Table 3.1 Extension Services Personnel in Riau, 1990

Kabupaten/ Kotamadya	Head of BPP	PPUP	PPS	PPL
Kampar	18	52	7	267
Indragiri Hulu	11	4	7	174
Indragiri Hilir	12	22	7	189
Bengkalis	11	22	6	184
Kepulauan Riau	4	0	5	69
Pekanbaru	1	2	1	27
Total	57	102	33	910

Source: Bimas Secretariat, Riau

Note:

PPUP=Penyuluh Pertanian Urusan Program (Program Officer)
PPS=Penyuluh Pertanian Spesialis (Extension Specialist)
PPL=Penyuluh Pertanian Lapangan (Field Extension Worker)

Table 3.2 Working Areas and Staff of BPP in the Objective Area

Name of BPP	Location (Kecamatan)	WKPP	WILKEL	Total Staff	PPL
Kampar					
Dalu-Dalu	Tambusai	18	109	16	13
Batas	Tambusai	16	183	17	14
Ps. Panggarayan	Rambah	16	159	24	21
Kota Lama	Kunto Darusalam	15	90	13	8
Rokan	Rokan IV Koto	12	75	5	5
Sei. Tapung	Tandun	11	115	16	9
Bengkalis					
Bangko	Bangko	14	146	17	14
Tg. Lumba-Lumba	Kubu	18	181	10	7
Bagan Sinemba	Kubu	11	107	9	7
Tanah Putih	Tanahputih	19	118	10	7
Total		150	1,283	137	105

Source: Agricultural Extension Programs

Source: WKPP = Wilayah Kerja Penyluhan Pertanian
WILKEL = Wilayah Kerja Kelompok Tani

Table 3.3 Number of BRI Unit Desa in Riau, 1990

Kabupaten/ Kotamadya	Branch	BRI Unit Desa	Year of Establishment
Kampar	Bangkinang	Air Tiris	1989
		Bangkinang	1976
		Ps. Panggarayan *	1987
		Teratak Buluh	1987
		Ujung Batu *	1989
Bengkalis	Dumai	Pangkalan Sesai	1977
		Sukajadi	1981
		Duri *	1981
		Dumai Kota	n.a.
		Bagan Batu *	n.a.
	Selat Panjang	Selat Panjang	1974
	Bengkalis	Sungai Apit	1975
		Bengkalis Kota	1981
Indragiri Hulu	Rengat	Taluk Kuantan	1973
		Lubuk Jambi	1973
		Baserah	1981
		Cerenti	1982
		Air Molek	1982
		Rengat	1982
Indragiri Hilir	Tembilahan	Pulau Kijang	1973
		Sungai Salak	1975
		Kotabaru	1975
		Sungai Guntung	1977
		Kuala Enok	1981
		Tembilahan	1981
Kepulauan Riau	Tanjung Pinang	Tg. Pinang Kota	1989
		Kijang	1989
		Tanjung Uban	1989
Pekanbaru	Pekanbaru	Jl. Sudirman	1987
		Jl. Nangka	1989
		Rumbai	1989

Source: BRI Pekanbaru Branch

Note: * located within the Objective Area

Table 3.4 Supplied Quantity of Farm Input by PT. PERTANI, 1990

	Foodcrops	Estate (PTP)	Estate (Private)	Others 1/	Total
Fertilizers (in kg)					
Urea	576,563	11,582,350	2,639,000	114,400	14,912,313
TSP	85,804	2,050,500	854,000	83,800	3,074,104
KCl	243,862	10,055,050	2,451,500	26,800	12,777,212
Z.A.	26,356	0	1,662,521	6,050	1,694,927
Kaptan	0	767,500	0	0	767,500
Sub-total	932,584	24,455,400	7,607,021	231,050	33,226,055
Pesticide (in liter)					
Insecticide (a) 2/	10,833	2,209	1,670	924	15,635
Insecticide (b) 3/	15,150	906	7,940	1,814	25,810
Rodenticide	17,083	1,200	178,212	528	197,023
Fungicide	94	0	0	62	155
Sub-total	43,159	4,315	187,822	3,328	238,623
Seeds (in kg)					
Paddy	6,930	0	0	6,188	13,118
Palawija	1,900	0	0	61,996	63,896
Horticulture	0	0	0	106,260	106,260
Sub-total	8,830	0	0	174,444	183,274

Source: P.T. Pertani, Riau

Note: 1/ Others include projects undertaken by the government
2/ Insecticide 1 = liquid type
3/ Insecticide 2 = granule type

Table 3.5 Farmer Groups in the Objective Area, 1989

WKBPP	Kecamatan	Farmers Groups Total	Adult Male Group	Women's Group	Youth's Group
Kampar					
Dalu-Dalu	Tambusai	114	99	2	13
Batas	Tambusai	180	152	22	6
Ps. Panggarayan	Rambah	157	140	8	9
Kota Lama	Kunto Darusalam	85	85	0	0
Rokan	Rokan IV Koto	75	75	0	0
Sei. Tapung	Tandun	115	113	1	1
Sub-total		726	664	33	29
Bengkalis					
Bangko	Bangko	175	144	17	14
Tg. Lumba-Lumba	Kubu	113	96	10	7
Bagan Sinemba	Kubu	123	107	9	7
Tanah Putih	Tanahputih	135	118	10	7
Sub-total		546	465	46	35
Total		1,272	1,129	79	64

Source: 1. Laporan Tahunan Dinas Pertanian Tanaman Pangan, Kabupaten Kampar 1989/1990
2. Laporan Tahunan Dinas Pertanian Tanaman Pangan, Kabupaten Bengkalis 1989

Table 4.1 Monthly Expenditure for Food in Riau
(in Rural Area, 1987)

Food Items	Per Capita Expenditure (Average in Rp)	Percentage (%)
Cereals	4,431	27.48
Cassava	230	1.43
Fish	2,778	17.23
Meat	561	3.48
Eggs and Milk	441	2.74
Vegetables	1,703	10.56
Beans	223	1.38
Fruits	757	4.70
Oil and Fat	956	5.93
Beverage	1,298	8.05
Seasoning	465	2.88
Miscellaneous Foods	86	0.53
Prepared Food/Beverage	655	4.06
Alcoholic Beverages	42	0.26
Tobacco and Betelnut	1,497	9.28
Total	16,123	100.00

Source: Riau Dalam Angka 1988/1989

Table 4.2 Fishery Production in Riau, 1984-1988

Unit: ton

Category	1984	1985	1986	1987	1988	A.G.R.(%)
Marine Fishery (A)	145,346	148,950	151,185	157,466	159,499	2.35
Inland Fishery (B)	10,753	11,810	11,929	12,561	12,699	4.25
Inland Open Water	10,482	11,425	11,491	12,015	12,122	3.70
Aquaculture (Brac.)	58	47	33	90	93	12.53
Aquaculture (Fresh)	213	338	405	456	484	22.78
Total (A+B)	156,099	160,760	163,114	170,027	172,198	2.48

Source: Riau Dalam Angka 1988/1989

Note: 1. A.G.R. = Average Annual Growth Rate
2. Brac. = Brackish water
3. Fresh = Fresh water

Table 4.3 Number of Fishing Gears Utilized in the Objective Area of Kab. Kampar, 1989

Location	Gill Net	Portable Net	Long Line	Line & Hook	Scoop Net	Drift Net
Tambusai	0	0	0	117	0	0
Kunto Darusalam	7	38	0	212	0	23
Rokan IV Koto	22	12	0	219	0	0
Rambah	215	370	25	53	12	30
Kepenuhan	34	67	0	30	0	0
Tandun	5	59	11	12	7	85
Total	283	546	36	643	19	138

Source: Laporan Tahunan Dinas Perikanan, Kabupaten Kampar, 1989

Table 4.4 Pond Culture Household, Pond Area and Production in the Objective Area in Kampar, 1989

Location	Pond Culture Household	Pond Area (ha)	Production (ton)	Pond Area per H.H. (m2)	Production per H.H. (kg)
Tambusai	198	3.94	3.10	199.0	15.7
Kunto Darusalam	185	5.90	10.60	318.9	57.3
Rokan IV Koto	295	3.70	5.90	125.4	20.0
Rambah	396	54.47	87.10	1,375.5	219.9
Kepenuhan	35	0.28	0.20	80.0	5.7
Tandun	15	2.01	2.80	1,375.3	191.8
Sub-total	1,124	70.30	109.70	625.6	97.6
Mandau/Tanah Putih	431	55.7	23.1	1,292.3	53.6
Kubu	0	0	0	0	0
Bangko	50	56.8	1.0	11,360.0	20.0
Sub-total	481	112.5	24.1	2,338.9	50.1
Total	1,605	182.8	133.8	1,139.2	83.4

Source: Laporan Tahunan Dinas Perikanan, Kabupaten Kampar, 1989

Table 4.5 Consumption Pattern of Fresh Water Fishes in the Objective Area within KAmpar, 1989

Unit: ton

Location	Consumed Fresh	%	Dried/ Salted	%	Smoked	%	Total
Tambusai	57.0	50.4	43.5	38.5	12.5	11.1	113.0
Kunto Darusalam	111.7	50.5	85.3	38.5	24.4	11.0	221.4
Rokan IV Koto	89.8	50.4	68.6	38.5	19.6	11.0	178.0
Rambah	133.2	50.5	101.7	38.5	29.0	11.0	263.9
Kepenuhan	162.1	50.5	123.8	38.5	35.4	11.0	321.3
Tandun	31.1	50.5	23.8	38.5	6.8	11.0	61.6
Total	584.9	50.5	446.7	38.5	127.7	11.0	1,159.2

Source: Laporan Tahunan Dinas Perikanan, Kabupaten Kampar, 1989

Table 4.6 Average Prices of Fresh Water Fishes in KAmpar and Bengkalis, 1989

Unit: Rupiah/kg

Kind of Fish	Kabupaten Kampar	Kabupaten Bengkalis
(Inland Open Water)		
Jambal (Catfish)	2,500	950
Gabus (Snake Head)	1,500	800
Lais (Catfish)	1,500	800
Sepat Siam	900	800
Tambakan (Kissing Gouramy)	1,000	850
(Aquaculturte)		
Mas (Common Carp)	2,500	2,000
Nila (Tilapia)	1,500	1,350
Gurami (Giant Gouramy)	1,750	1,300
Fresh Water Shrimp	2,500	1,550

Source: Buku Tahunan Statistik Perikanan, Dinas Perikanan, Riau, 1989

Table 5.1 Economic Price of Rice
(at constant 1991 prices)

Item	Unit	Paddy/Rice
Projected 2000 World Market Price 1/	US$/ton	304.00
Quality Adjustment	%	80
Adjusted Price	US$/ton	243.20
Ocean Freight and Insurance	US$/ton	15.00
Border Price	US$/ton	258.20
	Rp/ton	502,199
Inland Transportation and Handling	Rp/ton	(25,000)
Farmgate Price (unhusked rice)	Rp/ton	477,199
Processing Ratio	%	65
Economic Farmgate Price of Rice	Rp/ton	310,179
	Rp/kg	310

Source: World Bank, International Economics Department, International Trade Division, December 1990

Note: 1/. Projected price in 1985 constant dollars has been converted to 1991 price level using price index of 160.48.

Table 5.2 Net Value of Production per ha.

	Paddy, Irrigated	Paddy, Rainfed	Paddy, Upland
Without Project (1)			
Yield (ton/ha)	3.57	3	2.47
Farmgate price (Rp'000/ton)	310	310	310
Gross Prod. Value (Rp'000/ha)	1106.7	930	765.7
Production cost (Rp'000/ha)	369.1	328.3	328.3
Net Prod. Value (Rp'000)	737.6	601.7	437.4
With Project (2)			
Yield (ton/ha)	5.25	5.25	5.25
Farmgate price (Rp'000/ton)	310	310	310
Gross Prod. Value (Rp/ha)	1627.5	1627.5	1627.5
Production cost (Rp/ha)	512.8	512.8	512.8
Net Prod. Value (Rp'000)	1114.7	1114.7	1114.7
Net Value of Prod. (2)-(1)	377.1	513	677.3

Note: Production costs are presented in Tables 5.3 (1) and 5.3 (2)

Table 5.3(1) Production Cost for Wetland Paddy

	Future Without Project			Future With Project		
	Q'ty	Unit Price	Amount (Rp)	Q'ty	Unit Price	Amount (Rp)
Seeds (kg)	29	310	8,990	30	310	9,300
Fertilizers (kg)						
Urea	91	210	19,110	200	210	42,000
T.S.P.	12	260	3,120	100	260	26,000
KCl	4	260	1,040	50	260	13,000
Agrochemicals (liter)						
Insecticide	2.4	15,000	36,000	3	15,000	45,000
Labor Force (man-day)						
Total man-days	104	2,500	260,000	135	2,500	337,500
Animal Power (animal-day)						
Total animal-days	10.2	4,000	40,800	10	4,000	40,000
Production Cost			369,060			512,800

Source: Estimate of the Study Team

Table 5.4(2) Production Cost for Upland Paddy

	Future Without Project			Future With Project		
	Q'ty	Unit Price	Amount (Rp)	Q'ty	Unit Price	Amount (Rp)
Seeds (kg)	38	310	11,780	30	310	9,300
Fertilizers (kg)						
Urea	63	210	13,230	200	210	42,000
T.S.P.	44	260	11,440	100	260	26,000
KCl	11	260	2,860	50	260	13,000
Agrochemicals (liter)						
Insecticide	1.6	15,000	24,000	3	15,000	45,000
Labor Force (man-day)						
Total man-days	98	2,500	245,000	135	2,500	337,500
Animal Power (animal-day)						
Total animal-days	5	4,000	20,000	10	4,000	40,000
Production Cost			328,310			512,800

Source: Estimate of the Study Team

Table 5.4 Benefits Calculation

Unit: Million Rp

Project Name	N.V.P. w/o Project			N.V.P. with Project	Benefits
	Irrigated	Upland	Total		
BL C-1	0.0	201.2	201.2	1,024.9	823.7
C-2	138.0	1,051.9	1,189.9	3,301.9	2,112.0
C-3	138.0	596.3	734.3	4,801.3	4,067.0
C-4	213.1	541.4	754.4	5,955.4	5,201.0
US C-1	0.0	1,417.8	1,417.8	8,020.8	6,603.0
C-2	10.2	1,654.3	1,664.5	8,838.5	7,174.0
C-3	10.2	1,653.4	1,663.6	8,956.6	7,293.0
C-4	10.2	1,653.4	1,663.6	8,956.6	7,293.0
LR C-1	0.0	1,093.4	1,093.4	43,000.4	41,907.0
C-2	24.1	1,200.4	1,224.5	43,343.5	42,119.0
C-3	24.1	1,148.1	1,172.3	43,419.3	42,247.0
C-4	24.1	1,148.1	1,172.3	43,419.3	42,247.0
BU C-1	0.0	1,835.0	1,835.0	9,045.7	7,210.7
C-2	138.0	2,446.1	2,584.1	12,140.4	9,556.3
C-3	148.2	2,535.7	2,683.9	13,757.9	11,074.0
C-4	223.2	2,310.8	2,534.0	14,912.0	12,378.0
MHT	0.0	7,674.0	7,674.0	20,052.0	12,378.0
LS	0.0	1,032.4	1,032.4	26,290.4	25,258.0

Note:
BL = Batang Lubuk
US = Upper Sosa
LR = Lower Rokan Kiri
BU = Batang Lubuk + Upper Sosa
MHT = Mahato
LS = Lower Sosa
N.V.P. = Net Value of Production

Table 5.5(1) EIRR Calculation(Bt.Lubuk:C-1)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	14922.5	0.0	14922.5	0.0	-14922.5
2	14922.5	0.0	14922.5	0.0	-14922.5
3	14922.5	0.0	14922.5	0.0	-14922.5
4	14922.5	0.0	14922.5	0.0	-14922.5
5	0	27.6	27.6	164.7	137.1
6	0.0	27.6	27.6	329.5	301.9
7	0.0	27.6	27.6	494.2	466.6
8	0.0	27.6	27.6	659.0	631.4
9	0.0	27.6	27.6	823.7	796.1
10	0.0	27.6	27.6	823.7	796.1
11	0.0	27.6	27.6	823.7	796.1
12	0.0	27.6	27.6	823.7	796.1
13	0.0	27.6	27.6	823.7	796.1
14	0.0	27.6	27.6	823.7	796.1
15	0.0	27.6	27.6	823.7	796.1
16	0.0	27.6	27.6	823.7	796.1
17	0.0	27.6	27.6	823.7	796.1
18	0.0	27.6	27.6	823.7	796.1
19	0.0	27.6	27.6	823.7	796.1
20	0.0	27.6	27.6	823.7	796.1
21	0.0	27.6	27.6	823.7	796.1
22	0.0	27.6	27.6	823.7	796.1
23	0.0	27.6	27.6	823.7	796.1
24	0.0	27.6	27.6	823.7	796.1
25	0.0	27.6	27.6	823.7	796.1
EIRR					-8.9%

