Table F.4.12 Reservoir Operation

Case.1 :Original

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
Rainfall (mm)	103.0	89.0	51.0	23.0	0.0	0.0	0.0	0.0	0.0	27.0	49.0	102.0	444.0
C.U (mm)	93.0	90.4	82.0	40.2	8.7	5.7	8.8	19.5	28.4	50.1	72.8	84.1	583.7
E.Rain (mm)	72.1	62.3	35.7	16.1	0	0	0	0	0	18.9	34.3	71.4	310.8
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
C.U (mm)	91.0	67.1	54.9	36.1	0.0	0.0	0.0	26.8	59.0	94.8	105.7	102.2	637.6
E.Rain (mm)	72.1	62.3	35.7	16.1	0	0	0	0	0	18.9	34.3	71.4	310.8
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
N.W.R (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	0.722	0.845	0.294	5.620
Supply (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	0.722	0.845	0.294	5.620
Supply Rate	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Inflow (MCM)	4.085	4.592	3.688	1.833	0.595	0.231	0.067	0.043	0.054	0.174	0.568	2.086	18.015
Balance (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	-0.092	-0.366	-0.582	-0.548	-0.278	1.793	
Storage (MCM)	2.900	2.900	2.900	2.900	2.900	2.900	2.808	2.442	1.859	1.311	1.033	2.826	
Shortage(MCM)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Outflow (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	0.000	0.000	0.000	0.000	0.000	0.000	12.468

Case.2 :No Rainfall on October

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
Rainfall (mm)	103.0	89.0	51.0	23.0	0.0	0.0	0.0	0.0	0.0	0.0	49.0	102.0	417.0
C.U (mm)	93.0	90.4	82.0	40.2	8.7	5.7	8.8	19.5	28.4	50.1	72.8	84.1	583.7
E.Rain (mm)	72.1	62.3	35.7	16.1	0.0	0.0	0.0	0.0	0.0	0.0	34.3	71.4	291.9
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	53%	0%	0%	
C.U (mm)	91.0	67.1	54.9	36.1	0.0	0.0	0.0	26.8	59.0	94.8	105.7	102.2	637.6
E.Rain (mm)	72.1	62.3	35.7	16.1	0.0	0.0	0.0	0.0	0.0	0.0	34.3	71.4	291.9
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
N.W.R (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	1.104	0.845	0.294	6.302
Supply (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	0.623	0.845	0.294	5.521
Supply Rate	100%	100%	100%	100%	100%	100%	100%	100%	100%	56%	100%	100%	92%
Inflow (MCM)	4.085	4.592	3.688	1.833	0.595	0.231	0.067	0.043	0.054	0.054	0.568	2.086	17.895
Balance (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	-0.092	-0.366	-0.582	-0.569	-0.278	1.793	
Storage (MCM)	2.900	2.900	2.900	2.900	2.900	2.900	2.808	2.442	1.859	1.291	1.013	2.806	
Shortage(MCM)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Outflow (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	0.000	0.000	0.000	0.000	0.000	0.000	12.468

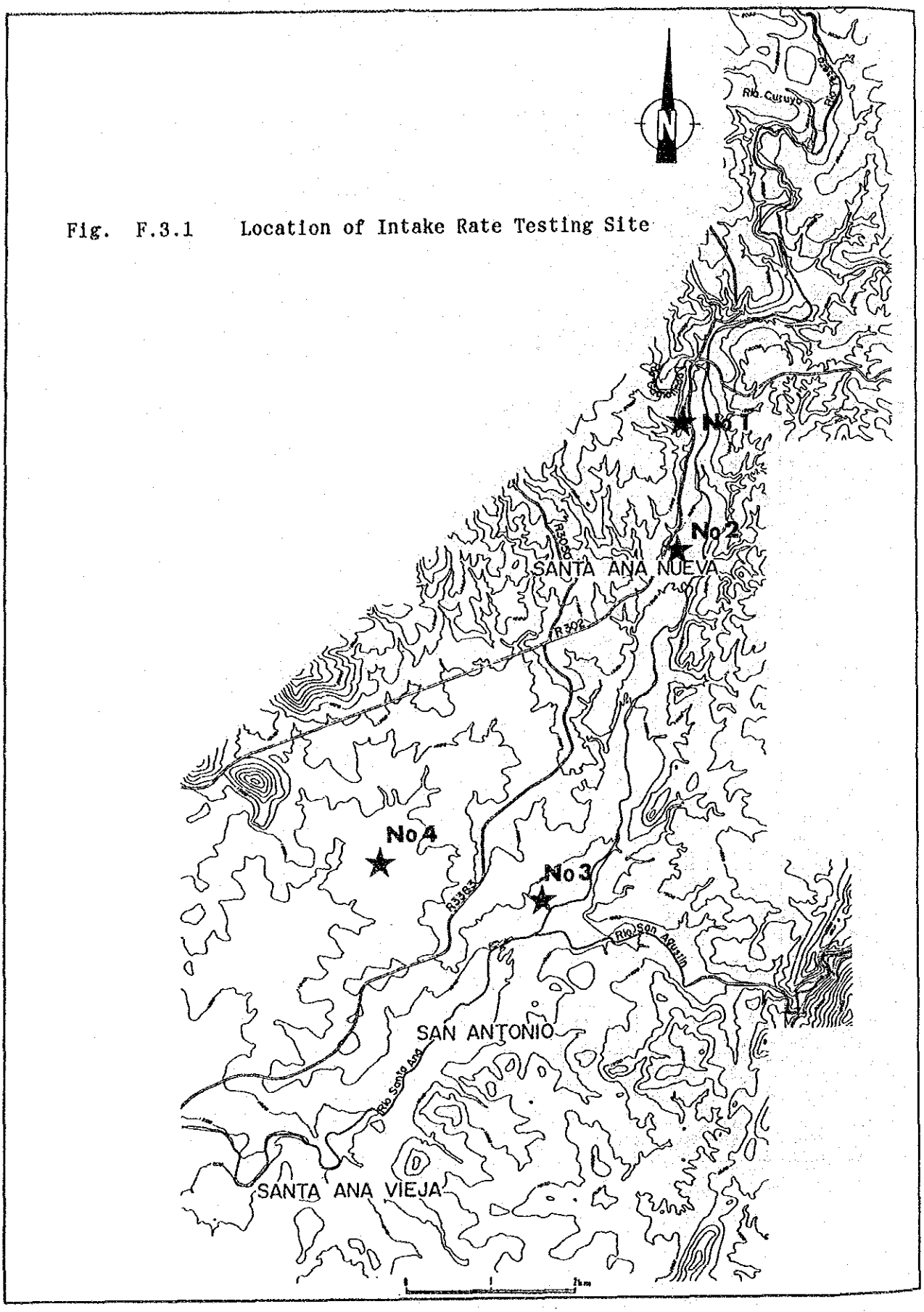
Case.3 :No rainfall on October & November

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
Rainfall (mm)	103.0	89.0	51.0	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	102.0	368.0
C.U (mm)	93.0	90.4	82.0	40.2	8.7	5.7	8.8	19.5	28.4	50.1	72.8	84.1	583.7
E.Rain (mm)	72.1	62.3	35.7	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.4	257.6
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	53%	64%	0%	
C.U (mm)	91.0	67.1	54.9	36.1	0.0	0.0	0.0	26.8	59.0	94.8	105.7	102.2	637.6
E.Rain (mm)	72.1	62.3	35.7	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.4	257.6
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
N.W.R (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	1.104	1.538	0.294	6.694
Supply (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	0.623	0.694	0.294	5.369
Supply Rate	100%	100%	100%	100%	100%	100%	100%	100%	100%	56%	45%	100%	80%
Inflow (MCM)	4.085	4.592	3.688	1.833	0.595	0.231	0.067	0.043	0.054	0.054	0.054	2.086	17.382
Balance (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	-0.092	-0.366	-0.582	-0.569	-0.639	1.793	
Storage (MCM)	2.900	2.900	2.900	2.900	2.900	2.900	2.808	2.442	1.859	1.291	0.651	2.444	
Shortage(MCM)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Outflow (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	0.000	0.000	0.000	0.000	0.000	0.000	12.468

Case4. :No rainfall on October, November & December

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
Rainfall (mm)	103.0	89.0	51.0	23.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	266.0
C.U (mm)	93.0	90.4	82.0	40.2	8.7	5.7	8.8	19.5	28.4	50.1	72.8	84.1	583.7
E.Rain (mm)	72.1	62.3	35.7	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	186.2
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	53%	64%	94%	
C.U (mm)	91.0	67.1	54.9	36.1	0.0	0.0	0.0	26.8	59.0	94.8	105.7	102.2	637.6
E.Rain (mm)	72.1	62.3	35.7	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	186.2
Saving Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	94%	
N.W.R (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	1.104	1.538	1.735	8.135
Supply (MCM)	0.418	0.519	0.878	0.478	0.158	0.103	0.159	0.409	0.637	0.623	0.694	0.104	5.180
Supply Rate	100%	100%	100%	100%	100%	100%	100%	100%	100%	56%	45%	6%	64%
Inflow (MCM)	4.085	4.592	3.688	1.833	0.595	0.231	0.067	0.043	0.054	0.054	0.054	0.054	15.350
Balance (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	-0.092	-0.366	-0.582	-0.569	-0.639	-0.050	
Storage (MCM)	2.900	2.900	2.900	2.900	2.900	2.900	2.808	2.442	1.859	1.291	0.651	0.602	
Shortage(MCM)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Outflow (MCM)	3.667	4.073	2.810	1.355	0.437	0.127	0.000	0.000	0.000	0.000	0.000	0.000	12.468

Fig. F.3.1 Location of Intake Rate Testing Site



Intake-Rate (NO.1)

No.	T	Dc	DD	log T	log Dc	(log T)**2	logT*logDc	Dc	Ic	logDc	logIc
1	1	11	660	0.000	1.041	0.000	0.000	11.195	416.305	1.049	2.619
2	2	17	510	0.301	1.230	0.091	0.370	17.202	319.861	1.236	2.433
3	3	22	440	0.477	1.342	0.228	0.640	22.117	274.164	1.345	2.324
4	4	26	390	0.602	1.415	0.362	0.852	26.434	245.759	1.422	2.246
5	5	29	348	0.699	1.462	0.489	1.022	30.355	225.769	1.482	2.186
6	10	51	306	1.000	1.708	1.000	1.708	46.645	173.466	1.669	2.000
7	15	59	236	1.176	1.771	1.383	2.083	59.972	148.684	1.778	1.890
8	20	77	231	1.301	1.886	1.693	2.454	71.678	133.279	1.855	1.813
9	30	102	204	1.477	2.009	2.182	2.967	92.157	114.239	1.965	1.704
10	60	122	122	1.778	2.086	3.162	3.710	141.615	87.773	2.151	1.517
Total				8.812	15.952	10.589	15.806				

Dc = C*T^n Ic = 60*C*n*T^(n-1) Ib = 60*C*n*(600*(1-n))^(n-1) Tb = 600*(1-n)

C = 11.195
n = 0.620
Dc = 11.195 * T ^ 0.620 (mm)
Ic = 416.454 * T ^ -0.380 (mm/hr)
Ib = 52.825 (mm/hr)
Tb = 228.119 (min)

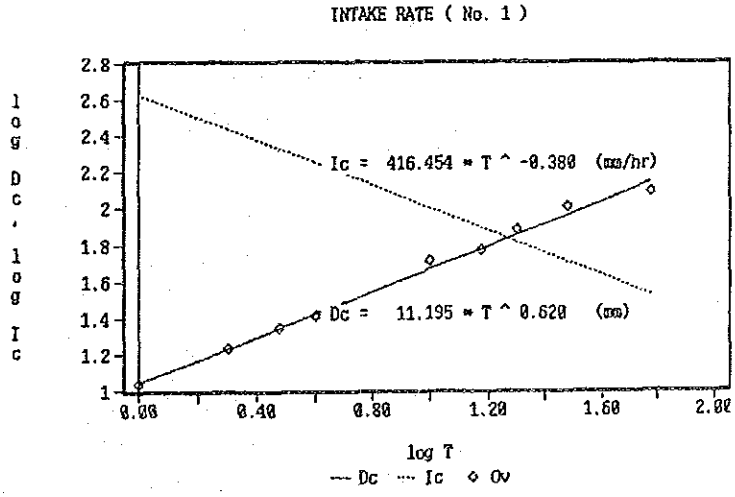


Fig. F.3.2 Intake Rate Analyzed Results (1)

Intake-Rate (NO.2)

No.	T	Dc	DD	log T	log Dc	(log T)**2	logT*logDc	Dc	Ic	logDc	logIc
1	1	38	2280	0.000	1.580	0.000	0.000	35.896	618.134	1.555	2.791
2	2	44	1320	0.301	1.643	0.091	0.495	43.797	377.093	1.641	2.705
3	3	47	940	0.477	1.672	0.228	0.798	49.202	282.420	1.692	2.654
4	4	49	735	0.602	1.690	0.362	1.018	53.437	230.045	1.728	2.618
5	5	57	684	0.699	1.756	0.489	1.227	56.971	196.208	1.756	2.590
6	10	73	438	1.000	1.863	1.000	1.863	69.510	119.697	1.842	2.504
7	15	80	320	1.176	1.903	1.383	2.238	78.089	89.646	1.893	2.454
8	20	85	255	1.301	1.929	1.693	2.510	84.810	73.021	1.928	2.418
9	30	95	190	1.477	1.978	2.182	2.921	95.276	54.688	1.979	2.367
10	60	116	116	1.778	2.064	3.162	3.671	116.246	33.363	2.065	2.281
Total				8.812	18.079	10.589	16.741				

Dc = C*T^n Ic = 60*C*n*T^(n-1) Ib = 60*C*n*(600*(1-n))^(n-1) Tb = 600*(1-n)

