) The working capital is to be reimbursed over 15 years starting from the sixth year of production after five years grace.

(9) Interests on the working capital are assessed at 8% of the debt outstanding at the beginning of each year, including the grace period.

The financial statement for The Project with the financing plan described above would become as given in Table 9-6 and Table 9-7 for Case A and Case B, respectively. Both operating profit and profit after tax are negative for all the years of project implementation except the last year of production for both cases. Actually the plant operation can not be sustained with such a persistently negative operating profit.

Table 9-6 and Table 9-7 also show that the total variable costs of production are almost equal to the net sales revenue of The Project for both Case A and Case B, and the total production costs actually exceed the latter. This fact alone explains such poor financial viability of The Project.

Table 9-6 Financial Statement for Case A

(PLANT CAPACITY: 7000. TON/YEAR)

UNIT: 1000SL

	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION (TON/YEAR)	0.	0.	0.	5760.	7000.	7000.	7000.	7000.
GROSS SALES REVENUE	0.0	0.0	0.0	2741.8	3332.0	3332.0	3332.0	3332.0
NET SALES REVENUE	0.0	0.0	0.0	2467.6	3165.4	3165.4	3332.0	3332.0
PRODUCTION COSTS								
VARIABLE COSTS								
MAIN RAW MATERIAL	0.0	0.0	0.0	684.3	831.7	831.7	831.7	831.7
POWER	0.0	0.0	0.0	906.2	1101.2	1101.2	1101.2	1101.2
SUBSIDIARY MATERIALS	0.0	0.0	0.0	736.7	895.3	895.3	895.3	895.3
TOTAL VARIABLE COSTS	0.0	0.0	0.0	2327.2	2828.2	2828.2	2828.2	2828.2
FIXED COSTS								
LABOR	67.7	67.7	67.7	244.2	244.2	244.2	244.2	244.2
OTHER FIXED COSTS	0.0	0.0	0.0	399.1	467.9	467.9	467.9	467.9
TOTAL FIXED COSTS	67.7	67.7	67.7	643.3	712.1	712.1	712.1	712.1
TOTAL PRODUCTION COSTS	67.7	67.7	67.7	2970.5	3540.3	3540.3	3540.3	3540.3
INVESTMENT COSTS								
INVESTMENT	2804.5	6310.1	4907.9	0.0	0.0	0.0	0.0	0.0
WORKING CAPITAL	0.0	0.0	0.0	1215.9	261.8	0.0	0.0	0.0
TOTAL INVESTMENT COSTS	2804.5	6310.1	4907.9	1215.9	261.8	0.0	0.0	0.0
OPERATING PROFIT	-2872.2	-6377.8	-4975.6	-1718.8	-636.7	-374.9	-208.3	-208.3
DEPRECIATION	0.0	0.0	0.0	496.4	496.4	496.4	496.4	496.4
AMORTIZATION	0.0	0.0	0.0	520.0	520.0	520.0	520.0	520.0
FINANCIAL CHARGES	0.0	0.0	0.0	534.7	513.9	493.1	472.3	451.5
PROFIT BEFORE TAX	-2872.2	-6377.8	-4975.6	-3269.9	-2167.0	-1884.4	-1697.0	-1676.2
INCOME TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROFIT AFTER TAX	-2872.2	-6377.8	-4975.6	-3269.9	-2167.0	-1884.4	-1697.0	-1676.2

Table 9-6 (continued)

(PLANT CAPACITY: 7000. TON/YEAR)

UNIT: 1000SL

	1991	1992	1993	1994	1995	1996	1997	1998
PRODUCTION (TON/YEAR)	7000.	7000.	7000.	7000.	7000.	7000.	7000.	7000.
GROSS SALES REVENUE	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0
NET SALES REVENUE	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0
PRODUCTION COSTS								
VARIABLE COSTS								
MAIN RAW MATERIAL	831.7	831.7	831.7	831.7	831.7	831.7	831.7	831.7
POWER	1101.2	1101.2	1101.2	1101.2	1101.2	1101.2	1101.2	1101.2
SUBSIDIARY MATERIALS	895.3	895.3	895.3	895.3	895.3	895.3	895.3	895.3
TOTAL VARIABLE COSTS	2828.2	2828.2	2828.2	2828.2	2828.2	2828.2	2828.2	2828.2
FIXED COSTS								
LABOR	244.2	244.2	244.2	244.2	244.2	244.2	244.2	244.2
OTHER FIXED COSTS	467.9	467.9	467.9	467.9	467.9	467.9	467.9	467.9
TOTAL FIXED COSTS	712.1	712.1	712.1	712.1	712.1	712.1	712.1	712.1
TOTAL PRODUCTION COSTS	3540.3	3540.3	3540.3	3540.3	3540.3	3540.3	3540.3	3540.3
INVESTMENT COSTS								
INVESTMENT	0.0	0.0	0.0	0.0	3031.6	0.0	0.0	0.0
WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INVESTMENT COSTS	0.0	0.0	0.0	0.0	3031.6	0.0	0.0	0.0
OPERATING PROFIT	-208.3	-208.3	-208.3	-208.3	-3239.9	-208.3	-208.3	-208.3
DEPRECIATION	496.4	496.4	496.4	496.4	496.4	496.4	496.4	496.4
AMORTIZATION	618.0	618.0	618.0	618.0	618.0	618.0	618.0	618.0
FINANCIAL CHARGES	430.7	402.1	373.4	344.0	316.2	287.5	258.9	230.2
PROFIT BEFORE TAX	-1753.4	-1724.8	-1696.1	-1667.5	-4670.5	-1610.2	-1581.6	-1552.9
INCOME TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROFIT AFTER TAX	-1753.4	-1724.8	-1696.1	-1667.5	-4670.5	-1610.2	-1581.6	-1552.9

Table 9-6 (continued)

(PLANT CAPACITY: 7000. TON/YEAR)

UNIT: 1000SL

	1999	2000	2001	2002	2003	2004	2005
PRODUCTION (TON/YEAR)	7000.	7000.	7000.	7000.	7000.	7000.	7000.
GROSS SALES REVENUE	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0
NET SALES REVENUE	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0	3332.0
PRODUCTION COSTS							
VARIABLE COSTS							
MAIN RAW MATERIAL	831.7	831.7	831.7	831.7	831.7	831.7	831.7
POWER	1101.2	1101.2	1101.2	1101.2	1101.2	1101.2	1101.2
SUBSIDIARY MATERIALS	895.3	895.3	895.3	895.3	895.3	895.3	895.3
TOTAL VARIABLE COSTS	2828.2	2828.2	2828.2	2828.2	2828.2	2828.2	2828.2
FIXED COSTS							
LABOR	244.2	244.2	244.2	244.2	244.2	244.2	244.2
OTHER FIXED COSTS	467.9	467.9	467.9	467.9	467.9	467.9	467.9
TOTAL FIXED COSTS	712.1	712.1	712.1	712.1	712.1	712.1	712.1
TOTAL PRODUCTION COSTS	3540.3	3540.3	3540.3	3540.3	3540.3	3540.3	3540.3
INVESTMENT COSTS							
INVESTMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	-1477.7
TOTAL INVESTMENT COSTS	0.0	0.0	0.0	0.0	0.0	0.0	-1477.7
OPERATING PROFIT	-208.3	-208.3	-208.3	-208.3	-208.3	-208.3	1269.4
DEPRECIATION	496.4	496.4	496.4	496.4	496.4	496.4	496.4
AMORTIZATION	618.0	618.0	618.0	618.0	618.0	618.0	618.3
FINANCIAL CHARGES	201.6	173.0	144.3	115.7	87.0	58.4	29.8
PROFIT BEFORE TAX	-1524.3	-1495.7	-1467.0	-1438.4	-1409.7	-1381.1	104.9
INCOME TAX	0.0	0.0	0.0	0.0	0.0	0.0	62.9
PROFIT AFTER TAX	-1524.3	-1495.7	-1467.0	-1438.4	-1409.7	-1381.1	42.0

Table 9-7 Financial Statement for Case B

(PLANT CAPACITY: 15000. TON/YEAR)

UNIT: 10000$

	1903	1904	1905	1906	1907	1908	1909	1910
PRODUCTION (TON/YEAR)	0.	0.	0.	0.	12430.	15000.	15000.	15000.
GROSS SALES REVENUE	0.0	0.0	0.0	0.0	5730.2	6915.0	6915.0	6915.0
NET SALES REVENUE	0.0	0.0	0.0	0.0	5157.2	6569.2	6569.2	6915.0
PRODUCTION COSTS								
VARIABLE COSTS								
MAIN RAW MATERIAL	0.0	0.0	0.0	0.0	1398.4	1687.5	1687.5	1687.5
POWER	0.0	0.0	0.0	0.0	1955.5	2359.8	2359.8	2359.8
SUBSIDIARY MATERIALS	0.0	0.0	0.0	0.0	1511.5	1824.0	1824.0	1824.0
TOTAL VARIABLE COSTS	0.0	0.0	0.0	0.0	4865.4	5871.3	5871.3	5871.3
FIXED COSTS								
LABOR	50.8	50.8	50.8	50.8	298.5	298.5	298.5	298.5
OTHER FIXED COSTS	0.0	0.0	0.0	0.0	857.1	1034.3	1034.3	1034.3
TOTAL FIXED COSTS	50.8	50.8	50.8	50.8	1155.6	1332.8	1332.8	1332.8
TOTAL PRODUCTION COSTS	50.8	50.8	50.8	50.8	6021.0	7204.1	7204.1	7204.1
INVESTMENT COSTS								
INVESTMENT	3560.6	8326.8	7137.2	4758.2	0.0	0.0	0.0	0.0
WORKING CAPITAL	0.0	0.0	0.0	0.0	2480.3	512.8	0.0	0.0
TOTAL INVESTMENT COSTS	3568.6	8326.8	7137.2	4758.2	2480.3	512.8	0.0	0.0
OPERATING PROFIT	-3619.4	-8377.6	-7188.0	-4809.0	-3344.1	-1147.6	-634.8	-289.1
DEPRECIATION	0.0	0.0	0.0	0.0	907.1	907.1	907.1	907.1
AMORTIZATION	0.0	0.0	0.0	0.0	901.0	901.0	901.0	901.0
FINANCIAL CHARGES	0.0	0.0	0.0	0.0	960.2	924.2	888.1	852.1
PROFIT BEFORE TAX	-3619.4	-8377.6	-7188.0	-4809.0	-6112.4	-3879.9	-3331.0	-2949.3
INCOME TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROFIT AFTER TAX	-3619.4	-8377.6	-7188.0	-4809.0	-6112.4	-3879.9	-3331.0	-2949.3

Table 9-7 (continued)

(PLANT CAPACITY: 15000. TON/YEAR)

UNIT: 1000SL

	1991	1992	1993	1994	1995	1996	1997	1998
PRODUCTION (TON/YEAR)	15000.	15000.	15000.	15000.	15000.	15000.	15000.	15000.
GROSS SALES REVENUE	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0
NET SALES REVENUE	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0
PRODUCTION COSTS								
VARIABLE COSTS								
MAIN RAW MATERIAL	1687.5	1687.5	1687.5	1687.5	1687.5	1687.5	1687.5	1687.5
POWER	2359.8	2359.8	2359.8	2359.8	2359.8	2359.8	2359.8	2359.8
SUBSIDIARY MATERIALS	1824.0	1824.0	1824.0	1824.0	1824.0	1824.0	1824.0	1824.0
TOTAL VARIABLE COSTS	5871.3	5871.3	5871.3	5871.3	5871.3	5871.3	5871.3	5871.3
FIXED COSTS								
LABOR	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5
OTHER FIXED COSTS	1034.3	1034.3	1034.3	1034.3	1034.3	1034.3	1034.3	1034.3
TOTAL FIXED COSTS	1332.8	1332.8	1332.8	1332.8	1332.8	1332.8	1332.8	1332.8
TOTAL PRODUCTION COSTS	7204.1	7204.1	7204.1	7204.1	7204.1	7204.1	7204.1	7204.1
INVESTMENT COSTS								
INVESTMENT	0.0	0.0	0.0	0.0	0.0	5701.5	0.0	0.0
WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INVESTMENT COSTS	0.0	0.0	0.0	0.0	0.0	5701.5	0.0	0.0
OPERATING PROFIT	-289.1	-289.1	-289.1	-289.1	-289.1	-5990.6	-289.1	-289.1
DEPRECIATION	907.1	907.1	907.1	907.1	907.1	907.1	907.1	907.1
AMORTIZATION	901.0	1101.0	1101.0	1101.0	1101.0	1101.0	1101.0	1101.0
FINANCIAL CHARGES	816.1	780.0	720.0	675.9	623.9	571.9	519.8	467.8
PROFIT BEFORE TAX	-2913.3	-3077.2	-3025.2	-2973.1	-2921.1	-8570.6	-2817.0	-2765.0
INCOME TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROFIT AFTER TAX	-2913.3	-3077.2	-3025.2	-2973.1	-2921.1	-8570.6	-2817.0	-2765.0

Table 9-7 (continued)

(PLANT CAPACITY: 15000. TON/YEAR)

UNIT: 1000SL

	1999	2000	2001	2002	2003	2004	2005	2006
PRODUCTION (TON/YEAR)	15000.	15000.	15000.	15000.	15000.	15000.	15000.	15000.
GROSS SALES REVENUE	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0
NET SALES REVENUE	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0	6915.0
PRODUCTION COSTS								
VARIABLE COSTS								
MAIN RAW MATERIAL	1687.5	1687.5	1687.5	1687.5	1687.5	1687.5	1687.5	1687.5
POWER	2359.8	2359.8	2359.8	2359.8	2359.8	2359.8	2359.8	2359.8
SUBSIDIARY MATERIALS	1824.0	1824.0	1824.0	1824.0	1824.0	1824.0	1824.0	1824.0
TOTAL VARIABLE COSTS	5871.3	5871.3	5871.3	5871.3	5871.3	5871.3	5871.3	5871.3
FIXED COSTS								
LABOR	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5
OTHER FIXED COSTS	1034.3	1034.3	1034.3	1034.3	1034.3	1034.3	1034.3	1034.3
TOTAL FIXED COSTS	1332.8	1332.8	1332.8	1332.8	1332.8	1332.8	1332.8	1332.8
TOTAL PRODUCTION COSTS	7204.1	7204.1	7204.1	7204.1	7204.1	7204.1	7204.1	7204.1
INVESTMENT COSTS								
INVESTMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WORKING CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2993.1
TOTAL INVESTMENT COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2993.1
OPERATING PROFIT	-289.1	-289.1	-289.1	-289.1	-289.1	-289.1	-289.1	2704.0
DEPRECIATION	907.1	907.1	907.1	907.1	907.1	907.1	907.1	907.1
AMORTIZATION	901.0	1101.0	1101.0	1101.0	1101.0	1101.0	1101.0	1094.5
FINANCIAL CHARGES	415.7	363.7	311.7	259.6	207.6	155.5	103.5	51.5
PROFIT BEFORE TAX	-2512.9	-2660.9	-2608.9	-2556.8	-2504.8	-2452.7	-2400.7	650.9
INCOME TAX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	390.5
PROFIT AFTER TAX	-2512.9	-2660.9	-2608.9	-2556.8	-2504.8	-2452.7	-2400.7	260.4

2. Economic Analysis

2–1 Derivation of Ecnomic Costs

All the cost and benefit figures used in economic analysis of The Project have to represent real values to the nation's economy rather than nominal ones such as prevailing prices in imperfect markets. Major modifications and adjustments introduced in the analysis are described in the following.