Table 5.5(2) EIRR Calculation(Bt.Lubuk:C-2)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	13694.0	0.0	13694.0	0.0	-13694.0
2	13694.0	0.0	13694.0	0.0	-13694.0
3	13694.0	0.0	13694.0	0.0	-13694.0
4	13694.0	0.0	13694.0	0.0	-13694.0
5	13694.0	0.0	13694.0	0.0	-13694.0
6	0.0	88.9	88.9	422.4	333.5
7	0.0	88.9	88.9	844.8	755.9
8	0.0	88.9	88.9	1267.2	1178.3
9	0.0	88.9	88.9	1689.6	1600.7
10	0.0	88.9	88.9	2112.0	2023.1
11	0.0	88.9	88.9	2112.0	2023.1
12	0.0	88.9	88.9	2112.0	2023.1
13	0.0	88.9	88.9	2112.0	2023.1
14	0.0	88.9	88.9	2112.0	2023.1
15	0.0	88.9	88.9	2112.0	2023.1
16	0.0	88.9	88.9	2112.0	2023.1
17	0.0	88.9	88.9	2112.0	2023.1
18	0.0	88.9	88.9	2112.0	2023.1
19	0.0	88.9	88.9	2112.0	2023.1
20	0.0	88.9	88.9	2112.0	2023.1
21	0.0	88.9	88.9	2112.0	2023.1
22	0.0	88.9	88.9	2112.0	2023.1
23	0.0	88.9	88.9	2112.0	2023.1
24	0.0	88.9	88.9	2112.0	2023.1
25	0.0	88.9	88.9	2112.0	2023.1
EIRR:					-4.4%

Table 5.5(3) EIRR Calculation(Bt.Lubuk:C-3)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	16994.0	0.0	16994.0	0.0	-16994.0
2	16994.0	0.0	16994.0	0.0	-16994.0
3	16994.0	0.0	16994.0	0.0	-16994.0
4	16994.0	0.0	16994.0	0.0	-16994.0
5	16994.0	0.0	16994.0	0.0	-16994.0
6	0.0	129.3	129.3	813.4	684.1
7	0.0	129.3	129.3	1626.8	1497.5
8	0.0	129.3	129.3	2440.2	2310.9
9	0.0	129.3	129.3	3253.6	3124.3
10	0.0	129.3	129.3	4067.0	3937.7
11	0.0	129.3	129.3	4067.0	3937.7
12	0.0	129.3	129.3	4067.0	3937.7
13	0.0	129.3	129.3	4067.0	3937.7
14	0.0	129.3	129.3	4067.0	3937.7
15	0.0	129.3	129.3	4067.0	3937.7
16	0.0	129.3	129.3	4067.0	3937.7
17	0.0	129.3	129.3	4067.0	3937.7
18	0.0	129.3	129.3	4067.0	3937.7
19	0.0	129.3	129.3	4067.0	3937.7
20	0.0	129.3	129.3	4067.0	3937.7
21	0.0	129.3	129.3	4067.0	3937.7
22	0.0	129.3	129.3	4067.0	3937.7
23	0.0	129.3	129.3	4067.0	3937.7
24	0.0	129.3	129.3	4067.0	3937.7
25	0.0	129.3	129.3	4067.0	3937.7
EIRR:					-1.3%

Table 5.5(4) EIRR Calculation(Bt.Lubuk:C-4)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	17246.0	0.0	17246	0.0	-17246.0
2	17246.0	0.0	17246	0.0	-17246.0
3	17246.0	0.0	17246	0.0	-17246.0
4	17246.0	0.0	17246	0.0	-17246.0
5	17246.0	0.0	17246	0.0	-17246.0
6	0.0	160.4	160.4	1040.2	879.8
7	0.0	160.4	160.4	2080.4	1920.0
8	0.0	160.4	160.4	3120.6	2960.2
9	0.0	160.4	160.4	4160.8	4000.4
10	0.0	160.4	160.4	5201.0	5040.6
11	0.0	160.4	160.4	5201.0	5040.6
12	0.0	160.4	160.4	5201.0	5040.6
13	0.0	160.4	160.4	5201.0	5040.6
14	0.0	160.4	160.4	5201.0	5040.6
15	0.0	160.4	160.4	5201.0	5040.6
16	0.0	160.4	160.4	5201.0	5040.6
17	0.0	160.4	160.4	5201.0	5040.6
18	0.0	160.4	160.4	5201.0	5040.6
19	0.0	160.4	160.4	5201.0	5040.6
20	0.0	160.4	160.4	5201.0	5040.6
21	0.0	160.4	160.4	5201.0	5040.6
22	0.0	160.4	160.4	5201.0	5040.6
23	0.0	160.4	160.4	5201.0	5040.6
24	0.0	160.4	160.4	5201.0	5040.6
25	0.0	160.4	160.4	5201.0	5040.6
EIRR					-0.4%

Table 5.5(5) EIRR Calculation(Upper Sosa:C-1)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	18574	0.0	18574	0.0	-18574.0
2	18574	0.0	18574	0.0	-18574.0
3	18574	0.0	18574	0.0	-18574.0
4	18574	0.0	18574	0.0	-18574.0
5	18574	0.0	18574	0.0	-18574.0
6	0.0	216.0	216.0	1320.6	1104.6
7	0.0	216.0	216.0	2521.2	2305.2
8	0.0	216.0	216.0	3961.8	3745.8
9	0.0	216.0	216.0	5282.4	5066.4
10	0.0	216.0	216.0	6603.0	6387.0
11	0.0	216.0	216.0	6603.0	6387.0
12	0.0	216.0	216.0	6603.0	6387.0
13	0.0	216.0	216.0	6603.0	6387.0
14	0.0	216.0	216.0	6603.0	6387.0
15	0.0	216.0	216.0	6603.0	6387.0
16	0.0	216.0	216.0	6603.0	6387.0
17	0.0	216.0	216.0	6603.0	6387.0
18	0.0	216.0	216.0	6603.0	6387.0
19	0.0	216.0	216.0	6603.0	6387.0
20	0.0	216.0	216.0	6603.0	6387.0
21	0.0	216.0	216.0	6603.0	6387.0
22	0.0	216.0	216.0	6603.0	6387.0
23	0.0	216.0	216.0	6603.0	6387.0
24	0.0	216.0	216.0	6603.0	6387.0
25	0.0	216.0	216.0	6603.0	6387.0
EIRR					1.6%

Table 5.5(6) EIRR Calculation(Upper Sosa:C-2)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	18574	0.0	18574	0.0	-18574.0
2	18574	0.0	18574	0.0	-18574.0
3	18574	0.0	18574	0.0	-18574.0
4	18574	0.0	18574	0.0	-18574.0
5	18574	0.0	18574	0.0	-18574.0
6	0.0	238.0	238.0	1434.8	1196.8
7	0.0	238.0	238.0	2869.6	2631.6
8	0.0	238.0	238.0	4304.4	4066.4
9	0.0	238.0	238.0	5739.2	5501.2
10	0.0	238.0	238.0	7174.0	6936.0
11	0.0	238.0	238.0	7174.0	6936.0
12	0.0	238.0	238.0	7174.0	6936.0
13	0.0	238.0	238.0	7174.0	6936.0
14	0.0	238.0	238.0	7174.0	6936.0
15	0.0	238.0	238.0	7174.0	6936.0
16	0.0	238.0	238.0	7174.0	6936.0
17	0.0	238.0	238.0	7174.0	6936.0
18	0.0	238.0	238.0	7174.0	6936.0
19	0.0	238.0	238.0	7174.0	6936.0
20	0.0	238.0	238.0	7174.0	6936.0
21	0.0	238.0	238.0	7174.0	6936.0
22	0.0	238.0	238.0	7174.0	6936.0
23	0.0	238.0	238.0	7174.0	6936.0
24	0.0	238.0	238.0	7174.0	6936.0
25	0.0	238.0	238.0	7174.0	6936.0
EIRR					2.2%

Table 5.5(7) EIRR Calculation(Upper Sosa:C-3)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	18610	0.0	18610.0	0.0	-18610.0
2	18610	0.0	18610.0	0.0	-18610.0
3	18610	0.0	18610.0	0.0	-18610.0
4	18610	0.0	18610.0	0.0	-18610.0
5	18610	0.0	18610.0	0.0	-18610.0
6	0.0	241.2	241.2	1458.6	1217.4
7	0.0	241.2	241.2	2917.2	2676.0
8	0.0	241.2	241.2	4375.8	4134.6
9	0.0	241.2	241.2	5834.4	5593.2
10	0.0	241.2	241.2	7293.0	7051.8
11	0.0	241.2	241.2	7293.0	7051.8
12	0.0	241.2	241.2	7293.0	7051.8
13	0.0	241.2	241.2	7293.0	7051.8
14	0.0	241.2	241.2	7293.0	7051.8
15	0.0	241.2	241.2	7293.0	7051.8
16	0.0	241.2	241.2	7293.0	7051.8
17	0.0	241.2	241.2	7293.0	7051.8
18	0.0	241.2	241.2	7293.0	7051.8
19	0.0	241.2	241.2	7293.0	7051.8
20	0.0	241.2	241.2	7293.0	7051.8
21	0.0	241.2	241.2	7293.0	7051.8
22	0.0	241.2	241.2	7293.0	7051.8
23	0.0	241.2	241.2	7293.0	7051.8
24	0.0	241.2	241.2	7293.0	7051.8
25	0.0	241.2	241.2	7293.0	7051.8
EIRR					2.4%

Table 5.5(9) EIRR Calculation(Lower R.Kiri:C-1)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	38504	0.0	38504	0.0	-38504.0
2	38504	0.0	38504	0.0	-38504.0
3	38504	0.0	38504	0.0	-38504.0
4	38504	0.0	38504	0.0	-38504.0
5	38504	0.0	38504	0.0	-38504.0
6	0.0	1158.0	1158.0	8381.4	7223.4
7	0.0	1158.0	1158.0	16762.8	15604.8
8	0.0	1158.0	1158.0	25144.2	23986.2
9	0.0	1158.0	1158.0	33525.6	32367.6
10	0.0	1158.0	1158.0	41907.0	40749.0
11	0.0	1158.0	1158.0	41907.0	40749.0
12	0.0	1158.0	1158.0	41907.0	40749.0
13	0.0	1158.0	1158.0	41907.0	40749.0
14	0.0	1158.0	1158.0	41907.0	40749.0
15	0.0	1158.0	1158.0	41907.0	40749.0
16	0.0	1158.0	1158.0	41907.0	40749.0
17	0.0	1158.0	1158.0	41907.0	40749.0
18	0.0	1158.0	1158.0	41907.0	40749.0
19	0.0	1158.0	1158.0	41907.0	40749.0
20	0.0	1158.0	1158.0	41907.0	40749.0
21	0.0	1158.0	1158.0	41907.0	40749.0
22	0.0	1158.0	1158.0	41907.0	40749.0
23	0.0	1158.0	1158.0	41907.0	40749.0
24	0.0	1158.0	1158.0	41907.0	40749.0
25	0.0	1158.0	1158.0	41907.0	40749.0
EIRR:					11.7%

Table 5.5(10) EIRR Calculation(Lower R.Kiri:C-2)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	38514	0.0	38514	0.0	-38514.0
2	38514	0.0	38514	0.0	-38514.0
3	38514	0.0	38514	0.0	-38514.0
4	38514	0.0	38514	0.0	-38514.0
5	38514	0.0	38514	0.0	-38514.0
6	0.0	1167.2	1167.2	8423.8	7256.6
7	0.0	1167.2	1167.2	16847.6	15680.4
8	0.0	1167.2	1167.2	25271.4	24104.2
9	0.0	1167.2	1167.2	33695.2	32528.0
10	0.0	1167.2	1167.2	42119.0	40951.8
11	0.0	1167.2	1167.2	42119.0	40951.8
12	0.0	1167.2	1167.2	42119.0	40951.8
13	0.0	1167.2	1167.2	42119.0	40951.8
14	0.0	1167.2	1167.2	42119.0	40951.8
15	0.0	1167.2	1167.2	42119.0	40951.8
16	0.0	1167.2	1167.2	42119.0	40951.8
17	0.0	1167.2	1167.2	42119.0	40951.8
18	0.0	1167.2	1167.2	42119.0	40951.8
19	0.0	1167.2	1167.2	42119.0	40951.8
20	0.0	1167.2	1167.2	42119.0	40951.8
21	0.0	1167.2	1167.2	42119.0	40951.8
22	0.0	1167.2	1167.2	42119.0	40951.8
23	0.0	1167.2	1167.2	42119.0	40951.8
24	0.0	1167.2	1167.2	42119.0	40951.8
25	0.0	1167.2	1167.2	42119.0	40951.8
EIRR					11.7%

Table 5.5(11) EIRR Calculation(Lower R.Kiri:C-3)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	38514	0.0	38514	0.0	-38514.0
2	38514	0.0	38514	0.0	-38514.0
3	38514	0.0	38514	0.0	-38514.0
4	38514	0.0	38514	0.0	-38514.0
5	38514	0.0	38514	0.0	-38514.0
6	0.0	1169.3	1169.3	8449.4	7280.1
7	0.0	1169.3	1169.3	16898.8	15729.5
8	0.0	1169.3	1169.3	25348.2	24178.9
9	0.0	1169.3	1169.3	33797.6	32628.3
10	0.0	1169.3	1169.3	42247.0	41077.7
11	0.0	1169.3	1169.3	42247.0	41077.7
12	0.0	1169.3	1169.3	42247.0	41077.7
13	0.0	1169.3	1169.3	42247.0	41077.7
14	0.0	1169.3	1169.3	42247.0	41077.7
15	0.0	1169.3	1169.3	42247.0	41077.7
16	0.0	1169.3	1169.3	42247.0	41077.7
17	0.0	1169.3	1169.3	42247.0	41077.7
18	0.0	1169.3	1169.3	42247.0	41077.7
19	0.0	1169.3	1169.3	42247.0	41077.7
20	0.0	1169.3	1169.3	42247.0	41077.7
21	0.0	1169.3	1169.3	42247.0	41077.7
22	0.0	1169.3	1169.3	42247.0	41077.7
23	0.0	1169.3	1169.3	42247.0	41077.7
24	0.0	1169.3	1169.3	42247.0	41077.7
25	0.0	1169.3	1169.3	42247.0	41077.7
EIRR					11.7%

Table 5.5(13) EIRR Calculation(Bt.LBK-UPSOS:C-1)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	28758.0	0.0	28758.0	0.0	-28758.0
2	28758.0	0.0	28758.0	0.0	-28758.0
3	28758.0	0.0	28758.0	0.0	-28758.0
4	28758.0	0.0	28758.0	0.0	-28758.0
5	28758.0	0.0	28758.0	0.0	-28758.0
6	0.0	243.6	243.6	1442.1	1198.5
7	0.0	243.6	243.6	2884.3	2640.7
8	0.0	243.6	243.6	4326.4	4082.8
9	0.0	243.6	243.6	5768.6	5525.0
10	0.0	243.6	243.6	7210.7	6967.1
11	0.0	243.6	243.6	7210.7	6967.1
12	0.0	243.6	243.6	7210.7	6967.1
13	0.0	243.6	243.6	7210.7	6967.1
14	0.0	243.6	243.6	7210.7	6967.1
15	0.0	243.6	243.6	7210.7	6967.1
16	0.0	243.6	243.6	7210.7	6967.1
17	0.0	243.6	243.6	7210.7	6967.1
18	0.0	243.6	243.6	7210.7	6967.1
19	0.0	243.6	243.6	7210.7	6967.1
20	0.0	243.6	243.6	7210.7	6967.1
21	0.0	243.6	243.6	7210.7	6967.1
22	0.0	243.6	243.6	7210.7	6967.1
23	0.0	243.6	243.6	7210.7	6967.1
24	0.0	243.6	243.6	7210.7	6967.1
25	0.0	243.6	243.6	7210.7	6967.1

EIRR: -0.1%

Table 5.5(14) EIRR Calculation(Bt.LBK-UPSOS:C-2)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	30542.0	0.0	30542.0	0.0	-30542.0
2	30542.0	0.0	30542.0	0.0	-30542.0
3	30542.0	0.0	30542.0	0.0	-30542.0
4	30542.0	0.0	30542.0	0.0	-30542.0
5	30542.0	0.0	30542.0	0.0	-30542.0
6	0.0	326.9	326.9	1911.3	1584.3
7	0.0	326.9	326.9	3822.5	3495.6
8	0.0	326.9	326.9	5733.8	5406.8
9	0.0	326.9	326.9	7645.0	7318.1
10	0.0	326.9	326.9	9556.3	9229.4
11	0.0	326.9	326.9	9556.3	9229.4
12	0.0	326.9	326.9	9556.3	9229.4
13	0.0	326.9	326.9	9556.3	9229.4
14	0.0	326.9	326.9	9556.3	9229.4
15	0.0	326.9	326.9	9556.3	9229.4
16	0.0	326.9	326.9	9556.3	9229.4
17	0.0	326.9	326.9	9556.3	9229.4
18	0.0	326.9	326.9	9556.3	9229.4
19	0.0	326.9	326.9	9556.3	9229.4
20	0.0	326.9	326.9	9556.3	9229.4
21	0.0	326.9	326.9	9556.3	9229.4
22	0.0	326.9	326.9	9556.3	9229.4
23	0.0	326.9	326.9	9556.3	9229.4
24	0.0	326.9	326.9	9556.3	9229.4
25	0.0	326.9	326.9	9556.3	9229.4