C = 35.896
n = 0.287
Dc = 35.896 * T ^ 0.287 (mm)
Ic = 618.129 * T ^ -0.713 (mm/hr)
Ib = 8.223 (mm/hr)
Tb = 427.800 (min)

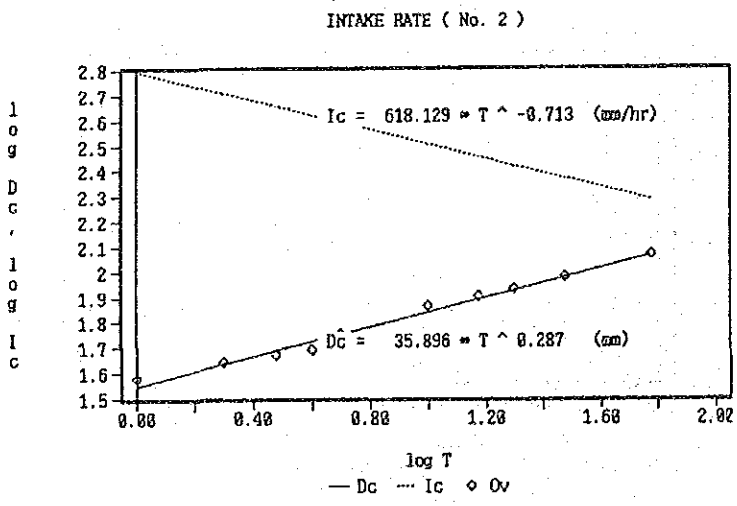


Fig. F.3.3 Intake Rate Analyzed Results (2)

Intake-Rate (NO.3)

No.	T	Dc	DD	log T	log Dc	(log T)**2	logT*logDc	Dc	Ic	logDc	logIc
1	1	10	600	0.000	1.000	0.000	0.000	10.783	268.796	1.033	2.429
2	2	15	450	0.301	1.176	0.091	0.354	14.382	179.248	1.158	2.304
3	3	17	340	0.477	1.230	0.228	0.587	17.021	141.423	1.231	2.231
4	4	21	315	0.602	1.322	0.362	0.796	19.181	119.533	1.283	2.179
5	5	23	276	0.699	1.362	0.489	0.952	21.045	104.915	1.323	2.139
6	10	27	162	1.000	1.431	1.000	1.431	28.067	69.963	1.448	2.014
7	15	32	128	1.176	1.505	1.383	1.770	33.217	55.199	1.521	1.941
8	20	33	99	1.301	1.519	1.693	1.976	37.434	46.655	1.573	1.889
9	30	42	84	1.477	1.623	2.182	2.398	44.302	36.810	1.646	1.816
10	60	66	66	1.778	1.820	3.162	3.235	59.086	24.547	1.771	1.691
Total				8.812	13.988	10.589	13.499				

Dc = C*T^n Ic = 60*C*n*T^(n-1) Ib = 60*C*n*(600*(1-n))^(n-1) Tb = 600*(1-n)

C = 10.783
n = 0.415
Dc = 10.783 * T ^ 0.415 (mm)
Ic = 268.497 * T ^ -0.585 (mm/hr)
Ib = 8.745 (mm/hr)
Tb = 350.733 (min)

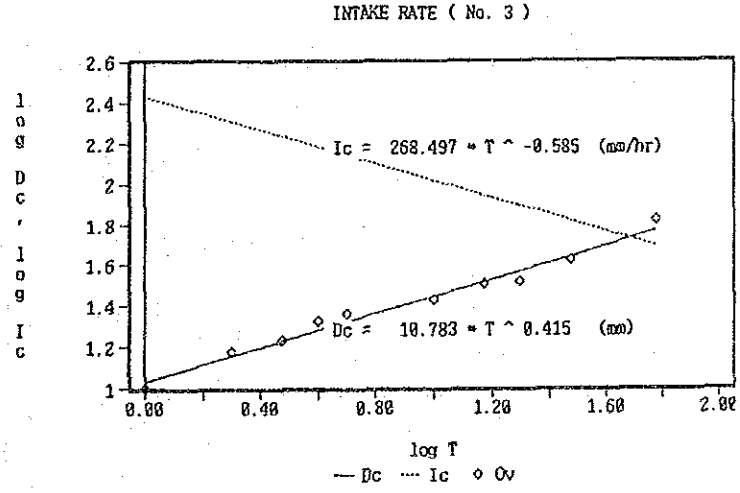


Fig. F.3.4 Intake Rate Analyzed Results (3)

Intake-Rate (NO.4)

No.	T	Dc	DD	log T	log Dc	(log T)**2	logT*logDc	Dc	Ic	logDC	logIc
1	1	5	300	0.000	0.699	0.000	0.000	6.800	233.825	0.832	2.369
2	2	11	330	0.301	1.041	0.091	0.313	10.116	173.937	1.005	2.196
3	3	13	260	0.477	1.114	0.228	0.531	12.763	146.293	1.106	2.095
4	4	17	255	0.602	1.230	0.362	0.741	15.050	129.387	1.178	2.024
5	5	18	216	0.699	1.255	0.489	0.877	17.104	117.631	1.233	1.968
6	10	29	174	1.000	1.462	1.000	1.462	25.446	87.503	1.406	1.796
7	15	37	148	1.176	1.568	1.383	1.844	32.103	73.596	1.507	1.695
8	20	41	123	1.301	1.613	1.693	2.098	37.857	65.091	1.578	1.623
9	30	44	88	1.477	1.643	2.182	2.428	47.761	54.746	1.679	1.522
10	60	56	56	1.778	1.748	3.162	3.109	71.056	40.724	1.852	1.350
Total				8.812	13.375	10.589	13.404				

Dc = C*T^n Ic = 60*C*n*T^(n-1) Ib = 60*C*n*(600*(1-n))^(n-1) Tb = 600*(1-n)

C = 6.800
n = 0.573
Dc = 6.800 * T ^ 0.573 (mm)
Ic = 233.784 * T ^ -0.427 (mm/hr)
Ib = 21.918 (mm/hr)
Tb = 256.122 (min)

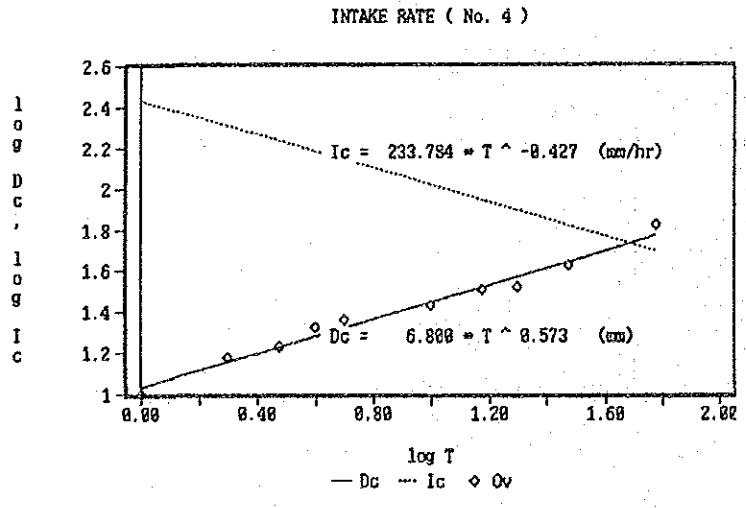


Fig. F.3.5 Intake Rate Analyzed Results (4)

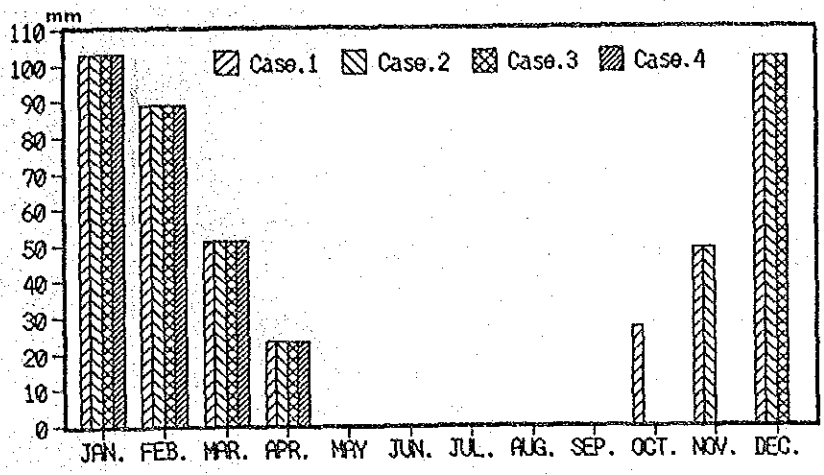


Fig. F.4.1 Reservoir Operation (Rainfall)

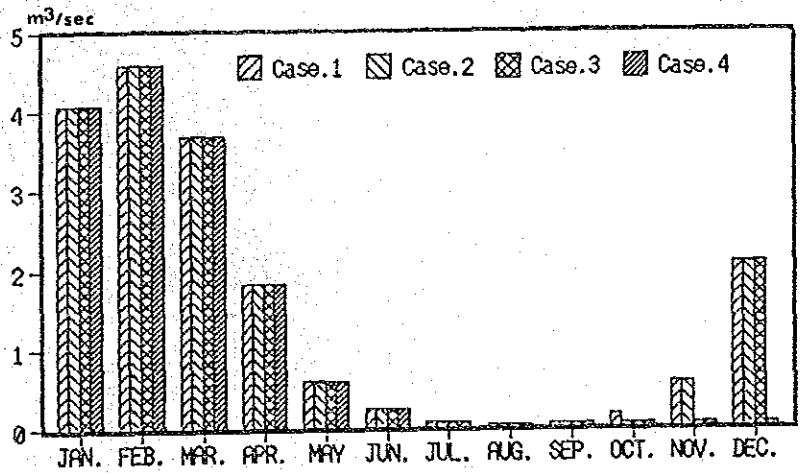


Fig. F.4.2 Reservoir Operation (Discharge)

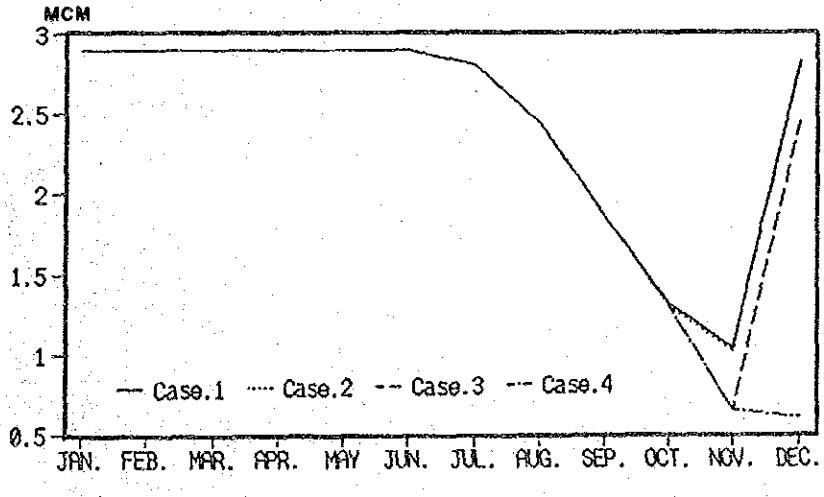
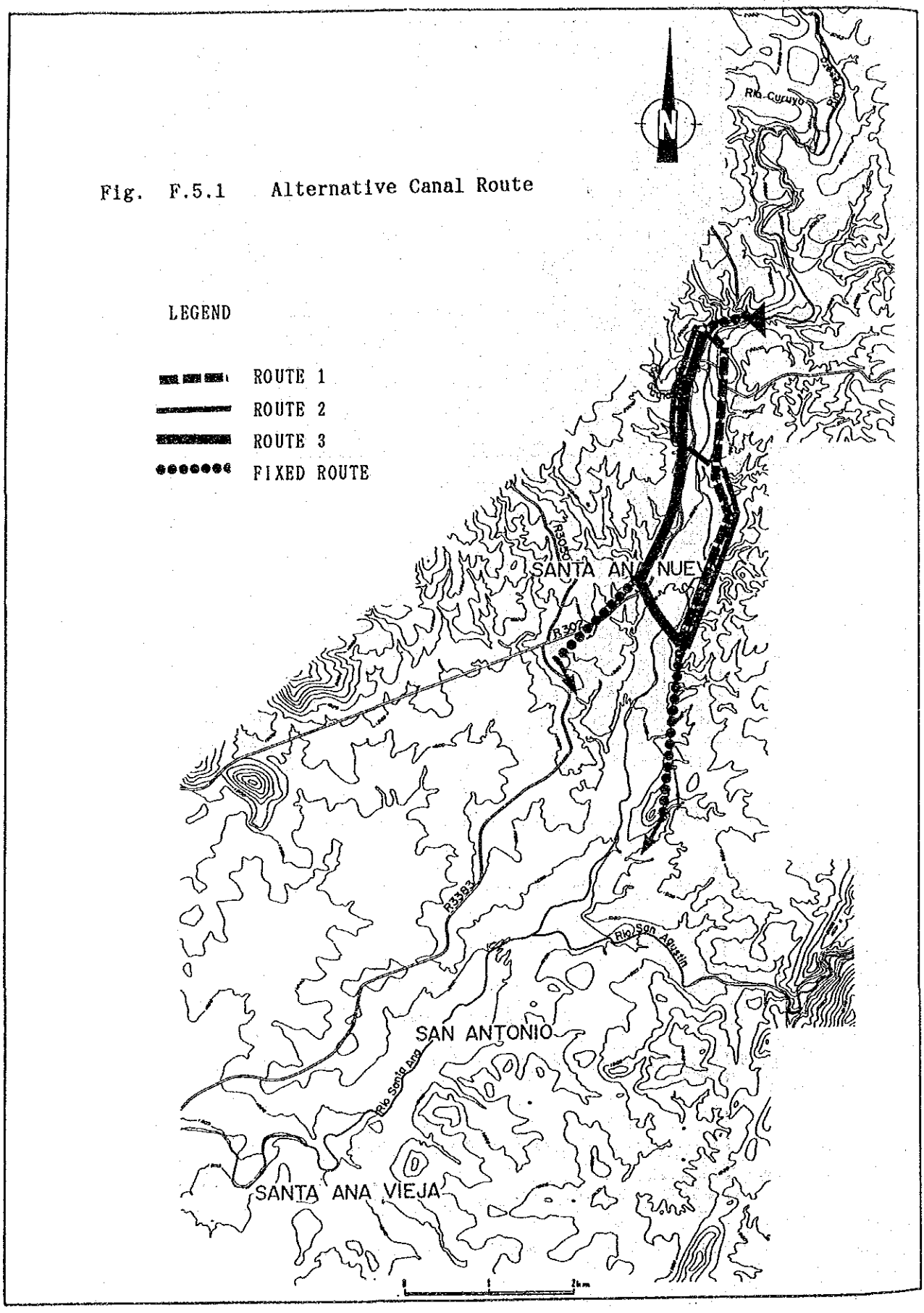


Fig. F.4.3 Operation of Santa Ana Reservoir

Fig. F.5.1 Alternative Canal Route



ANNEX G PROPOSED FACILITIES

ANNEX G PROPOSED FACILITIES

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEX G PROPOSED FACILITIES

G.1 Main Features of the Dam and the Reservoir

1.1 Storage Capacity

Inundation area and storage capacity for water level of the Santa Ana Reservoir are measured by utilizing the topographical map with a scale of 1:2,000 which has been prepared by CODETAR. The water level and its storage curve is shown in Fig. G.1.1.