Electricity rates

The power requirements of the ferrochrome plant will most likely be met by the supply from the Roseires power station after additional generators are installed as presently planned. The costs of electricity to be used in economic analysis, however, have to be evaluated from more macroscopic point of view, since any cost data used in economic analysis have to reflect opportunity costs or real resource costs to be incurred to the nation.

When a significant fraction of additional power made available by installing the Nos. 5 and 6 generators at the Roseires power station has to be used for the ferrochrome plant, two things may follow. The power supply originally planned to meet increased demand for other purposes may be reduced, or additional power will have to be procured by other means. Two problems are involved in estimating real costs of electricity in this case. First opportunity costs will be incurred to the power diverted from other uses to the ferrochrome plant. Secondly some part of construction costs associated with additional power development may have to be assessed as being attributable to The Project.

Suppose first no additional power would be developed to compensate the power diverted to the ferrochrome plant. This diversion will be done most likely by sacrificing power for domestic uses. Thus opportunity costs of domestic power need to be estimated.

It is in general difficult to estimate marginal productivity and thus the opportunity costs of electricity in the case of domestic activities. Simply assume herein that the rate applicable to domestic users according to the electricity tariff that is currently effective reflects the production costs as real resource costs at the margin and benefits that the domestic users derive from electricity. Then the opportunity costs of electricity diverted from domestic uses to the ferrochrome plnat are determined to be S£0.054/KWH

Secondly a part of construction costs associated with additional power development has to be assessed as being attributable to the ferrochrome plant. In this case, the relevant concept is again "marginal costs". In reality, if all the users including the ferrochrome plant bear only their marginal costs, the total costs of power development would not be fully

covered due to scale economy almost inherent in such a large-scale development. This would call for some arrangement for cost allocation. It is erroneous, however, to include cost allocation in economic analysis. Only marginal costs attributable to this particular use should be assessed.

The Nos. 5 and 6 generators will be installed at the Roseires power station whether or not the ferrochrome plant is constructed. In this sense, the marginal costs associated with construction of these facilities are nil except the costs of facilities necessary for connection.[2] The latter have already been included in the initial investment costs. Therefore the marginal costs of electricity to be used for the ferrochrome plant is simply opportunity costs of domestic uses as described above.

If, on the other hand, more electricity is to be generated to compensate the diversion, the costs of this development have to be assessed as the marginal costs of the electricity used for the ferrochrome plant. According to the latest "Development Plan for Electricity" drafted by PEWC in 1980, the power development plan and the expenditure expected during the 6 year period between 1980 and 1986 are as given in Table 9-8. The total incremental power generated during this period is 5,415 Gwh (see Table 9-8), and the total expenditure obtained as the sum of the annual incidence of expenditure that is discounted to the year 1981 at the rate corresponding to the opportunity costs of capital or 15% are S£.322.4 x 10^6. Assuming 10% for the internal transfer portion included in the total expenditure, the real production costs of electricity to be obtained in the future are S£290.1 x 10^6. From these figures the unit economic cost of electricity is calculated on average as:

$$\frac{S£\ 290.1 \times 10^6}{5{,}415 \times 10^5\ KWH} = S£\ 0.0536/KWH$$

Table 9-8 Total Incremental Power Generated and Total Expenditure for Power Development, 1980/81 – 1985/86

Year		1980/81	81/82	82/83	83/84	84/85	85/86	Total
Incremental Power	Gwh	425	647	853	991	1,157	1,342	5,415
Total expenditure	10^6 S£	62	137	89	61	47	14	410
Discounted total expenditure	10^6 S£	62	119.1	67.3	40.1	26.9	7.0	322.4

Source: PEWC, 1980 Development Plan for Electricity

2) If the implementation of the power development has to be expedited to meet the requirements of ferrochrome plant, the marginal costs of construction attributable to the ferrochrome plant can be assessed by the difference between the total construction costs and the same costs discounted over the period of expedition at the rate representing the opportunity costs of capital.

Since two figures obtained above agree quite well with each other, the value S£0.054/kwh is used as real costs of electricity in economic analysis. Note this value is considerably higher than the value used in the standard case of financial analysis, which was determined from the electricity tariff that is currently effective.

Labor costs

Labor costs to be used in economic analysis should also be estimated based on opportunity costs of workers recruited from different places. Many difficulties arise, however, in estimating the opportunity costs of labor or shadow wages. When the labor market is tight, the prevailing wage levels can be used as proxy of the opportunity costs of labor, but this is not necessarily the case.

Often no reliable data are available on unemployment of various classes of workers in different localities, and official unemployment figures may not tell much about availability of workers. Some workers, even if unemployed, may not be economically active, or even if some workers are officially on pay-rolls, their marginal productivity may be extremely low due to mismatch of their ability and the kinds of work they are engaging or for some other reasons. In the latter case, virtually no opportunity costs would be involved in utilizing these workers for other projects.

According to the latest "Six Year Plan of Economic and Social Development, 1977/78 – 1982/83" drafted by Ministry of National Planning, it is expected in the Sudan that managers, technicians and skilled workers are generally in short supply in the near future, while unskilled workers are relatively abundant. The situations seem to be similar in the Damazin area, except that fewer skilled workers specialized in engineering are available (see Chapter 7, Section 2 Manpower Planning).

For skilled workers, technicians and managers, therefore, prevailing wage levels may be used in economic analysis. Most of the unskilled workers will be recruited from neighboring farms in and around the Damazin area. How much the agricultural production will be reduced as a result depends in general on how the remaining farmers will adjust their farm operation after such changes. The ferrochrome plant, however, will be shut down during the critical period of power supply, which coincides with a rainy season when demand for farmers is the highest. Agricultural production will not be significantly reduced, if most of the unskilled workers are allowed to return to their farms during rainy seasons. Thus zero opportunity costs are assessed for these workers, and the total labor costs are slightly reduced from the value used in financial analysis.

Prices of chromium ore

The price of chromium ore used in the standard case of financial analysis should be the price at which the ore would most likely be purchased. The price may be estimated as a FOB price at a Port Sudan less transportation costs between Damazin and Port Sudan. Another way is to estimate the price of chromium ore based on its production costs at existing mines, as done in the previous subsection. Naturally the production costs themselves do not include profits of the mines nor taxes and other internal transfer portions of the costs reflected in the FOB price. When transportation costs between the mine and the plant are estimated and added to the production costs, the accounting costs of chromium ore to be used in economic analysis are obtained. The accounting costs are S£54.5 per unit ton of chromium ore, the same as the price used in financial analysis.

Internal transfer portions

All the internal transfer portions have to be eliminated from the cost figures used in financial analysis. These include taxes, custom duties and royalty.

Shadow exchange rate

Obviously a tariff system may significantly affect viability of projects; inputs and outputs of any project are in general subject to different rates of custom duties. In economic analysis, real price of foreign exchange or shadow exchange rate that reflect the effects of a tariff system has to be used rather than a nominal one represented by the official exchange rate.

Suppose a certain import commodity has a CIF price of one dollar, but $\lambda = 0.2$ or 20% import duty is imposed on it. Applying the exchange rate R = S£ 0.79 to one dollar, this commodity has a value in the domestic market of US$1.2 x 0.79 = S£0.948 as long as the market is functioning properly. In other words, one dollar spent on this commodity yields the internal value of S£0.948. The shadow exchange rate in this single commodity case is thus $(1 + \lambda) R$ = S£0.948 to one dollar.

If there exist n import commodities with values $x_1, x_2, \ldots, x_n$ and tariff rates applicable to them being $\lambda_1, \lambda_2, \ldots, \lambda_n$ respectively, the shadow exchange rate SER can be calculated as the official rate multiplied by a weighted sum of $(1 + \lambda_i)$, with the weight for the i th commodity being $\Delta x_i / \sum_i \Delta x_i$, where Δx_i represents foreign exchange to be allocated to the purchase of the i th commodity when the amount $\sum_i x_i$ becomes available:

$$(1) \quad SER = \left(\sum_i (1 + \lambda_i) \frac{\Delta x_i}{\sum_i \Delta x_i} \right) R$$

The similar arguement applies to the case of export commodities, and in fact, the formula (1) is valid for a package of all imports and exports, if negative values are used for tariff rates corresponding to export commodities. By explicitly writing values of m export commodities as $y_1, y_2 \ldots, y_m$ with tariff rates for these being $\mu_1, \mu_2, \ldots, \mu_m$, the fomula for the shadow exchange rate becomes as follows:

$$(2) \quad SER = \frac{\sum_i (1+\lambda_i)\Delta x_i + \sum_j (1-\mu_j)\Delta y_j}{\sum_i \Delta x_i + \sum_j \Delta y_j} R$$

Here Δy_j represents foreign exchange to be earned by sales of the j th export commodity when the total amount $\sum_j \Delta y_j$ is to be obtained.

How much foreign exchange is allocated to the i th import commodity, if a unit foreign exchange becomes available, or what fraction of foreign exchange requirement is met by increasing export of j th commodity is expressed respectively by elasticity of demand for foreign exchange or elasticity of supply of foreign exchange. Define herein the demand and supply elasticity with respect to a change ΔZ of a certain parameter (e.g. the official exchange rate itself) from its original value Z as follows.

$$(3) \quad \eta i = \frac{\Delta xi}{xi} / \frac{\Delta Z}{Z}$$

$$(4) \quad \epsilon i = \frac{\Delta yi}{yi} / \frac{\Delta Z}{Z}$$

Solve the equations (3) and (4) for Δxi and Δyi, respectively, and substitute them in the formula (2) to obtain:

$$(5) \quad SER = \frac{\sum_i (1+\lambda i)\,\eta i xi + \sum_j (1-\mu j)\,\epsilon j yj}{\sum_i \eta i xi + \sum_j \epsilon j yj} R$$

In reality, it is difficult to estimate values of elasticity, and usually unity is assumed for each. This implies in this case that the structure of foreign trade does not basically change. Thus the formula (5) is simplified to:

$$SER = \frac{\sum_i (1+\lambda i)xi + \sum_j (1-\mu j)yi}{\sum_i xi + \sum_j yj} R$$

or

$$(6) \quad SER = \frac{\sum_i xi + \sum_j yj + \sum_i \lambda i xi - \sum_j \mu j yj}{\sum_i xi + \sum_j yj} R.$$

Clearly the terms $\sum_j xi$ and $\sum_i yj$ are respectively total value of import and export commodities, and $\sum_j \lambda ixi$ and $\sum_j \mu jyj$ are total value of import and export duties, respectively.

If the simplified formula (6) is applied to the foreign trade data for 1979 given in Table 9-9, the following is obtained.

$$SER = \frac{393.8 + 252.9 + 137.6 - 24.1}{393.8 + 252.9} R = \frac{760.2}{646.7} R \cong 1.18R$$

Similarly by using the data for 1977 and 1978, the shadow exchange rate is computed as 1.19 and 1.20 times the official rate.

For economic analysis, the shadow exchange rate is taken to be 1.20 times the official rate. That is, by using the official exchange rate R = S$0.79/US$ at the time of field investigation, the shadow exchange rate is computed as

SER = 1.20 x 0.79 = S$0.95/US$[3])

Table 9-9 Foreign Trade Statistics, 1977–1979

(Unit: 10^5 S$)

Year	Imports	Import duties	Export	Export duties
1977	342.2	133.5	223.3	25.8
1978	329.4	125.4	183.1	20.6
1979	393.8	137.6	252.9	24.1

Note: The import and export figures are slightly different from values given in Table 1.4 of this report, primarily because the figures in this table are taken for a calendar year rather than a fiscal year.
Source: Minsitry of National Planning, Foreign Trade Statistics

3) Incidentally this calculated value of foreign exchange agree quite well with the rate in the "black market", which was about 1.01S$ to one dollar at the time of field investigation.

2–2 Benefits of Vocational Training

One of the objectives of The Project is to utilize the ferrochrome plant as a training ground for Sudanese workers to acquire experiences and knowledge in high-temperature furnace industry (refer to Subsection 1-2 of Chapter 3). Value of The Project, therefore, may not be judged simply from a financial point of view. Even if The Project is only meagerly viable financially, it will still provide opportunities for the Sudanese workers to gain valuable experiences and may also contribute to promoting the industrialization policy of the Sudanese government.

There are at least two ways to reflect the benefits associated with the vocational training in economic analysis of projects. One is to consider the second best alternative to attain the same goal. If a project to provide a training ground for domestic workers is not implemented, all of these workers may have to be sent abroad for training to acquire the same skill levels, and costs involved in such a dispatch may be quite significant. If the project is implemented, these costs would be saved.

The other way to represent the benefits of vocational training is to ask what additional value the workers will have at the end of a project life as a result of project implementation. Since the workers engaged in the project implementation will have acquired higher skill levels than is otherwise the case, their marginal productivity would be higher. In other words, they will produce higher value even after the project life.

It is not very meaningful, however, to ask which one of these two methods is theoretically superior. The selection would depend on attitudes of decision makers toward the project. If the vocational training itself is the prime objective of the decision makers, the costs of dispatching many workers abroad that will be saved by implementation of the project would constitute legitimate benefits of the project in economic analysis, as far as established theories and present practice of project evaluation are concerned. If, on the other hand, the implementation of the project is the main concern of the decision makers with vocational training being only a comparatively minor side effect, the first method may not have much relevance.

The analysis of the vocational training effect of The Project herein is based on the second method described above. It is difficult, however, to estimate increased marginal productivity of workers resulting from project implementation. It is assumed that for those workers in all the categories except the unskilled, the labor market is tight so that their wages may be regarded as proxy of their marginal productivity. Then the benefits of vocational training can be estimated based on the difference in wage levels with an without The Project.

The average wage of 118 or 151 workers excluding the unskilled workers without The Project is calculated from the data in Table 7-5 to be S£1,832 or S£1,696 for respective

plant capacity of 7,000 or 15,000 ton/year ferrochrome production Assuming that these workers will be promoted by one class as a result of experiences and skills aquired, except the presided and the director who will stay in the same categories, the average wage with The Project is calculated as S£2,237 or S£2,076 for 7,000 or 15,000 tons/year plnat capacity, respectively. Life-time streams of the incremental income are discounted at the annual rate of 15% to obtain the total value that those workers will have at the end of the project life. The calculated value is S£ 1,182,000 or S£1,594,100 for respective plant capacity of 7,000 or 15,000 tons/year. This value in a sense is "salvage value" of the workers. The Project is evaluated in the next subsection both with and without this additional benefit element.