EIRR: 0.6%

Table 5.5(15) EIRR Calculation(Bt.LBK-UPSOS:C-3)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	34582.0	0.0	34582.0	0.0	-34582.0
2	34582.0	0.0	34582.0	0.0	-34582.0
3	34582.0	0.0	34582.0	0.0	-34582.0
4	34582.0	0.0	34582.0	0.0	-34582.0
5	34582.0	0.0	34582.0	0.0	-34582.0
6	0.0	370.5	370.5	2214.8	1844.3
7	0.0	370.5	370.5	4429.6	4059.1
8	0.0	370.5	370.5	6644.4	6273.9
9	0.0	370.5	370.5	8859.2	8488.7
10	0.0	370.5	370.5	11074.0	10703.5
11	0.0	370.5	370.5	11074.0	10703.5
12	0.0	370.5	370.5	11074.0	10703.5
13	0.0	370.5	370.5	11074.0	10703.5
14	0.0	370.5	370.5	11074.0	10703.5
15	0.0	370.5	370.5	11074.0	10703.5
16	0.0	370.5	370.5	11074.0	10703.5
17	0.0	370.5	370.5	11074.0	10703.5
18	0.0	370.5	370.5	11074.0	10703.5
19	0.0	370.5	370.5	11074.0	10703.5
20	0.0	370.5	370.5	11074.0	10703.5
21	0.0	370.5	370.5	11074.0	10703.5
22	0.0	370.5	370.5	11074.0	10703.5
23	0.0	370.5	370.5	11074.0	10703.5
24	0.0	370.5	370.5	11074.0	10703.5
25	0.0	370.5	370.5	11074.0	10703.5

EIRR: 0.8%

Table 5.5(16) EIRR Calculation(Bt.LBK-UPSOS:C-4)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	34104.0	0.0	34104.0	0.0	-34104.0
2	34104.0	0.0	34104.0	0.0	-34104.0
3	34104.0	0.0	34104.0	0.0	-34104.0
4	34104.0	0.0	34104.0	0.0	-34104.0
5	34104.0	0.0	34104.0	0.0	-34104.0
6	0.0	401.6	401.6	2475.6	2074.0
7	0.0	401.6	401.6	4951.2	4549.6
8	0.0	401.6	401.6	7426.8	7025.2
9	0.0	401.6	401.6	9902.4	9500.8
10	0.0	401.6	401.6	12378.0	11976.4
11	0.0	401.6	401.6	12378.0	11976.4
12	0.0	401.6	401.6	12378.0	11976.4
13	0.0	401.6	401.6	12378.0	11976.4
14	0.0	401.6	401.6	12378.0	11976.4
15	0.0	401.6	401.6	12378.0	11976.4
16	0.0	401.6	401.6	12378.0	11976.4
17	0.0	401.6	401.6	12378.0	11976.4
18	0.0	401.6	401.6	12378.0	11976.4
19	0.0	401.6	401.6	12378.0	11976.4
20	0.0	401.6	401.6	12378.0	11976.4
21	0.0	401.6	401.6	12378.0	11976.4
22	0.0	401.6	401.6	12378.0	11976.4
23	0.0	401.6	401.6	12378.0	11976.4
24	0.0	401.6	401.6	12378.0	11976.4
25	0.0	401.6	401.6	12378.0	11976.4
EIRR:					1.8%

Table 5.5(17) EIRR Calculation(Mahato)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	19406	0.0	19406	0	-19406.0
2	19406	0.0	19406	0	-19406.0
3	19406	0.0	19406	0	-19406.0
4	19406	0.0	19406	0.00	-19406.0
5	19406	0.0	19406	0.00	-19406.0
6	0.0	540.0	540.0	3852.94	3312.9
7	0.0	540.0	540.0	7705.88	7165.9
8	0.0	540.0	540.0	11558.82	11018.8
9	0.0	540.0	540.0	15411.76	14871.8
10	0.0	540.0	540.0	19264.70	18724.7
11	0.0	540.0	540.0	19264.70	18724.7
12	0.0	540.0	540.0	19264.70	18724.7
13	0.0	540.0	540.0	19264.70	18724.7
14	0.0	540.0	540.0	19264.70	18724.7
15	0.0	540.0	540.0	19264.70	18724.7
16	0.0	540.0	540.0	19264.70	18724.7
17	0.0	540.0	540.0	19264.70	18724.7
18	0.0	540.0	540.0	19264.70	18724.7
19	0.0	540.0	540.0	19264.70	18724.7
20	0.0	540.0	540.0	19264.70	18724.7
21	0.0	540.0	540.0	19264.70	18724.7
22	0.0	540.0	540.0	19264.70	18724.7
23	0.0	540.0	540.0	19264.70	18724.7
24	0.0	540.0	540.0	19264.70	18724.7
25	0.0	540.0	540.0	19264.70	18724.7
EIRR:					10.7%

Table 5.5(18) EIRR Calculation(Lower Sosa)

Unit: Million Rp

	Investment Cost	O & M Cost	Total Cost	Total Benefit	Net Cash Flow
					0.1
1	21240	0.0	21240	0.0	-21240.0
2	21240	0.0	21240	0.0	-21240.0
3	21240	0.0	21240	0.0	-21240.0
4	21240	0.0	21240	0.0	-21240.0
5	21240	0.0	21240	0.0	-21240.0
6	0.0	708.0	708.0	5051.6	4343.6
7	0.0	708.0	708.0	10103.2	9395.2
8	0.0	708.0	708.0	15154.8	14446.8
9	0.0	708.0	708.0	20206.4	19498.4
10	0.0	708.0	708.0	25258.0	24550.0
11	0.0	708.0	708.0	25258.0	24550.0
12	0.0	708.0	708.0	25258.0	24550.0
13	0.0	708.0	708.0	25258.0	24550.0
14	0.0	708.0	708.0	25258.0	24550.0
15	0.0	708.0	708.0	25258.0	24550.0
16	0.0	708.0	708.0	25258.0	24550.0
17	0.0	708.0	708.0	25258.0	24550.0
18	0.0	708.0	708.0	25258.0	24550.0
19	0.0	708.0	708.0	25258.0	24550.0
20	0.0	708.0	708.0	25258.0	24550.0
21	0.0	708.0	708.0	25258.0	24550.0
22	0.0	708.0	708.0	25258.0	24550.0
23	0.0	708.0	708.0	25258.0	24550.0
24	0.0	708.0	708.0	25258.0	24550.0
25	0.0	708.0	708.0	25258.0	24550.0
EIRR:					12.6%

ANNEX F

IRRIGATION AND DRAINAGE

ANNEX F IRRIGATION AND DRAINAGE

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ANNEX F IRRIGATION AND DRAINAGE

1. INTRODUCTION

Now, DPU Riau provincial government is carrying out 10(ten) irrigation schemes in the Objective Area. Total areas under the provincial government's existing schemes are said to be 5,525 ha. Out of the total areas of 5,525 ha, 4,370 ha is potential area now for which the main system has already been developed, and 1,155 ha is potential area for which the main system has not been developed yet. Now, the existing paddy field is 1,628 ha in which the tertiary system has already been developed for 1,303 ha.

In the Objective Area, there is an increasing need to stabilize the production of crops for food in the wet season and increase that in the dry season. To meet these irrigation needs, the increase of irrigation water supply and the extension of irrigation area must be realized. Among several measures under consideration, the development of new sources of water supply is the most important measure to be adopted as future plans.

As the diversion weirs of the existing schemes are located at the feet of hills with small catchment areas, the quantity of available river water is subject to limitations. For the effective use of limited water, it is necessary to construct a set of well-harmonized facilities, from main systems to tertiary systems, for the timely, equal and efficient supply and distribution of water. In addition to this, an operation and maintenance organization should be introduced to prevent even a drop of water from being wasted by benefiting farmers.

2. Existing Irrigation Schemes and water use

2.1 The Level of Existing Irrigation Schemes

The planning and design concepts of the existing schemes are evaluated from the technical viewpoints under the present Study. The results reveal that there are many schemes where potential irrigation development areas have been overestimated because of insufficient hydrological analyses of water-supplying rivers. This point will be described in and after Chapter 4, and this Chapter 2 describes the state of existing irrigation facilities based on the data of DPUP Riau.

2.2 Distribution and Classification of Schemes

In two Kabupatens of the Objective Area, 10 irrigation schemes are being carried out covering a total irrigable area of 5,525 ha. This is the DPUP's recent figures arranged by DPUP on its own estimates. As shown in the following table, 8(eight) schemes concentrate in Kabupaten Kampar where are located in the southern part of the Objective Area; the total irrigation scheme areas in Kabupaten Kampar are 4,061 ha. The number of schemes and DPUP's revised irrigation areas by Kabupaten are as follows:

Kabupaten	No. of Schemes	DPUP'Planned Irrigation Area(ha)
Kampar	8	4,061
Bengkalis	2	1,464
Total	10	5,525

The progress and distribution of existing schemes are shown in Table 2.1. Now, the irrigation area of 1,303 ha is being irrigated which covers 8(eight) schemes. The remaining 325 ha is rain-fed paddy fields annually or occasionally used in the existing Teluk Retti scheme.

The present level of irrigation systems prevailing in the Objective Area is semi-technical irrigation system. The definition of the system is as follows:

Semi-technical irrigation system: Irrigation system that includes a permanent or semi-permanent diversion structure with gates or stoplogs for control of the water flow and with some primary canal,but with all water distribution to the

lands handled entirely by the village officials and farmers.

2.3 Features of Schemes

The existing irrigation schemes depend on tributaries of the Lubuk, Rokan Kiri, Kumu, Rokan Kanan, Rokan rivers for sources of water supply. As diversion weirs have been constructed on these tributaries at the foot of hills, their catchment areas are small. Furthermore, the irrigation command area is small owing to topographical restrictions. The quantity of water available in these tributaries is limited so that the command areas of 9 (nine)irrigation schemes cover an area of 600 ha or less. In the dry season, the available natural flows of these small rivers are extremely small and quite often run dry. For this reason, the most of the existing irrigation facilities can only supply water for paddy cultivation during the wet season.

2.4 Present Condition of Facilities

Primary canals of irrigation schemes run along contour lines at the foot of hills. Soil washed out from hillsides directly enter canals, reduce the maximum design flow of canals and break them. In addition, lack of any preventive measures against highly permeable soils results in leakage from earth canals and collapses of slopes. These conditions have extremely impaired function of irrigation canals.

2.5 Operation and Maintenance

Most of the existing irrigation schemes have own management head(Pengamat), and he is responsible for the operation and maintenance for the schemes. Although most of the irrigation schemes have own organizations, beneficial farmers live far away from their paddy fields and apart from each other. As a result, it is difficult to organize these beneficial farmers when operation and maintenance works are carried out in the group work manner. Further, operation and maintenance organizations do not function as intended in some schemes.

In the case of the Kaiti-Samo scheme, the office head (Pengamat) is responsible for the operation and maintenance of the Kaiti-Samo, Menaming, Sei Perak, and Aek Tangum schemes. The office employs for the Samo scheme three(3) irrigation field workers for the three(3) secondary canal areas DK I, DK II, and DK III, one operation and maintenance supervisor, one gate keeper and one coordinator of the field workers.

2.6 Constraints

In the existing irrigation schemes where the quantity of available water is limited, it is essential for using limited water in an effective manner to construct well-balanced facilities from the main to tertiary systems. However, beneficial farmers are not willing to allow such tertiary canals to be laid in their own farmlands because they do not want to reduce their lands for paddy cultivation. Without any thorough understanding of these farmers, effective use of water will not be accomplished with complete main systems.

3. IRRIGATION WATER DEMAND

3.1 Calculation Procedures

The following is the basic items considered in the calculation of net irrigation requirements:

3.1.1 Cropping Pattern

The following is the prevailing cropping patterns in the Objective Area. Irrigation requirements are calculated by staggering start of land preparation by 10 days.

(1) Variety	:	Sentani and PB42
(2) Period of land preparation	:	30 days
(3) Total growing period (For dry and wet season paddies)	:	120 days
(4) Period of surface drainage and harvesting	:	20 days
(5) Beginning of land preparation		
dry season cultivation	:	Mar. 1st
wet season cultivation	:	Sept.1st
(6) Ending of land preparation		
dry season cultivation	:	Apr.30 th
wet season cultivation	:	Oct.31 th

3.1.2 Effective Rainfall

The effective rainfall is calculated by rainfall of Pasir Pangarayan during the period from 1970 to 1990.

For the study, 10-day effective rainfall is adopted at 70 percent of the 10-day rainfall of the base year(1984)with a 20 % probability of non-exceedance.

3.1.3 Percolation

The percolation rate in the Objective Area is to be 2 mm/day considering the Batang Samo project.

3.1.4 Land Preparation Water Requirements

(1) Land preparation period : 30 days (according to the field survey)
(2) Water requirements for land preparation : 250 mm.

Water requirements for land preparation of rice fields are taken at 200 mm, including (1) presaturation of the soil, (2) puddling of the soil, and (3) water requirements for nurseries.

The above 200 mm figure assumes (1) heavy textured soils with good puddling suitability, and (2) land has not been fallow for more than 2.5 months.

At the start of transplanting, another 50 mm water layer will be added. In total, this leads to 250 mm for land preparation and an initial water layer after planting.

(3) Irrigation requirements during land preparation

For the calculation of the irrigation requirements during land preparation, the following formula is used:

$$IR = Me^k/(e^k-1)$$

Where:

IR : Irrigation requirement at field level (mm/day).
M : water requirement to compensate for evaporation and percolation of the fields already saturated already saturated (mm/day).
M= Eo + P
Eo is open water evaporation taken at 1.1 ETo during land preparation (mm/day)
k : MT/S
T : land preparation period (days)=30 days
S : Presaturation requirement added with 50 mm water layer (mm) =250 mm.

Monthly mean evaporation at Pasirpangarayan during the land preparation is as follows:

Dry season		Wet season	
March	4.7 mm/day	Sept.	4.9 mm/day
April	4.8	Oct.	4.7
June	5.1	Nov.	4.7
Ave.	4.9	Ave.	4.8

M = Eo + P

Eo = 1.1*Eto

ETo is evaporation pan values. As mentioned above, ETo for the dry season is 4.9 mm/day, and that for the wet season 4.8 mm/day. To be on the safe side, 5 mm/day is applied to the calculation of Eo for both seasons.

Eo = 1.1*5 = 5.5 mm/day
M = 5.5 + 2 = 7.5 mm/day

$$k = 7.5*30/250 = 0.90$$

$$IR = 7.5e^{0.90}/(e^{0.90}-1)$$
$$= 7.5*2.460/(2.460-1)$$
$$= 12.6 \text{ (mm/day)}$$

3.1.5 Water Layer Replacement

Because of no data available, 2 replacements, each of 50 mm at about 1 month and 2 months after transplanting are considered according to page 153 of IRRIGATION DESIGN STANDARDS, KP-01 published by Directorate General Water Resources Development, Ministry of Public Works (hereinafter called DESIGN STANDARDS).

3.1.6 Consumptive Use

The consumptive use is calculated as

$$ETc = kc*ETo$$

Where :

ETc : crop evapotranspiration (mm/day)
ETo : reference crop evapotranspiration (mm/day)
kc : crop coefficient

(1)Evapotranspiration

For evaporation computation, the modified Penman formula was used taking into account the meteorological data in Pasirpangarayan.

(2) Crop coefficients

The crop coefficients for rice given by FAO are used for the calculation.

See Table A.2.2, page 152 of DESIGN STANDARDS.

Month	HYV
0.5	1.10
1	1.10
1.5	1.05
2	1.05
2.5	0.95
3	0

In the Objective Area, the high varieties of Sentani and PB42 are prevailing. Therefore, the crop coefficient for the high variety(HYV) was employed.

3.2 Irrigation Diversion Requirements

Irrigation diversion requirements are calculated by considering operation loss and conveyance loss, and net irrigation requirements at farm level are calculated by irrigation efficiencies. Irrigation efficiencies are calculated by the following assumptions of operation losses and conveyance losses of primary canals, secondary canals and tertiary canals.