Effective storage capacity is estimated to be 2.30 (MCM) for irrigation water supply in the irrigation plan. Dead storage is the estimated volume of sedimented materials in the reservoir. Sedimented volume will be 0.6 (MCM) estimating the proposed value of sedimentation in the neighboring areas.

Therefore, the storage capacity of the Santa Ana reservoir is as follows.

Effective storage capacity	2.30 (MCM)
Dead storage capacity	0.60 (MCM)
Gross reservoir capacity	2.90 (MCM)
Effective water depth	10.85 (m)
Limited water level	EL. 1,962.60 (m)
Normal full water level	EL. 1,973.45 (m)

1.2 Designed Flood Discharge and Designed Flood Water Level

The designed flood discharge of the Santa Ana dam is for a 200-year flood, which statistically occurs once in 200 years. Flood discharge is estimated by utilizing the rainfall data at the stations in the Santa Ana River basin and its surrounding areas.

Probable year	T = 200 (years)
Designed flood discharge	Q = 676 (m^3/s)

Since the catchment area at the dam site is larger than the inundation area of the reservoir (C.A/I.A = 800), storage effects at the reservoir will not expected. Therefore, the designed flood discharge is applied to the design of the spillway.

A generalized form of the discharge formula at the spillway crest is as follows.

$$Q = C * L * H^{3/2}$$

where,

Q : Discharge (m^3/sec)
C : Discharge coefficient (2.1)
L : Effective length of weir (m)
H : Total head above crest (m)

The relationship between the effective crest length of the spillway and the total head are as follows.

Effective length (m)	40	60	80	100
Total head (m)	4.05	3.10	2.55	2.20

Considering the longitudinal section of the dam and the transversal section of the river, the effective length of the spillway crest will be 60 m. The total head above crest and the designed flood water level are as follows.

Total head above crest	3.10 (m)
Designed flood water level	EL. 1,976.55 (m) (1973.45+3.10)

1.3 Elevation of Non-overflow Section and Dam Crest

Elevation of the non-overflow section is the highest level among the normal full water level and designed flood water level, to which has been added freeboard, namely

Hf + hw + he (when hw + he < 2, Hf + 2)
Hh + hw (when hw < 1, Hh + 1)

where,

Hf : Normal full water level (m)
Hh : Designed flood water level (m)
hw : Wind induced wave height from reservoir surface (m)
he : Earthquake induced wave height from reservoir surface by earthquake (m)

The highest level out of them is adopted.

(1) Wave height from reservoir surface

The wave height from reservoir surface is calculated by S.M.B. (Sverdrup-Munk-Bretschneider) method considering the relationship between the wind velocity and fetch on designed flood water level.

$$hw = Hw$$
$$Hw = 0.00086 * V^{1.1} * F^{0.45}$$

where,

hw : Wave height from reservoir surface by wind (m)
Hw : Wave by wind (total wave height)
F : Fetch (500 m)
V : Wind velocity (30 m/sec)

hw = Hw = 0.6 (m)

(2) Wave height from reservoir surface by earthquake

In general, the formula below by Dr. Seiich Sato is applied:

$$he = \frac{1}{2} * \frac{Kt}{3.14} * sqrt.(g * Ho)$$

where,

he : Wave height from reservoir surface by earthquake (m)
K : Design seismic co-efficient (0.1)
Ho : Depth of reservoir at normal full water level (29 m)
g : Acceleration of gravity (9.8 m/sec^2)

he = 0.3 (m)

From the results calculated above, the elevation of the non-overflow section is;

Hf + hw + he
= 1973.45+0.6+0.3
= 1974.35 (m)

but

hw + he
= 0.6+0.3 = 0.9 < 2

then

Hf + 2
= 1973.45 + 2
= 1975.45 (m)

Meanwhile, the height for the designed flood water level

Hh + hw
= 1976.55 + 0.6
= 1977.15 (m)

but

hw = 0.6 < 1

then

Hh + 1
= 1976.55 + 1
= 1977.55 (m)

Then, the elevation of the non-overflow section is designed with the higher value of the above-mentioned, EL.1977.5 (m) is applied.

G.2 Design of the Dam Body and Foundation

2.1 Selection of Type of Dam

As dam type of the Santa Ana dam, fill-type dam and concrete gravity-type dam are proposed. Typical transversal sections of each dam are shown in Fig. G.2.1 and DRAWINGS. The dam type of the Santa Ana dam is concluded from the view point of natural and economic conditions as follows.

- Since the dam site is located at valley, both sides are relatively sharp in inclination, the valley is narrow, and the basement rock for foundation is strong enough. These conditions are suitable for constructing a concrete dam.
- The physical properties of the core materials of the core material used for the fill-type dam is not sufficient. When volcanic ash soil and clayey soil available near the site are used, the transversal section of dam will become large.
- A coffer dam is necessary for constructing any type of dam. The fill-type dam, according to its structural features, will need a larger coffer dam as compared with the concrete dam.
- Seeding that the river basin for the spillway is large at the dam site and that a large flooding discharge is expected, the fill-type dam will need a large cost for constructing a spillway as compared with the concrete dam.
- There is an arched concrete dam constructed in San Jacint project adjoining the study area, and the capability needed for construction of a concrete dam has sufficiently been proven.
- Comparing the construction costs of fill-type dam and concrete gravity-type dam, the concrete gravity-type dam has advantage of low cost (see Table G.2.1).

From the above-mentioned, the concrete gravity-type dam will be proposed as the dam type of the Santa Ana dam.

2.2 Design Conditions of the Dam Body and Foundation

(1) Case of structural analysis and loads to be considered

Study of structural analysis for dam body and foundation shall be carried out for the water levels at the dam site and for load conditions as indicated below.

Case	Water level in reservoir	Load to be considered
Case 1	Design flood water level	W, P, Pe, U
Case 2	Normal full water level	W, P, Pe, U, I, Pd
Case 3	Empty	W, I

(Note) Each symbol stands for the following loads.

where, W : Dead load of dam body
P : Hydrostatic pressure of storage water
Pe : Sedimentary pressure of sediment
Pd : Dynamic water pressure of storage water by earthquake
I : Inertia force of dam body by earthquake
U : Uplift of storage water

(2) Seismic force

According to the earthquake records which have been occurred in Bolivia, the north of Chile and the Argentine during the last 50 years, the frequency and scales of earthquakes in the Tarija department and its surrounding area to which the Project area belongs, are exceedingly small. Considering this phenomenon, the San Jacinto and the Guadalquivir project projects, which are located near the Santa Ana area employed Kh = 0.1 as the designed seismic coefficient in the design of the dam. Therefore, the same seismic coefficient is applied for the Santa Ana Project.

2.3 Decision of Fundamental Triangle Section

(1) Stability for overturning

In order to maintain dam body stability, dam body should be designed so that vertical tension does not occur at every section. For the purpose, a resultant which acts on dam body should act within the middle third of dam body. The upstream and downstream slopes which satisfy the condition will be calculated. The results on three cases mentioned above are shown in Table G.2.2. From this results, the upstream slope is calculated to be 1:0.05 and the downstream slope to be 1:0.72.

(2) Stability for sliding

Stability for sliding at the section of joint between dam body and basement rock, and neighboring section is analyzed with applying Henny's equation.

$$Fs = \frac{t*l + f*V}{H} > 4$$

where, Fs : safety factor for sliding
t : shearing strength of basement rock
l : length of searing face to be considered
f : internal friction coefficient of basement rock
V : vertical force acting on shearing face
H : horizontal force acting on shearing face

Dam foundation of the Santa Ana dam is composed of the alternation strata of sandstone and mudstone which is classified into CL to CH. The shearing strength of the sandstone is estimated to be 300 to 350 (kg/cm^2) and the shearing strength of the mudstone to be 50 to 60 (kg/cm^2) (see ANNEX C). Considering the crack and nonhomogeneity of basement rock, the overall shearing strength for the basement rock is estimated to be 10 (kg/cm^2). Though the internal friction angle of basement rock is estimated to be 50 to 60 (deg) for sandstone and 50 (deg) for mudstone (see ANNEX C), the overall internal friction angle is estimated to be 40 (deg) taking account of crack and nonhomogeneity of basement rock as well as shearing strength. Then, the internal friction coefficient is of 0.84.

The safety factors for sliding by each case are as follows.

Case	Shearing strength (kg/cm2)	Internal fric. Coef.	Shearing length (m)	Horizontal force (ton)	Vertical force (ton)	Safety factor
Case 1	100	0.84	28.33	699	916	5.15
Case 2	100	0.84	28.33	770	940	4.70
Case 3	100	0.84	28.33	53	1,057	70.21

From the results mentioned above, the safety factors for sliding are more than 4.0 at any case and then, it is considered that dam body is satisfied with safety for sliding.

2.4 Foundation Treatment

In order to increase the bearing capacity and the watertightness of the foundation, consolidation grouting is proposed. And in order to reduce foundation seepage to within a tolerable limit, curtain grouting is proposed and also, because of drainage seepage from the foundation reducing the uplift acting on the dam body, a drainage hole is proposed.

Grouting	Description		
	hole spacing	row spacing	hole depth
Consolidation grouting	3.0	3.0	7.0
Curtain grouting	2.0	1.5	26.0
Drainage hole	5.0		10.0

2.5 Inspection Gallery

An inspection galley is installed in the dam body for inspection after completion of the dam facilities, and also for access to the operation room, to inspect the drainage of seepage water through a the joints, dam body and foundation. A dimension of the inspection galley is proposed as follows taking account for the space necessary for grouting work.

Width of inspection gallery	2.0 m
Height of inspection gallery	2.5 m

G.3 Design of Spillway

3.1 Design Flood Discharge

A spillway is compose of inlet portion, guide portion and dissipator. Out of them, inlet and guide portions are to be designed to ensure the safe release of a maximum flow equivalent to the design flood discharge. In design of the energy dissipator, the proposed effect of dissipation is preferably enough to maintain the level of flow energy equivalent to that of the river before dam construction, when the design discharge for the spillway is released. In general, a structure which satisfies the proposed dissipation effect for the predicted flood discharge with 100-year return period is to be considered in design of the energy dissipator.

Therefore, the design flood discharge for inlet and guide portions proposed to be 676 m^3/s as well as design flood discharge for dam. And also, the design flood discharge for energy dissipator is proposed to be 577 m^3/s which is probable flood discharge with 100-year return period.

3.2 Type of Spillway

For a outlet system of dam, a non-control system without a crest gate is recommended taking account for operation and maintenance of dam. And also, as type of spillway, straight crest type at inlet potion and overflow type at guide portion are adopted, respectively. Since width of the spillway is large than the river width, dam abutment waterway is proposed. Namely, water which overflows on the downstream slope of dam body is reduced flow energy at dam abutment and flows into the energy dissipator. The energy dissipator is, moreover, composed of end sill type dissipator which is one of hydraulic jump type energy dissipator.

3.3 Design of Spillway

(1) Depth before jump

Depth before jump at the beginning point of the apron is

calculated as follows.

$$h1^3 - (H - hf) * h1^2 + q^2/(2 * g) = 0$$

where, h1 : water depth before jump (m)
H : difference of total head = 30.45+2.76=33.21(m)
hf : friction loss (m)
0.02 D/h = 0.02x30.45/2.76 = 7.33 (m)
q : flood discharge per meter = 577/60 = 9.62 (m^3/s)

Substituting h1=0.43 for above equation,

$$0.43^3 - (33.21 - 7.33) * 0.43^2 + 9.62 / (2 * 9.8) = 0.0$$

above equation is satisfied.

(2) Jump depth

Water depth after natural jump can be calculated by following formula.

$$\frac{h1}{h2} = \frac{1}{2} - (\mathrm{sqrt.}(1 + 8 * Fr1^2) - 1)$$

where, h2 : jump depth
Fr1 : froude number before jump
= v1/sqrt.(g h1) = 22.37/sqrt(9.8x0.43) = 10.9

$$h1/h2 = 1/2 * (\mathrm{sqrt.}(1 + 8 * 10.9^2) - 1) = 14.9$$

$$h1 = 14.9 * 0.43 = 6.4 \ (m)$$

Then, jump depth is estimated to be 6.4 (m).