2–3 Economic Rate of Return

Using those economic costs derived in the previous subsection, the internal economic rate of return can be calculated as shown in **Table 9-10.** The calculated value of economic rate of return for the standard case without the benefits of vocational training is –13.2% or –12.3% for the respective plant capacity of 7,000 tons/year or 15,000 tons/year ferrochrome production, indicating poor economic viability of The Project. These figures are in fact worse than the results of financial analysis. Even with the benefits of vocational training calculated in the previous subsection, the value is only slightly improved to –10.8% or –10.6% in Case A or Case B, respectively.

2–4 Sensitivity Analysis

Some important elements in economic analysis were investigated in subsection 2-1, and economic costs were derived. Other elements are more subject to exogenous factors, and thus sensitivity analysis is performed on parameters representing these elements. In particular, the sensitivity analysis for Case B has been performed on the price of ferrochrome, operating rate of the plant and the initial investment costs. The first and the third may vary significantly as a result of changes in international market situations, and the second factor may vary due to changes in availability of electricity or some other unforeseen conditions specific to the country or the project area.

As shown in Table 9-11, the 20% increase in ferrochrome price improves the calculated value of economic rate of return to –1.1%. The 30% reduction in initial investment costs also increases the calculated value of economic rate of return, but if this reduction is coupled with the 20% reduction in operating rate of the plant, the result is no better than the standard case. If the 20% increase in the ferrochrome price is combined with the 30% cut in the initial investment costs, the economic rate of return turns positive, but the value is only 2.9%.

Table 9-10 Calculation of Economic Rate of Return

(a) Case A -- 7,000 ton/year ferrochrome production

UNIT: 10000L

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	3194.9	73.1	0.0	-3268.0
2.	1984	0.0	7188.5	73.1	0.0	-7261.6
3.	1985	0.0	5591.1	73.1	0.0	-5664.3
4.	1986	2961.1	1135.3	3534.0	0.0	-1708.2
5.	1987	3798.5	244.4	4227.3	0.0	-673.2
6.	1988	3798.5	0.0	4227.3	0.0	-428.8
7.	1989	3998.4	0.0	4227.3	0.0	-228.9
8.	1990	3998.4	0.0	4227.3	0.0	-228.9
9.	1991	3998.4	0.0	4227.3	0.0	-228.9
10.	1992	3998.4	0.0	4227.3	0.0	-228.9
11.	1993	3998.4	0.0	4227.3	0.0	-228.9
12.	1994	3998.4	0.0	4227.3	0.0	-228.9
13.	1995	3998.4	2561.0	4227.3	0.0	-2789.9
14.	1996	3998.4	0.0	4227.3	0.0	-228.9
15.	1997	3998.4	0.0	4227.3	0.0	-228.9
16.	1998	3998.4	0.0	4227.3	0.0	-228.9
17.	1999	3998.4	0.0	4227.3	0.0	-228.9
18.	2000	3998.4	0.0	4227.3	0.0	-228.9
19.	2001	3998.4	0.0	4227.3	0.0	-228.9
20.	2002	3998.4	0.0	4227.3	0.0	-228.9
21.	2003	3998.4	0.0	4227.3	0.0	-228.9
22.	2004	3998.4	0.0	4227.3	0.0	-228.9
23.	2005	3998.4	-1379.7	4227.3	0.0	3036.5

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 7000. TON/YEAR

INTERNAL RATE OF RETURN: -0.132

PRESENT VALUE NET BENEFIT: -20018.5 (DISCOUNT RATE=0.05)
-18115.0 (DISCOUNT RATE=0.10)
-16602.7 (DISCOUNT RATE=0.15)

(b) Case A with benefits of vocational training

UNIT: 10000L

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	3194.9	73.1	0.0	-3268.0
2.	1984	0.0	7188.5	73.1	0.0	-7261.6
3.	1985	0.0	5591.1	73.1	0.0	-5664.3
4.	1986	2961.1	1135.3	3534.0	0.0	-1708.2
5.	1987	3798.5	244.4	4227.3	0.0	-673.2
6.	1988	3798.5	0.0	4227.3	0.0	-428.8
7.	1989	3998.4	0.0	4227.3	0.0	-228.9
8.	1990	3998.4	0.0	4227.3	0.0	-228.9
9.	1991	3998.4	0.0	4227.3	0.0	-228.9
10.	1992	3998.4	0.0	4227.3	0.0	-228.9
11.	1993	3998.4	0.0	4227.3	0.0	-228.9
12.	1994	3998.4	0.0	4227.3	0.0	-228.9
13.	1995	3998.4	2561.0	4227.3	0.0	-2789.9
14.	1996	3998.4	0.0	4227.3	0.0	-228.9
15.	1997	3998.4	0.0	4227.3	0.0	-228.9
16.	1998	3998.4	0.0	4227.3	0.0	-228.9
17.	1999	3998.4	0.0	4227.3	0.0	-228.9
18.	2000	3998.4	0.0	4227.3	0.0	-228.9
19.	2001	3998.4	0.0	4227.3	0.0	-228.9
20.	2002	3998.4	0.0	4227.3	0.0	-228.9
21.	2003	3998.4	0.0	4227.3	0.0	-228.9
22.	2004	3998.4	0.0	4227.3	0.0	-228.9
23.	2005	3998.4	-1379.7	4227.3	0.0	4218.5

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 7000. TON/YEAR

INTERNAL RATE OF RETURN: -0.100

PRESENT VALUE NET BENEFIT: -19614.5 (DISCOUNT RATE=0.05)
-17969.8 (DISCOUNT RATE=0.10)
-16548.0 (DISCOUNT RATE=0.15)

Table 9-10 (continued)

(c) Case B --- 15,000 ton/year ferrochrome production

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	4083.4	54.9	0.0	-4138.2
2.	1984	0.0	9527.9	54.9	0.0	-9582.8
3.	1985	0.0	8166.7	54.9	0.0	-8221.6
4.	1986	0.0	5444.6	54.9	0.0	-5499.4
5.	1987	6188.6	2338.3	7238.6	0.0	-3388.2
6.	1988	7883.1	483.4	8679.7	0.0	-1280.0
7.	1989	7883.1	0.0	8679.7	0.0	-796.6
8.	1990	8298.0	0.0	8679.7	0.0	-381.7
9.	1991	8298.0	0.0	8679.7	0.0	-381.7
10.	1992	8298.0	0.0	8679.7	0.0	-381.7
11.	1993	8298.0	0.0	8679.7	0.0	-381.7
12.	1994	8298.0	0.0	8679.7	0.0	-381.7
13.	1995	8298.0	0.0	8679.7	0.0	-381.7
14.	1996	8298.0	4845.6	8679.7	0.0	-5227.3
15.	1997	8298.0	0.0	8679.7	0.0	-381.7
16.	1998	8298.0	0.0	8679.7	0.0	-381.7
17.	1999	8298.0	0.0	8679.7	0.0	-381.7
18.	2000	8298.0	0.0	8679.7	0.0	-381.7
19.	2001	8298.0	0.0	8679.7	0.0	-381.7
20.	2002	8298.0	0.0	8679.7	0.0	-381.7
21.	2003	8298.0	0.0	8679.7	0.0	-381.7
22.	2004	8298.0	0.0	8679.7	0.0	-381.7
23.	2005	8298.0	0.0	8679.7	0.0	-381.7
24.	2006	8298.0	-2821.7	8679.7	0.0	5823.0

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.123

PRESENT VALUE NET BENEFIT: -33618.1 (DISCOUNT RATE=0.05)
-29773.9 (DISCOUNT RATE=0.10)
-26757.9 (DISCOUNT RATE=0.15)

(d) Case B with benefits of vocational training

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	4083.4	54.9	0.0	-4138.2
2.	1984	0.0	9527.9	54.9	0.0	-9582.8
3.	1985	0.0	8166.7	54.9	0.0	-8221.6
4.	1986	0.0	5444.6	54.9	0.0	-5499.4
5.	1987	6188.6	2338.3	7238.6	0.0	-3388.2
6.	1988	7883.1	483.4	8679.7	0.0	-1280.0
7.	1989	7883.1	0.0	8679.7	0.0	-796.6
8.	1990	8298.0	0.0	8679.7	0.0	-381.7
9.	1991	8298.0	0.0	8679.7	0.0	-381.7
10.	1992	8298.0	0.0	8679.7	0.0	-381.7
11.	1993	8298.0	0.0	8679.7	0.0	-381.7
12.	1994	8298.0	0.0	8679.7	0.0	-381.7
13.	1995	8298.0	0.0	8679.7	0.0	-381.7
14.	1996	8298.0	4845.6	8679.7	0.0	-5227.3
15.	1997	8298.0	0.0	8679.7	0.0	-381.7
16.	1998	8298.0	0.0	8679.7	0.0	-381.7
17.	1999	8298.0	0.0	8679.7	0.0	-381.7
18.	2000	8298.0	0.0	8679.7	0.0	-381.7
19.	2001	8298.0	0.0	8679.7	0.0	-381.7
20.	2002	8298.0	0.0	8679.7	0.0	-381.7
21.	2003	8298.0	0.0	8679.7	0.0	-381.7
22.	2004	8298.0	0.0	8679.7	0.0	-381.7
23.	2005	8298.0	0.0	8679.7	0.0	-381.7
24.	2006	8298.0	-2821.7	8679.7	0.0	7417.1

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.106

PRESENT VALUE NET BENEFIT: -33099.1 (DISCOUNT RATE=0.05)
-29595.9 (DISCOUNT RATE=0.10)
-26693.8 (DISCOUNT RATE=0.15)

3. Observations

Table 9-12 summarises the results of calculation of internal rates of return, including the calculated values of financial rate of return and economic rate of return for the standard runs of both Case A and Case B. Also included in the table are the results of sensitivity analysis for Case B, which appear to be slightly more promising than Case A.

The calculated values of internal rates of return for the standard cases are all negative for both Case A and Case B. That is, The Project is infeasible both financially and economically at either plant scale of 7,000 tons/year or 15,000 tons/year ferrochrome production, as long as those conditions which constitute the standard cases prevail. Financial infeasibility means that The Project would not be successfully undertaken by any private enterprise. Economic infeasibility implies that implementation of The Project may not be justified from the viewpoint of nation's economy. If the benefits of vocational training, as estimated in Subsection 2-2, are included in economic analysis, the economic rate of return is improved but only slightly, indicating these positive effects would not totally save The Project. A note for precaution here, however, is that there may be other benefits associated with The Project including the intangible, which cannot easily be measured in monetary terms such as promotion of industrialization in the Sudan or symbolic value of implementing The Project.

The results for Case B are somewhat better than those for Case A, primarily because of scale economy pertaining to establishing and operating the ferrochrome plant. The calculated values of economic rate of return are no better than the values of financial rate of return, mainly due to high economic costs of electricity as calculated in Subsection 2-1. Although all the internal transfer portions included in the cost figures used in financial analysis are excluded, and the economic value of ferrochrome is calculated to be higher by application of the shadow exchange rate, effects of these favorable factors are substantially cancelled out by the significantly higher economic costs of electricity.

It may be misleading to evaluate effects of various parameters on the internal rates of return in such an unusual case where the calculated values of internal rates of return are mostly negative. Still careful inspection of the cash flow figures given in Table 9-4, 9-5, 9-10 and 9-11, financial statements in Table 9-6 and Table 9-7 as well as the calculated values of internal rates of return lead to the following observations concerning the project costs and effects of various parameters on them.

Variable costs are by far the major part of the production costs as seen from Table 9-6 and Table 9-7. Three major elements of variable costs account respectively for about one-third of the total variable costs. Costs of main raw material (i.e. chromium ore) may not be decreased further, since such a reduction may undermine the viability of the mine operation

Table 9-11 Sensitivity of Economic Rate of Return for Case B

(a) Ferrochrome price up by 20%

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	4083.4	54.9	0.0	-4138.2
2.	1984	0.0	9527.9	54.9	0.0	-9582.8
3.	1985	0.0	8166.7	54.9	0.0	-8221.6
4.	1986	0.0	5444.6	54.9	0.0	-5499.4
5.	1987	7423.7	2338.3	7238.6	0.0	-2153.2
6.	1988	9456.3	483.4	8679.7	0.0	293.2
7.	1989	9456.3	0.0	8679.7	0.0	776.6
8.	1990	9954.0	0.0	8679.7	0.0	1274.3
9.	1991	9954.0	0.0	8679.7	0.0	1274.3
10.	1992	9954.0	0.0	8679.7	0.0	1274.3
11.	1993	9954.0	0.0	8679.7	0.0	1274.3
12.	1994	9954.0	0.0	8679.7	0.0	1274.3
13.	1995	9954.0	0.0	8679.7	0.0	1274.3
14.	1996	9954.0	4845.6	8679.7	0.0	-3571.3
15.	1997	9954.0	0.0	8679.7	0.0	1274.3
16.	1998	9954.0	0.0	8679.7	0.0	1274.3
17.	1999	9954.0	0.0	8679.7	0.0	1274.3
18.	2000	9954.0	0.0	8679.7	0.0	1274.3
19.	2001	9954.0	0.0	8679.7	0.0	1274.3
20.	2002	9954.0	0.0	8679.7	0.0	1274.3
21.	2003	9954.0	0.0	8679.7	0.0	1274.3
22.	2004	9954.0	0.0	8679.7	0.0	1274.3
23.	2005	9954.0	0.0	8679.7	0.0	1274.3
24.	2006	9954.0	-2821.7	8679.7	0.0	7479.0

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.011

PRESENT VALUE NET BENEFIT: -16263.5 (DISCOUNT RATE=0.05)
-19567.1 (DISCOUNT RATE=0.10)
-20260.0 (DISCOUNT RATE=0.15)

(b) Initial investment costs down by 30%

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	2858.4	54.9	0.0	-2913.2
2.	1984	0.0	6659.5	54.9	0.0	-6724.4
3.	1985	0.0	5716.7	54.9	0.0	-5771.6
4.	1986	0.0	3811.2	54.9	0.0	-3866.1
5.	1987	6188.6	2338.3	7238.6	0.0	-3388.2
6.	1988	7883.1	483.4	8679.7	0.0	-1280.0
7.	1989	7883.1	0.0	8679.7	0.0	-796.6
8.	1990	8298.0	0.0	8679.7	0.0	-381.7
9.	1991	8298.0	0.0	8679.7	0.0	-381.7
10.	1992	8298.0	0.0	8679.7	0.0	-381.7
11.	1993	8298.0	0.0	8679.7	0.0	-381.7
12.	1994	8298.0	0.0	8679.7	0.0	-381.7
13.	1995	8298.0	0.0	8679.7	0.0	-381.7
14.	1996	8298.0	3391.9	8679.7	0.0	-3773.6
15.	1997	8298.0	0.0	8679.7	0.0	-381.7
16.	1998	8298.0	0.0	8679.7	0.0	-381.7
17.	1999	8298.0	0.0	8679.7	0.0	-381.7
18.	2000	8298.0	0.0	8679.7	0.0	-381.7
19.	2001	8298.0	0.0	8679.7	0.0	-381.7
20.	2002	8298.0	0.0	8679.7	0.0	-381.7
21.	2003	8298.0	0.0	8679.7	0.0	-381.7
22.	2004	8298.0	0.0	8679.7	0.0	-381.7
23.	2005	8298.0	0.0	8679.7	0.0	-381.7
24.	2006	8298.0	-2821.7	8679.7	0.0	5823.0