Description	Primary Canal	Secondary Canal	Tertiary Canal	Total
Operation losses	5%	5%	5%	15%
Accumulated losses	15%	10%	5%	-
Efficiency(A)	85%	90%	95%	-
Conveyance losses	5%	10%	5%	20%
Accumulated losses	20%	15%	5%	-
Efficiency(B)	80%	85%	95%	-
Overall efficiency (C=A x B)	68%	76.5%	90%	-

The diversion requirements(start of land preparation: March 21 and September 21) is shown in Table 3.1 as one of the calculation results.

4. POSSIBILITIES OF FUTURE IRRIGATION DEVELOPMENT

4.1 Potential Irrigation Development Area

The present condition of the irrigation schemes managed by DPUP Riau is shown in Table 2.1. The delay of the development that is due to the following reasons obstructs the attainment of the goal. In Table 2.1, the areas presently not yet irrigated are included in irrigable areas.

A) Financial reason
B) Step by step development of paddy field conducted by Ministry of Agriculture, and
C) Limit of river discharge

To review the optimum development scale for the existing irrigation schemes, water balance computation is made. The focal points to be taken into account are available quantity of river discharge at the water source sites and irrigation water requirements for the prevailing cropping patterns are compared with the dependable flows and the potential areas.

By referring to the result of hydrological analysis, water availability at intake sites is reviewed for the existing 10 irrigation schemes on the basis of non-exceedance probable discharge in five years(See Table 4.1).

The summary of re-estimated irrigable areas is below. In the present study, the re-estimated irrigable area is defined as the irrigation scheme area.

Project	DPUP's Planned Irrigation Area(ha)	Re-estimated Irrigable Area(ha)	
		Wet Season	Dry Season
(Bt. Lubuk basin)			
1. Sei Perak	95	238	146
2. Sei Menaming	423	959	596
3. Kaiti-Samo	1,695	1,082	673
4. Aek Tangun	420	82	53
(S. Rokan Kiri basin)			
5. Sei Kijang	516	405	162
6. Sei Palis	400	358	142
7. Kota Intan	188	81	34
(Bt. Kumu basin)			
8. Medang Mahato	324	963	920
(S. Rokan Kanan basin)			
9. Siarang-arang	464	326	338
(S. Rokan basin)			
10. Teluk Retti	1,000	93	86
Total	5,525	4,587	3,159

Out of the existing 10 irrigation schemes in the Objective Area, only 3(three) schemes have reasonable planning, while the remaining 7(seven) schemes have inadequate planning.

4.2 Development Possibilities of New Irrigation Schemes

4.2.1 Areas to be Newly Irrigated

(1) Background

In the Objective Area, there is an increasing need to stabilize the production of crops for food both in the wet and dry seasons. To meet these needs, the increase of irrigation water supply and the extension of irrigable area are prerequisite. Among several measures under consideration, the development of new water sources is one of the most important measures to be adopted in future planning.

The provincial government has proposed the following 5(five) projects in the Objective Area as the agricultural development projects:

1) The Bt.Lubuk project
2) The Upper Sosa project
3) The Lower Sosa project
4) The Mahato project
5) The Rokan Kiri project

On the other hand, the survey team proposed the Lower Rokan Kiri project as the alternative of the above projects. Therefore, 6(six) projects are studied.

The basis of the irrigation development planning in the Objective Area is the gravitational irrigation method in line with the DGWRD's policy. Therefore, additional areas to be irrigated are estimated by placing major emphasis on the precise estimation of the quantity of available water and the selection of areas to which irrigation water supply is topographically feasible.

(2) Conditions for the estimation of areas to be irrigated

In studying new irrigation development areas, gravity irrigation system without a reservoir is regarded as the given condition. Based on this concept, locations of water sources for new projects were surveyed, paying attention to the following items:

1) Sufficient water available to irrigable area
2) Flow condition at weir sites to be proposed
3) Easiness of water conveyance
4) Easiness of weir construction
5) Extent of inundation after completion of weirs
6) Inland navigation at weir sites to be proposed

Along with the above items for selection of the weir sites, further considerations as below were taken into as the factors for selection of the weir sites considering the irrigable areas and weir sites totally:

1) To select approximate locations of water sources facilities presupposing elevation and location of the highest part of the potential irrigation areas, and
2) To regard a confluence of rivers as an important location where economical run-off can be collected.

With respect to water conveyance, the following points are taken into considerations: selection of canal routes that connect the above water-supplying facility sites with areas to be irrigated as straight as possible or with shorter distance as possible; leveling between cuts and fills in canals; and headrace routes at higher elevations.

(3) Summary of proposed projects

The summary of each project is mentioned as follows:

1) The Bt.Lubuk project

The Bt.Lubuk scheme is an additional area to the existing Kaiti-Samo scheme to expand it more than 1,695 ha.
In planning the Bt.Lubuk project, the following existing projects will be incorporated because they are located along the right bank of the Bt.Lubuk river and near the Bt.Lubuk project.

(1) Sei Perak scheme
(2) Sei Menaming scheme,and
(3) Kaiti-Samo scheme

The command areas for the Sei Perak and the Sei Menaming projects are located on lower area along the Batang Lubuk river, while the command area of the Kaiti-Samo project is expanding over the comparatively high hilly terrain area with 80m to 50m above the sea level where rises sheer from the right bank of the Bt.Lubuk.

It is said that river discharges of the Sei Perak and Sei Menaming are enough to cover even the dry season paddy cultivation, while even the wet season paddy cultivation is unstable in the Samo project. Consequently, the Kaiti-Samo supply weir had already been constructed on the Kaiti river to supply water to the Samo weir. However, about 9.4 km of the connecting canal has not been constructed yet from the Kaiti-Samo supply weir to the Samo weir. Even though the connecting canal would be completed, it is said that the Kaiti-Samo project can not attain the target.

To stabilize both dry and wet season cultivations for the Kaiti-Samo project and to cover irrigation water for the

Batang Lubuk project, water will be supplied from the main water source, the Bt.Lubuk river.

On the other hand, the area is raised in undulations as mentioned above. Therefore, the irrigable area for the Batang Lubuk scheme will be dotted over the area.

2) The Upper Sosa project

The Upper Sosa project is located on the hilly terrain hemmed in between the Bt.Lubuk and the Bt.Sosa rivers. The project area is raised in undulations, and the elevation of the area ranges from about 90m to 50m. The provincial road that runs through the highest part of the project area divides the area into two. The left side of the road, facing Dalu Dalu, is occupied by the transmigration settlement area, SKP-C and the right side of the road by SKP-D. The SKP-C area is located a little to the Bt.Lubuk, while the SKP-D a little to the Bt.Sosa. From standpoint of developing paddy fields, land and slope may be problem. The area is raised in undulations as mentioned above. Therefore, the irrigable area will be dotted over the area.

Considering the conveyance of water from the water source, the Batang Lubuk river is suitable for the water source from the view point of topography. The existing Aek Tangun scheme that is located close to the project and on the left bank of the Batang Lubuk river is included in the new project formulation.

3) The Lower Sosa project

The Lower Sosa project is located in the left bank of the Bt.Sosa river upstream from the confluence of the Bt.Lubuk and the Bt.Sosa, and Bt.Lubuk. The project is extending over the comparatively flat area, centering the regional capital, Kota Tengah. The elevation of the area ranges from around 40m to 20m. The water source will be the Bt.Sosa. The primary canal will be aligned along the 50m contour line, and then will pass through the field with 35m to 25m high in the direction of north-east.

4) The Mahato project

The project is situated, hemmed in by the Mahato Kiri and the Meranti rivers. The area is flat, and is expanding over around 50m above sea level. The irrigation area will be developed in the direction from the West to the conflu ence of the Bt.Kumu and the S.Napangga. The water source will be the Mahato Kiri.

5) The Rokan Kiri project

Most of the Rokan Kiri project area has already been developed for the oil plantations and the rubber plantations. More development for irrigation will not be expected from the view point of topography and location of water source.

6) The Lower Rokan Kiri project

The proposed area is situated at either bank of the Rokan Kiri river. The left bank area is a comparatively flat area hemmed in by the Bt.Lubuk and the Rokan Kiri, extending from the skirts of the hills stretched from Tandun to Dalu Dalu, to the lower reaches of the both rivers. The elevation of the area ranges from around 40m to 20m. The right bank area is located the downstream end of the hilly area that is stretching along the right bank of the Rokan Kiri river from Kota Lama. In the area, the transmigration settlement schemes have already been executed.

The existing Kota Intan project is located on the left bank of the river and close to the project is included in the new project formulation. The water source will be the Rokan Kiri river.

(4) Topographically irrigable area

Considering the above (2) Conditions for the estimation of areas to be irrigated, the topographical conditions of the proposed projects are examined except the Rokan Kiri project. As a result, 5(five) areas are delineated as topographically irrigable area of 46,960 ha as shown below:

	Scheme	Topographically Irrigable area(ha)
1)	Bt.Lubuk project	460
2)	Upper Sosa project	3,600
3)	Lower Sosa project	11,800
4)	Mahato project	11,800
5)	Lower Rokan Kiri project	19,300
	Total	46,960

Remarks Lower Rokan Kiri project

Left bank area :	12,400 ha
Right band area:	6,900 ha
Total	19,300 ha

(5) Quantity of available water at new water-supplying facility sites

To have a proper irrigation plan for each irrigable area selected, quantities of available discharges at each new water-

supplying facility site are examined on the basis of non-exceedance probable discharge in 5 years as shown in Table 4.2.

(6) Scale of development

After examining quantities of available discharges at each intake site, potential area is decided as follows. Out of the irrigable area of 46,960 ha topographically selected, 44,160 ha is concluded to be the proper scale of new irrigation schemes considering the limitations of water resources.

	Scheme	Irrigable Area(ha) based on	
		Topography	Water Availability
1)	Bt.Lubuk project	460	460
2)	Upper Sosa project	3,600	3,600
3)	Lower Sosa project	11,800	11,800
4)	Mahato project	11,800	9,000
5)	Lower Rokan Kiri project	19,300	19,300
	Total	46,960	44,160

4.2.2 Alternative Considerations for Irrigation Water Supply to Existing Schemes

Among newly identified 5(five) irrigation schemes, additional water supply can be expected from the Bt.Lubuk, Upper Sosa(water source is Bt.Lubuk), and Lower Rokan Kiri irrigation schemes to their neighboring schemes that topographically can receive irrigation water. As for irrigation water supply areas, the following cases are considered:

(1) Case 1: New irrigation scheme only,
(2) Case 2: Supplemental water supply to the existing irrigation scheme with a water shortage problem in its water source,
(3) Case 3: Water source conversion of the existing irrigation scheme with the same condition of Case 2, and
(4) Case 4: Maximum utilization of newly developed water source by the neighboring schemes as much as possible.

(1) Case 1: New irrigation scheme only

Among newly identified water source facilities,the Bt.Lubuk, Upper Sosa(water source is Bt.Lubuk), and Lower Rokan Kiri (water source is Rokan Kiri) weir can divert a plenty of river discharge

to meet irrigation water demand not only for new irrigable areas but also for the existing irrigation schemes as follows:

Scheme	Potential Area(ha) Wet S.	Potential Area(ha) Dry S.	Scheme Area (ha)	Available Area(ha) Wet S.	Available Area(ha) Dry S.
1) Bt.Lubuk	13,975	8,731	460	13,515	8,271
2) Upper Sosa	13,975	8,731	3,600	10,375	5,131
3) Lower Sosa	24,066	15,035	11,800	12,266	3,235
4) Mahato	9,046	8,704	9,000	0	0
5) L.Rokan Kiri	61,944	53,681	19,300	42,644	34,381
Total	123,006	94,882	44,160	78,800	51,018

Remarks Wet S.: Wet Season
Dry S.: Dry Season

The balance between the potential and scheme areas can be considered as extra water resources for enhancement of irrigation water supply to the existing schemes. In the Objective Area, 7 (seven) existing irrigation projects are under shortage of water sources in either wet and dry seasons as shown in Table 4.1. The following is alternative considerations concerning irrigation supply to these existing schemes by allocating some portions of the above available area.

(2) Case 2: Supplemental water supply to the irrigation schemes with a water shortage problem in its water source

New water-supplying facilities at Bt.Lubuk, Upper Sosa, and Lower Rokan Kiri can supplement irrigation water demand both in the wet and dry seasons for the existing irrigation scheme as below:

Water Sources/ Scheme	Existing Irrigation Scheme	Wet S. (ha)	Dry S. (ha)
1) Bt.Lubuk			
	(1) Kaiti-Samo	613	1,022
2) Upper Sosa			
	(1) Aek Tangun	338	367
3) L.Rokan Kiri			
	(1) Kota Intan	107	154
Total	3 Existing Schemes	1,058	1,543

(3) Case 3: Water source conversion of the existing irrigation scheme with the same condition of Case 2

New water-supplying facilities at the Bt.Lubuk, Upper Sosa(water source is Bt.Lubuk), and L.Rokan Kiri can function as new water sources of the existing schemes as follows:

Water Source/ Scheme	Existing Irrigation Scheme	Wet S. (ha)	Dry S. (ha)
1) Bt.Lubuk		460	460
	(1) Kaiti-Samo	1,695	1,695
	Sub-total	2,155	2,155
2) Upper Sosa		3,600	3,600
	(1) Aek Tangun	420	420
	Sub-total	4,020	4,020
3) L.Rokan Kiri		19,300	19,300
	(1) Kota Intan	188	188
	Sub-total	19,488	19,488
Total	(Alternative Area)	2,303	2,303

(4) Case 4: Maximum utilization of newly developed water source by the neighboring schemes as much as possible

New water-supplying facility at the Bt.Lubuk has possibility to transfer water to the existing irrigation schemes as below if a new conveyance canal is constructed:

Water Source/ Scheme	Existing Irrigation Scheme	Wet S. (ha)	Dry S. (ha)
1) Bt.Lubuk		460	460
	(1) Kaiti-Samo	1,695	1,695
	(2) Sei Perak	95	95
	(3) Sei Menaming	423	423
	Sub-total	2,673	2,673
Total	(Alternative Area)	2,213	2,213

4.2.3 Additional Scheme Resulting from the Studies

As mentioned above, irrigation water for either the Batang Lubuk scheme and the Upper Sosa scheme are derived from the Batang Lubuk river, and both schemes can be irrigated by unifying water source on the Batang Lubuk river from the view point of the topographical conditions. Along with this, the existing schemes close to the Batang Lubuk and Upper Sosa schemes can be incorporated to stabilize their water supply. In addition to the above 5(five) new schemes, the Bt.Lubuk-Upper Sosa scheme can be studied as an additional scheme.

In this scheme, the existing (1) Kaiti-Samo, (2) Sei Perak, (3) Sei Menaming, and (4) Aek Tangun schemes are incorporated. As for

irrigation water supply areas, the same cases as mentioned in 4.2.2 are applied to alternative considerations. Namely, the results of study can be obtained by combining each case of the Bt.Lubuk scheme and the Upper Sosa scheme as mentioned in 4.2.2. After combining both schemes, the irrigable area is as follows:

	New Scheme (ha)	Existing Scheme (ha)	Total (ha)
(1) Case 1	4,060	0	4,060
(2) Case 2	4,060	1,389	5,449
(3) Case 3	4,060	2,115	6,175
(4) Case 4	4,060	2,633	6,693

5. IMPROVEMENT OF EXISTING IRRIGATION SYSTEM

As described in Section 2.2, there exist 10 semi-technical irrigation systems in the Objective Area.

An important increase occurs when technical irrigation has been introduced. This assures the water input. Once the water input is assured, substantial additional production increases may be realized by such program as SUPRA INSUS.

5.1 Facilities

Effective utilization of limited river discharge cannot be achieved by semi-technical irrigation system. Technical irrigation requires facilities that are properly operated and maintained. This applies to the diversion facilities, the primary, secondary and tertiary canal irrigation systems and the drainage system.

In the case of the existing irrigation schemes in the Objective Area, it is necessary to improve canal systems and to take consistent measures in proper operation and management to make it possible to flow water to tertiary level for timely, uniform and efficient supply and distribution of water. These prerequisites are summarized as follows:

1) Measurement facility for water intake just below intake ports.
2) Structures which can measure and control flow in canal systems.
3) Tertiary networks to be thoroughly furnished in all schemes.
4) Independent setting of irrigation and drainage canals on farm level.
5) Systematic and technical support systems for operation and maintenance.

5.2 Operation and Maintenance

Operation and maintenance are divided into such functions as operation of water control to intake, convey and divert water, and maintenance of facilities by inspection, improvement, repair and removal of obstacles to water supply.

5.2.1 Operation

(1) Headworks

The water management and control at headworks should be performed so that a diversion weir and an intake part can be functioned safely and rationally. A scouring sluice gate to remove sedimentation is operated on managing person's judgment. During the flood period, a scouring sluice functionates to let flood

discharge flow. In an intake part, opening and closing of gate are controlled to secure necessary amount of intake water.