(3) Height of endsill and distance between the beginning point of the apron and the endsill

The endsill dissipator functions to artificially maintain sequent depth of jump in relation to supercritical flows depth, and the water depth directly upstream of the end sill is adjusted to jump depth. The height of the endsill can be calculated by Iwasakis's formula.

$$\frac{W}{h1} = \frac{(1 + 2F1^2) * \mathrm{sqrt.}(1+8F1^2)-1-5 * F1^2}{1 + 4 * F1^2 + 4 * F1^2 - \mathrm{sqrt.}(1 + 8 * F1^2)} - \frac{3}{2} * F1^{2/3}$$

where, W : height of endsill
F1 : froude number before jump = 10.9
h1 : depth before jump = 0.43 (m)

Substituting h1=0.43 for above equation,

W/h1 = 7.81
W = 7.81 * 0.42 = 3.35 (m)

The distance between the beginning point of the apron and the endsill should be larger than $6*d_2$ in the case of the natural jump style. Then, the required distance is calculated to be 6 * 6.4 = 39 (m).

G.4 Design of Intake Facilities

The maximum intake discharge calculated in the irrigation plan is 0.74 (m^3/s). Irrigation water is taken from the intake installed above low water level and is released to the energy dissipator through the outlet pipe installed in the dam body. The water which is released to the energy dissipator is taken into the main canal.

Table G.2.1 Comparison of Construction Cost

(Unit: US$)

Works	Fill Dam					Concrete Gravity Dam					Remarks
1. Temporary Works	Item	Q'ty	Unit	U.P	Cost	Item	Q'ty	Unit	U.P	Cost	
	Excavation (R)	5,500	m3	9.67	53,185	Crane Equip.		L.S		780,000	
	Emb. (Core)	2,400	m3	4.00	9,600	Concrete Plnt.		L.S		169,000	
	Emb. (Rock)	12,000	m3	8.00	96,000						
	Diversion tunnel	2,120	m3	50.00	106,000						
	RC Concrete	594	m3	66.55	39,531						
	Gate		L.S		20,000						
	Sub-total				324,316	Sub-total				949,000	
2. Dam Body											
	Excavation (R)	34,800	m3	9.67	336,516	Excavation (R)	14,400	m3	9.67	139,248	
	Excavation (E)	81,200	m3	5.09	413,308	Excavation (E)	9,600	m3	5.09	48,864	
	Embank. (Core)	29,900	m3	5.00	149,500	Mass Concrete	28,700	m3	78.97	2,266,439	
	Embank. (Filter)	19,200	m3	8.00	153,600	RC Concrete	1,400	m3	66.55	93,170	
	Embank. (Tran)	76,750	m3	8.00	614,000	Form	8,700	m2	65.26	567,762	
	Embank. (Rock)	114,300	m3	6.00	685,800	Rein. bar	10	t	1715.00	17,150	
						Operation Deck	210	L.S	931.00	195,510	
						Gate etc.		L.S		199,500	
	Sub-total				2,352,724	Sub-total				3,527,643	
3. Foundation Treatment											
	Consoli. Grout	2,500	m	27.52	68,800	Contact Grout	6,000	m	27.52	165,120	
	Curtain Grout	3,630	m	27.52	99,898	Curtain Grout	3,630	m	27.52	99,898	
	Sub-total				168,698	Sub-total				265,018	
4. Spill Way											
	Excavation (R)	40,000	m3	9.67	386,800	Excavation (R)	4,800	m3	9.67	46,416	
	Excavation (E)	24,000	m3	5.09	122,160	RC Concrete	2,600	m3	66.55	173,030	
	RC Concrete	9,600	m3	66.55	638,880	Rein. bar	26	t	1715.00	44,590	
	Rein. bar	960	t	1715.00	1,646,400	Form	1,440	m2	46.49	66,946	
	Form	8,000	m2	46.49	371,920						
	Sub-total				3,166,160	Sub-total				330,982	
5. Intake											
	RC Concrete	151	m3	66.55	10,036	Gate		L.S		133,000	
	Rein. bar	30	t	1715.00	51,450						
	Gate		L.S		150,000						
	Sub-total				211,486	Sub-total				133,000	
6. Total					6,223,383					5,205,642	

Table G.2.2 Stability Analysis

Features for Structural Analysis

Dam Height	H	34.55	Dens. of Conc.	Wc	2.30
F.W.L.	Hf	30.45	Dens. of Wtr.	Ww	1.00
Overflow Dpt.	hd	3.10	Sb. Wgt. of Sed.	Ws	1.00
Wind Wave H.	hw	0.60	Seismic Coef.	Kh	0.10
Ear. Wave H.	he	0.30	Uplift Coef.	Up	0.40
Sed. Depth	hs	19.60	Sed. Coef.	Ce	0.60
Up. Slope	m	0.05			
Dw. Slope	n	0.72			

Case Ⅰ : Design Flood Level
h = 34.15 (m)

Load	Symbol	Force		Distance from point of action to up. end		Moment	
Horizontal Force							
W.P.	Hw	1/2·Ww·h^2	583.11	1/3·h	11.38	1/6·Ww·h^3	6,637.75
S.P	Hs	1/2·Ws·Ce·hs^2	115.25	1/3·hs	6.53	1/6·Ws·Ce·hs^3	752.95
Inertia F. in Ear.	Hc	1/2·(m+n)·Wc·k·H^2		1/3·H		1/6·(m+n)·Wc·k·h^3	
Dy.W.P	Hwk	7/12·Ww·k·h^2		2/5·h		7/30·Ww·k·h^3	
Sum. F.	ΣHi		698.36				
Sum. Mo.	ΣMi		7,390.70				
Vertical Force							
W.P on Up. slope	Vw	1/2·m·Ww·h^2	29.16	1/3·m·h	0.57	1/6·m^2·Ww·h^3	16.59
S.P	Vs	1/2·m·Ws·hs^2	9.60	1/3·m·hs	0.33	1/6·m^2·Ws·hs^3	3.14
D.W.	Vc	1/2·(m+n)·Wc·H^2	1,057.02	(2m+n)/3·H	9.44	1/6·(m+n)(2m+n)·Wc·h^3	9,982.18
Uplift	Vu	-1/2·(m+n)·Up·Ww·h^2	-179.60	1/3·(m+n)·h	8.77	-1/6·(m+n)^2·Up·Ww·h^3	-1,574.21
Sum. F.	ΣVi		916.18				
Sum. Mo.	ΣMi		8,427.70				

Point of action Xo = 17.27 ≦ 17.74 = 2/3·(m+n)·H

Case Ⅱ : Normal Full Water Level
h = 31.35 (m)

Load	Symbol	Force		Distance from point of action to up. end		Moment	
Horizontal Force							
W.P.	Hw	1/2·Ww·h^2	491.41	1/3·h	10.45	1/6·Ww·h^3	5,135.25
S.P	Hs	1/2·Ws·Ce·hs^2	115.25	1/3·hs	6.53	1/6·Ws·Ce·hs^3	752.95
Inertia F. in Ear.	Hc	1/2·(m+n)·Wc·k·H^2	105.70	1/3·H	11.52	1/6·(m+n)·Wc·k·h^3	1,217.34
							0.00
Dy.W.P	Hwk	7/12·Ww·k·h^2	57.33	2/5·h	12.54	7/30·Ww·k·h^3	718.93
Sum. F.	ΣHi		769.69				
Sum. Mo.	ΣMi		7,824.47				
Vertical Force							
W.P on Up. slope	Vw	1/2·m·Ww·h^2	24.57	1/3·m·h	0.52	1/6·m^2·Ww·h^3	12.84
S.P	Vs	1/2·m·Ws·hs^2	9.60	1/3·m·hs	0.33	1/6·m^2·Ws·hs^3	3.14
D.W.	Vc	1/2·(m+n)·Wc·H^2	1,057.02	(2m+n)/3·H	9.44	1/6·(m+n)(2m+n)·Wc·h^3	9,982.18
Uplift	Vu	-1/2·(m+n)·Up·Ww·h^2	-151.35	1/3·(m+n)·h	8.05	-1/6·(m+n)^2·Up·Ww·h^3	-1,217.88
Sum. F.	ΣVi		939.84				
Sum. Mo.	ΣMi		8,780.28				

Point of action Xo = 17.67 ≦ 17.74 = 2/3·(m+n)·H

Case Ⅲ : Empty (Immediately after complation)
h = 0.00 (m)

Load	Symbol	Force		Distance from point of action to up. end		Moment	
Horizontal Force							
W.P.	Hw	1/2·Ww·h^2		1/3·h		1/6·Ww·h^3	0.00
S.P	Hs	1/2·Ws·Ce·hs^2		1/3·hs		1/6·Ws·Ce·hs^3	0.00
Inertia F. in Ear.	Hc	1/2·(m+n)·Wc·k·H^2	52.85	1/3·H	11.52	1/6·(m+n)·Wc·k·h^3	608.67
							0.00
Dy.W.P	Hwk	7/12·Ww·k·h^2		2/5·h		7/30·Ww·k·h^3	0.00
Sum. F.	ΣHi		52.85				
Sum. Mo.	ΣMi		608.67				
Vertical Force							
W.P on Up. slope	Vw	1/2·m·Ww·h^2		1/3·m·h		1/6·m^2·Ww·h^3	0.00
S.P	Vs	1/2·m·Ws·hs^2		1/3·m·hs		1/6·m^2·Ws·hs^3	0.00
D.W.	Vc	1/2·(m+n)·Wc·H^2	1,057.02	(2m+n)/3·H	17.16	1/6·(m+n)(2m+n)·Wc·h^3	18,138.35
Uplift	Vu	-1/2·(m+n)·Up·Ww·h^2		1/3·(m+n)·h		-1/6·(m+n)^2·Up·Ww·h^3	0.00
Sum. F.	ΣVi		1,057.02				
Sum. Mo.	ΣMi		18,138.35				