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.110

PRESENT VALUE NET BENEFIT: -25266.7 (DISCOUNT RATE=0.05)
-22277.3 (DISCOUNT RATE=0.10)
-19884.5 (DISCOUNT RATE=0.15)

(c) Initial investment costs down by 30% + Operating rate down by 20%

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	2858.4	54.9	0.0	-2913.2
2.	1984	0.0	6669.5	54.9	0.0	-6724.4
3.	1985	0.0	5716.7	54.9	0.0	-5771.6
4.	1986	0.0	3811.2	54.9	0.0	-3866.1
5.	1987	4950.9	1870.6	6006.3	0.0	-2926.0
6.	1988	6306.5	366.7	7192.5	0.0	-1272.8
7.	1989	6306.5	0.0	7192.5	0.0	-886.1
8.	1990	6638.4	0.0	7192.5	0.0	-554.1
9.	1991	6638.4	0.0	7192.5	0.0	-554.1
10.	1992	6638.4	0.0	7192.5	0.0	-554.1
11.	1993	6638.4	0.0	7192.5	0.0	-554.1
12.	1994	6638.4	0.0	7192.5	0.0	-554.1
13.	1995	6638.4	0.0	7192.5	0.0	-554.1
14.	1996	6638.4	3391.9	7192.5	0.0	-3946.0
15.	1997	6638.4	0.0	7192.5	0.0	-554.1
16.	1998	6638.4	0.0	7192.5	0.0	-554.1
17.	1999	6638.4	0.0	7192.5	0.0	-554.1
18.	2000	6638.4	0.0	7192.5	0.0	-554.1
19.	2001	6638.4	0.0	7192.5	0.0	-554.1
20.	2002	6638.4	0.0	7192.5	0.0	-554.1
21.	2003	6638.4	0.0	7192.5	0.0	-554.1
22.	2004	6638.4	0.0	7192.5	0.0	-554.1
23.	2005	6638.4	0.0	7192.5	0.0	-554.1
24.	2006	6638.4	-2257.4	7192.5	0.0	5088.2

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: -0.137

PRESENT VALUE NET BENEFIT: -26582.0 (DISCOUNT RATE=0.05)
-22851.4 (DISCOUNT RATE=0.10)
-20128.8 (DISCOUNT RATE=0.15)

(d) Initial investment costs down by 30% + Ferrochrome price up by 20%

UNIT: 1000SL

	YEAR	NET SALES REVENUE	TOTAL INVESTMENT COSTS	TOTAL PRODUCTION COSTS	INCOME TAX	NET CASH FLOW
1.	1983	0.0	2858.4	54.9	0.0	-2913.2
2.	1984	0.0	6669.5	54.9	0.0	-6724.4
3.	1985	0.0	5716.7	54.9	0.0	-5771.6
4.	1986	0.0	3811.2	54.9	0.0	-3866.1
5.	1987	7665.3	2335.3	7238.6	0.0	-1911.6
6.	1988	9764.1	483.4	8679.7	0.0	601.0
7.	1989	9764.1	0.0	8679.7	0.0	1084.4
8.	1990	10278.0	0.0	8679.7	0.0	1598.3
9.	1991	10278.0	0.0	8679.7	0.0	1598.3
10.	1992	10278.0	0.0	8679.7	0.0	1598.3
11.	1993	10278.0	0.0	8679.7	0.0	1598.3
12.	1994	10278.0	0.0	8679.7	0.0	1598.3
13.	1995	10278.0	0.0	8679.7	0.0	1598.3
14.	1996	10278.0	3391.9	8679.7	0.0	-1793.6
15.	1997	10278.0	0.0	8679.7	0.0	1598.3
16.	1998	10278.0	0.0	8679.7	0.0	1598.3
17.	1999	10278.0	0.0	8679.7	0.0	1598.3
18.	2000	10278.0	0.0	8679.7	0.0	1598.3
19.	2001	10278.0	0.0	8679.7	0.0	1598.3
20.	2002	10278.0	0.0	8679.7	0.0	1598.3
21.	2003	10278.0	0.0	8679.7	0.0	1598.3
22.	2004	10278.0	0.0	8679.7	0.0	1598.3
23.	2005	10278.0	0.0	8679.7	0.0	1598.3
24.	2006	10278.0	-2821.7	8679.7	0.0	7803.0

ECONOMIC ANALYSIS

PRODUCTION CAPACITY: 15000. TON/YEAR

INTERNAL RATE OF RETURN: 0.029

PRESENT VALUE NET BENEFIT: -4516.7 (DISCOUNT RATE=0.05)
-10073.5 (DISCOUNT RATE=0.10)
-12115.4 (DISCOUNT RATE=0.15)

itself. Application of a lower rate for electricity contributes significantly to improving the values of financial rate of return as can be seen from Table 9-12, but may not be very realistic, when the economic costs of electricity is in fact much higher than the average rate currently effective.

As seen from Table 9-4 and Table 9-10, net cash flow exhibits persistently negative values in the standard case of financial and economic analysis for both Case A and Case B, not only during the construction period but also for all the years of production period except the last year. In financial analysis for Case B, positive net cash flow is observed for most years of production period except the tenth year when additional investment would be required to renovate some of the plant facilities, if the electricity rate is reduced by 30% or ferrochrome price increases by 20%. In economic analysis of Case B, net cash flow becomes positive for all the years of production except the tenth year, if the ferrochrome price goes up by 20%. The calculated values of internal rates of return, however, are negative even in these cases.

Only in the most optimistic case of financial analysis investigated in this chapter, the value of financial rate of return becomes positive 5.4% for Case B. This is the case where the 30% reduction in electricity rate, the 20% increase in ferrochrome price, the 30% cut in the initial investment costs and exemption of all the taxes and custom duties are combined. Possibility of such a combination, however, may not be very high. Moreover the economic rate of return corresponding to this case is found to be only 2.9%, lower than the financial rate of return.

Table 9-12 Summary of IRR Calculation

Case A (7,000 ton/year ferrochrome production)	
Financial analysis	FRR
Standard	−11.0%
Economic analysis	ERR
Standard	−13.2%
+ Benefits of vocational training	−10.8%
Case B (15,000 ton/year ferrochrome production)	
Financial analysis	FRR
Standard	−10.1%
Sensitivity	
Electricity rate: 30% down (0.0239 S£/kwh)	−5.2%
Ferrochrome price: 20% up (557 S£/ton)	−1.4%
Initial investment costs: 30% down	−9.1%
Taxes and Custom duties: all exempted	−9.6%
Most optimistic: all of the above	+5.4%
Economic analysis	ERR
Standard	−12.3%
+ Benefits of vocational training	−10.6%
Sensitivity	
Ferrochrome price: 20% up (556 S£/ton)	−1.1%
Initial investment costs: 30% down	−11.0%
+ Operating rate: 20% down	−13.7%
+ Ferrochrome price: 20% up	+2.9%

CHAPTER 10

CONCLUSIONS

CONCLUSIONS

The values of internal rates of return calculated for the standard cases are all negative for both Case A and Case B. That is, The Project is infeasible both financially and economically at either plant capacity of 7,000 tons/year or 15,000 tons/year ferrochrome production, as long as those conditions that constitute the standard cases prevail. Financial infeasibility means that The Project would not be successfully undertaken by any private enterprise. Economic infeasibility implies that implementation of The Project may not be justified from a viewpoint of nation's economy. If the estimated benefits of vocational training are included in economic analysis, the economic rate of return is improved but only slightly, indicating that these positive effects would not totally save The Project.

A note of precaution here, however, is that there may be other benefits associated with The Project including the intangible, which can not be easily measured in monetary terms. Among these possibilities are (i) promotion of industrialization in the Sudan and provision of a better-balanced economic base, (ii) direction of attention to a less developed region, (iii) provision of employment opportunities and improvement of income distribution, and (iv) other symbolic value of implementing The Project.

The results for Case B are somewhat better than those for Case A, primarily because of scale economy pertaining to establishment and operation of the ferrochrome plant. It should be noted that, however, that the total amount of subsidy required to make The Project financially viable, should it be implemented, would be larger for Case B than for Case A, since the former is larger in development scale.

Sensitivity analysis for Case B has revealed that the 30% reduction in electricity rate, the 20% increase in ferrochrome price, the 30% cut in initial investment costs or exemption of all the taxes and custom duties whould not by itself make The Project sufficiently viable financially. Only in the most optimistic case of financial analysis investigated, where all of the favorable conditions above are combined, the value of financial rate of return becomes positive, but the value is regrettable low 5.4%. Even more annoying is the fact that the economic rate of return corresponding to this case is as low as 2.9%.

Taking all of the conditions described above into consideration, The Study Team recommends that a very careful attitude be taken in proceeding toward implementation of The Project at this time.

APPENDIX I

MINUTES

OF MEETING ON MARCH 4, 1981

MINUTES OF THE MEETING CONCERNING THE FEASIBILITY STUDY ON THE ESTABLISHMENT OF A FERROCHROME PLANT IN

THE DEMOCRATIC REPUBLIC OF THE SUDAN

MARCH 4, 1981

KHARTOUM

H. Haga

HIDEO HAGA
LEADER OF THE JAPANESE STUDY TEAM

YOUSIF SULEIMAN
UNDER SECRETARY
MINISTRY OF ENERGY AND MINING

Hideo Yasuki

HIDEO YASUKI
PLANNING AND SURVEY DEPT.
JAPANESE INTERNATIONAL COOPERATION AGENCY

MUSTAFA B. M. MITWALLI
DIRECTOR GENERAL
GEOLOGICAL MINERALS RESOURCES DEPT.
MINISTRY OF ENERGY AND MINING

On the 4th March, 1981, The Japanese Study Team (hereinafter referred to as "The Study Team") sent by The Japan International Cooperation Agency, The Official Agency responsible for the implementation of technical cooperation of the Government of Japan, and The Sudanese side had the meeting at Geological Department, Ministry of Energy And Mining concerning the feasibility study (hereinafter referred to as "The Study") on the project to establish a ferrochrome plant in The Sudan (hereinafter referred to as "The Project").
Members of The Sudanese side participated in the discussions are listed below:-

NAME	TITLE	NAME OF FIRM/ORGANIZATION
Mustafa B. Mitwalli	Director General	Geological & Mineral Resources Dept.
M. Safi El Din	Director, Mineral Res. Administration	"
Gamal Abuseif	Director, Exploration	"
Mahdi Ahmad	Director, Project Design	"
Yassin Hassan Karrar	Geologist	"
M. Akasha	Technical Manager	Sudanese Mining Corp.
M. A. El Hindi	Chief Geologist	Ingassanna Hills Mines Corp.

Provided the basis of the discussions was the talking paper that The Study Team had prepared and submitted to The Sudanese side in advance.
The original of the talking paper is included in Appendix.
The Sudanese side basically agreed on most parts of the talking paper, but each section of the paper was carefully examined by both sides.
Specific issues raised and discussed in the course of examination are detailed section by section in the following :-

I Background :
The Sudanese side expressed satisfaction on the contents of this section. No addition or modification are considered necessary by The Study Team and The Sudanese side.

II Objectives of The Project and the Basic Premise :
The following fifth objective is added to those listed in the talking paper, in consideration of the desire of The Sudanese side.
5) To promote development of industry in The Sudan related to the production.
Also the Sudanese side indicated that the establishment of ferrochrome plant is not totally export-oriented, but they expect that domestic demand for ferrochrome may arise in the future.
With these addition and comment, both sides agreed on the objectives of The Project.
Concerning the scale of the ferrochrome plant, The Study Team stated that they had judged the plant scale of 7,000 tons - annual ferrochrome production is most reasonable and beneficial to the Sudan based on their past experiences, consideration of the objectives of The Project, international market situation of ferrochrome as well as the estimated reserve and present production capacity of existing mine in the Ingassanna area. The Sudanese side however, expressed a strong concern for establishing a larger - scale plant and suggested 15,000 tons-annual ferrochrome production. Main grounds of their argument were that more reserve could be confirmed by further exploration at the Ingassanna Area, and that a larger plant could be more economical, although they noticed unfavourable conditions prevailing in the ferrochrome market as pointed out by The Study Team.
Although The Study Team considers the annual ferrochrome production of 7,000 tons the most reasonable, it agreed to study on another plant scale of 15,000 tons - annual ferrochrome production in view of the serious concern by The Sudanese side for this alternative.

III Scope of Work

The Sudanese side and the Study Team agreed on the following points related to overall scope of the Study

1. This study is concerned with investigating the feasibility of a ferro-chrome plant to be located in the Damazin Area.
2. Further exploration of the chrome ore reserve in the Ingassanna Area and a plan to establish a concentration plant are subjects of separate studies and are therefore not included in the present study.
3. Results of these studies mentioned in item 2), however, will be utilized as much as possible to the extent appropriate for the present study.

In this connection, The Sudanese side suggested the possibility of utilizing low-grade ore. The Study Team pointed out that this question cannot be answered until the above-mentioned studies come to a conclusion. Therefore, both sides agreed to exclude it from the scope of work of The Study being carried out at this time.

The Sudanese side accepted other parts of the scope of work, including not only the purpose of The Study, the specific tasks necessary to accomplish the purpose and the field investigation, but also the more detailed specifications of The Study given in Annex 3 of the talking paper.

IV Schedule of Work and Reports

The Sudanese side just confirmed that the draft final report should be prepared in about two and a half months after the return of The Study Team to Japan.

The Study Team assured that the final report should be delivered by the end of August 1981 but that every effort should be made to shorten the preparation period.

V Cooperation Expected from The Sudanese Government

The Sudanese side agreed to provide cooperation to The Study Team in carrying out the field investigation to the extent they consider possible.

The Sudanese side assured that they would designate the counterpart in order to provide answers to the questionaire (see Annex 5 in the talking paper) and to arrange for appoint-ments as requested by The Study Team. The Study Team assured in turn that the field investigation would be carried out in close collaboration with the Sudanese side so that results of the investigation would be most satisfactory for the both sides.

The both sides agreed that they would discuss on the draft of the final report to be prepared by The Study Team.

A P P E N D I X

TALKING PAPER

FOR

THE FEASIBILITY STUDY

ON

THE ESTABLISHMENT OF A FERROCHROME PLANT

IN

THE DEMOCRATIC REPUBLIC OF THE SUDAN

March, 1981

Japanese Study Team

sent by

Japan International Cooperation Agency, Japan

I. BACKGROUND

In proceeding with the economic development plans, the Government of the Democratic Republic of the Sudan places high priority not only on the development of agriculture but also on the industrialization of mineral resources of the country. One of the priority projects in the mining industry is the development of chromite mines and ferrochrome industry. In the hope that establishment of a ferrochrome plant would constitute a nucleus of the industrialization policy of the Sudan and contribute also to earning foreign exchanges, the Government of the Sudan requested cooperation of the Japanese Government in carrying out a feasibility study on the project (hereinafter referred to as "The Project") to establish a ferrochrome plant in the Sudan.