(2) Canals

Water management and control in canals should be performed so that diversion structures and check gates can be functioned safely and rationally. At a diversion structure, water level, rates of flow and opening degree of gate are checked. At the same time, it shall be prohibited for farmers to operate or break facilities voluntarily for their purposes. At a check gate, water-level shall be watched for proper distribution.

In respect to canal management, it is important to ensure such facilities as headworks, canals and structures are always kept in good condition for securing proper and functional distribution. In principle, main systems should be well managed by the administration and tertiary systems by irrigation associations or beneficial farmers.

5.2.2 Maintenance

In the existing irrigation schemes, most of the earth canals without periodical maintenance require to remove sedimentation that results in thick growth of waterweed and loss of a designed cross-sectional area of flow.

Facility maintenance consists of 2 functions; regular facility maintenance and emergency facility maintenance.

1) Regular facility maintenance: Staff of management office should regularly inspect facilities and if he finds any damage, he should make a report to a management office. If damage is heavy, he should arrange a temporary repair as soon as possible. It is another his duty to make repair plan of canal structures periodically.
2) Emergency facility maintenance : Emergency facility maintenance should be performed when damage is heavy. A facility should be repaired at once by using materials obtained on site to avoid further extension of damage.

Main items of inspections and works for facility maintenance are as follows:

1) As damaged gates result in scour of embankments, a functioning of scouring sluice gates of headworks should be regularly inspected.
2) Weir bodies of headworks should be inspected whether cracks, piping or peelings of surfaces occur or not.
3) Erosion of ripraps is considered to be inevitable. However, if ripraps are washed away, new ripraps should be constructed at once and if necessary the construction lengths should be extended. Without ripraps,

piping will occur and lowering of the foreaprons will be resulted.

4) Sediment, waterweed and suspended solids should be removed.
5) Freeboard of canals should be cleaned.
6) Trees and plants growing at joints in concrete works should be removed.
7) Sediment on gate sills of diversion structures and turnouts should be removed.
8) Joints between earth canals and concrete works should be checked.
9) Gates, safety bars and handrails should be regularly coated.
10) Full opening and full closing of gates should be checked and parts of gates should be lubricated.
11) Stoplogs for gates should be reserved.

As a part of the management system, management offices should be established under each Kabupaten office. Each management office consisting of an inspector, overseer and gate keepers is recommended to have jurisdiction over an area of about 1,000 ha with several schemes.

The main works of management offices are summarized as follows:

1) Formulation of irrigation schedule
2) Collection and analysis of data
3) Water supply control and canal system management
4) Guidance in technique for irrigation associations and benefiting farmers
5) General affairs and accountancy

6. IRRIGATION DEVELOPMENT PLAN

6.1 Existing schemes

There are eight(8) ongoing schemes in Kabupaten Kampar, and two(2) schemes in Kabupaten Bengkalis. The outline of upgrading plan for these schemes is shown below. Table gives a summary of work items and quantities by schemes.

Scheme	Area (ha)	Upgrading of System	Early Completion of Main System(ha)	Tertiary System Development (ha)
		Target		
Bt.Lubuk basin				
1.Sei Perak	95	T	-	33
2.Sei Menaming	423	T	-	286
3.Kaiti-Samo	1,695	T	195	1,329
4.Aek Tangun	420	T	-	393
S.Rokan Kiri basin				
5.Sei Kijang	405	T	405	405
6.Sei Palis	358	T	-	211
7.Kota Intan	188	T	-	124
Bt.Kumu basin				
8.Medang Mahato	324	T	104	324
S.Rokan Kanan basin				
9.Siarang-arang	338	T	-	113
S.Rokan basin				
10.Teluk Retti	93	T	0	0
Total	4,339		704	3,218

Remarks T: Technical irrigation

In the Sei Perak, Sei Menaming, Aek Tangun, Sei Palis, and Kota Intan schemes, the main systems have already been completed. However, the tertiary systems for these schemes still are left undeveloped because of the reasons mentioned in Chapter 4. In the Kaiti-Samo scheme, about 9 km of the connecting canal between the Kaiti-Samo supply weir and the Samo weir has not been completed. Therefore, although the main system for 1,500 ha out of 1,695 ha has already been completed, only 366 ha of the area where is commanded by the Samo weir is being irrigated.

The irrigation system has not fulfilled the function yet in the Sei Kijang schemes because the irrigation facilities such as headworks and canal had been constructed partly due to financial reason. In fiscal year 1991/92, 125 ha of paddy field will be developed by Ministry of Agriculture.

In the Medang Mahato scheme, irrigation facility is under construction, and 100 ha of paddy field development will be commenced in fiscal year 1991/92.

In respect to alternative considerations on irrigation water supply from the new Bt.Lubuk, Upper Sosa, and Lower Rokan Kiri schemes to the existing Kaiti-Samo, Aek Tangun, and Kota Intan irrigation schemes as described in Section 4.2.2(2) and (3), further extension of tertiary system is required in these 3(three) schemes and the Kaiti-Samo scheme needs additional extension of the main system.

The Siarang-arang, and Teluk Retti schemes are located in the lower reaches of the Rokan river. In the areas, irrigation water supply is unstable even in wet season because water source for irrigation depends on the small rivers. It seems to be difficult to supplement irrigation water to the areas from other water sources from the standpoint of topographical view. In the Teluk Retti scheme, the irrigation area is extending over the swamp area. Therefore, the area is suffering from flood in the wet season.

6.2 New schemes

There are 5(five) schemes newly identified in Kabupaten Kampar. The outline of irrigation development target is described below.

Scheme	Scheme Area(ha)	Irrigation Area(ha) Wet S.	Dry S.
1) Bt.Lubuk	460	460	460
2) Upper Sosa	3,600	3,600	3,600
3) Lower Sosa	11,800	11,800	11,800
4) Mahato	9,000	9,000	8,700
5) L.Rokan Kiri	19,300	19,300	19,300
Total	44,160	44,160	43,860

With the location of the existing schemes, the following newly identified schemes can supply additional water to the existing schemes by alternative water supply as follows:

Scheme	Alternative Water Supply	Wet S. (ha)	Dry S. (ha)	Incorporated Scheme
1) Bt.Lubuk	(1)supplemental water supply	613	1,022	(a) Kaiti-Samo
	(2)Water source conversion	1,695	1,695	(a) Kaiti-Samo
	(3)Maximum utilization	2,213	2,213	(a) Kaiti-Samo (b) Sei Perak (c) Sei Menaming
	Sub-total	4,521	4,930	
2) Upper Sosa	(1)Supplemental water supply	338	367	(a) Aek Tangun
	(2)Water source conversion	420	420	(a) Aek Tangun
	(3)Maximum utilization	420	420	(a) Aek Tangun
	Sub-total	1,178	1,207	
3) L.Rokan Kiri	(1)Supplemental water supply	107	154	(a) Kota Intan
	(2)Water source conversion	188	188	(a) Kota Intan
	(3)Maximum utilization	188	188	(a) Kota Intan
	Sub-total	483	530	
	Total	6,182	6,667	

On the other hand, irrigation water for either the Batang Lubuk scheme and the Upper Sosa scheme is derived from the Batang Lubuk river, and both schemes can be irrigated by unifying water source on the Batang Lubuk river from the view point of the topographical conditions. Therefore, the Bt.Lubuk-Upper Sosa scheme can be studied as an additional scheme.

In this scheme, the existing (1) Kaiti-Samo, (2) Sei Perak, (3) Sei Menaming, and (4) Aek Tangun schemes are incorporated. After combining both new schemes, the irrigable area is as follows:

	New Scheme (ha)	Existing Scheme (ha)	Total (ha)
(1) Case 1	4,060	0	4,060
(2) Case 2	4,060	1,389	5,449
(3) Case 3	4,060	2,115	6,175
(4) Case 4	4,060	2,633	6,693

In the Bt.Lubuk scheme, the command area is located on the high hilly terrain area. Therefore, the headworks with intake port on the right bank should be constructed on the site with high elevation. The weir site will be located at the meander bend around Batu Bintang. A canal should be aligned from the headworks along the steep hillside because the hill rises sheer from the right bank of the Bt.Lubuk, and conveyed water from the water source is poured in the primary canal for the Samo scheme that is connected from the intake of the Samo weir. To prevent soils washed out from hillsides from being directly entered the canal, the concrete flume with cover will be adopted for the conveyance canal. The Bt.Lubuk area is additional area to the existing Kaiti-Samo scheme to expand it more than 1,695 ha. Therefore, the canal route of the Kaiti-Samo scheme is used for that of the Bt.Lubuk schemes.

The Upper Sosa scheme is located on the left bank of the Bt.Lubuk. Topographical condition of the Upper Sosa scheme is same as that of the Bt.Lubuk scheme. Therefore, the weir site is the same site as Bt.Lubuk scheme, and structure type is also same. In the Upper Sosa scheme, the existing Aek Tangun scheme is located between the weir site and the Upper Sosa scheme. Therefore, the Upper Sosa weir can supplement irrigation water demand both in the wet and dry seasons for the Aek Tangun scheme.

In the Lower Sosa scheme, the headworks with intake port on the left bank are required to be constructed at the meander bend around Setia Baru in the Bt.Sosa. The irrigation command area is extending on the comparatively flat area with the elevation of 40 m to 20 m, centering the regional capital, Kota Tengah. The primary canal will be aligned along the 50m contour line, and then will pass through the field with 35m to 25m high in the direction of north-east. The canal type for the primary canal will be trapezoidal cross section with thin concrete lining.

In the Mahato scheme, the headworks with intake port on the left band are required to be constructed on the upper reach of the Mahato Kiri river. The irrigation command area having around 50 m above sea level extends on the left bank. The canal route will be aligned along the Mahato river and crosses the Mahato Kanan by an embankment canal. At around the lumber company, the canal will direct to the center of the area, and passes in the direction of the confluence of the Bt.Kumu and the S.Napangga. The canal type for the primary canal will be trapezoidal cross section with thin concrete lining. When the canal crosses the small rivers, embankment canal with drainage culverts will be employed because their catchment areas are small.

As mentioned in Sub chapter 4.2 Development Possibilities of New Irrigation Schemes, most of the Rokan Kiri project has already been developed for the oil palm plantations and the rubber plantations. However, the existing Kota Intan scheme is located in the scope of the Rokan Kiri project. Now, regardless of the completion of main system, water supply can not cover the nominal irrigable area of 188 ha because of water source shortage. Therefore, the Lower Rokan Kiri scheme will incorporate the Kota Intan scheme to supplement irrigation water.

In the Lower Rokan Kiri scheme, the headworks with intake ports on both the banks will have to be constructed at the meander bend located about three(3) km upstream from Kota Intan village. The existing Kota Intan irrigation scheme is located on the left bank and between the intake and the left side area of the Lower Rokan Kiri scheme. The primary canal location on the left bank area will be selected along the skirts of the hills and along the Rokan Kiri river. Some part of the canal will be constructed on the embankment between the transmigration settlement SKP-B, SKP-F, and SKP-G. As for the right bank area, the primary canal will be aligned along the river up to Kota Lama village, and then along the river side of the hilly area to the transmigration settlement SKP-A.

In the Bt.Lubuk-Upper Sosa scheme, the headworks with intake ports on both the banks will have to be constructed at the same site as the Bt.Lubuk weir.

7. COST ESTIMATES

Necessary cost for upgrading and development works for each irrigation scheme is calculated on the basis of the following conditions:

1) Unit prices are based on "Basic Price in November, 1990-March, 1991" published by 1CIPTA KARYA DPUP in Riau(See Table 6.1 and 6.2).
2) The above unit prices are increased by 20% in consideration of a 22% raising of gasoline held in July 1991.
3) Costs of miscellaneous works of 10%, general items of 15% and value added tax of 10% is taken into consideration.
4) As to land acquisition, Rp.300/m² is considered for irrigation and drainage systems. However, land acquisition for tertiary systems is excluded from consideration.

Table 6.3 shows costs required for upgrading of the existing schemes and development of the new schemes, respectively. As for alternative considerations from the newly developed water sources, additional costs required are also summarized in Table 6.3.

Table 2.1 Irrigated Area and Development Potential of Existing Irrigation Projects

Unit : Ha

River Basin and Project Name	Levels of Irrigation Systems	Net Irrigable Area (A)	Potential Area at present	Potential Area not developed yet	Existing Paddy Field (B)	Land to be developed as Paddy Field	Development Potential (A)-(B)	Existing Irrigable Area		Catchment Area
								Dry Season	Wet Season	
Bt. Lubuk										
1. Sei. Perak	S.T.	95	95	-	62	33	33	45/ 5	62	1,390
2. Sei. Menaming	S.T.	423	423	-	137	286	286	-	137	5,600
3. Kaiti-Samo	S.T.	1,695	1,500	195	366	1,329	1,329	324/41	366	6,300
4. Aek Tangun	S.T.	420	420	-	27	393	393	-/15	27/30	470
Sub Total		2,633	2,438	195	592	2,041	2,041	369/61	592/30	13,760
S. Rokan Kiri										
1. Sei Kijang	S.T.	516	-	516	-	516	516	-	-	1,650
2. Sei Palis	S.T.	400	400	-	147	253	253	25/10	147	1,460
3. Kota Intan	S.T.	188	188	-	64	124	124	-/ 3	64	325
Sub Total		1,104	588	516	211	893	893	25/13	211	3,435
Bt. Kumu										
1. Medang Mahato	S.T.	324	220	104	-	324	324	-	-	5,600
Sub Total		324	220	104	-	324	324	-	-	5,600
S. Rokan Kanan										
1. Siarang-arang	S.T.	464	464	-	225	239	239	-	225	1,460
Sub Total		464	464	-	225	239	239	-	225	1,460
S. Rokan										
1. Teluk Retti	S.T.	1,000	660	340	600	400	400	-	275	416
Sub Total		1,000	660	340	600	400	400	-	275	416
T O T A L		5,525	4,370	1,155	1,628	3,897	3,897	394/74	1,303/30	24,671

Remarks : S.T. ; Semi-Technical
* ; Paddy / Palawija

Table 4.1 Re-estimated Irrigable Area of Existing Irrigation Schemes

Project	DPUP's Planned Irrigation Area(ha)	Re-estimated Irrigable Area(ha)	
		Wet Season	Dry Season
Bt. Lubuk basin			
1. Sei Perak	95	238	146
2. Sei Menaming	423	959	596
3. Kaiti-Samo	1,695	1,082	673
4. Aek Tangun	420	82	53
S. Rokan Kiri basin			
5. Sei Kijang	516	405	162
6. Sei Palis	400	358	142
7. Kota Intan	188	81	34
Bt. Kumu basin			
8. Medang Mahato	324	963	920
S. Rokan Kanan basin			
9. Siarang-arang	464	326	338
S. Rokan basin			
10. Teluk Retti	1,000	93	86
Total	5,525	4,587	3,159

Table 4.2 Estimation of Potential Irrigable Area for New Schemes

Scheme	Wet Season(ha)	Dry Season(ha)
1. Mahato	9,046	8,704
2. Bt. Lubuk	13,975	8,731
3. Upper Sosa	13,975	8,731
4. Lower Sosa	24,066	15,035
5. Lower Rokan Kiri	61,944	53,681
Total	123,006	94,882

Table 6.1 List of Unit Price

Work Items	Unit	Unit Price(Rp.)	Remarks
A. EARTH WORKS			
1. Site Clearing	100 m2	14,500	
2. Stripping	m3	1,600	
3. Excavation			
3.1 Normal	m3	4,500	Exc. (2m>) Rp.2,700, Hauling(1=1,000-2,000 m) Rp.1,800
3.2 Rock	m3	18,000	Excavation(normal)*4
4. Backfill	m3	3,000	
5. Earthfill	m3	4,000	E.fill(re-use)Rp.2,200,Hauling(1=1,000-2,000 m)Rp.1,800
6. Sod Facing	m2	1,100	Pait-paitan
7. Road Metaling	m2	3,600	
B. CONCRETE WORKS			
1. Concrete			
1.1 Reinforced	m3	228,000	
1.2 Plain	m3	124,000	
2. Reinforced Bar	t	1,355,000	Deformed bar
C. OTHERS			
1. Gabion Mattress	m2	28,500	Gabion mattress 1.0*1.2*0.4
2. Sluice Gate	m2	2,200,000	per m2
3. Romijn Gate	m	2,700,000	per m (width)