Point of action Xo = 17.74 ≦ 17.74 = 2/3·(m+n)·H

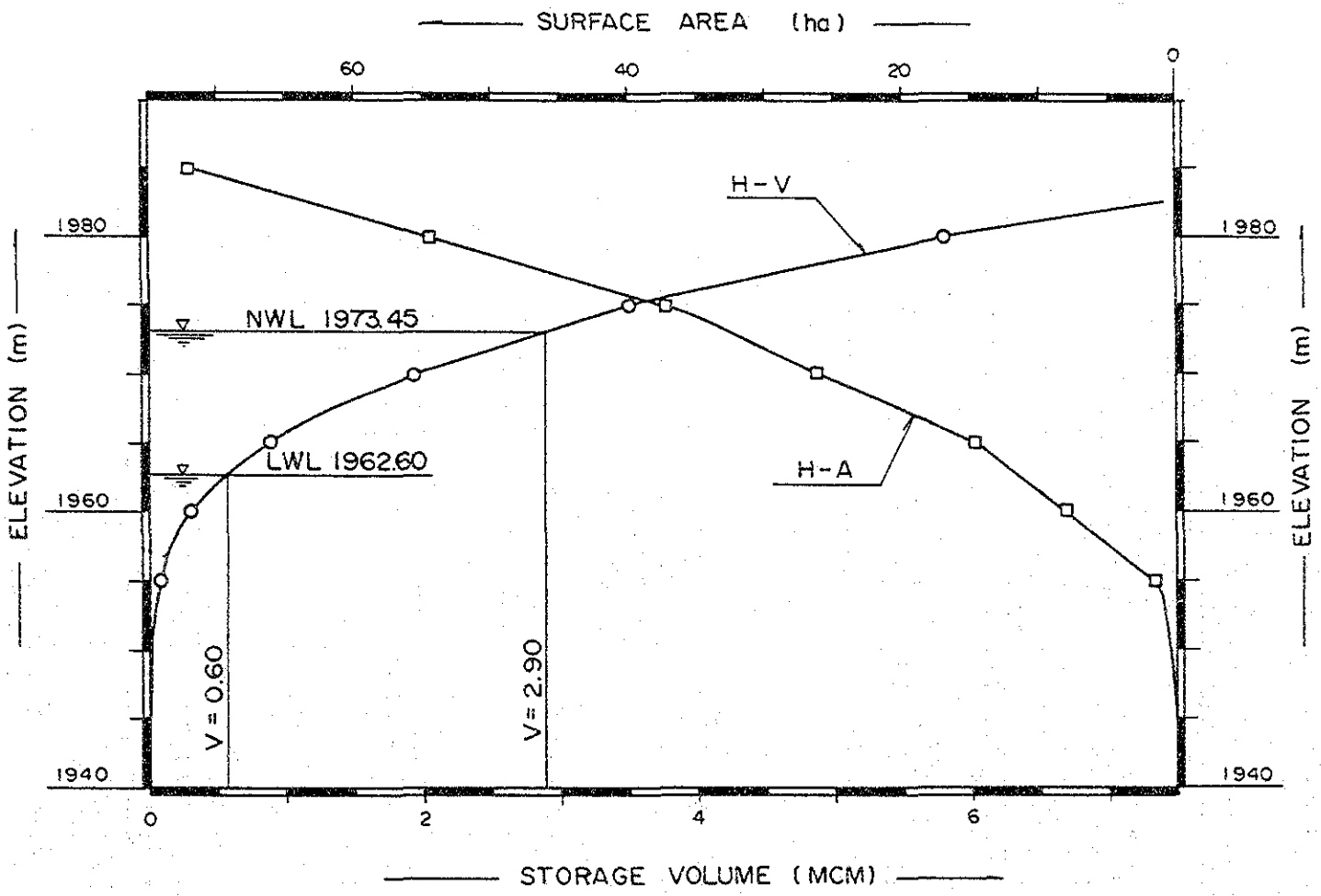


Figure G.1.1 Reservoir Area-Storage Curve

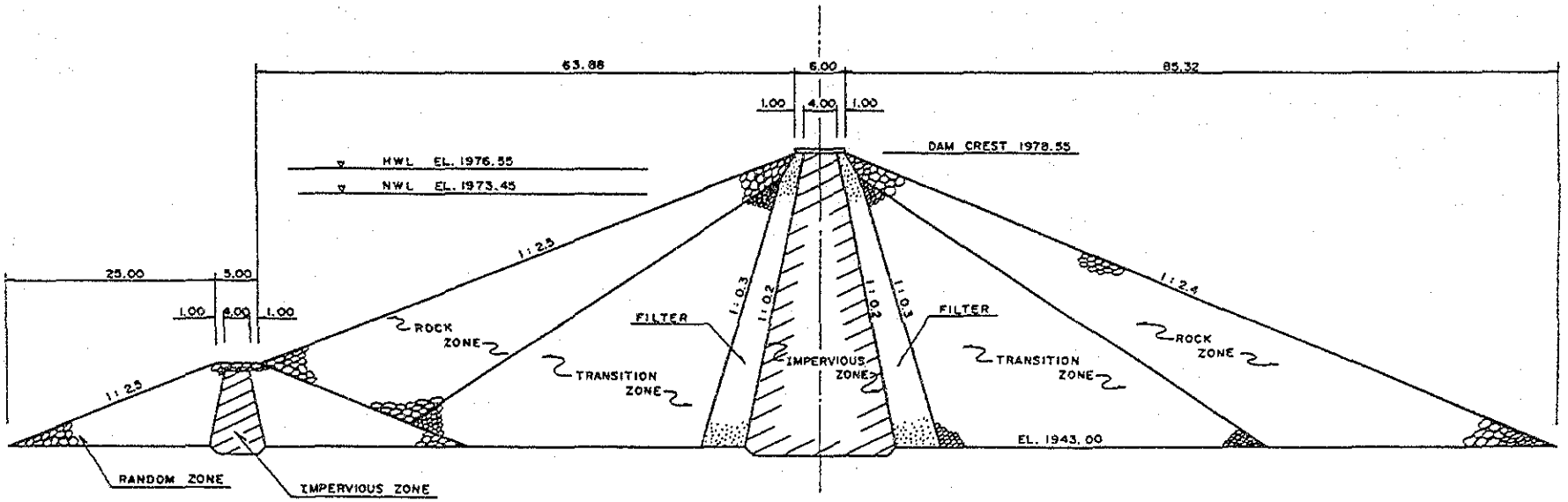


Figure G.2.1 Typical Transversal Section of Fill Type Dam

ANNEX H RURAL INFRASTRUCTURE

ANNEX H RURAL INFRASTRUCTURE

CONTENTS

LIST OF FIGURES

ANNEX H RURAL INFRASTRUCTURE

H.1 CURRENT SITUATION

1.1 General

Tarija Department consists of six provinces such as Cercado, Mendes, Aviles, Arce, O'connor and Gran Chaco.

The Study Area is located in Cercado Province of Tarija Department. The area extends into the four administrative districts; Yesera Sur, Santa Ana, San Agustin and Portillo.

The composition of Tarija Department are as follows:

- Dept. TARIJA
  - Mendes
  - Aviles
  - Arce
  - O'connor
  - Gran Chaco
  - Cercado
    - 1.Cercad(Tarija)
    - 2.Lourdes
    - 3.San Mateo
    - 4.San Luis
    - 5.San Jacinto
    - 6.Turumayo
    - 7.Tablada
    - 8.Tolomosita
    - 9.Tolomosa
    - 10.Churquis
    - 11.Pantipampa
    - 12.Pampa Redonda
    - 13.Pinos
    - 14.Bella Vista
    - 15.San Andres
    - 16.Guerra Huayco
    - 17.El Monte
    - 18.Sella
    - 19.Yesera Norte
    - 20.Yesera Sur
    - 21.Santa Ana
    - 22.San Agustin
    - 23.Portillo
    - 24.Alto Espana
    - 25.Junacas
    - 26.Carlaso

1.2 Current Situation

(1) Population

1) Movement of the Population in Tarija Department
Based on the national census data, the recent population changes are shown below:

Year	Arce	Aviles	Cercado	Gran Chaco	Mendez	O'Conner	TOTAL
1977	35,295	13,557	60,074	46,021	24,939	15,230	195,116
1978	37,597	13,539	62,428	48,358	24,995	15,350	202,267
1979	39,985	13,520	64,876	50,814	25,052	15,670	209,917
1980	42,528	13,501	67,419	53,394	25,109	15,592	217,543
1981	45,232	13,482	70,061	56,105	25,165	15,716	225,761
1982	48,108	13,462	72,808	58,954	25,222	15,839	234,393
1983	51,167	13,442	75,662	61,948	25,279	15,963	243,461
1984	54,420	13,423	78,627	65,093	25,336	16,088	252,987
1985	57,880	13,404	81,709	68,398	25,393	16,214	262,998
1986	61,560	13,384	84,912	71,870	25,451	16,341	273,518
1987	65,474	13,364	88,240	75,519	25,509	16,469	284,575

2) Population Distribution in Tarija Department
The population distribution within Tarija Department is illustrated in Fig. H.1.1.

3) Population Index
Based on the census, major population indexes are classified into four divisions as shown below:

Index		Tarija	Santa Ana
a.Juvenile Rate	(A/B)	0.80	1.09
b.Aged People Rate	(C/B)	0.07	0.08
c.Subordinate Rate	([A+C]/B)	0.87	1.16
d.Aged Rate	(C/A)	0.08	0.07

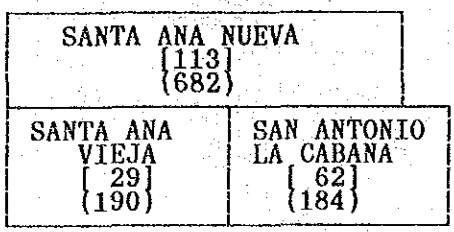
(note) A= 14 years old or younger
B= 15 - 64 years old
C= 65 years old or older

(2) Residence Distribution

Distribution map of the facilities in the area is shown in Fig. H.1.2.

Houses in the rural area, which are found clustered along the roads, rivers and streams are divided into 3 administrative districts called COMPANIA.

The divisions are arranged in the following manner:



According to the 1989 survey in CODETAR and JICA, population and the number of houses at each administrative section is as follows:

Item (Year)	SANTA ANA NUEVA			SANTA ANA VIEJA			SAN ANTONIO LA CABANA			SANTA ANA (TOTAL)		
	F	M	TOTAL	F	M	TOTAL	F	M	TOTAL	M	F	TOTAL
0 - 5	64	59	123	13	16	29	9	11	20	86	86	172
6 - 11	61	61	122	17	16	33	20	23	43	98	100	198
12 - 17	44	64	108	12	11	23	15	14	29	71	89	160
18 - 23	40	30	70	13	11	24	13	6	19	66	47	113
24 - 29	28	29	57	11	8	19	8	11	19	47	48	95
30 - 35	15	23	38	9	8	17	9	9	18	33	40	73
36 - 41	19	19	38	10	5	15	7	4	11	36	28	64
42 - 47	21	18	39	3	11	14	4	0	4	28	29	57
48 - 53	13	11	24	4	1	5	0	5	5	17	17	34
54 - 59	5	6	11	3	2	5	5	6	11	13	14	27
60 - 65	7	14	21	1	1	2	1	1	2	9	16	25
66 >	17	14	31	2	2	4	1	2	3	20	18	38
TOTAL	334	348	682	98	92	190	92	92	184	524	532	1,056

	SANTA ANA NUEVA						SANTA ANA VIEJA					
	PRE ESCOLA.	ESTUDI-ANTES	AGRICU-LTORES	OTROS	DE CASA	TOTAL	PRE ESCOLA.	ESTUDI-ANTES	AGRICU-LTORES	OTROS	DE CASA	TOTAL
0 - 5	123	-	-	-	-	123	29	-	-	-	-	29
6 - 11	59	63	-	-	-	122	-	33	-	-	-	33
12 - 17	13	56	13	-	26	108	-	12	7	-	4	23
18 - 23	-	3	32	6	29	70	-	3	12	2	7	24
24 - 29	-	-	26	4	27	57	-	2	9	-	8	19
30 - 35	-	-	14	2	22	38	-	-	7	2	8	17
36 - 41	-	-	19	-	19	38	-	-	10	1	4	15
42 - 47	-	-	20	1	18	39	-	-	3	-	11	14
48 - 53	-	-	13	-	11	24	-	-	4	-	1	5
54 - 59	-	-	5	-	6	11	-	-	3	-	2	5
60 - 65	-	-	6	1	14	21	-	-	1	-	1	2
66 >	-	-	17	-	14	31	-	-	2	-	2	4
TOTAL	195	122	165	14	186	682	29	50	58	5	48	190

	SAN ANTONIO LA CABANA						SANTA ANA AREA					
PRE ESCOLA.	ESTUDI-ANTES	AGRICU-LTORES	OTROS	DE CASA	TOTAL	PRE ESCOLA.	ESTUDI-ANTES	AGRICU-LTORES	OTROS	DE CASA	TOTAL
19	1	-	-	-	20	171	1	-	-	-	172
3	40	-	-	-	43	62	136	-	-	-	198
-	10	12	-	7	29	13	78	32	-	37	160
-	-	13	-	6	19	-	6	57	8	42	113
-	-	8	-	11	19	-	2	43	4	46	95
-	-	9	-	9	18	-	-	30	4	39	73
-	-	7	-	4	11	-	-	36	1	27	64
-	-	4	-	-	4	-	-	27	1	29	57
-	-	-	-	5	5	-	-	17	-	17	34
-	-	5	-	6	11	-	-	13	-	14	27
-	-	1	-	1	2	-	-	8	1	16	25
-	-	1	-	2	3	-	-	20	-	18	38
22	51	60	-	51	184	246	223	283	19	285	1,056

(3) Health and Medical Care

1) Facility Situation
- National Health Center (CENTRO DE SALUD) : 1 place

2) National Health Center

a.Composition: Chief (Pediatrics) : vacancy
Nurse : 1 person

b.Service hours: AM 7:00 - PM 5:00 (Monday - Friday)

c.Diagnosis items: The center nurse makes a round of all the treatment items. The medical activities at the center are mainly designed for prevention and early treatment of diseases. Patients who need operation and who are seriously ill will be sent by car to large hospitals in Tarija.

Treatment records in December 1989 are as shown below:

Children	:	20 people
Adults	:	12
Pregnant women	:	16
Gynecology	:	4
Child-bearing	:	2

d.Disease situation: General Diseases :Stomach/Intestinal Catarrh
Bronchitis (common cold, flu) Parasites
: Adult Diseases :High-blood pressure
Anemia caused by mainutrition Diabetes

(4) Schooling

1) Education System
The following education system is adopted for schooling in Bolivia.

Infant education	(Pre-Basico	:One or two years)
Primary education	(Basico	:Five years)
Mid-level education	(Intermedio	:Three years)
Advanced education	(Medio	:Fore years)
	(Ensenanza Tecnica)	
High-level education	(Universidad)	

(a)Primary Education
The primary education is five years long. The constitution stipulates that education is mandatory for every school age children and therefore is free of charge. However, the parents bear the costs of school uniforms and other expenses such as notebooks, pencils, etc. Ministry of Education is responsible for this schooling. The class is being conducted under the unified curriculum.

(b)Mid-level Education
The seven-year-long mid-level education is divided into two periods: the first half called Intermedio is from one to three years and the last half called Medio is from four to seven years. This Medio is further divided into the general course and the technical course (Ensenanza Tecnica).

2) Situation of Education Facilities
(a)Primary Education Facilities
Three primary schools, "Santa Ana Nueva", "San Antonio" and "Santa Ana vieja" , are located in the rural area of Santa Ana. Schooling distance is set at 5 km as a rule, but it is up to the students which school to attend. The class is taught with two time sets, morning and afternoon, at schools. Each class is 40 minutes long and five classes a day are taught.

The school starts on Feb. 26 and ends on Nov. 30, with a 15 day-long winter break in August and a 80-day-long summer vacation starting in December.

Major schooling indexes in the area are as shown below:
.Schooling Rate : 90 %
.Rate of students taking upper education: 45 %
.Rate of students taking High School : 6 %

The table below gives some basic information about each school (as of December 1989).

Item	Santa Ana Nueva	San Antonio	Santa Ana Vieja
School	Nucleo Escolar	Escuela Seccional	Escuela Seccional
Pre-Basico	2 years	1 year	1 year
Basico	5 years	5 years	5 years
Intermedio	3 years	non	non
Students	281	50	51

Changes in the number of students in the past eleven years are shown below:

School Name	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89
.Santa Ana Nueva	153	150	165	165	162	159	173	154	158	194	281
.San Antonio	46	46	50	48	49	47	50	50	45	45	50
.Santa Ana Vieja	48	43	43	47	43	48	40	41	49	52	51
TOTAL	247	239	258	260	254	254	263	245	252	291	382

(b) Situation of Mid-level Education Facilities

As a mid-level education school, "Intermedio" institute is only one located in Santa Ana Nueva.

On average, about 80 students are enrolled each year, with 45 % of them finish all the required courses. And about 6 % of the graduates move on to the higher schools.