On the basis of this request and in accordance with the technical assistance policy of Japan, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation of the Government of Japan, has made a decision to send a study team (hereinafter referred to as "The Study Team") to carry out a feasibility study (hereinafter referred to as "The Study") on the ferrochrome smelting plant to be located in the Damazin area. Members of The Study Team are given in Annex 1.

In 1977, a pre-feasibility study was conducted by JICA for the purposes of formulating an infrastructure improvement plan for the mine development and also of drafting a preliminary construction plan for the ferrochrome plant. This pre-feasibility study provides a point of departure for The Study being carried out at this time. Results and findings of the pre-feasibility study will be utilized as much as possible, but

The Study is directed more toward implementation of The Project itself rather than surrounding conditions such as infrastructure. The costs associated with The Project will be estimated more accurately based on the best data available, and technical, institutional, legal and other problems involved in implementing The Project will be carefully dealt with.

II. OBJECTIVES OF THE PROJECT AND THE BASIC PREMISE

The objectives that the Sudanese Government attaches to The Project, as understood by The Study Team, are as follows.

1) To construct a ferrochrome plant in the Damazin area.
2) To earn foreign exchanges through exporting ferrochrome in order to improve balance of payments of the Sudan.
3) To utilize the plant as a training ground for Sudanese workers to acquire experiences and knowledge in high-temperature furnace industry.
4) To place the plant as a core or a symbol of the industrialization policy of the Sudanese Government for the purposes of educating the Sudanese people and bringing about a better understanding of the policy.

As for the scale of the ferrochrome plant that constitutes the basic premise of The Study, the following analysis is in order at this stage. Based on the estimated exploitable reserve of about 950,000 tons and the present production capacity of the existing mine, the amount of chrome ore made available annually would be about 25,000 - 30,000 tons,

not sufficient to warrant a large-scale ferrochrome plant. The plant scale should be small enough to be manageable by those who have not acquired high skills to operate the plant, but large enough to provide most appropriate opportunities for the Sudanese workers to develop their skills. Also the international market for ferrochrome at present is characterized by high variability in prices and oversupply, and the situations do not seem to improve much in the near future. These situations imply that high risk may be involved in launching a large-scale ferrochrome plant at this time.

In view of the factors mentioned above, The Study Team has reached a tentative conclusion to plan the smeltery for handling approximately 15,000 tons chrome ore annually or annual ferrochrome production of about 7,000 tons. Annex 2 gives the basic dimensions of The Project corresponding to this plant scale.

III. SCOPE OF WORK (draft)

Purpose of The Study

The purpose of The Study is to investigate the feasibility of The Project by exchanging views with the authorities in the Democratic Republic of the Sudan, carrying out field investigation and analyzing The Project from technological, economic and other points of view based on the information obtained.

Specific Tasks

To accomplish the purpose delineated above, the following tasks

have to be carried out.

1) To clarify specific intentions and requirements of the Sudanese Government with regard to the establishment of ferrochrome industry.
2) To examine domestic supply capacity of chrome ore and its relation to ferrochrome production in order to determine the plant scale and other demensions of The Project.
3) To collect data on economic, institutional, legal, social and other situations in the Sudan in connection with The Project.
4) To grasp the latest situations of infrastructure and its improvement plans as related to The Project.
5) To investigate the availability of manpower and materials necessary for plant construction and production.
6) To draft a plan for constructing and operating the ferrochrome smelting plant, including preliminary engineering design of facilities.
7) To estimate costs associated with construction, operation and maintenance of the plant and also production costs.
8) To investigate profitability of the plant and possible measures to make it more viable.

More detailed specification of items to be covered by The Study is given in Annex 3.

Field Investigation

A tentative schedule of the field investigation is given in Annex 4. Areas and items to be covered during the field investigation

are summarized as follows.

(1) Khartoum and its surroundings

infrastructure, availability of raw materials and construction equipments and materials, labor situations, legislation, economic, institutional, social and other conditions.

(2) Damazin area

conditions for plant location, infrastructure (electricity in particular)

(3) Ingessana Hills area

availability of raw materials and other subsidiary materials, infrastructure (especially roads)

(4) Port Sudan area

infrastructure (especially port facilities)

A questionnaire for the field investigation is attached in Annex 5.

IV. SCHEDULE OF WORK AND REPORTS

The schedule of the work being carried out at this time is given by the figure in Annex 6. As seen from the figure, the field investigation will be carried out based on the scope of work that will be finalized by the Sudanese authorities and The Study Team. The Study Team will submit an interim report before it leaves the Sudan, which will contain findings of the field investigation, the schedule and the contents of the work thereafter, and other items as appropriate. The draft final report will be prepared in about two months after The Study Team returned to Japan, based on the comprehensive analyses of information obtained before,

during and after the field investigation.

Both the interim and draft final reports will be written in English with all the statistics therein in units of the metric system. The draft final report will make the final report after corrections and modifications are made as necessary, following discussions between the authorities in the Democratic Republic of the Sudan and The Study Team.

V. COOPERATION EXPECTED FROM THE SUDANESE GOVERNMENT

The Government of the Sudan is expected to cooperate with The Study Team either in direct collaboration with it or through the counterpart designated by the Government. Specifically cooperation on the following matter would be highly appreciated.

(1) Participation in discussions with The Study Team necessary to set an overall framework of the investigation.

(2) Confirmation of basic premises for the feasibility study, including the plant scale, future development and/or improvement of infrastructure related to The Project and other aspects.

(3) Assistance in every aspect of data collection and analyses by The Study Team, including the following:

i) Attendance of proper personnel as required by The Study Team.

ii) Arrangement of appointments with Government officials, personnel from public or private organizations etc. as appropriate.

iii) Distribution of a questionnaire to be furnished by The

Study Team upon its arrival, and provision of answers before the departure of The Study Team from the Sudan.

iv) Provision of office space and secretarial assistance for The Study Team upon request.

v) Arrangement for transportations and other conveniences as necessary.

ANNEX 1

MEMBERS OF THE JAPANESE STUDY TEAM

NAME	SPECIALITY	FUNCTION
Hideo Haga	Metallurgical Engineer	Leader
Akira Ayukawa	Geologist, Mining Engineer	Raw Material
Kazuta Kawamura	Geologist, Mining Engineer	Transportation
Shigeyuki No	Mechanical Engineer	Production Facility
Katuhiro Shoji	Mechanical Engineer	Equipments
Masaharu Shimomura	Electrical Engineer	Electricity
Hiroaki Ueno	Architectural Engineer	Civil Works, Architecture
Yoji Ono	Economist	Institutions Market Analysis
Tsuyoshi Hashimoto	Economist	Economical and Financial Analysis
Hideo Yasuki	Planning & Survey Dept. Industrial Survey Div. Japan International Corp. Agency	Coordination
Gen-ichi Koguchi	Iron & Steel Production Div. Basic Industries Bureau Ministry of International Trade & Industry	Technical Corporation Policy

Japan International Corporation Agency
P. O. Box No. 216, 48th Floor
Shinjuku Mitsui Bldg.
No. 1, 2-chome, Nishi-Shinjuku
Shinjuku-ku, Tokyo, Japan

Tel Tokyo (03) 346-5287∿9
Cable: JICAHDQ
Telex: J22271 JICAHDQ J

Annex 2

Tentative Basic Dimentions of a Feasibility Study on the Establishment of Ferrochrome Plant in the Democratic Republic of the Sudan

ITEM	QUANTITY & SPECIFICATION
1. Production Amount:	7,000 T/Y Cr 66.5% Si 3.0% C 7.5%
2. Production Facility:	6,000 KVA x 1 Electric Furnace
3. Land Area for Plant:	54,000 m^2 (180 m x 300 m)
4. Raw Material Requirement:	
Chrome Ore	15,000 T/Y Cr_2O_3 48% up
Coke	3,400 T/Y FC 80 % up 5-30m/m
Bauxite	1,300 T/Y Al_2O_3 50% up 3-50m/m
Quartz	1,500 T/Y SiO_2 90% up 3-50m/m
Electrode Paste	140 T/Y Soederberg type
5. Power Reuirement:	
Contract Demand	5,000 KW
Usage (Hourly Rate)	4,500 KW
Usage (Total Year)	31,500 x 10^3 KWH
6. Water Requirement:	
Industrial Water	70 T/H
7. Manpower Requirement:	
Managerial/Supervisory	5
Engineering/Technical	5
Clerk	10
Work Force	50
Total	70

ANNEX 4. Tentative Schedule of the Field Investigation

DATE	PLACE	CONTENTS OF SURVEY
Mar. 1 (Sun)	Tokyo → Frankfurt	
2 (Mon)	Frankfurt → Khartoum	
3 (Tue)	Khartoum	Greeting on Japanese embassy and Sudanese government.
4 (Wed)	Khartoum	Meeting with Sudanese counter parts.
5 (Thu)	Khartoum → Damazin	Survey in Damazine district.
6 (Fri)	Damazin	- do -
7 (Sat)	- do -	- do -
8 (Sun)	Damazin → Ingessana Hills	Survey in Ingessana Hills
9 (Mon)	Ingessana Hills	- do -
10 (Tue)	Ingessana Hills → Damazin	Survey in Damazine district.
11 (Wed)	Damazin	- do -
12 (Thu)	Damazin → Khartoum	Survey in Khartoum district.
13 (Fri)	Khartoum	- do -
14 (Sat)	- do -	- do -
15 (Sun)	Khartoum → Port Sudan	Survey in Port Sudan district.
16 (Mon)	Port Sudan	- do -
17 (Tue)	Port Sudan → Khartoum	Survey in Khartoum district
18 (Wed)	Khartoum	- do -
19 (Thu)	- do -	- do -
20 (Fri)	- do -	Preparation of interim report.
21 (Sat)	- do -	Explanation of interim report.
22 (Sun)	Khartoum → Paris	
23 (Mon)	Paris	
24 (Tue)	→ Tokyo	

ANNEX 6. Tentative Investigation Schedule of the Feasibility Study on the Establishment of a Ferrochrome Plant in The Democratic Republic of the Sudan

ITEM OF WORKING	MAR.	APR.	MAY	JUN.	JUL.	AUG.
1. Main Raw Material						
2. Subsidiary Raw Material						
3. Factory Site Conditions						
4. Enviromental Conditions						
5. Infrastructure						
6. Plant Size, Specification						
7. Equipment Planning						
8. Operation Planning						
9. Labor Conditions						
10. Laws, Regulations & Market Situation						
11. Economic Evaluation & Capital Analisys						
12. Recommendations						
13. Submittance of Interim Report						
14. Preparation of Draft Final Report						
15. Presentation in Sudan						
16. Preparation of Final Report and its Submittance						

APPENDIX II

INTERIM REPORT

MEMORANDUM ON THE SUBMISSION OF AN INTERIM REPORT OF THE FEASIBILITY STUDY ON THE ESTABLISHMENT OF A FERROCHROME PLANT IN THE DEMOCRATIC REPUBLIC OF THE SUDAN

March 21, 1981
KHARTOUM

The Japanese Study team (The Study Team) sent by the Japan International Cooperation Agency has submitted to the Sudanese authorities concerned an interim report of the Feasibility Study (The Study) on the establishment of a ferrochrome plant in the Democratic Republic of the Sudan. This interim report marks a progress made heretofore in fulfilling the roles of The Study Team in accordance with the Scope of work for The Study as established in the Minutes of March 4, 1981 by both the Sudanese side and The Study Team.

The Study Team has conducted a field investigation as a part of The Study during its stay (March 4-21, 1981) in the Khartoum, Damasin, Ingessana Hills and Fort Sudan areas. The interim report contains major findings of the field investigation as well as basic conditions of The Study. This report will constitue the basis for the work to be done hereafter by The Study Team.

Yousif Suleiman
Under Secretary
Ministry of Energy and Mining

Hideo Haga
Leader of the Japanese
Study Team sent by the
Japan International
Cooperation Agency

INTERIM REPORT

OF

THE FEASIBILITY STUDY

ON

THE ESTABLISHMENT OF A FERROCHROME PLANT

IN

THE DEMOCRATIC REPUBLIC OF THE SUDAN

March 21, 1981

Japanese Study Team

sent by

Japan International Cooperation Agency, Japan

TABLE OF CONTENTS

LIST OF FIGURES AND TABLE

I. INTRODUCTION

In proceeding with the economic development plans, the Government of the Democratic Republic of the Sudan places high priority not only on the development of agriculture but also on the industrialization of mineral resources of the country. One of the priority projects in the mining industry is the development of chromium mines and ferrochrome industry. In the hope that establishment of a ferrochrome plant would constitute a nucleus of the industrialization policy of the Sudan and contribute also to earning foreign exchanges, the Government of the Sudan requested cooperation of the Japanese Government in carrying out a feasibility study on the project (hereinafter referred to as "The Project") to establish a ferrochrome plant in the Sudan.

On the basis of this request and in accordance with the technical cooperation policy of Japan, the Japan International Cooperation Agency, the official agency responsible for the implementation of technical cooperation of the Government of Japan, made a decision to send a study team (hereinafter referred to as "The Study Team") to carry out a feasibility study (hereinafter referred to as "The Study") on the ferrochrome smelting plant to be located in the Damazin area.

Representatives of the Democratic Republic of the Sudan concerned with The Project and The Study Team had a meeting on March 4, 1981 at Geological Department, the Ministry of Energy and Mining. Basic agreements were reached between the both sides ("Minutes of the Meeting concerning the Feasibility Study on the Establishment of a Ferrochrome Plant in the Democratic Republic of the Sudan, March 4, 1981").

The field investigation has been carried out by The Study Team for the period between March 4 and March 21, 1981 in accordance with the Scope of Work, covering the Khartoum, Damazin, Ingessana Hills and Port Sudan areas. This interim report contains major findings of the field investigation as well as basic conditions of The Study.

II. BASIC CONDITIONS OF THE STUDY

1. Plant Site

Three alternative sites in the Damazin area have been considered for a ferrochrome plant (see Figure 1). Alternative 1 in the figure was originally proposed by The Study Team in conformance with a development plant of heavy industry in Damazin drafted by the Sudanese side. The Sudanese side, however, cited another plan to raise the height of Roseires Dam by 10m, which prohibits any construction within 1,000m from the existing embankment. Alternative 1 was thus abandoned, since it is located only 550m away from the embankment. Alternative 2 represents a parallel shift of Alternative 1 so that it is exactly 1,000m from the embankment. The Sudanese side pointed out a few problems associated with this alternative as summarized below.

1) The site may be incompatible with a future extention of the Damazin airport to southeast direction.

2) Water for industrial purposes to be taken from the Blue Nile has to be transported over a long distance crossing the built-up area.