File name: UNITRATE.WJ2

Table 6.2 Basic Price

ITEM NO.	WORK ITEM	UNIT	UNIT PRICE (Rp.)	TYPE OFF CLASS
	L A B O U R			
A.	Plant operator I	m-d	7,000	
1.	Operator			
B.	Plant operator II	m-d	5,000	
1.	Driver			
2.	Assistant operator			
C.	Tradesman I	m-d	7,000	FOREMAN
1.	Chief of carpenter			
2.	Chief of blacksmith			
3.	Chief of bricklayer			
4.	Chief of painter			
D.	Tradesman II	m-d	5,500	SKILLED
1.	Carpenter			LABOUR
2.	Blacksmith			
3.	Bricklayer			
4.	Painter			
5.	Chief of driller			
6.	Welder			
7.	Digger			
8.	Electrician			
9.	Mason			
10.	Mechanic			
E.	Tradesman III	m-d	4,500	ASSISTANT
1.	Driller			SKILLED
2.	Asphaltman			LABOUR
3.	Assistant mechanic			
4.	Guard			
5.	Assistant driver			
F.	Common labour	m-d	4,500	
1.	Common labour			

Table 6.3 Summary of Cost Estimate for New Schemes and Existing Schemes

(1) New Schemes with Incorporated Existing Schemes

New Scheme	Case	Irrigable Area (ha)		Total Area (ha)	Construction Cost (mil. Rp.)		Total Cost (mil. Rp.)	Incorporated Existing Schemes
		New Scheme	Existing Scheme		New Scheme	Existing Scheme		
(1) Bt. Lubuk	1. Case 1	460	0	460	59.690	0	59.690	
	2. Case 2	460	1.022	1.482	68.470	1.980	70.450	(1) Kaiti-Samo=1.022 ha
	3. Case 3	460	1.695	2.155	84.970	4.760	89.730	(1) Kaiti-Samo=1.695 ha
	4. Case 4	460	2.213	2.673	86.230	5.820	92.050	(1) Sei Perak=95 ha. (2) Sei Menaming=423 ha. (3) Kaiti-Samo=1.695 ha
(2) Upper Sosa	5. Case 1	3.600	0	3.600	92.870	0	92.870	
	6. Case 2	3.600	367	3.967	93.010	1.010	94.020	(1) Aek Tangun=367 ha
	7. Case 3	3.600	420	4.020	93.050	1.160	94.210	(1) Aek Tangun=420 ha
	8. Case 4	3.600	420	4.020	93.050	1.160	94.210	(1) Aek Tangun=420 ha
(3) Lower Rokan Kiri	9. Case 1	19.300	0	19.300	192.520	0	192.520	
	10. Case 2	19.300	154	19.454	192.570	270	192.840	(1) Kota Intan=154 ha
	11. Case 3	19.300	188	19.488	192.570	430	193.000	(1) Kota Intan=188 ha
	12. Case 4	19.300	188	19.488	192.570	430	193.000	(1) Kota Intan=188 ha
(4) Bt. Lubuk-Upper Sosa (Unification of Water Source)	13. Case 1	4.060	0	4.060	147.440	0	147.440	
	14. Case 2	4.060	1.389	5.449	156.360	2.990	159.350	(1) Kaiti-Samo=1.022 ha. (2) Aek Tangun=367 ha
	15. Case 3	4.060	2.115	6.175	172.910	5.920	178.830	(1) Kaiti-Samo=1.695 ha. (2) Aek Tangun=420 ha
	16. Case 4	4.060	2.633	6.693	174.160	6.980	181.140	(1) Sei Perak=95 ha. (2) Sei Menaming=423 ha. (3) Kaiti-Samo=1.695 ha
								(4) Aek Tangun=420 ha

(2) New Schemes without Incorporated Existing Schemes

New Scheme	Irrigable Area (ha)	Construction Cost (mil. Rp.)	Remarks
(5) Mahato	9.000	97.030	
(6) Lower Sosa	11.800	106.200	
Total		203.230	

(3) Existing Schemes with Re-estimated Area

Existing Scheme	Irrigable Area (ha)	Construction Cost (mil. Rp.)	Remarks
1. Sei Perak	95	120	
2. Sei Menaming	423	940	
3. Kaiti-Samo	1.082	2.100	
4. Aek Tangun	82	170	
5. Sei Kijang	405	3.170	
6. Sei Palis	358	520	
7. Kota Intan	81	110	
8. Medang Mahato	324	1.410	
9. Siaran-arang	338	390	
10. Teluk Retti	93	340	
Total	3.281	9.270	

File name: AAA.WJ2

Fig.3.1 Calculation of Diversion Requirement

ITEMS	Jan.			Feb.			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.		
	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
Cropping Pattern																																				
(1). Eto (mm/day)	4.19	4.24	4.30	4.79	4.86	4.90	4.96	4.94	4.92	5.20	5.14	5.08	4.98	4.89	4.50	5.03	5.00	4.97	5.00	5.04	5.13	4.70	4.78	4.64	4.82	4.87	4.89	4.90	4.89	4.85	4.77	4.70	4.67	4.26	4.23	4.23
(2). P (')	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
(3). Re (')	1.80	9.30	10.70	3.40	3.30	4.50	2.10	5.20	5.10	6.20	6.70	4.20	2.20	4.90	0.60	2.70	2.80	1.50	3.40	3.50	2.40	2.90	0.00	0.60	3.90	2.90	5.60	2.50	6.10	3.10	2.90	5.00	1.90	5.70	2.00	0.70
(4). AWLR: Average WLR(')	0.00	1.67	1.53	0.00	0.83	0.93								0.83	0.77	0.00	1.67	1.67	0.00	1.67	1.53	0.00	0.83	0.77								0.83	0.83	0.00	1.67	1.53
(5). ACC: Average crop coeff.	1.03	0.72	0.67	0.67	0.35	0.32			LP	LP	LP	1.10	1.10	1.10	0.72	0.72	0.72	1.03	1.03	0.72	0.67	0.67	0.35	0.32			LP	LP	LP	1.10	1.10	1.10	0.72	0.72	0.72	1.03		
(6). LPA: Land prep. area									1.00	1.00	1.00	0.67	0.67	0.67	0.33	0.33	0.33										1.00	1.00	1.00	0.67	0.67	0.67	0.33	0.33	0.33		
(7). CA: Crop area	0.67	0.67	0.67	0.33	0.33	0.33	0.00					0.33	0.33	0.33	0.67	0.67	0.67	1.00	0.67	0.67	0.67	0.33	0.33	0.33	0.00					0.33	0.33	0.33	0.67	0.67	0.67	1.00	
(8). LPWR (mm/day)									12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60										12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60		
(9). Etc (mm/day)	4.33	3.04	2.87	3.19	1.70	1.55	0.00	0.00	0.00	0.00	0.00	5.58	5.48	5.38	3.44	3.60	3.58	5.14	5.17	3.61	3.42	3.13	1.67	1.53	0.00	0.00	0.00	0.00	0.00	5.34	5.25	5.17	3.35	3.05	3.03	4.37
(10). NLPR (')	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.56	6.40	5.90	5.60	6.97	5.16	4.00	3.27	3.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	10.10	6.50	6.33	7.10	5.09	3.57	2.28	3.50	0.00
(11). (ETc+P-Re)*CA (')	3.03	0.00	0.00	0.59	0.13	0.00	0.00	0.00	0.00	0.00	0.00	1.12	1.74	0.82	3.24	1.95	1.86	5.64	2.52	1.42	2.02	0.74	1.21	0.97	0.00	0.00	0.00	0.00	0.00	1.40	1.75	0.72	2.31	0.00	2.03	5.67
(12). NFR (mm/day)	3.03	1.67	1.53	0.59	0.97	0.93	0.00	0.00	7.50	6.40	5.90	6.72	8.71	6.61	8.01	5.21	6.77	7.30	2.52	3.08	3.56	0.74	2.05	1.73	0.00	0.90	7.00	10.10	6.50	7.73	8.83	6.64	5.71	2.28	7.20	7.20
(13). NFR*Days (mm)	30.30	16.70	16.86	5.90	9.70	3.40	0.00	0.00	82.50	64.00	59.00	67.20	87.10	66.10	88.10	52.10	67.70	73.00	25.20	30.80	39.13	7.40	20.50	19.07	0.00	0.00	70.00	101.00	65.00	85.04	88.30	66.40	57.10	22.80	72.00	79.24
(14). Diversion Req. (1). (mm)	44.56	24.56	24.80	8.68	14.26	12.35	0.00	0.00	121.32	94.12	86.76	98.82	128.09	100.15	129.56	76.62	99.56	107.35	37.06	45.29	57.54	10.88	30.15	28.05	0.00	0.00	102.94	148.53	95.59	125.06	129.85	97.65	83.88	33.53	105.88	116.54
(15). Diversion Req. (2). (l/sec/ha)	0.52	0.28	0.28	0.10	0.17	0.16	0.00	0.00	1.28	1.09	1.00	1.14	1.48	1.16	1.36	0.89	1.15	1.24	0.43	0.52	0.61	0.13	0.35	0.28	0.00	0.00	1.19	1.72	1.11	1.32	1.50	1.13	1.14	0.39	1.23	1.23

File name: DREQDEPT.WK2

ANNEX G

RURAL INFRASTRUCTURE

ANNEX G RURAL INFRASTRUCTURE

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ANNEX G RURAL INFRASTRUCTURE

1. INTRODUCTION

This ANNEX G presents the results of the study on rural infrastructure in the Objective area including domestic water, public roads, inland water transport and power supply. Main purposes of this study are to clarify the present conditions and to propose development policy of rural infrastructure in the Objective area. To achieve these purposes, related data and information were collected at the offices as mentioned below.

a. BAPPEDA I at Pekanbaru and Padang
b. BAPPEDA II at Bangkinang,Bengkalis,Padangsidempuan and Rantauprapat
c. PU office at Pekanbaru, Bengkalis, Padansidempuan and Rantauprapat
d. Transmigration office at Pekanbaru and Padansidempuan
e. Estate office at Pekanbaru, Bangkinang and Padan-sidempuan
f. Forestry office at Pekanbaru, Bangkinang and Padan-sidempuan
g. Water Supply office at Pekanbaru
h. Water Transportation office at Pekanbaru
i. National Electric Company at Pekanbaru and Bukit-tinggi

To grasp present conditions and needs for development in the Objective area, reconnaissance survey was conducted and a series of meetings were held during the field survey period.

The basic approach to the development of domestic water supply in the Objective area is to increase the coverage ratio for water service facilities. Especially, priority would be given to cover kecamatan capitals as planned under the fifth 5-year development plan.

To upgrade the utility rate of existing roads is the basic policy of the development of public roads under the provincial fifth 5-year development plan. On the basis of this policy,priority roads have been selected out of kabupaten roads which need improvement in the province. And in view of long term development, the construction of new roads which connect to Bengkalis and Kampar districts was proposed.

Inland water transport plays an important role in transport despite a gradual decline in use. The basic approach for inland water transport development is to integrate the same in the most rational manner with the expanding road network. Priority would be given to O/M rather than the construction of new facilities.

The basic approach to the development of power supply in Riau province is given in the fifth 5-year development plan of provincial government, and in view of long term development, the report of IDEP indicates the basic approach to the development of power supply in Riau, Aceh and North Sumatra provinces.

2. DOMESTIC WATER

2.1 Present Condition

(1) Water Quality

The Indonesian standard of water quality was established by the Ministry of Health in 1975,in accordance with WHO standards. Table 2.1 shows this Indonesian standard. Detailed data on water quality in the Objective area are not available. However, contamination from organic content of the peat moss layer in swampy area,and saline intrusion in low coastal area is reported.

Although population in these area catch rain water for domestic use,there is a general shortage of potable water. These residents accordingly strongly desire a stable water supply. It is also noted that population within the Objective area have the custom of first boiling water prior to drinking,regardless of the source (river,water supply system,etc.).

(2) Existing Facilities

a. Urban Area

According to statistical data for 1989, 14 water service pipeline systems exist in urban areas of Riau province and these systems provide a water amount of 635 l/s. Capacity of these facilities are 280 l/s at Pekanbaru the capital of the province, 90 l/s at Tanjung Pinang located in Bintan island and 2.5 l/s to 40 l/s at each kabupaten and kecamatan capital. These facilities provide domestic water to cover about 41% of population in these urban areas. However, this is indicative of a very low coverage ratio for water supply facilities given the fact that there are 2 autonomous urban zones and 76 kecamatans in the province. The water sources consist of rivers (7 locations),springs (4 locations) and others (3 locations).

Table 2.2 Water Supply Facilities in Riau

Items	Unit	1984	1985	1986	1987	1988
Facilities	nos.	12	14	14	14	14
Capacity	l/s	447	497	558	565	635
Water Source						
River	nos.	5	6	6	6	7
Spring	nos.	2	2	4	4	4
Well	nos.	4	5	4	4	-
Others	nos.	1	1	-	-	3

As in the case of the overall province, the coverage ratio of water supply facilities within the Objective area is low. The facilities are only available at kecamatan capitals of Bagan siapiapi(kec.Bangko;20l/s),Ujung batu(kec.Tandun;5l/s) and Pasir pangarayan(kec.Rambah;10l/s).

b. Rural area

The rural area population rely on shallow wells, river water and rainfall for domestic water. Data on numbers of shallow wells in the Objective area are not available. However,many shallow wells were observed at the time of reconnaissance in the hill area. According to information from concerned agencies, 1 shallow well without manual pump is excavated for every 4 transmigrant families. These wells are 1m in diameter and 4m to 10m in depth. However,some of the wells are dry in the dry season.

Population near the rivers use river water,and population within swampy area and low coastal area use rainfall for domestic water because of the poor water quality in the area as stated before.

2.2 Development Policy in the Objective Area

Under the fifth 5-year development plan of provincial government, water service pipeline systems will be constructed at kecamatan capitals where the systems are not available yet, and augment of existing systems will be done. Consequently, 80% of population in urban area(Kota) and 60% of population in rural area(Desa) will get domestic water service by these systems.

As indicated in Table 2.3, construction of new water supply facilities in the Objective area is planned at Duri(kec.Mandau; 80l/s), Bagan batu(kec.Kubu;20l/s), Kotalama(kec.Kunto darusalam; 10l/s), Kota tengah (kec.Kepenuhan;10l/s),Dalu dalu(kec.Tambusai; 10l/s) and Sedinginan (kec. Tanah putih; 10l/s). And existing systems at Bagan siapiapi (kec. Bangko; 20l/s), Ujung batu (kec. Tandun;5l/s) and Pasir pangarayan (kec.Rambah;10l/s) are planned for capacity augmentation to 40l/s,20l/s and 60l/s respectively.

Water sources of these systems are located in the Rokan river

basin except the system at Bagan siapiapi. Consequently, the amount of domestic water from the Rokan river will be 220l/s. The construction of new water supply system at Dumai which locates near the Objective area is planned to take 40l/s of water amount from the Mesjid river. However, this river is out of the Rokan river basin.

In consideration of all the plans as mentioned above, the total amount of domestic water taken from the Rokan river is estimated as below. Ratios in the formula are based on Indonesia design criteria of water supply systems(IKK systems).

(Average daily demand) = (System capacity)/R1/R2

Where, R1: Ratio of maximum daily demand to average daily demand (R1=1.1)
R2: Ratio of Peak hourly demand to maximum daily demand (R2=1.0)

Average daily demand = 220/1.1/1.0 = 200 (l/s)
= 200*24*3600 = 17,300 (cu.m/day)

As a result,amount of average daily domestic water from the Rokan river is estimated as 17,300 cu.m.

It is necessary to execute a survey on water sources, development measures for the same and water demand for swamp and low coastal areas where water quality is poor.

3. PUBLIC ROADS

3.1 Present Condition

(1) Road Length

According to statistical data in 1987,the total length of public roads in Riau province is 6,220km which consist of national road (840km), provincial roads(1,498km) and kabupaten road (3,882km). Surface condition of these roads are asphalt(1,927km;31%), gravel (1,452km;23%) and dirt(2,841km;46%).

Table 3.1 Road Length in Riau (1987) (km)

Classification	Asphalt	Gravel	Dirt	Total
National road	840	-	-	840
Provincial road	842	312	344	1,498
Kabupaten road	245	1,140	2,497	3,882
Total	1,927	1,452	2,841	6,220

Source: PU in Pekanbaru

As indicated in Figure 3.1,the major roads in the Study area are (i) the national highway from Dumai to Kota pinang in North Sumatra, and (ii) the provincial road from Rantau berangin (15km west of Bangkinang) via Tandun, Pasir pangarayan and Dalu dalu to Sibubuhan in North Sumatra. These routes traverse the Study area east-west, and provide access via kabupaten roads to the various kecamatan capitals scattered in the area.

In the Objective area, public roads consist of national road (127km), provincial roads(230km) and kabupaten roads(427km). Accordingly, 784km of total road length is constructed as shown in Table 3.2.

Road density in the Objective area(48.8m/sq.km) is more sparse compared with that for Riau province(65.8km) as a whole. Road length per capita in the Objective area is also lower than that in the province as a whole. Tables 3.2 and 3.4 show road length and road density in the Objective area,respectively.