(5) Traffic System

The wide area road network within Tarija Department is illustrated in Fig. H.1.3. Current roads condition within Tarija Department are as follows:

Class	Length	Rate
a.Fundamental	1,000 km	19.1 %
b.Complementaria	725	13.9
c.Vecinal	3,500	67.0
Total	5,225 km	100.0 %
Pavement	**Length**	**Rate**
a.Asphalt	54 km	1.0 %
b.Gravel	1,069	20.5
c.Nonpaved	4,102	78.5
Total	5,225 km	100.0 %

1) Current Road Condition

The area has one main roads, three provincial roads and some farm roads. The main road in the area is Route 302 (Provincial road). This road is connected to Route 1 (Departmental road) southwest of the area from Tarija to Bermejo. Moreover, this road, connected to Route 9 via Villamontes east of the area, leads to Santa Curz or Yacuiba. On the other hand, the district roads in the area comprise of Route 3050, 3383 and 3384. Route 3050 joins Route 302 at Santa Ana Nueva village to Yesera Norte. Route 3383 links Route 1 and 302. But these roads are not paved.

All these trunk roads are arranged in the right bank area of Santa Ana River, therefore the left bank area has no definite road networks.

Farm roads link the trunk roads to the cultivated land, but these farm roads are private roads, therefore making it very difficult to construct a network of farm roads within the area.

According to the survey, roads in the area are divided into the following four pattern:

Pattern A:	Wide Area Arterial Road	:R 302
B:	Connection Road -I (Join Arterial Road)	:R 3050,3384
C:	Connection Road -II (Linking Area)	:R 3383
D:	Simple Farm Road	

2) Public Transportation System
Only the bus service is available as a means of public transportation in the study area.

(6) Communication and Postal System

1) Communication

(a) Communication System in Bolivia
Wide area communication network is as follows:
Connected to La Paz via Sucre.
Connecting station from Tarija located in Pililojo.
Long distance calls to Junacas and Yacuiba are connected to other prefectures via Tarija.

(b) Telephone Facility Situation of the Area
One telephone station of ENTEL is located in Tarija city. But the study area has no telephone station. Dialing system is used for the ordinary calls. Long distance and overseas calls can be made through the operator. Some pay-phone booths are installed within the telephone station. It can be used to make such calls as ordinary calls, long distance calls and overseas calls. The station is open from Monday to Saturday, 8:00 - 22:00.

(c) Radio Communication
In general, this form of communication is not popularized use in the area. But few farmer use this system for outside communication. ENTELs' permission is necessary to use it.

(d) Other Communication Facilities

Radio set diffusion rate	: nearly 100 %
Television set diffusion rate	: 15 %
Broadcast station	: A TV station in Tarija City Four Radio stations in Tarija City

2) Postal Service
Central post office is located in Tarija city. The post office is responsible for receiving and sending mails, but does not conduct home delivery. Mails are received or sent to La Paz main office by airplane once a week. Office hours are AM 7:00 - 11:30 and 15:00 - 18:00.

(7) Electricity

Power is generated at two power station in Fran by ENDE, from where it will be distributed Tarija and San Lorenzo. To this area, power is first reduced from 220 kv to 66 kv at San Lorenzo and arrives Tarija city (where it is further reduced to 23 kv).

Current situation of the power distribution in rural area is shown below:

	Place	Beneficiary
Busy:	1. El Portillo	15
	2. San Luis	200
	3. Gerrahuayco	43
	4. San Andres	75
	5. Tolomosa Norte	46
	6. Tolomosa Sud	60
	7. San Mateo	89
Plan:	1. Santa Ana Vieja	
	2. Pampa Redonda	
	3. Bella Vista	
	4. Pantipampa	
	5. Tolomosa Centro	

(8) Drinking Water Supply System

Right now, no drinking water supply facilities are available in the rural area where private wells and streams are the predominant source of water. Most farm families have private wells about 10 m deep with the water depth of 0.3-3.0 m, but some of them run dry in dry season (May to September). Although some of the farmers store well water in a tank for home use, most of them get water from their wells as needs arise. Some farmers scattered in the mountainous regions get water directly from springs and streams, but they are small in number.

Current situation of the water supply system in rural area is shown below:

	Place	Beneficiary
Busy:	1. Tolomosa	300
	2. San Blas Norte	228
	3. Guerrahuayco	500
	4. San Luis	650
	5. San Blas Sud	210
	6. Tablada Grande Norte	150
	7. Lazareto	200
	8. Tabladita	240
	9. Sella Cercado	600
Under Construction	1. Torrecillas	
	2. Tablada Grande Sud	
	3. San Pedoro de Sola	
	4. San Andres	
Plan:	1. Junacas	
	2. Yesera	
	3. San Mateo	

(9) Waste and Sewage Treatment

The rural area have no sewer or drainage facilities. In most cases, human waste is buried in the ground by each farming family. Most of the households in the area are equipped with toilets, but their number is very small or none at all in the rural area.

As to the miscellaneous water, each farm family has a simple drainage channel within the premises to let the ground naturally absorb the water.

H.2 RURAL INFRASTRUCTURE IMPROVEMENT PLAN

2.1 General

Based on the situation of the existing facilities and improvement level of rural area at Cercado province, targets for improvement of the area are set up as follows:

a. Farm roads
b. Rural water supply
c. Rural electricity
d. Medical facilities
e. Education facilities
f. Agricultural extension office

The existing improvement level are summarized as follows:

Item	Santa Ana Area	Cercado Prov.	Tarija Dept.	Bolivia
a. Land holding (ha)	7	5 - 7	7 - 10	7 - 10
b. Farmer's income (1,000US$)	1.0 - 1.3	1.5 - 1.8	1.8 - 2.0	1.6 - 3.1
c. Main road density (km/km2)	0.5	1.1	0.8	0.7
d. Diffusion of water works (%)	0	12	11	10
e. Diffusion of electricity (%)	0	10	15	18
f. Diffusion of telephone (%)	0	5	5	7
g. Diffusion of radio (%)	85	87	88	86
h. Diffusion of TV (%)	15	25	18	20
i. School attendance rate (%)	90	95	92	90
j. Literacy rate (%)	85	88	86	85
k. Doctors per 1,000 men (men)	0	1.5	0.5	0.7
l. Teachers per 1,000 men (men)	5	7.5	6.6	5.5

2.2 Road Improvement Plan

The selection of roads to be improved will be decided taking the three major views into account. Factors for assessment are set up as follows:

1. Relativity with the agricultural activities
   a. Accessibility for farm land
   b. Convenient for collection and shipping of agricultural products
   c. Easiness of agricultural activities
   d. Relativity with the irrigation water supply

2. Effectiveness for the road network
   a. Numbers of related farmer (as direct)
   b. Numbers of related farmer (as indirect)
   c. Connectionability with other roads
   d. Accessibility to the public facilities

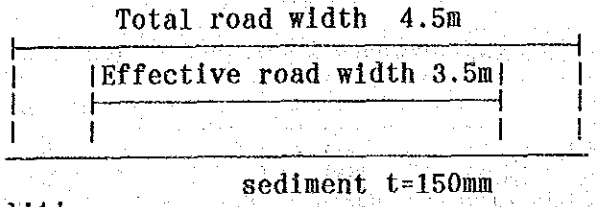
3. Executionability
   a. Topographical features
   b. Extent of improvement in sub-base
   c. Necessity of related structures such as bridge
   d. Extent of enlargement of road width

As a result of assessment, the urgent improvement point will be set up to establish the farm road networks in the left bank area of Santa Ana river. And these roads will be linked with the trunk road in the right bank area of Santa Ana river.

1) Road Structure

The fundamental concepts of road improvement aims to support agricultural activity, therefore standards provided by SENAC is used as the criteria for road structure. The criteria is as follows:

(a)	Standard	: Road Type III (SENAC)
(b)	Design Speed	: 40 - 80 km/hr.
(c)	Total Road Width	: 4.5 m
(d)	Effective Road Width	: 3.5 m
(e)	Pavement	: Sediment
(f)	Cross Section	: Typical road cross section is as shown below:

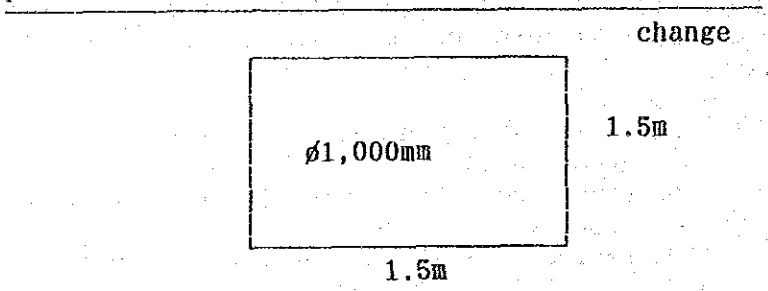


2) Incidental Facilities

Incidental facilities for each route are conduits and ground sills. And cross section where road and river meet is not crossing by bridge but a level crossing by these incidental facilities. The detail of incidental facilities are as follows:

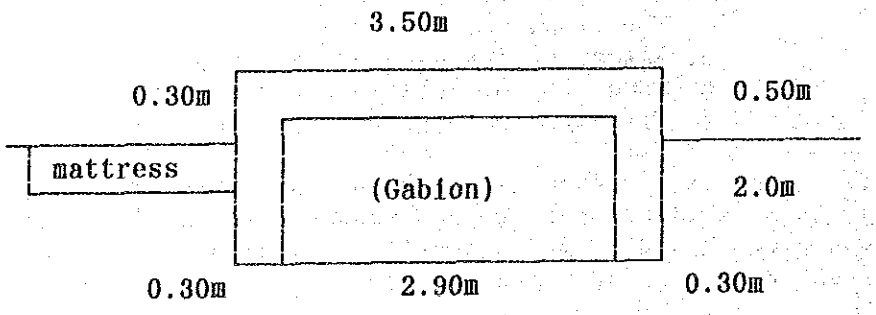
(a) Conduit

Conduit will be installed where road and small stream meet. The structure of conduit has a concrete pipe (ø1,000 mm) and its pipe will be fixed by concrete. The typical cross section is as follows:



(b) Ground sill

Ground sill will be adapted where road and river meet. Its upper part, in general, is used for cross-road of the river, and it will be used for stabilized facility of river course and river-bed water enriched facility. Basic design of ground sill is made up of gabion and concrete lining, and its downstream facing is constructed by mattress.



3) Summary of Road Improvement

The extent of improvement is as follows:

Route	Total Length (km)	Repair (km)	Treat (km)	Total Width (m)	Effective Width (m)	Pave-ment	Preripheral Facility Culvert (place)	Ground sill (m)
R-1	1.1	-	1.1	4.5	3.5	Sediment	3	-
R-2	1.5	1.5	-	4.5	3.5	Sediment	4	100
R-3	4.5	-	4.5	4.5	3.5	Sediment	6	295
R-4	4.8	-	4.8	4.5	3.5	Sediment	6	50
R-5	1.0	1.0	-	4.5	3.5	Sediment	4	350
R-6	3.5	3.5	-	4.5	3.5	Sediment	4	-
R-7	1.5	1.5	-	4.5	3.5	Sediment	-	35
R-8	0.8	0.8	-	4.5	3.5	Sediment	3	-
R-9	1.5	1.5	-	4.5	3.5	Sediment	3	55
TOTAL	20.2	9.8	10.4				33	885

2.3 Rural Water Supply Improvement Plan

Some public wells are bored for rural water supply, but it is not improved to supply water for each farm household by water-system.

The standard of public well is as follows:

a. Diameter of well : ø1,000 mm, brick masonry and mortar lining
b. Depth of well : H = 10 m
c. Suction pump : Manual pump ø50 mm
d. Suction pipe : ø50 mm L= 8 m
e. Infiltration gallery: ø500mm L= 20m

The installed places are as follows:

Place	Public Well	Remark
Santa Ana Nueva I	1 set	Manual pump
Santa Ana Nueva II	2 sets	Manual pump
Santa Ana Nueva III	3 sets	Manual pump
Santa Ana Nueva IV	4 sets	Manual pump
San Antonio I	1 set	Manual pump
San Antonio II	2 sets	Manual pump
Santa Ana Vieja	2 sets	Manual pump
Total	15 sets	

2.4 Electricity Improvement Plan

The installation of power transmission line to center of each administrative districts is planned and the cost for installing service lines to each household will be borne by the individuals.

The extension of power transmission lines will be as follows:

Route	Length	Voltage	Transformer	Utility Pole
E-1	10.0 km	25 kv	5 sets	51 poles
E-2	9.5 km	220 v	2 sets	8 poles
E-3	0.5 km	220 v	2 sets	3 poles
Total	20.0 km		9 sets	62 poles

2.5 Medical Facilities Improvement Plan

Present health center in Santa Ana Nueva is utilized as the core of medical care in the area. Besides, sub-health-center is provided at San Antonio and Santa Ana Vieja. This new center is attached to the agricultural extension office.

To summarized, the following improvement would be made:

Name	Place	Office	Medical Facility	Phone System	Ambulance
Core	Santa Ana Nueva	exist	1 set	1 set	1 car
Sub	San Antonio	20 m^2	1 set	1 set	-
Sub	Santa Ana Vieja	20 m^2	1 set	1 set	-

Main	Santa Ana Nueva	Enrichment of medical facilities Stayed a doctor, Communication system Emergency medical system
Sub	Santa Ana Vieja	Establishment of health center Stayed a nurse Communication system
Sub	San Antonio	Establishment of health center Stayed a nurse, Communication system

2.6 Education Improvement Plan

Old school buildings at Santa Ana Vieja and San Antonio are repaired and these schools have two courses for elementary and mid-level education. Therefore, following facilities are proposed.