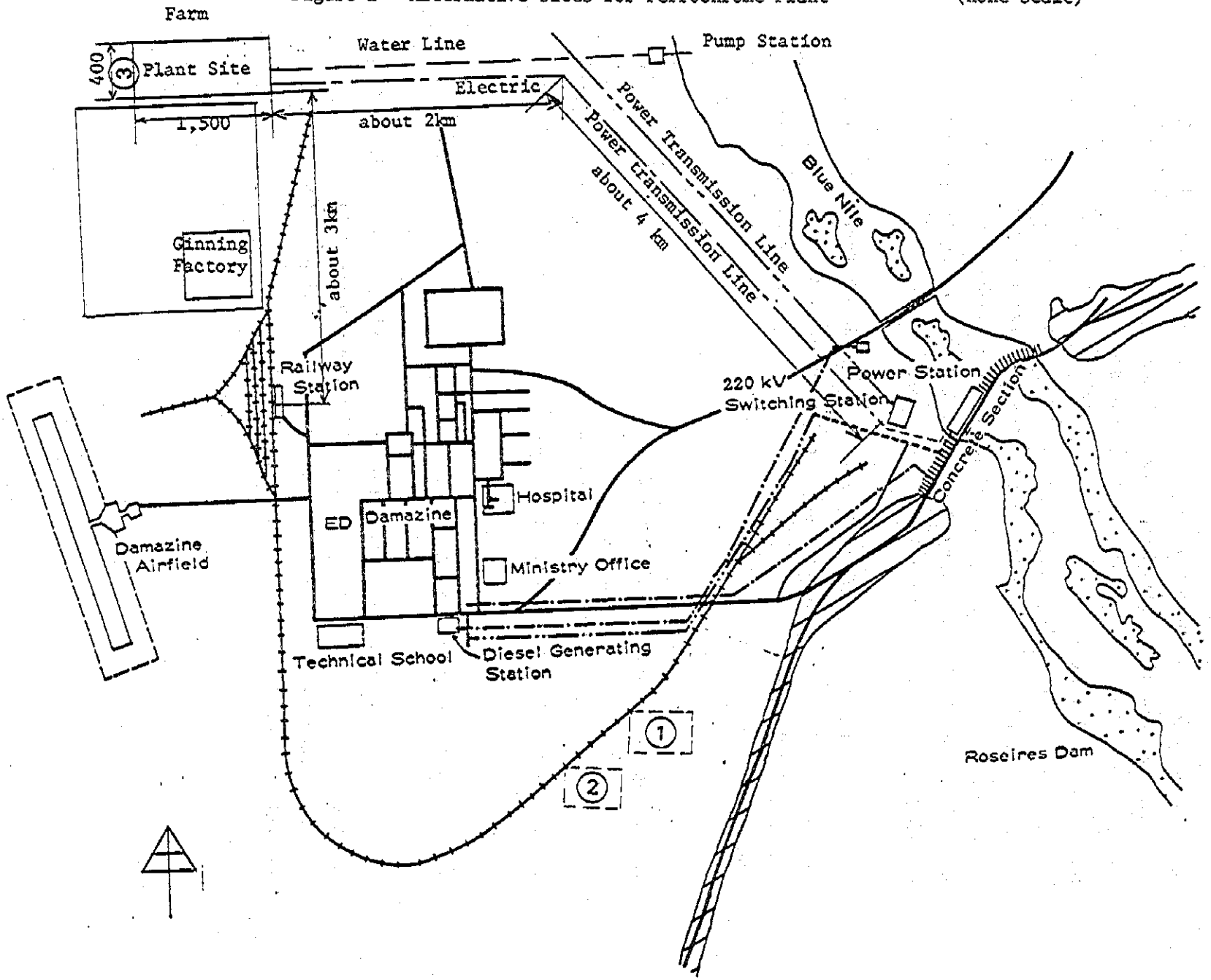
3) There exist some houses in and around the proposed site, and relocation of residents would be necessary.

In view of the factors described above and as a result of a joint survey of the Alternative 3 site, The Study Team and the Sudanese side have agreed on this third alternative as the site for ferrochrome plant. Dimension of this site is 1,500m x 400m although the area required for plant facilities is much smaller.

2. Capacity of the Plant

The Study Team proposed the plant Scale of 7,000 ton-annual

Figure 1 Alternative Sites for Ferrochrome Plant (none scale)



ferrochrome production based on their past experiences, consideration of the objectives of The Project, international market situations of ferrochrome as well as the estimated reserve and the present production capacity of existing mine in the Ingessana Hills area (for more detailed explanation, refer to "Telking Paper for the Feasibility Study on the Establishment of a ferrochrome plant in the Democratic Republic of the Sudan, March 1981"). The Sudanese side, however, expressed a strong concern for establishing a larger - scale plant and suggested 15,000 ton-annual ferrochrome production as an alternative.

Although The Study Team considers the annual ferrochrome production of 7,000 tons most reasonable and beneficial to the Sudan, it has agreed to study another plant scale of 15,000 ton-annual ferrochrome production.

3. Basic Dimensions of The Project

The basic dimensions of The Project corresponding to each plant scale determined in the previous sub-section are summarized in Table 1.

4. Preliminary Layout of the Plant

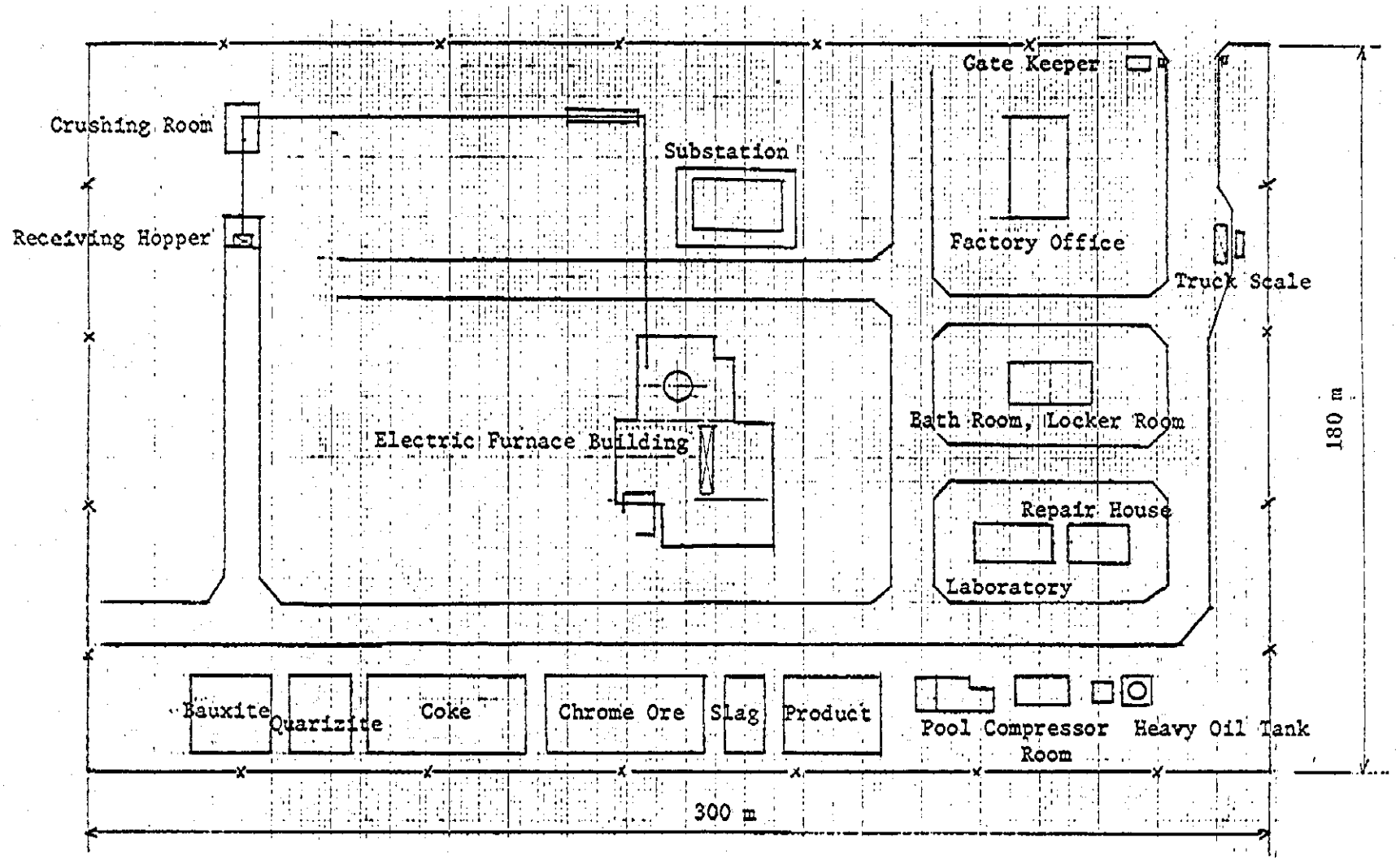
A preliminary layout of the plant is illustrated in Figure 2 for the plant scale of 7,000 ton-annual ferrochrome production. The case of 15,000 ton-annual ferrochrome production will also follow this general scheme.

Table 1 The Basic Dimensions of The Project

ITEM	CASE A	CASE B
1. Production Amount	7,000 T/Y	15,000 T/Y
2. Production Facility	6,000 KVA x 1	14,000 KVA x 1
3. Recieving Voltage	11 KV	33 KV
4. Land Area for Plant	54,000 m^2 (180 x 300)	100,000 m^2 (250 x 400)
5. Raw Material Requirement		
Chrom Ore	15,000 T/Y	32,000 T/Y Cr_2O_3 48%
Coke	3,400 T/Y	7,200 T/Y Fc 80% up 5-30m/m
Bauxite	1,300 T/Y	2,800 T/Y Al_2O_3 50% up 3-50m/m
Quartz	1,500 T/Y	3,200 T/Y Sio_2 90% up 3-50m/m
Electrode Paste	140 T/Y	300 T/Y Soederberg type
6. Power Requirement		
Contract Demand	5,000 KW	11,000 KW
Usage (Hourly Rate)	4,500 KW	10,000 KW
Usage (Total Year)	32,400 x 10^3KWH	72,000 x 10^3KWH
7. Water Requirement		
Industrial Water	70 T/H	150 T/H
8. Manpower Requirement		
Managerial/Supervisory	5	5
Engineering/Technical	5	10
Clerk	10	15
Work Force	50	80
Total	70	110

Figure 2 Preliminary Layout of the 7,000 tons Ferrochrome Plant

S = 1/1,500



III. MAJOR FINDINGS OF FIELD INVESTIGATION

The field investigation has been carried out following largerly the tentative schedule given in Annex 4 of the Talking Paper. Places and organizations that The Study Team visited during the field investigation and Sudanese people who provided cooperation for The Study Team are listed in Annex 1.

Substantial parts of the details of The Study (Annex 3 of the Talking Paper) as specified in the Scope of Work have been covered by the field investigation (see Annex 2 for "Details of The Study on the Establishment of a Ferrochrome Plant in the Democratic Republic of the Sudan"). Major findings of the field investigation are summarized by sector in the following.

1. Chromium Ore and Subsidiary Raw Materials

The Study Team has obtained data on production and mining costs of Gam Mine in Ingessana Hills. Prices at the plant site in Damazin can be estimated both from the mining costs at the mine and FOB price at Port Sudan, taking account of transportation costs.

Most of the subsidiary raw materials necessary for The Project has to be imported except that quartzite can be procured by developing a known large-scale reserve in Ingessana Hills. Charcoal is produced in the Damazin area, but majority of the production is used as domestic fuels and thus considered unavailable for ferrochrome production. For cokes and bauxite, further investigations will be made in Japan on their availability and prices in the international markets.

2. Civil Works and Architecture

Construction materials

Some construction materials are domestically produced, but the majority are imported. Those materials produced in the Sudan include sand, ballast, steel bars (9-25mm ø), bricks, steel pipes (1/2-2mm ø), galvanized steel plates (ø24, ø26), oxygen and acetylene. Cement is also domestically produced in small quantity, but the supply for constructing the ferrochrome plant would depend mainly on imports. The Study Team has obtained data on availability and prices of these and other construction materials.

Machinery and equipment

Most of construction machinery is available in the Khartoum area. Some small machinery including mixers, conveyors and electric walding machines and electric equipment have to be imported.

Contractors, subcontractors and workers

No local contractor is available in the Damazin area. Contractors in Khartoum may be used for both design and construction of civil works and architecture.

Various specialized workers have to be sent from the Khartoum area. A rest house will have to be provided for, and high wages will have to be paid to these workers. Data on labor costs and work load by types of work have been obtained. Many expatriates will also be required for technical supervision.

3. Plant Site

The plant site is located in the north-western part of Damazin, adjacent to the existing ginning factory close to the railway line (see Figure 1).

The site is presently covered by thick bushes but generally flat. Soil conditions of the site is being studied by the Sudanese side

in Damazin and the results should be transmitted to The Study Team within one-month time.

The site may undergo flooding during rainy seasons, and some precautions would be required in designing the plant. Some meteorolagical data for the Damazin area have been obtained.

4. Water

Domestic water

In the Damazin area, water for domestic purposes is taken from Roseires reservoir at 467m level during dry seasons to be transported over 650m distance by gravity to a booster pumping station at 455m. During rainy seasons, the intake from the reservoir becomes difficult so that water is pumped up at about 400m downstream of the dam. The water is transported for about 3km from the booster pumping station to water treatment works, where it is stored in a tank with 500m^3 capacity after sedimentation, caustification and filtration. Supply capacity is approximatly 800m^3/day. Water for domestic purposes at the plant should be provided by the existing waterworks in accordance with city planning of Damazin.

Industrial water

The water requirement for industrial purposes at the ferrochrome plant is 70 tons/hour or 150 tons/hour for operating scale of 7,000 tons or 15,000 tons-annual ferrochrome production respectively. It can be met by installing intake facilities about 4 km downstream from Roseires dam. The facilities should be adapted to the variation in water level of the river.

Another problem may arise in connection with water quality of the river especially during rainy seasons, when dissolved and suspended

solid contents significantly increase. No data were available for the water quality of the Blue Nile near the plant site, and the data for the Khartoum area will be utilized for The Study.