(2) Road Surface

The national and provincial roads are asphalt surface within the Objective area,and in generally good condition. However, many on the kabupaten roads are dirt, and impassable during the rainy season when the surface changes to mud. According to Table 3.5 which shows the change of road surface condition in Riau province from 1985 to 1988, "Extremely bad condition" increases with decreasing "Good condition". And 35%(2,160km) of the total road length in Riau province is described as "Bad" or "Extremely bad".

3.2 Development Policy

(1) Fifth 5-year Development Plan

Priority is given to widening,paving and rehabilitation of roads under the fifth 5-year development plan of the provincial government to upgrade the utility rate of existing roads,under the basic policy of the fourth 5-year development plan. Rehabilitation and upgrade of existing roads are proposed under the fifth 5-year development plan. Consequently,58.4%(4,150km) of the total road length in Riau province will be paved:(100% of national and provincial road length and 40% of kabupaten road

length will be paved). Construction of bridges will total 4,645m including replacement of existing bridge proposed under the fifth 5-year development plan.

(2) Short term development policy in the Objective area

As stated in the fifth 5-year development plan, priority will be given to upgrade the utility rate of existing roads in the Objective area. In particular, the improvement of connecting roads from the trunk routes to the kecamatan capitals is being expedited. The total length of such roads in the Objective area is 138km. The remaining road length of 289km also plays an important role in access between settlements, and should be steadily upgraded.

Table 3.7 Priority Road Routes for Improvement in the Objective Area

Kecamatan	Segment	Length(km)
Kepenuhan	Sp.Kumu - Kota tengah	36
K.Dalusalam	Ujung batu - Kotalama	23
Rokan IV koto	Ujung batu - Rokan	29
Kubu	Bangko - Tanjung lumbalumba	33
Tanah putih	Ujung tanjung - Sedinginan	17
	Total	138

(3) Long Term Development Policy in the Objective Area

The major industries in the Objective area are primary products in agricultural(including plantations) and forestry sectors. As such, connector roads to processing and consumption centers in Dumai and Pekanbaru are essential. At present, national and provincial roads connect kabupaten Benkalis in the north with Dumai,and Kabupaten Kampar in the south with Pekanbaru. However, there is no road in north-south direction through the area,which at present can be traversed only by inland waterway transport.

Accordingly, the following 2 roads are proposed (however,this is premised on a long term construction program in view of the serious engineering and economic constraints affecting routes which are proposed over swampy terrain):

- A 97km road (including 70km of existing kabupaten road) along the Kumu river to connect Dalu dalu(Kec.Tambusai) and Sedinginan(Kec.Tanah putih).
- A 94km road (including 58km of existing kabupaten road) along the Rokan kiri river to connect Kotalama (Kec.Kunto darusalamu) and Duri(Kec.Mandau).

4. IULAND WATERWAY TRANSPORT

4.1 Present Condition

In Riau province, there are four(4) large rivers i.e. Siak river, Indragiri river, Kampar river and Rokan river. The total waterway length of 2,100km including seven(7) small rivers is available for passage,and fulfill a major transportation function. Inland waterways connect the small to medium sized urban areas within Riau province, and are used for transport of persons, farm, plantation and forest products, food, fuel and other goods necessary in the daily life of the regional population. These waterways continue to play an important role in transportation in the province despite a gradual decline in numbers of vessels and carried loads with increase in road development.

Table 4.1 Utilization of Inland Waterway Transport in Riau

Year	Vessels		Cargo(ton)		Persons	
	Arrival	Departure	Loading	Unloading	Departure	Arrival
1985	7,930	7,957	48,281	30,625	63,896	62,703
1986	5,151	5,191	31,614	15,304	40,912	31,990
1987	3,968	3,968	11,741	7,025	29,529	24,935
1988	3,301	33,01	4,212	2,458	27,300	30,677

Source: Riau in Figures

Inland waterways are likewise important to the Objective area. This is particularly true of the swampy middle reaches of the Rokan river basin where lack of roads makes water transport the sole means of movement. Twenty four 3-ton boats are registered at Ujung tanjung in kabupaten Bengkalis, and eighteen 1-ton vessels at Ujung batu in kabupaten Kampar. These vessels are all motored and ply the waterways according to unfixed schedules. In addition ,population along rivers use small paddled boats for day to day movement. Waterways are also used to transport a portion of the raw timber cut in the forests.

4.2 Development Policy in the Objective Area

The basic approach for inland waterway development is to integrate the same in the most rational manner with the expanding road network in the area. With the increased development of the latter, the utilization ratio for inland waterway transport has steadily decreased. Accordingly,under the fifth 5-year development plan of the provincial government, development efforts focus on the effective O/M of existing facilities as opposed to construction of new facilities, and the upgrading of navigational safety. Dredging in the Indragiri river is proposed

(80km in distance) under the plan.

At present, there is not a severe problem for inland waterway transport in the Objective area. However, as inland waterways continue to play an important role, priority is given to the effective O/M of existing facilities and to the upgrading of navigational safety,following the basic approach of the fifth 5-year development plan. Dredging the river mouth of the Rokan river is not planned by the concerned agency, because there is no hindrance for navigation although the river is gradually shallowing due to sediment.

5. POWER SUPPLY

5.1 Present Condition

Riau and West Sumatra provinces belong to region III of the National Electric Company (PLN;Willayah III). In West Sumatra, there are some thermal power stations and hydroelectric power stations, and 150KV transmission line connecting to Padang,Bukit tinggi,Salak, etc. Power in Riau is provided from diesel generators operated by PLN and private companies. However,individual generators serve only their immediate isolated areas,and remain unconnected by grid. According to available data for 1987/88, PLN supplied an annual generated energy of 562,119KWH from facilities totalling 93,112KW of capacity (105sites). Civilian generating capacity totals 441,527KVA.

Table 5.1 Power Supply in Riau

FY year	Generator(nos.)	Capacity(KW)	Generated energy(KWH)
1984/85	78	35,551	107,997
1985/86	79	35,711	119,478
1986/87	104	54,822	138,130
1987/88	105	93,112	562,119

Source:REPELITA V

In the Objective area specifically, PLN operates generating facilities at major kecamatan capitals of Pasir pangarayan (220KW:1982) and Ujung batu (300KW:1984). Additional diesel generators are planned this year (FY1991/92) for Rokan, Kota tengah and Dalu dalu with 100KW of capacity respectively. Table 5.3 shows the details mentioned above.

Electrification rates for the districts which encompass the Objective area are 19% for Kampar (41 out of 211 villages or "desa") and 22% for Bengkalis(65 out of 290 villages).

Table 5.4 Rural Electrification in Riau

Kabupaten	Desa	Electrified Desa
Pekanbaru	33	42
Kampar	211	41
Bengkalis	290	65
Indragiri Hulu	293	87
Indragiri Hilir	108	13
Kepulauan Riau	157	30
Batam	12	2
Total	1,104	280

Source:REPELITA V

5.2 Development Policy

(1) Fifth 5-year Development Plan

The basic orientation for power supply development under the fifth 5-year development plan in Riau province is to respond to the increment in demand and upgrade customer service. Out of the development plans which are based on this orientation, plans which have relation to the Objective area are shown below.

-- Kota panjang Hydropower Station
A 114MW hydropower station is to be constructed on the upper Kampar river with funding assistance from the Japanese government. Construction is to commence in 1991 and be completed in 1997. After completion,150KV transmission line will connect to Bangkinang,Pakanbaru, Duri, Dumai and Bagan siapiapi in Riau province. The system is also planned to be connected to the existing transmission grid in West Sumatra. The construction plan of transmission line proposed by PLN is shown in Fig. 5.1.

-- Rural Electrification
All villages ("desa") are planned for electrification under the fifth 5-year plan.

-- Strengthen and Maintenance of Existing Diesel Facilities

-- Survey of Potential Hydropower Sites(see Table 5.5)
Within the Objective area,this would include Rokan kiri nos.1(67KW) and 2(65KW),and Rokan kanan nos.1(46KW) and 2(10KW). Table 5.6 shows the dimensions of each project, and Fig. 5.2 shows the location of these dam sites.

(2) The Integrated Regional Development Plan (IDEP) for the Northern Part of Sumatra

The long term development plan for region III of PLN is shown in Figure 5.7, which is quoted from the report on IDEP (1989;JICA). According to this plan, it is necessary over the long term to decrease dependance on diesel consumption in view of the national strategy to reduce petroleum consumption. Within this context, diesel generation is restored to the area where it is necessary in the short term to meet urgent requirements,with hydropower and thermal power generating capacity to be expanded over the long term.

In the Study area,Rokan kiri no.2(65KW) will be in operation in 2005, and Rokan kiri no.1(67KW) will be in operation in 2004. But Rokan kanan nos.1 and 2 are not considered in the report.

Table 2.1 Standard of Drinking Water Quality in Indonesia

Items	Unit	Standard Value min.	max.1/	max.2/
I. Physical property				
Water Temperature	degree	-	-	Temperature
Smell	graduation	-	5	50
Taste	-	-	-	-
Turbidity	graduation	-	5	25
II. Chemical property				
pH	-	6.5	-	9.2
Total residue	mg/l	-	500	1,500
Potassium permanganate consumed	mg/l	-	-	10
Corrosive free CO2	mg/l	-	-	0
Hardness	German code3/	-	-	10
Ca	mg/l	5	75	200
Mg	mg/l	-	30	150
Fe	mg/l	-	0.1	1.0
Mn	mg/l	-	0.05	0.5
Cu	mg/l	-	0.05	1.5
Zn	mg/l	-	1.00	15
Cl	mg/l	-	200	600
SO4	mg/l	-	200	400
H2S	mg/l	-	-	0
F	mg/l	1.0	-	2.0
NH3	mg/l	-	-	0
HNO3	mg/l	-	-	20
HNO2	mg/l	-	0.001	0
C6H5OH	mg/l	-	-	0.002
As	mg/l	-	-	0.05
Pb	mg/l	-	-	0.10
Se	mg/l	-	-	0.1
Cr	mg/l	-	-	0.05
CN	mg/l	-	-	0.05
Cd	mg/l	-	-	0.01
Hg	mg/l	-	-	0.001
III. Radioactivity				
α ray	μc/ml	-	-	10-9
β ray	μc/ml	-	-	10-4
IV. Bacteriological property				
Parasitic bacteria	-	-	-	0
Pathogenic bacteria	-	-	-	0

Note; 1/ Maxmum value (Suggested)
2/ Maxmum value (Permissible)
3/ German code = CACO3*0.056
Source: Ministry of Health(1975)

Table 2.3 Existing Water Supply Facilities in the Objective Area

Urban Area	Capacity(l/s) Existing	Capacity(l/s) Plan	Water source	Remarks
Duri	-	80	Rangau river(Rokan basin)	Design completed
Bagan siapiapi	20	40	Canal	Design in progress
Bagan batu	-	20	Buaya river(Rokan basin)	Implementation 91/92
Kotalama	-	10	Rokan kiri river	Design completed
Ujung batu	5	20	Rokan kiri river	Design in progress
Kota tengah	-	10	Lubuk river	Design completed
Pasir pangarayan	10	60	Lubuk river	Design in progress
Dalu-dalu	-	10	Sosa river	Design completed
Sedinginan	-	10	Rokan river	Design in progress

Source:PU in Pekanbaru

Table 3.2 Road Length in the Objective Area

Segment	Distance (km)	Segment	Distance (km)
NATIONAL ROAD		***PROVINCIAL ROAD***	
Tandun/Pasir pangarayan	56.00	Tandun/P.pangarayan	56.00
SP.Balam/Bagan batu	26.32	P.pangarayan/prov.boundary	43.52
Bagan batu/prov.boundary	38.50	P.pangarayan/prov.boundary	21.59
Duri/SP.Kulim	15.00	Bagan siapiapi/Sei.benar	77.03
Total	127.10	Bagan siapiapi/Sinaboy	31.58
		Total	229.72
KABUPATEN ROAD			
(Kab.Bengkalis)		(Kab.Kampar)	
Bagan batu/Bagan sinenba	22.0	Ujung batu/Rokan	29.0
Tl.merbau/Rt.panjan kiri	6.0	Ujung batu/Kotalama	23.0
Rt.panjan kiri/Sei pinang	4.0	Sp.kumu/Kota tengah	36.0
Rt.panjan kiri/Tl.nirap	4.0	Pekan tabih/Batu sasah	2.0
Tl.nirap/Pinang road	9.0	Pekan tabih/Lb.soting	3.0
Pinang road	33.0	Lb.soting/Dalu dalu	12.0
Ujung tanjung/Sedinginan	17.0	Kota tengah/Pasir pandak	5.0
Sedinginan/Sp.berkat	19.0	Kota tengah/Muala dilam	13.0
Sp.berkat/Si arangarang	8.0	Muala dilam/Sontang	16.0
Si arangarang/Pujut	15.0	Kotalama/Muala dilam	14.0
Duri/Sei rangau	28.0	Dalu dalu/Kota bangun	6.0
sub-total	165.0	Kota bangun/Kuala mahato	22.0
		P.pangarayan/Pawan	14.0
		P.pangarayan/Kubang buaya	19.0
		Kubang buaya/Simpang	10.0
		Simpang/Rokan	12.0
		Rokan/Pankalian	6.0
		Pankalian/Siberuang	9.0
		Tandun/Pankalian	11.0
		sub-total	262.0
National road		127.10	
Provincial road		229.72	
Kabupaten road		427.0	
Total		783.82	

Table 3.3 Road Density in Riau

Items	Unit	National	Provincial	Kabupaten	Total
Road Length	km	840	1,498	3,882	6,220
Road Density	m/sq.km	8.9	15.8	41.1	65.8
Per Capita Road Length	m/person	0.30	0.53	1.37	2.19

Note) Riau province:Area 94,561sq.km, Population 2,842,955
Source:Riau in Figures

Table 3.4 Road Density in the Objective Area

Items	Unit	National	Provincial	Kabupaten	Total
Road Length	km	127	230	416	784
Road Density	m/sq.km	7.9	14.3	25.9	48.8
Per Capita Road Length	m/person	0.23	0.41	0.74	1.84

Note) The Objective Area: 16,059sq.km, Population 426,899(1990)

Table 3.5 Road Condition in Riau (unit:km)

Year	Good	Normal	Bad	Extremely bad	Total
1985	3,319	2,244	667	240	6,170
1986	2,874	2,682	780	334	6,170
1987	2,707	2,383	1,127	458	6,175
1988	2,190	1,866	1,169	995	6,220

Source:Riau in Figures

Table 3.6 Road Paving Plan under REPELITA V (unit:km)

Classification	Paved	Unpaved	Extremely bad	Total
National Road	809.21	-	-	809.21
Provincial Road	1,368.09	-	-	1,368.09
Kabupaten Road	1,973.44	2,960.17	-	4,933.61
Total	4,150.74	2,960.17	-	7,110.91

Table 5.2 Civilian Generating Facilities in Riau

Location	Capacity(KVA)	Remarks
Indragiri hulu	5,809	9nos.
Indragiri hilir	11,190	5nos.
Bengkalis	53,798	16nos.
Kampar	21,623	7nos.
Kepulauan riau	19,502	10nos.
Pekanbaru	305	2nos.
PT.CPI	268,675	Bengkalis,Kampar,Pekanbaru
PT.Pertamina	45,625	Bengkalis,Pekanbaru
PT.Stanvac Indonesia	15,000	Indragiri Hulu,Bengkalis
Total	441,527	

Source:REPELITA V

Table 5.3 PLN Generating Facilities(Kab.Kampar)

Urban Area	Year	Generator (nos.)	Capacity (KW)	Benefisheries (households)
Pasir pangarayan	1982	1	220	931
Ujung batu	1984	3	300	848
Rokan	1991	1	100	200 *
Kota tengah	1991	1	100	200 *
Dalu-dalu	1991	1	100	200 *
Total		7	820	2,379

Note: * will be installed during this fiscal year 1991/92
Source: PLN in Pekanbaru

Table 5.5 Survey of Potential Hydropower Sites in Riau

River	Location	Capacity(MW)
Kampar	Kota panjang	110
	Kapurnaan Gadang	16
	Koto tengah	103
	Kampar kiri no.1	38
	Kampar kiri no.2	140
Rokan	Rokan kanan no.1	46
	Rokan kanan no.2	10
	Rokan kiri no.1	67
	Rokan kiri no.2	65
Kuantan	Kuantan	350