Place	Improved Facilities
Santa Ana Vieja	Repair of schoolhouse Enhancement of exercise facilities Availability of mid-level education
San Antonio	Repair of schoolhouse Enhancement of exercise facilities Availability of mid-level education

Place	Elementary Class	Mid-level Class	Practical Room	Staff Room	Pupil per class	Floor Space	Structure
Santa Ana Vieja	2	2	1	1	20	250 m^2	Brick masonry
San Antonio	2	2	1	1	20	250 m^2	Brick masonry

2.7 Agricultural Extension Office

Extension, operation and maintenance center will be the core facilities to execute the O & M of the facilities provided the project, extension of agricultural management and betterment of rural living standard.

The main center will be installed in Santa Ana Nueva, and the center will also be functioned for the O & M of the improved facilities, agricultural extension, collection and shipping facility, etc.

The sub-center will be set up as the branch office of the main center in San Antonio and Santa Ana Vieja. The sub-center has the functions of collection and shipping for agricultural products and meeting-hall.

To summarized, proposed improvement facilities are as follows:

Facility	Site	Lot	Improved Facilities
Main Center	Santa Ana Nueva	1,000 m^2	Agricultural extension office Machine room for maintenance Collection & shipping place Wireless telephone
Sub-Center	Santa Ana Vieja	500 m^2	Collection & shipping place Meeting Room Wireless telephone
Sub-Center	San Antonio	500 m^2	Collection & shipping Meeting Room Wireless telephone

The details of agricultural extension office are as follows:

Section	Site	Lot	Facility	Floor space	Structure
Maine	Santa Ana Nueva	1,000 m^2	Agricultural Extension Office	480 m^2	Brick work
			.Distribution & Shipping floor	200 m^2	
			.Machinery implement	50 m^2	
			.Carrying for shipment truck	80 m^2	
			.Administration office	30 m^2	
			.Training class room	100 m^2	
			.Toilet & Kitchen	20 m^2	
			Machine Room for Maintenance	200 m^2	Gauge steel
Sub	Santa Ana Vieja & San Antonio	500 m^2	Shipping Facility	175 m^2	Brick work
			.Shipping floor	80 m^2	
			.Machinery implement shed	10 m^2	
			.Carrying facility	40 m^2	
			.Administration office	15 m^2	
			.Training class room	20 m^2	
			.Toilet & Kitchen	10 m^2	

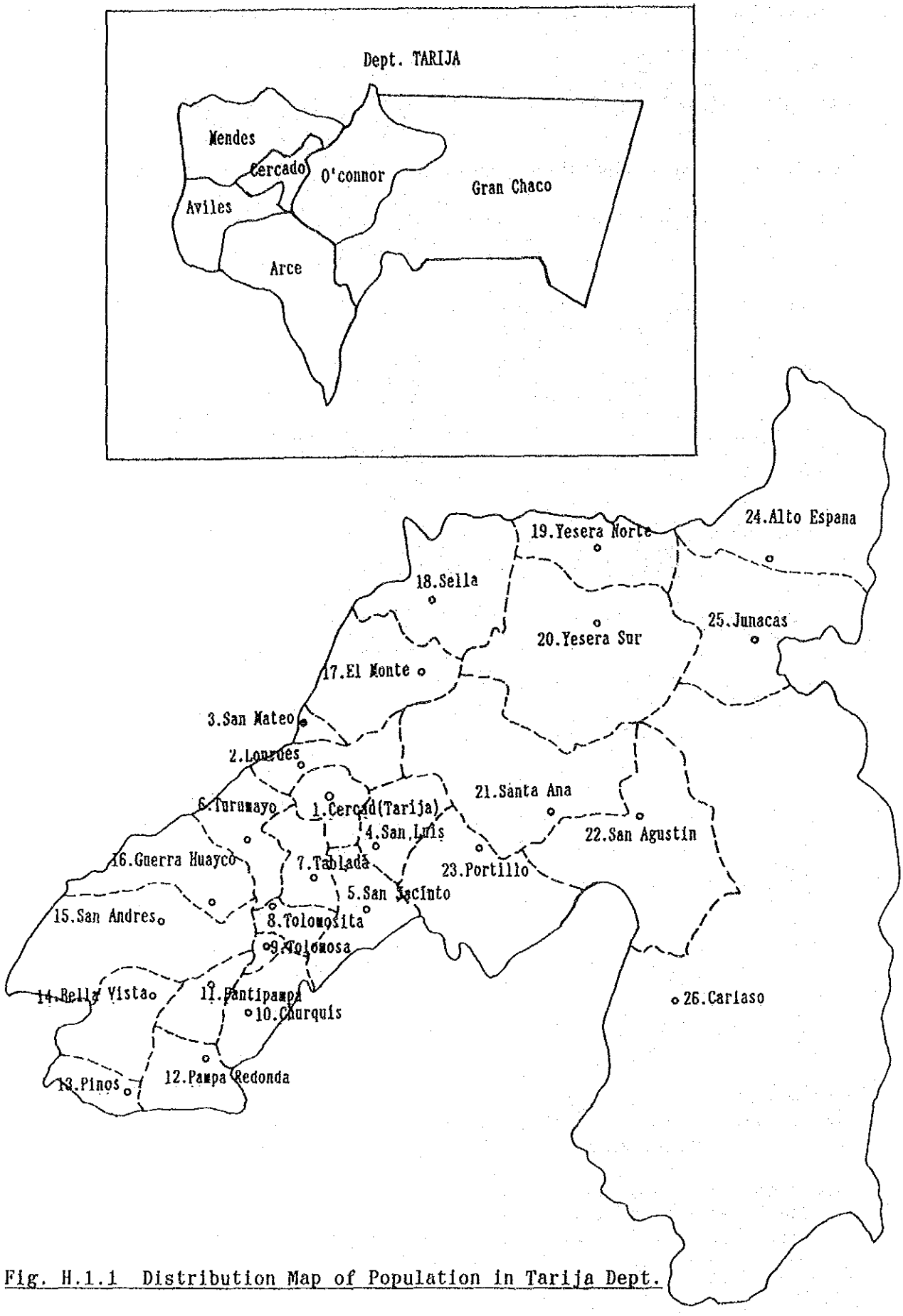


Fig. H.1.1 Distribution Map of Population in Tarija Dept.

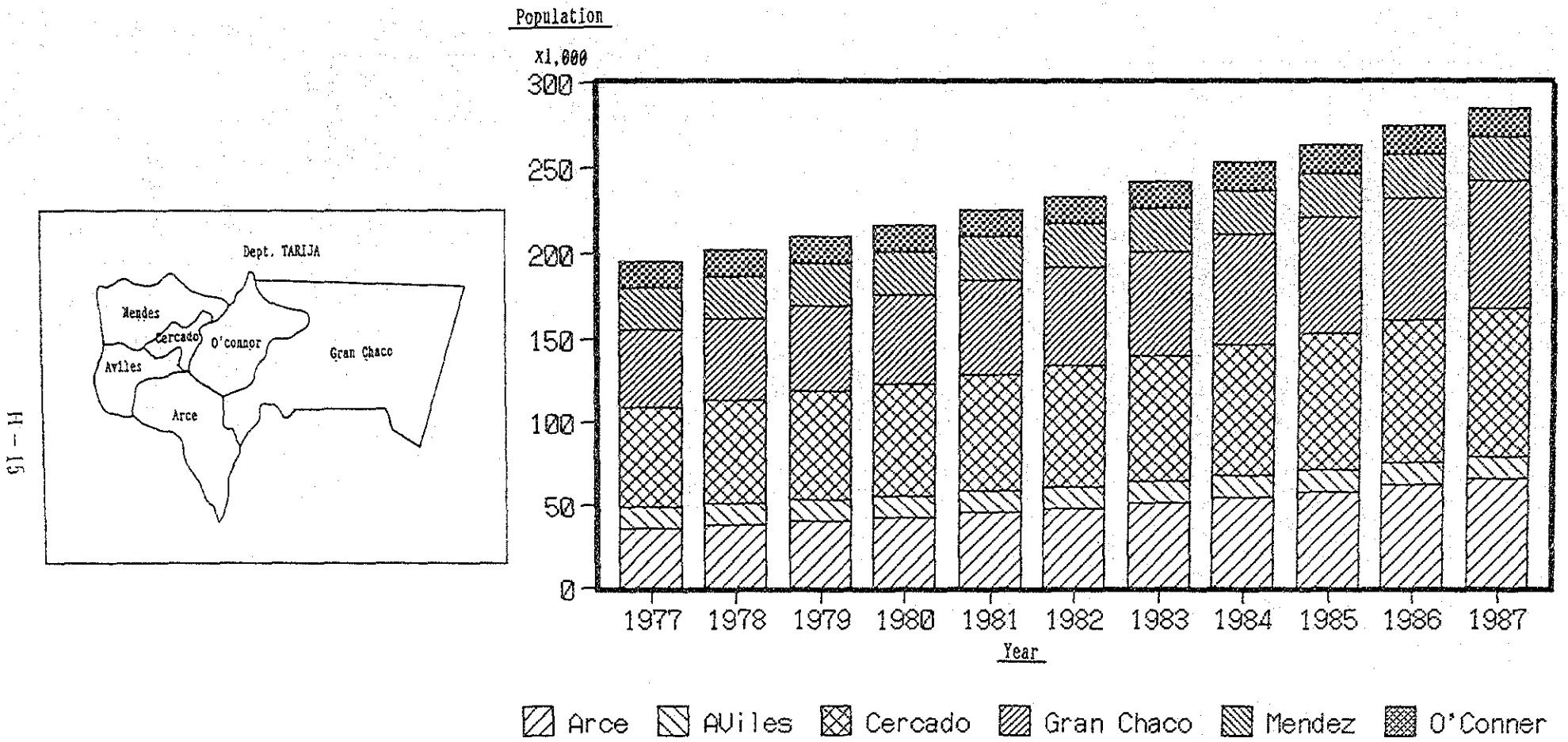


Fig. H.1.2 Movement of Population in Tarija Dept.