5. Electricity

Existing facilities and future plans of the Roseires power station

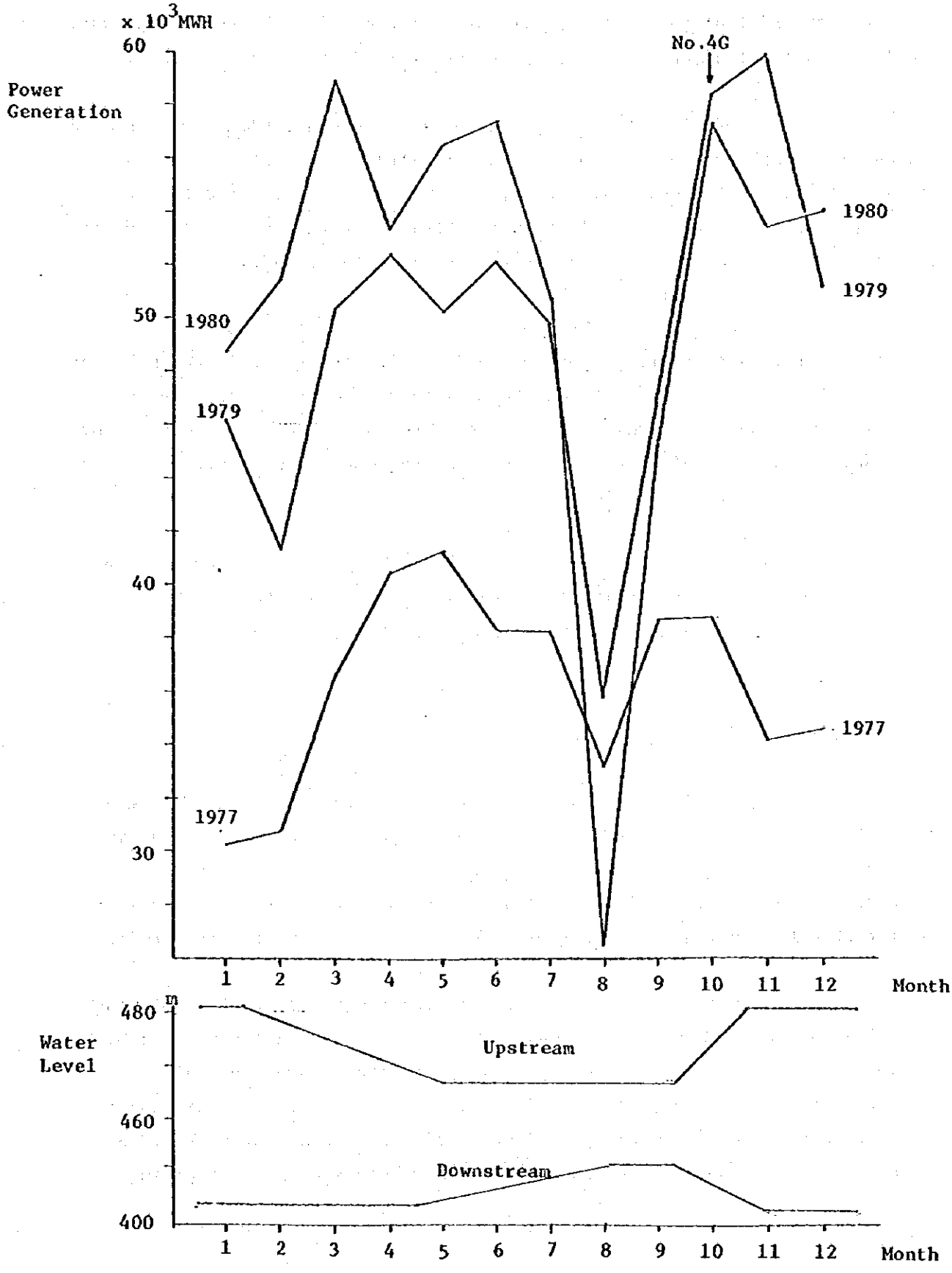
At the Roseires power station, four turbines are currently in operation. Generating capacity is 30MW for the first three turbines and 40MW for the fourth that was installed in October 1979. Most of the power generated is transmitted by 220KV line to Khartoum, and only a minor portion is used in Damazin mainly for domestic purposes.

According to the latest plan, the fifth turbine will be installed by April 1983 and the sixth by early 1984 with generating capacity of 40MW each. Also there exists a plan to raise the height of Roseires dam by 10m as previously mentioned in order to improve the generating performance of the plant especially during flood seasons as explained below, although time of implementations has not been specified.

Operating schedule of the station and problems

The operating schedule of the station is outlined below in reference to water levels of the Roseires reservoir and monthly data on power generation (see Figure 3). The water level of the reservoir is at its maximum of 481m from mid-October through mid-January, and the available head for power generation is also large during this period. Then more water is released than inflow quantity and the water level reaches its minimum sometime in May. Power generation is relatively high due to the increased release. The minimum water level is maintained through mid-September to provide sufficient storage space for floods. The downstream water level, however, rises as more water is released during flood seasons up to about 449m so that available head becomes only about 18m. This is

Figure 3 Monthly Power Generation at the Roseires Power Station and Upstream/Downstream Water Levels



the most critical period for power supply and usually observed in August. It takes about 45 days from mid-Spetember for filling the reservoir.

As seen from Figure 3, the total power generation has increased as additional generating capacity is installed. The performance of the station during the critical period, however, has not necessarily been improved. Power generated in August 1980 is less than a year ago inspite of the installation of the fourth turbine in October 1979.

Another major problem of the station is siltation in the reservoir. Silt is presently deposited in 20 to 30m thickness in the reservoir, extending to about 100m in backwater. Amount of silt in the water to drive the generators sometimes reaches 40 to 60% especially during rainy seasons. As a result, the power station frequently experiences disorder or shutdown of the generators.

The proposed plan to raise the dam height by 10m may improve the performance of the station by increasing available head without sacrificing the flood storage, but would be of little use to solve the problem of siltation and blockade.

Possibility and costs of supply

The receiving voltage is 11KV of 33KV for respective scale of 7,000 ton- or 15,000 ton-annual ferrochrome production as specified in Section II. PEWC presently does not have a plan in the Damazin area for extension and transmission facilities. It will take three to five years for PEWC to draft a plan for these facilities necessary for The Project.

The operating schedule of the ferrochrome plant of continuous 300 days with 65 days for shutdown and repair as originally planned by The Study Team may need reconsideration, since the power generated during four months period from mid-April to mid-August is significantly low. Also even during the period of continuous operation, peak cut of the supply for about four hours per day may be unavoidable, implying

further reduction in annual ferrochrome production.

Information necessary to design power supply facilities for The Project have been obtained from PEWC. The Study Team has also obtained data on costs and cost sharing related to construciton of the supply facilities together with the electricity tariff that is presently effective.

6. Transportation

Requirements

Of raw materials necessary for the ferrochrome plant, chromium ore and quartzite will be supplied from Ingessana Hills and cokes and bauxite will be imported. Most of construction materials, machinery and equipment will depend on imports and their total weight will amount to about 10,000 tons. Transportation planning for The Project will cover these items.

Railways

A questionnaire has been submitted to the Sudanese Railways Corporation concerning railway lines between Port Sudan and Damazin, and answers should be sent to The Study Team by the end of March. Information obtained so far includes the following:

1) Maximum loading capacity per wagon is 30 tons, since parts of the line between Sennar and Damazin are made of 50 lbs/m rails whose axial load is 12.75 tons.
2) No special discount rate is currently applied to railway transportation and the rolling stock is in a short supply.
3) Existing storage capacity available at Damazin station will not be sufficient for transportation needs of The Project.

Roads

The route for road transportation between Port Sudan and Damazin is as follows with the total distance of 1,412km.

Port Sudan - 220km - Haiya - 350km - Kassale - 217km - Gedaref - 227km - Wad Medani - 107km - Sennar 58km - Singa - 233km - Damazin.

The portion between Port Sudan and Sennar (1,121km) is already paved with asphalt. According to the latest plan, the 58km between Sennar and Singa will be paved with asphalt by June 1981, followed by asphalt pavement of the 223km route connecting Singa and Damazin by the end of 1982. Specifications that apply to the paved road are 7.0m wide pavement with 3.0m wide shoulders, weight limit of 9.0 tons axial load and 60 miles/hour speed limit.

A feeder road extending southward from Damazin is to be used to transport chromium ore and quartzite. This route connecting Damazin, J. Agadi, J. Buk, Ingessana Hills and Kurmuk is under consideration by local government especially in connection with the Damazin Company for Agricultural and Livestock Development. This feeder road will have 5.0m wide asphalt pavement with 3.0m shoulders and is expected to be completed in 10 years.

Surface transportation

Construction materials and equipment for the ferrochrome plant will be discharged at Port Sudan. Importation of cokes and bauxite will pose little problem, as the port is presently used to export chromium ore. Data on discharging capacity with available quays and cranes, storage and other charges and storage space available at the port have been obtained.

7. Labor

Requirements

In view of the severe working conditions mainly attributable to the local meteorology of the area, relatively low skill levels available and lack of experience in modern technology industry, manpower required for The Project would be significantly higher than is usually the case with a plant of an equivalent scale in many developed countries. The Study Team has obtained data on labor force at existing factories (the ginning factory and the Roseires Power Station in Damazin; the Sudanese Steel Products in Khartoum), which will be used as reference data in manpower planning for the Project.

Availability

Population of Damazin is approximatively 21,500, of which about 50% are engaged in agriculture and the rest in the government, commercial andother activities. Total population including surrounding areas is estimatedto be about 70,000. There seems little problem in obtaining unskilled workers except that consideration has to be given to seasonal variations in availability of labor force. In particular, many temporary workers may return to their farms during rainy seasons.

The Damazin High School has about 450 students with ages 17 through 21 year old, who are receiving general education in various subjects including mathematics, science (biology, chemistry and physics), languages, geography, history and arts. About 20 to 30 students go to higher education every year after graduation. It is considered that the graduates have sufficient basis to be trained as skilled workers.

Wages

Data on wage levels at existing firms and other relevant information have been obtained.

8. Laws, Regulations and Other Information

Laws and regulations that may have bearings on The Porject have been checked by interviews with the Sudanese authorities concerned (see Annex 1). These include laws and regulations related to labor, investments, taxes and custom duties. Some data on national economy of the Sudan and population and labor statistics have also been obtained.

The following is a partial list of the documents obtained by The Study Team as related to these aspects described above.

- The Encouragement of Investment Act, 1980.
- Statistical Yearbook, 1974 (Published in May 1977).
- The Six Year Plan of Economic and Social Development Volume 1, Volume 2.
- A Note for the Foreign Investore.
- National Income 1976/77, 1977/78.
- Internal Trade Statistics and Price Indices 1977.
- Foreign Trade Statistics 1978, 1979.
- Social Insurance Act, 1974 as amended in July, 1979.
- The Employers and Employed Persons Ordinance, 1948 as amended 1969/73.

These data will be fully analysed by The Study Team after its return to Japan.

IV. WORKS TO BE DONE HEREAFTER

The information obtained during the field investigation will be analysed by The Study Team in a comprehensive way after its return to Japan. Some additional information may be obtained in Japan and used for The Study. More specifically the following tasks will be carried out hereafter.

1) To draft a plan for constructing and operating the ferrochrome plant, including preliminary engineering design of facilities.
2) To estimate costs associated with construction, operation and maintenance of the plant.
3) To estimate benefits derived from sales of the products.
4) To estimate net foreign exchange to be earned by The Project.
5) To carry out the discount cash flow analyses using the estimated costs and benefits.
6) To make suggestions on the following points:
   - possible forms of management of the ferrochrome plant.
   - possible financing plans
   - profitability of The Project and necessary measures to be taken by the Sudanese Government
   - economic viability of The Project from the national point of view.

The schedule of The Study is given by the figure in Annex 3. As shown in the figure, the draft final report will be prepared by The Study Team in two and a half months after its return to Japan, and submitted to the Sudanese side no later than late June. The draft final report will make the final report after corrections and modifications are made as necessary, following discussions between the authorities in the Democratic Republic of the Sudan and The Study Team. The final report will be delivered to the Sudanese side by the end of August.

ANNEX 1 Visits by The Study Team

Place/Organization	Contacts
[Damazin]	
Geological and Mineral Resources Dept.	Ahmed Ali Abdelrahman (Regional Director)
Roseires Power Station	Abbas El Hassan El Hassan (Area Manager)
Governer's Office	Makki Mohamed Makki (Governer of the Blue Nile Prov.)
Ministry of Irrigation	Osman Elton (Resident Engineer)
Cotton Ginning Factory	
Damazin High School	
[Ingessana Hills]	
Gam Mine	
[Khartoum]	
Geological Dept.	Mustafa Abayazio Mitwalli (Director General)
	Gamal M. Abusaid (Director)
	Mohadi Ahmed (Geologist)
	Yassin Hassan Karrar (Geologist)
Sudanese Mining Corp. (SMC)	Ibrahim Mudawi Babiker (Managing Director)
	Mohamed Akasia (Deputy Managing Director
Ingessana Hills Mines Corp.	A. H. Enani (Administrative and Marketing Manager)
Public Electricity and Water Corp.	Syd El Sir Mohamed Salih (Director of Electricity)
	Mohd. Mustafa (Director of Commerce)

Public Electricity and Water Corp. (continued)	Humeida El Hussein (Assistant Director)
	Eh. Amin Sabri (Planning Engineer)
Sudanese Steel Products Co. Ltd. (SSP)	Abdalfattah Abdalghani (Personnel Manager)
African Holloware Factory Ltd. (AHF)	Abdalla Sholgami (Managing Director)
Labor Dept., M. of Public Service and Administrative Reform	Osman Mohamed Ahmed (Director)
Foreign Div., Labor Dept.	Fawzi Mohamed El Sayed (Head)
Companied Div., Taxation Dept., M. of Finance and National Economy	Amal El Sayed Emani
Statistics Dept., M. of National Planning	Omar El Toy (Director General)
National Income Accounts Div., Statistics Dept.	Sir El Khatuni (Head)
Population Census Div., Statistics Dept.	Ali Muddawi (Head)
M. of National Planning	Osman Mustafa (Acting Under Secretary)
Public Social Insurance Institution Institution	
Union Contracting Co., Ltd.	Mohamed Fouad Yousif (Director)
Public Corporation for Irrigation	Osman Mustafa (Manager)

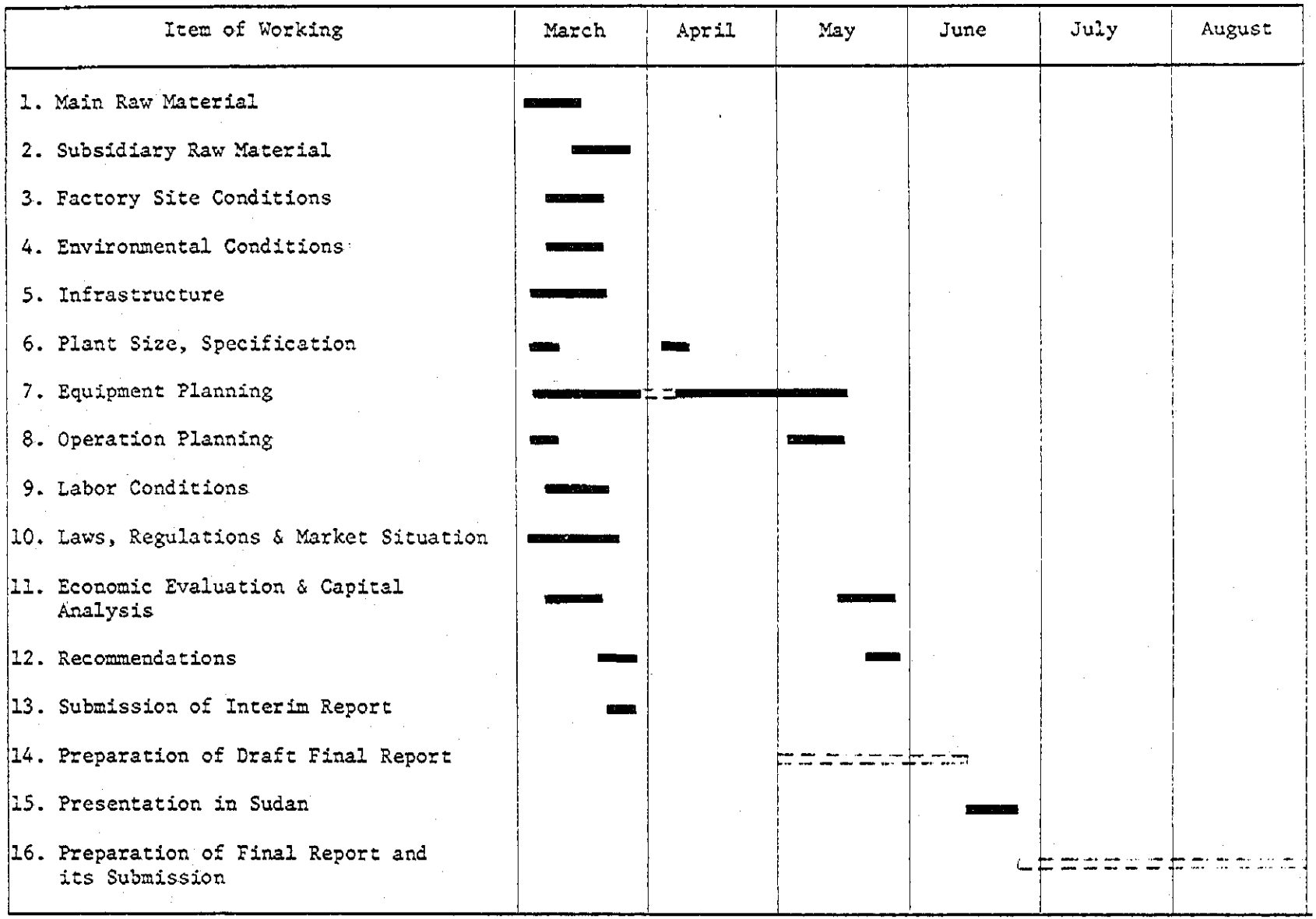
[Port Sudan]