Source:REPELITA V

Table 5.6 Dimensions of Hydroelectric Power Projects Proposed by PLN

Items	unit	Rokan kiri no.1 *	Rokan kiri no.2 *	Rokan kanan no.1	Rokan kanan no.2 *
Location	-	Riau	Riau	W.Sumatra	N.Sumatra
Type of dam	-	Fill	Gravity	Gravity	Fill
Catchment area	km2	2,300	2,805	210	605
Gross storage capacity	mil.m3	3,041	1,200	-	-
Effective storage capacity	mil.m3	1,150	252	30	300
Reservoir area	km2	101	230	-	-
Crest elevation	m	171	100	450	160
Highest water level	m	160	100	450	152
Lowest water level	m	147.5	94	-	-
Dam hight	m	68	47	40	44
100-year flood discharge	m3/s	(2,200)1,800	2,200	160	(570)470
20-year flood discharge	m3/s	1,270	1,500	120	330
5-year flood discharge	m3/s	870	1,100	80	230
Type of power station	-	Reservoir	Reservoir	Pondage	Reservoir
Maximum discharge	m3/s	155	190	30	40
Mean discharge	m3/s	105	129	10	28
Firm discharge	m3/s	-	-	3	-
Intake water level	m	160	100	450	152
Outlet water level	m	105	57	250	120
Gross head	m	55	43	200	32
Effective head	m	52	41	185	30
Maximum output	MW	(134) 67	(130) 65	46	(20) 10
Firm output	MW	(102) 51	(124) 62	14	(14) 7
Annual generated energy	GWH	353	376	74	37

Where:
1.Power stations of * are planned as 16-hour peak power stations and the value in ( ) indicate the future extension plan.
2.Rokan kanan no.1 station is planned as a 8-hour peak power station
Source:Kampar and Rokan Hydroelectric Power Development Project in Riau (Tokyo Electric Power Service Co.,Ltd. Consulting Engineers,Tokyo,Japan "Pre Feasibility Report,1980"

Table 5.7 Power Development Plan Proposed by PLN (Wilayah III) unit:MW

Project	Type	1988	1993	1998	2003	2008	Completion	Status
System peak P		133.2	333.6	436.3	601.3	949.8		
Required cap. A		285.0	444.8	581.7	707.4	1,117.5		
Existing								
Total existing		285.0	285.0	125.0	118.5	108.5		Operating
Scat.diesel	Diesel	206.5	206.5	40.5	34.0	24.0		Operation
Batang agam	Hydro	10.5	10.5	10.5	10.5	10.5		Operating
Maninjau	Hydro	68.0	68.0	68.0	68.0	68.0		Operating
Add.required								
Kerinci	Geo.ther			5.0	5.0	5.0	1997	
Scat.diesel	Diesel		34.4	44.4	42.7	42.7	1990	
Ombilin 1	Coal		65.0	65.0	65.0	65.0	1992	U.Const.
Ombilin 2	Coal		65.0	65.0	65.0	65.0	1993	U.Const.
Ombilin 3	Coal				100.0	100.0	2004	Pre.F/S
Ombilin 4	Coal					100.0	2005	Pre F/S
Bi-steam Duri						1,000.0	2006	
Mini hydro			8.5	15.4	22.2	22.2	1993	F/S
New&Renewable				6.0	6.0	6.0	1995	palm/husk
Kota panjang	Hydro			114.0	114.0	114.0	1995	D/D
Singkarak	Hydro			175.0	175.0	175.0	1997	D/D
Sinamar 1	Hydro					89.0	2004	RECN.S
Kuantan 1	Hydro					109.0	2007	RECN.S
Merangin 2	Hydro					232.0	2008	RECN.S
Rokan kiri 2	Hydro					65.0	2005	RECN.S
Rokan kiri 1	Hydro					67.0	2004	RECN.S
Total cap. B		285.0	458.0	608.8	707.5	2,359.5		
B - A		0.0	13.2	27.1	0.0	1,242.0		
W.I+II+III G.TL Cap.		967.1			3,270.6	5,861.6		
G.TL - Reqd		0.0			0.0	39.3		
Total peak		460.2			2,780.1	4,948.9		
Available Hydro								
Sangir	Hydro	27.0						
Bajang 1		29.0						
Bajang 2		48.0						
Bajang 3		22.0						
Merangin 1		41.0						
Merangin 3		57.0		224.0				

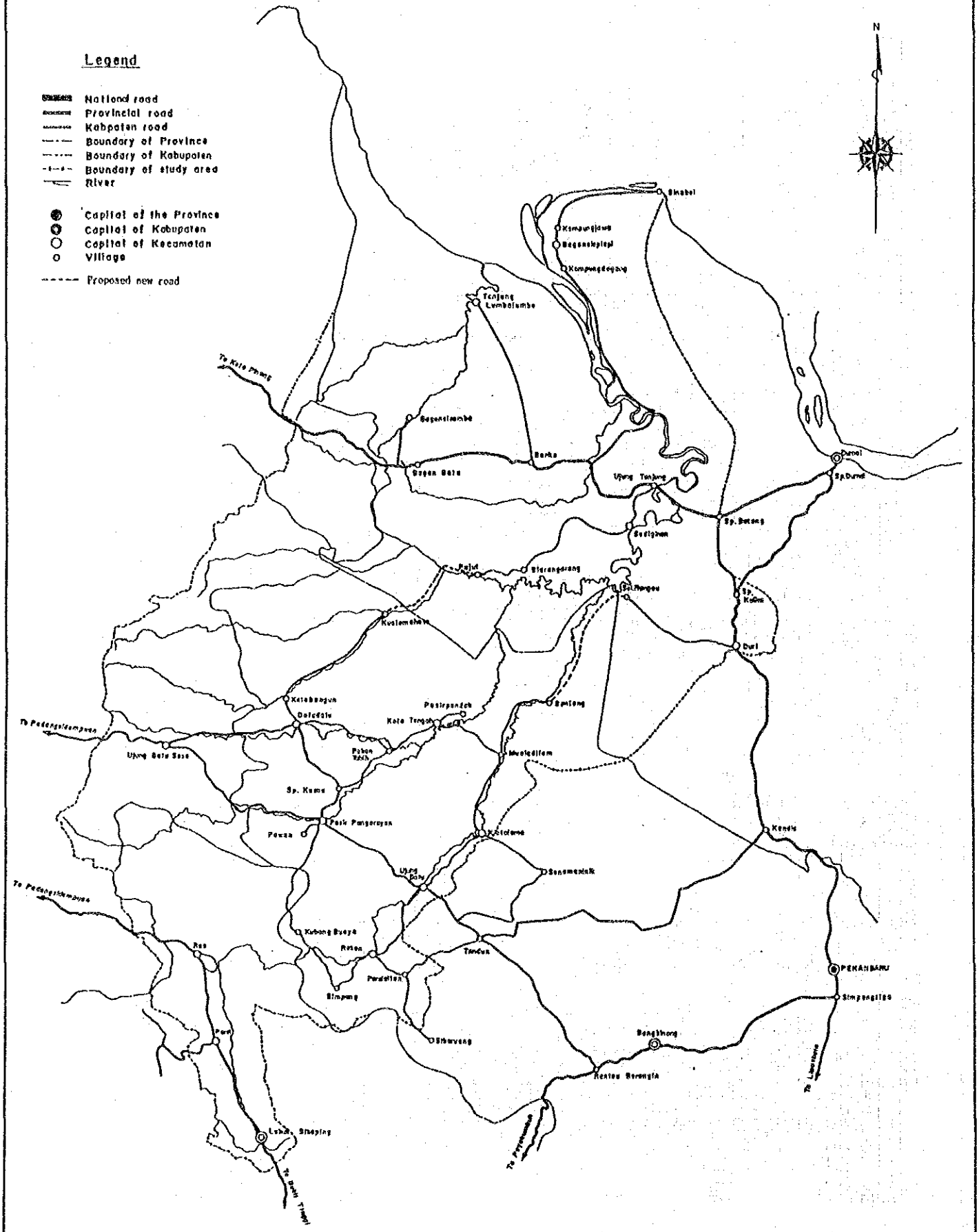

Fig. 3.1 Road Network

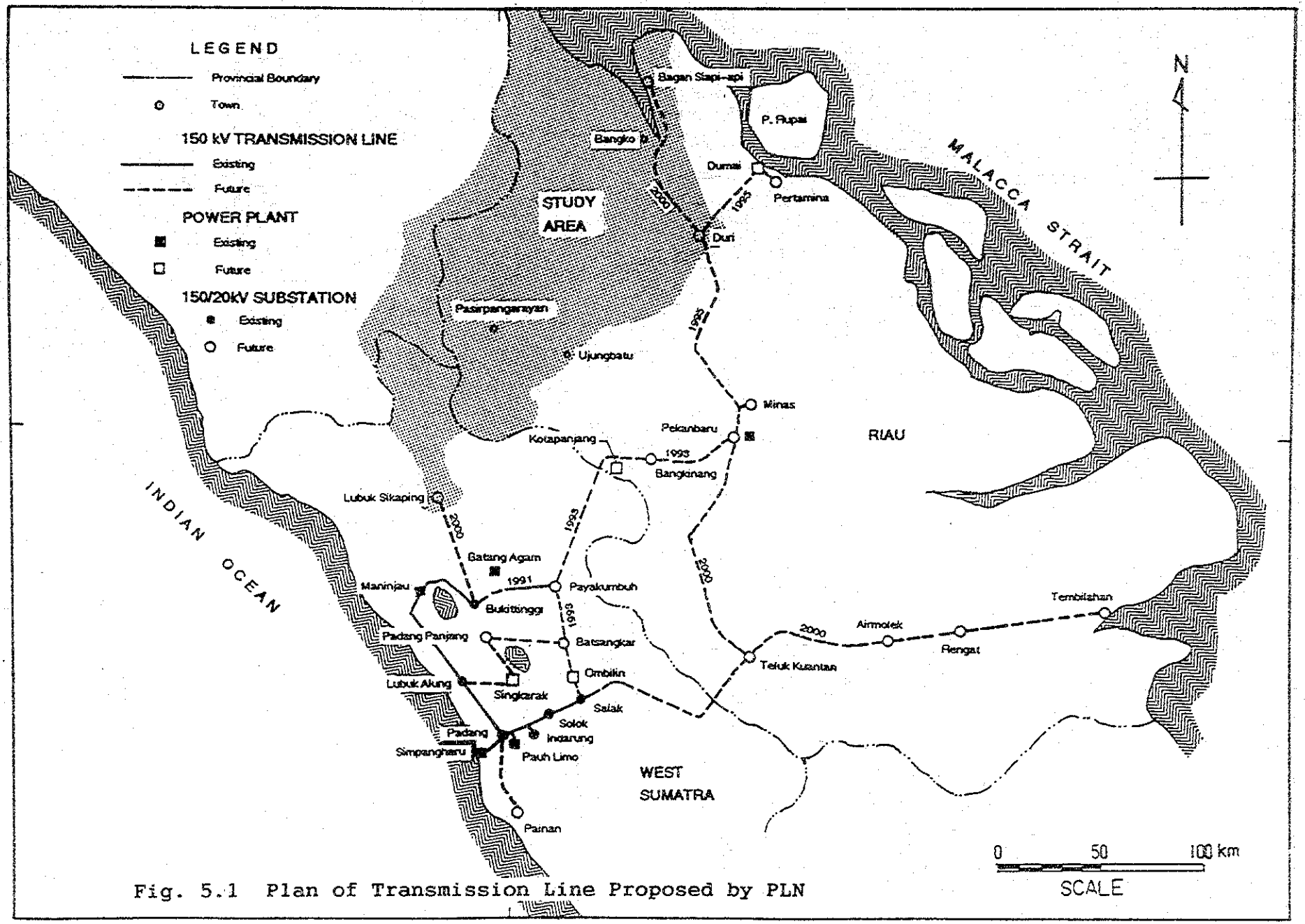

Fig. 5.1 Plan of Transmission Line Proposed by PLN

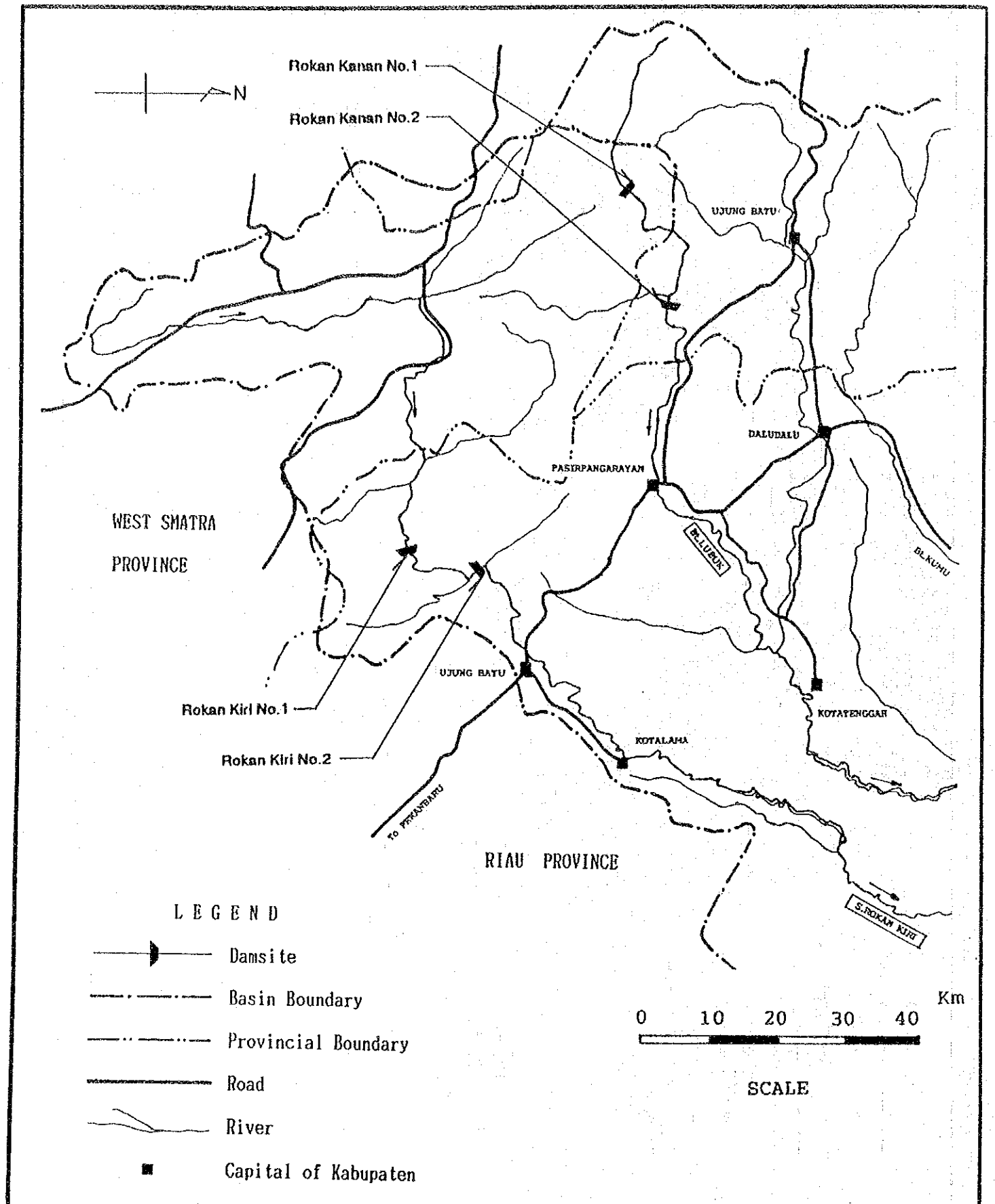

Fig. 5.2 Dam Plan Proposed by PLN

ANNEX H

REMOTE SENSING ANALYSIS

ANNEX H REMOTE SENSING ANALYSIS

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ANNEX H REMOTE SENSING ANALYSIS

1. INTRODUCTION

The remote sensing analysis for the Rokan River Basin Overall Irrigation Development Plan Study was carried out by the Center for Data Processing and Mapping, Ministry of Public Works, Indonesia (hereinafter referred to as PUSDATA) based on the contract between JICA and PUSDATA.

The study area for the remote sensing analysis, so called as Rokan River Basin and its vicinity, is located in the Riau Province, Sumatra and geographically, between 99°30' and 101°30' east longitude and 00°00' and 02°30' north latitude. The total area of the study area is 43,513 Km² and it implies whole the Rokan River Basin of 18,405 Km².

The objectives of the study is to prepare the basic data necessary for the Rokan River Basin Overall Irrigation Development Plan Study, based on the satellite data and other supporting data.

2. OUTLINE OF PROCESSING

2.1 Data Used

The LANDSAT TM data shown in the following table were selected and used in this study.

Path-row Number	Date	Remarks
127 - 58	Mar. 6, 1990	Quadrant III
127 - 59	Jul. 9, 1989	Full Scene
127 - 60	Jul. 25, 1989	Quadrant I
128 - 59	Jun. 14, 1989	Full Scene
128 - 60	Jun. 14, 1989	Quadrant II

The above data consist of seven channels and the ground resolution is 30 m x 30 m. Four out of seven channels were used in this study.

Topographical maps with a scale of 1:250,000 published by the National Agency for Survey and Mapping (hereinafter referred to as BAKOSURTANAL) in cooperation with the Faculty of Geography, Gadjah Mada University, First Edition 1986, were used either as reference to create the georeferenced spatial data file or as input data to produce the elevation and slope maps.