Sea Ports Corporation	Kamil Ali Rahman (Managing Director)
	Mustafa Nureldin
Afro-Asia Commission	Yahia Mohd Mirshani

[Port Sudan] (continued)

Traffic Supt.	Fathi Abbas
Gegira Trading Co.	Ahmed Ali Mageit
Khalafalla El-Bushra Trade and Commission	Khalafalla El-Bushra

ANNEX 3 Investigation Schedule of the Feasibility Study on the Establishment of a Ferrochrome Plant in the Democratic Republic of the Sudan



APPENDIX III

MINUTES

OF MEETINGS SIGNED ON JUNE 11, 1981

Minutes of the Meetings on the Presentation of the Draft Final Report of the "Feasibility Study on the Establishment of a Ferrochrome Plant in the Democratic Republic of the Sudan"

The Japanese team sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation of the Japanese government, and the Sudanese side had a series of meetings from June 7 through June 11, 1981, concerning the feasibility study (hereinafter referred to as "The Study") on the project to establish a ferrochrome plant in the Democratic Republic of the Sudan (hereinafter referred to as "The Project"). The meetings took place at the Geological Department, the Ministry of Energy and Mining in Khartoum. Participants that constituted the Sudanese side are as listed in the following.

	TITLE	ORGANIZATION
Mustafa E. Mitwalli	Director General	Geological and Mineral Resources Department
M. Safi El Din	Director of Mineral Resources Adm.	"
Gamal Abuseif	Director of Exploration	"
Yassin Hassan Tarrar	Geologist	"
M. Akasha	Technical Manager	Sudanese Mining Corporation.

Members of the Japanese team are listed below.

Junsaku Koizumi,	Head of the Japanese team
Hideo Haga,	Engineer, Leader of the feasibility study team dispatch in March 1981 by JICA to carry out the field investigation (hereinafter referred to as "The Study Team").
Akira Ayukawa,	Geologist, Member of the Study Team
Tsuyoshi Hashimoto,	Economist, Member of the Study Team.

At the beginning of the meeting on June 7, 1981, the Japanese team submitted to the Sudanese side copies of the Draft Final Report or the Main Report (draft) of the Study that had been prepared by the Study Team. Prior to this, copies of the Summary Report (draft), separately prepared by the Study Team, had been delivered to the Sudanese side so that they had obtained some general ideas on the results of the Study before the first meeting.

The Sudanese side asked if any other alternatives were conceivable. The Japanese team replied that the question of totally different alternatives is out of the Scope of Work of The Study.

Both the Sudanese side and the Japanese team have accepted the above.

(End of the Minutes)
June 11, 1981

Mustafa A. Mitwalli
Director General
Geological & Mineral Resource
Department
Ministry of Energy and Mining

Junsaku Koizumi
Head of the Japanese team
sent by
The Japan International
Cooperation Agency

Minutes of the Meetings on the Presentation of the Draft Final Report of the "Feasibility Study on the Establishment of a Ferrochrome Plant in the Democratic Republic of the Sudan"

The Japanese team sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation of the Japanese government, and the Sudanese side had a series of meetings from June 7 through June 11, 1981, concerning the feasibility study (hereinafter referred to as "The Study") on the project to establish a ferrochrome plant in the Democratic Republic of the Sudan (hereinafter referred to as "The Project"). The meetings took place at the Geological Department, the Ministry of Energy and Mining in Khartoum. Participants that constituted the Sudanese side are as listed in the following.

	TITLE	ORGANIZATION
Mustafa A. Mitwalli	Director General	Geological and Mineral Resources Department
M. Safi El Din	Director of Mineral Resources Adm.	"
Gamal Abuseif	Director of Exploration	"
Yassin Hassan Tarrar	Geologist	"
M. Akasha	Technical Manager	Sudanese Mining Corporation

Members of the Japanese team are listed below.

Junsaku Koizumi,	Head of the Japanese team
Hideo Haga,	Engineer, Leader of the feasibility study team dispatched in March 1981 by JICA to

carry out the field investigation (hereinafter referred to as "The Study Team").

Akira Ayukawa, Geologist, Member of the Study Team.

Tsuyoshi Hashimoto, Economist, Member of the Study Team.

At the beginning of the meeting on June 7, 1981, the Japanese team submitted to the Sudanese side copies of the Draft Final Report or the Main Report (draft) of The Study that had been prepared by The Study Team. Prior to this, copies of the Summary Report (draft), separately prepared by The Study Team, had been delivered to the Sudanese side so that they had obtained some general ideas on the results of the Study before the first meeting.

Opening Session (10:00 - 10:30 AM, June 7, 1981)

Mr. Tanaki, the Counsellor of the Embassy of Japan in Khartoum gave an opening address on behalf of the Government of Japan. He stated that the implementation of The Study is in accordance with the technical cooperation policy of the Japanese Government and described general background and procedures of the Study.

Following this, Mr. Koizumi from JICA, also the Head of the Japanese team, introduced other members of the Japanese team and explained the purposes of the visit. He said that the Japanese team had come here:

1) To present and explain the results of The Study conducted through discussions with the Sudanese side, the field investigation and works in Japan in accordance with the

Scope of Work established in the Minutes of March 4, 1981, by the Sudanese side and The Study Team, and

2) To exchange views with the Sudanese side concerning the contents of the Draft Final Report so that the Final Report would be prepared and submitted to the Sudanese side in due time.

He expressed his wish that fruitful and constructive discussions be made between the Sudanese side and the Japanese team.

Mr. Mustafa A. Mitwalli, Director General of Geological and Mineral Resources Department, expressed in turn his appreciation of the visit by the Japanese team and its purposes. He stated that the Draft Final Report is such an important document that we should go over it very carefully. He proposed to go through the entire results of The Study following for the most part the Summary Report but by referring to relevant parts of the Main Report as necessary. He further suggested to divide the entire Summary Report in the following four parts and to examine each part a day carefully:

I. Summary

(1)
1. Background
2. Present Status and Future Prospects of Ferrochrome Industry
3. The Project

(2)
4. Raw Materials
5. Infrastructure
6. Facility Planning

(3)
7. Organization and Manpower Planning

8. Operation Planning

(4) 9. Comprehensive Evaluation

II. Conclusions

The Japanese team accepted these propositions as being reasonable and agreed to proceed this way.

Discussion Session 1 (10:30 - 12:00 AM, June 7, 1981)

Specific questions raised and issues discussed in this session are summarized by section in the following.

1. Background

The Sudanese side pointed out that the third sentence in the first paragraph is misleading, since the expression "by utilizing the domestic chromium ore that is currently all exported" prescribes to use high-grade ore for the ferrochrome plant. The Japanese team accepted the point they made and agreed to modify this part in the following way: "by utilizing the domestic low- and high-grade ore procured from Ingessana Hills"

2. Present Status and Future Prospects of Ferrochrome Industry

The Japanese team clarified the ambiguity which the Sudanese side claimed to exist in the description of demand/supply balance of ferrochrome. That is, although the increase in demand for ferrochrome is assumed by the Study Team, the existing supply capacity still exceeds the demand for the foreseeable future. The Sudanese side said that one

could not immediately conclude from this fact that the ferrochrome price in the future would continue to be low, and thus the last statement in this section is too strong. The Japanese team agreed on this point. The second half of the last sentence in Section 2 will be eliminated.

3. The Project

The Sudanese side accepted the whole content of this section, since this is essentially a reiteration of the Minutes of March 4, 1981.

Discussion Session 2 (10:00 - 12:00 AM, June 8, 1981)

Specific questions raised and issues discussed in this session are summarized by section in the following.

4. Raw Materials

The Sudanese side observed that subsection 4-1 with Table S-8 is not clear enough. The Japanese team explained what this part means by referring to Section 1-1 in Chapter 4 of the Main Report, and also clarified all of the sources of information which this part is based on. The Sudanese side expressed their satisfaction to the explanations of the Japanese team, but both sides agreed to rewrite this part of the Summary Report for clarification and easier understanding (see Annex 1).

In responding to questions by the Sudanese side, the Japanese team explained differences in various kinds of ferrochrome and a few other technical and economic points related to ferrochrome production. Quality of ferrochrome for The Project, however, has been specified by the Minutes of March 4, 1981, as it is considered the most reasonable by

The Study Team (see Annex 2 for discussions).

The Japanese team explained by referring to Section 2-2 in Chapter 4 of the Main Report how The Study Team had come to the conclusion that the use of domestic charcoal is not considered very feasible due to insufficient production quantity.

5. Infrastructure

No major questions were raised nor comments made by the Sudanese side on this section, except a few minor questions that were immediately answered by the Japanese team.

Discussion Session 3 (10:00 - 12:00 AM, June 9, 1981)

The following is a section-wise summary of discussions during this session.

6. Facility Planning

The Sudanese side asked to explain what each item of construction costs given in Table S-10 includes. The Japanese Team explained and called attention to Table 6-5 of the Main Report for equipment list. A detailed breakdown of construction cost element was prepared by the Japanese team and submitted to the Sudanese side (see Annex 2).

7. Organization and Manpower Planning

The Japanese team showed the breakdown of manpower requirements and functions of each division of the organization given in Chapter 7 of the Main Report in answering questions raised by the Sudanese side.

8. Operation Planning

No questions were asked nor comments made by the Sudanese side on this section.

Discussion Session 4 (10:00 AM - 12:30 PM, June 10, 1981)

This session covered Section I-9. Comprehensive Evaluation and also II. Conclusions. Major points of discussions are as given in the following.

The Sudanese side expressed their understanding on the conclusion of The Study that The Project is infeasible at either plant scale of 7,000 ton/year or 15,000 ton/year ferrochrome production in the standard cases, but asked what the standard cases exactly mean. The Japanese team explained by pointing out the first paragraph of Subsection 9-2 in the Summary Report. The Japanese team added that the standard cases are based on exactly the same cost and benefit data used to calculate the unit costs as given in Table S-12 except that a partial substitution of cokes by domestic charcoal was assumed for comprehensive evaluation in an attempt to improve viability of The Project.

The Japanese team stated that various other possibilities had also been investigated to see if financial performance of the Project would be sufficiently improved, but they found out to their regret that the results were not encouraging. The Sudanese side showed their full comprehension of this point.

Both sides agreed that the Draft Final Report would make the Final Report after completion of the modifications indicated herein and typographic revision as necessary. The Final Report will be submitted to the Government of the Democratic Republic of the Sudan by the end of August, 1981.

The Sudanese side asked if any other alternatives were conceivable. The Japanese team replied that the question of totally different alternatives is out of the Scope of Work of The Study.

Both the Sudanese side and the Japanese team have accepted the above.

(End of the Minutes)

June 11, 1981

Mustafa B. M. Mitwalli Director General Geological & Mineral Resource Department Ministry of Energy and Mining	Junsaku Koizumi Head of the Japanese team sent by The Japan International Cooperation Agency

Annex 1:

Subsection 4-1 of the Summary Report

The first paragraph of the new subsection 4-1 should read as follows:

The chromium reserve in Ingessana Hills is estimated to be about 950,000 tons. Quality and quantity of the reserve in different areas are found by exploration heretofore as given below.

CLASSIFICATION	LOCATION	RESERVE (ton)	QUALITY (Cr_2O_3%)
High-grade area	Gam mine	579,000	50.1
	Unexploited areas	152,000	48.0
	Sub Total	731,000	49.7
Low-grade ore	Unexploited areas	221,000	38.3
Total		952,000	47.0

The annual production of chromium are at Gam mine is currently 15,000 to 25,000 tons (see Table S-7). Since the amount of chromium ore required for Case B or 33,800 ton/year exceeds the production quantity of existing mines, development of new deposits in the surrounding areas would be necessary. Quality and quantity of some of these deposite are found to be lower as indicated by the above table. Quality of chromium ore at the ferrochrome plant is given in Table S-8 for both Case A and Case B.

The second paragraph and Table S-8 are not changed.

Annex 2:

Discussion on Low-Carbon Ferrochrome

The Sudanese side raised the possibility of producing low-carbon ferrochrome. The Japanese team stated that it is not advisable, citing the following reasons. That is, more sophisticated technology and much higher investment costs would be involved in producing low-carbon ferrochrome, and the demand for ferrochrome of this type had been consistently declining.

Annex 3:

Breakdown of Construction Cost Elements

ITEM	DETAILED COST ELEMENT
Raw Material conveying and blending facilities	Raw material receiving and storage facilities, blending equipment.
Electric furnace facilities	Electric furnace, transformer for furnace, dust collector and other equipment.
Product handling facilities	Product crushing equipment, storage yards for products and slag.
Power receiving and transforming facilities	Power receiver and distributor, power receiving equipment for pumps, power transmission equipment.
Utility facilities	Water pumping and transporting equipment, water supply equipment, air compressor, equipment for fuels, vehicles and others.
Buildings	Building for electric furnace, product handling room, buildings for welfare facilities and other auxiliary buildings.
External structure	Paved service roads in the plant site, ditches, fences, lighting and others.
Construction materials and machinery	Road from the railway station to the plant site, trucks, cranes, buldozers, stagings and temporary facilities.
Materials for operation	Consumables necessary for plant operation such as oxygen.
Spare parts	Spare parts for machinery.
Subsidiary equipment	Office equipment, workshop machinery and Laboratory equipment.