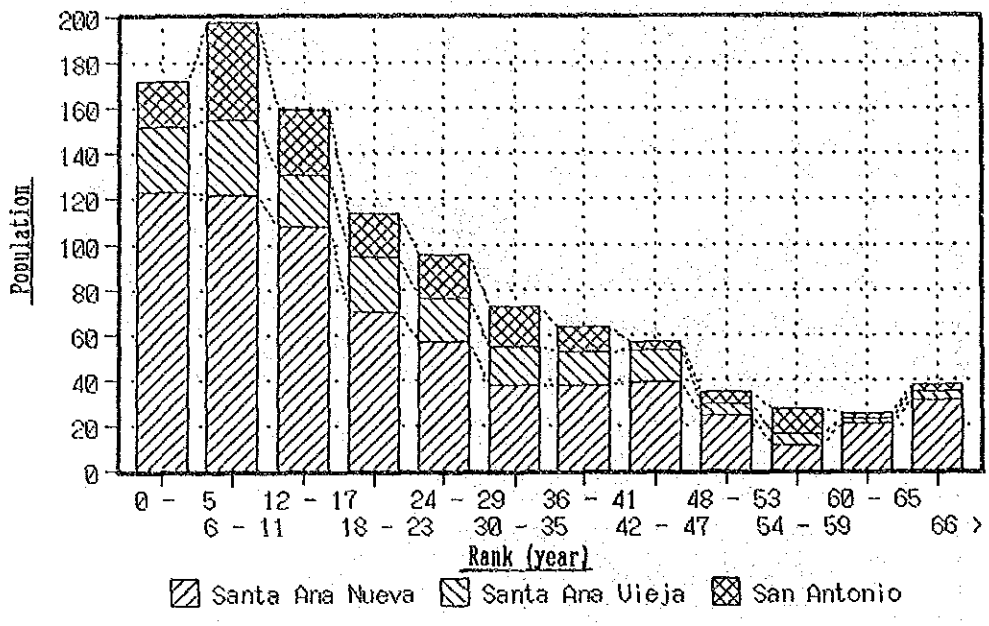


Fig. H.1.3 Composition of Population in Santa Ana Area

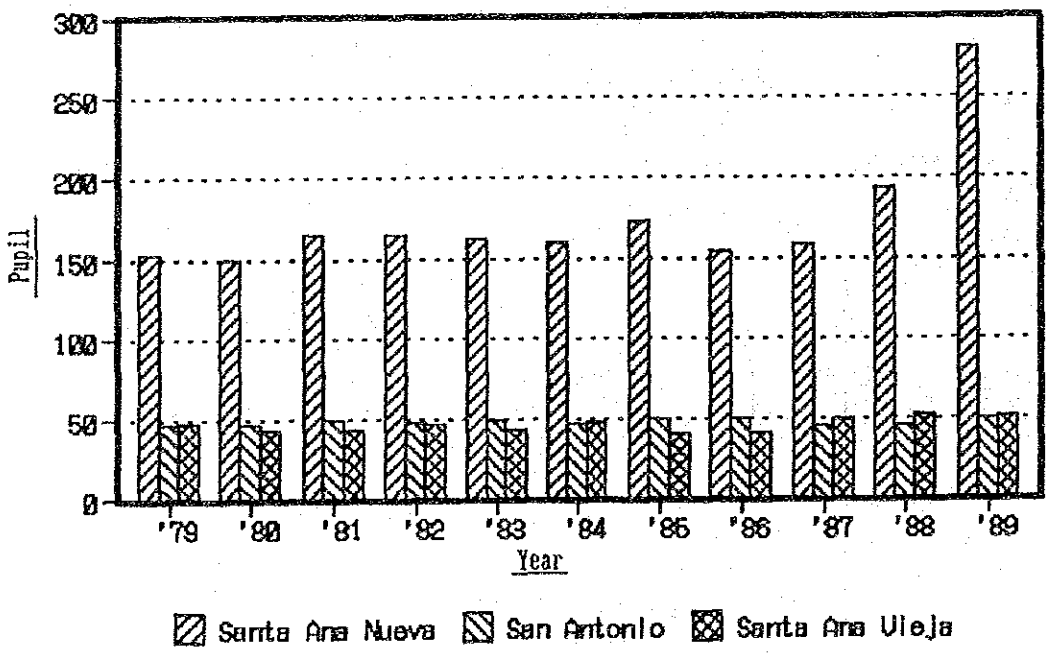


Fig. H.1.4 Movement of Pupil in Santa Ana Area

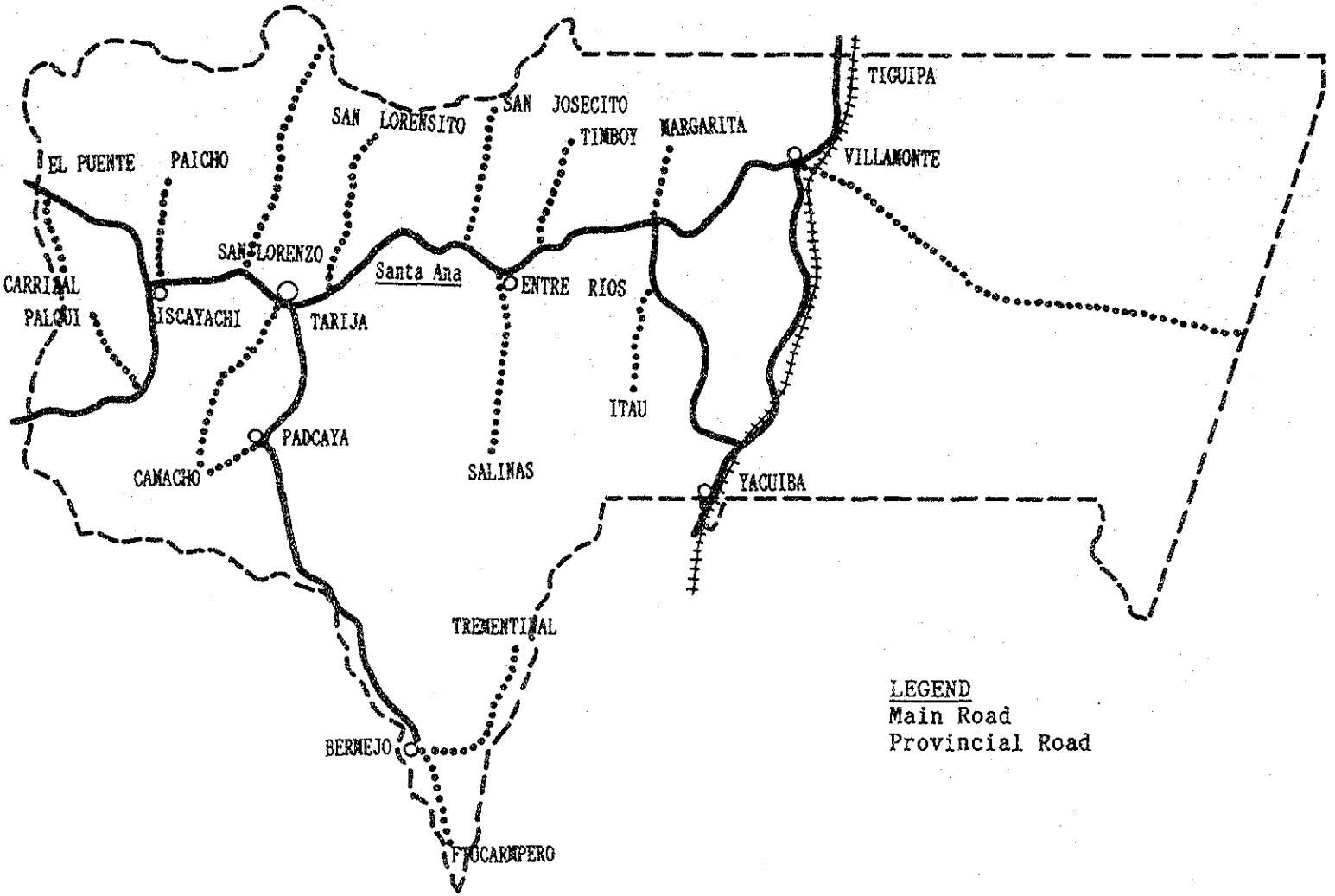


Fig. H.1.5 Wide Area Road Network in Tarija Dept.

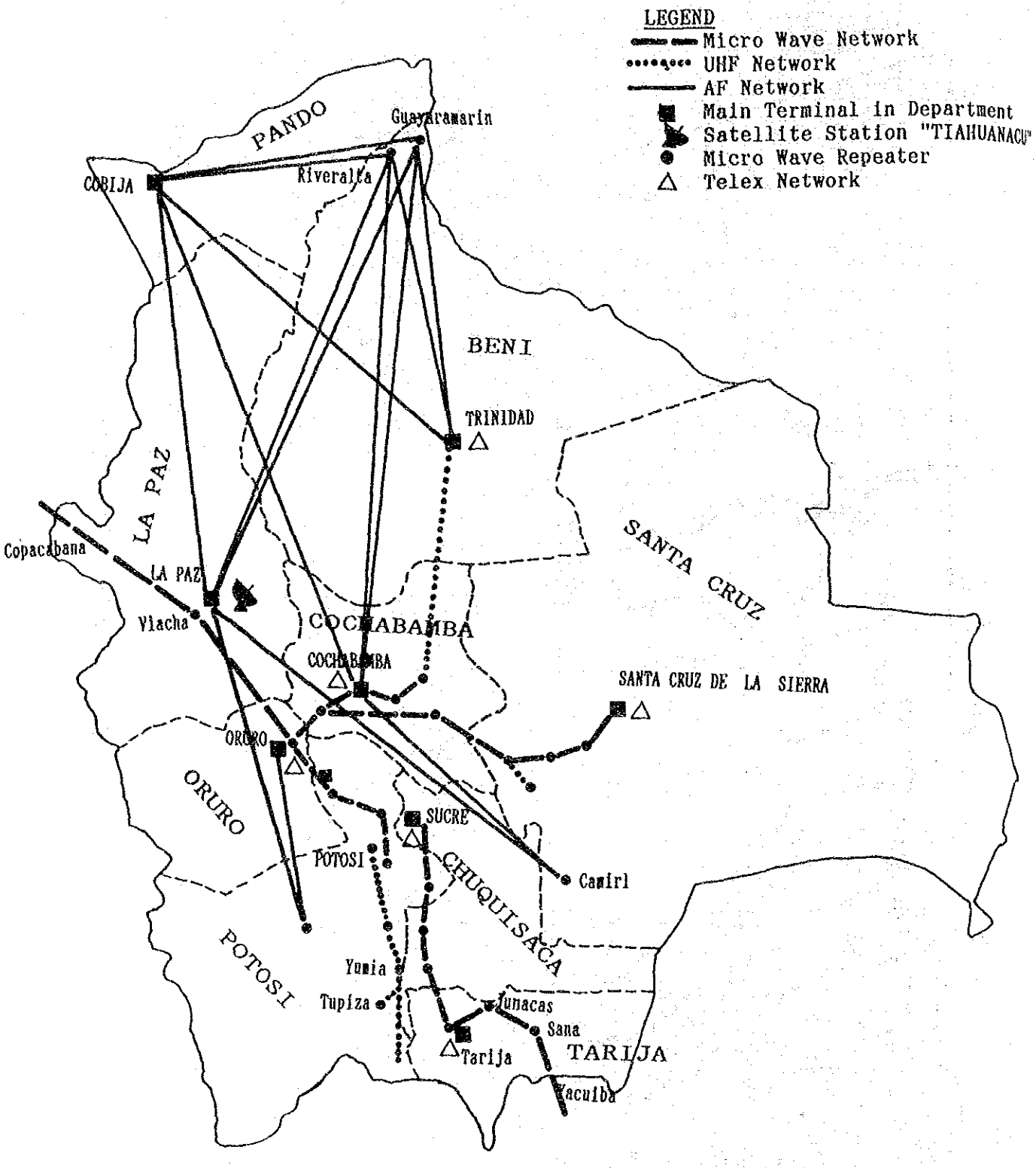
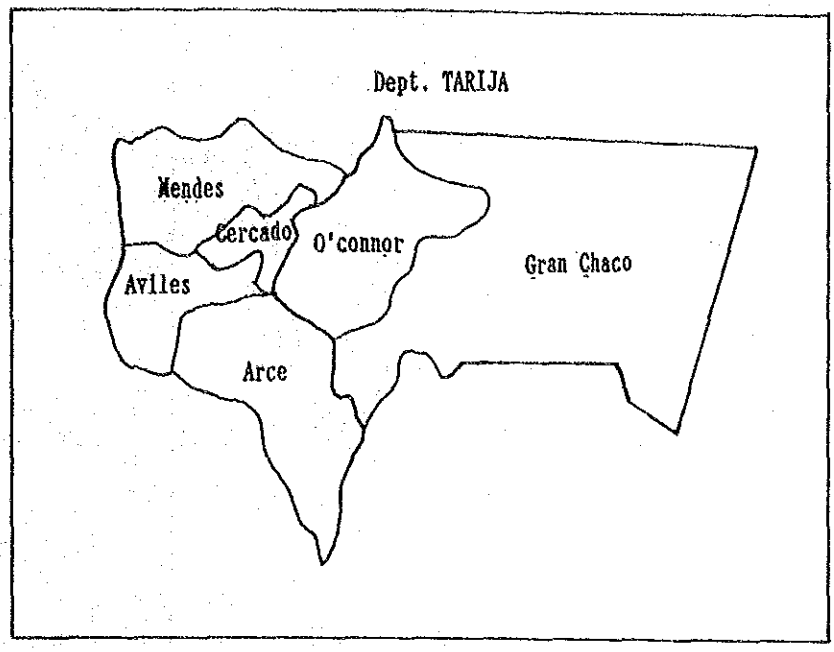


Fig. H.1.6 Communication Network in Bolivia



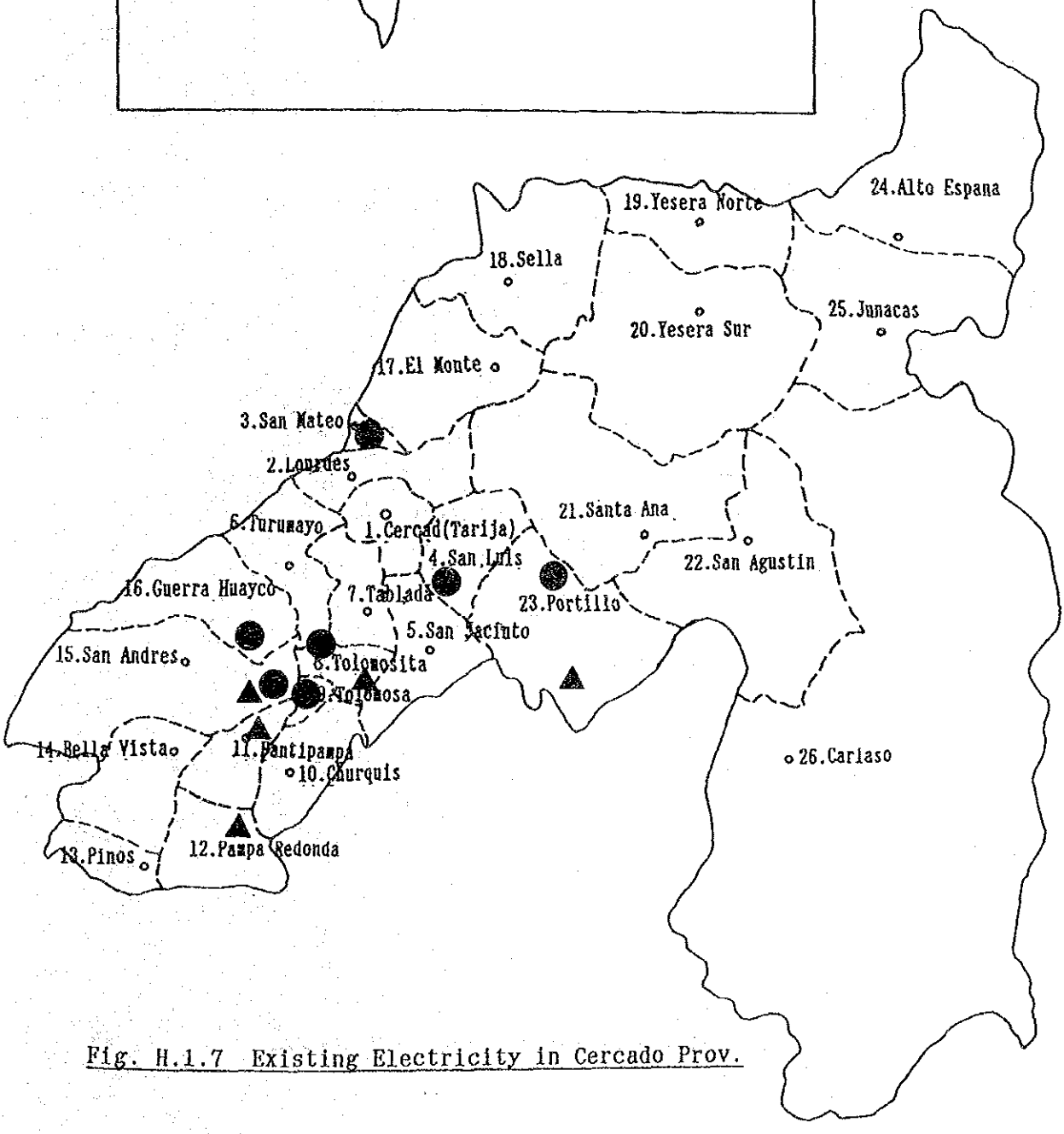


Fig. H.1.7 Existing Electricity in Cercado Prov.

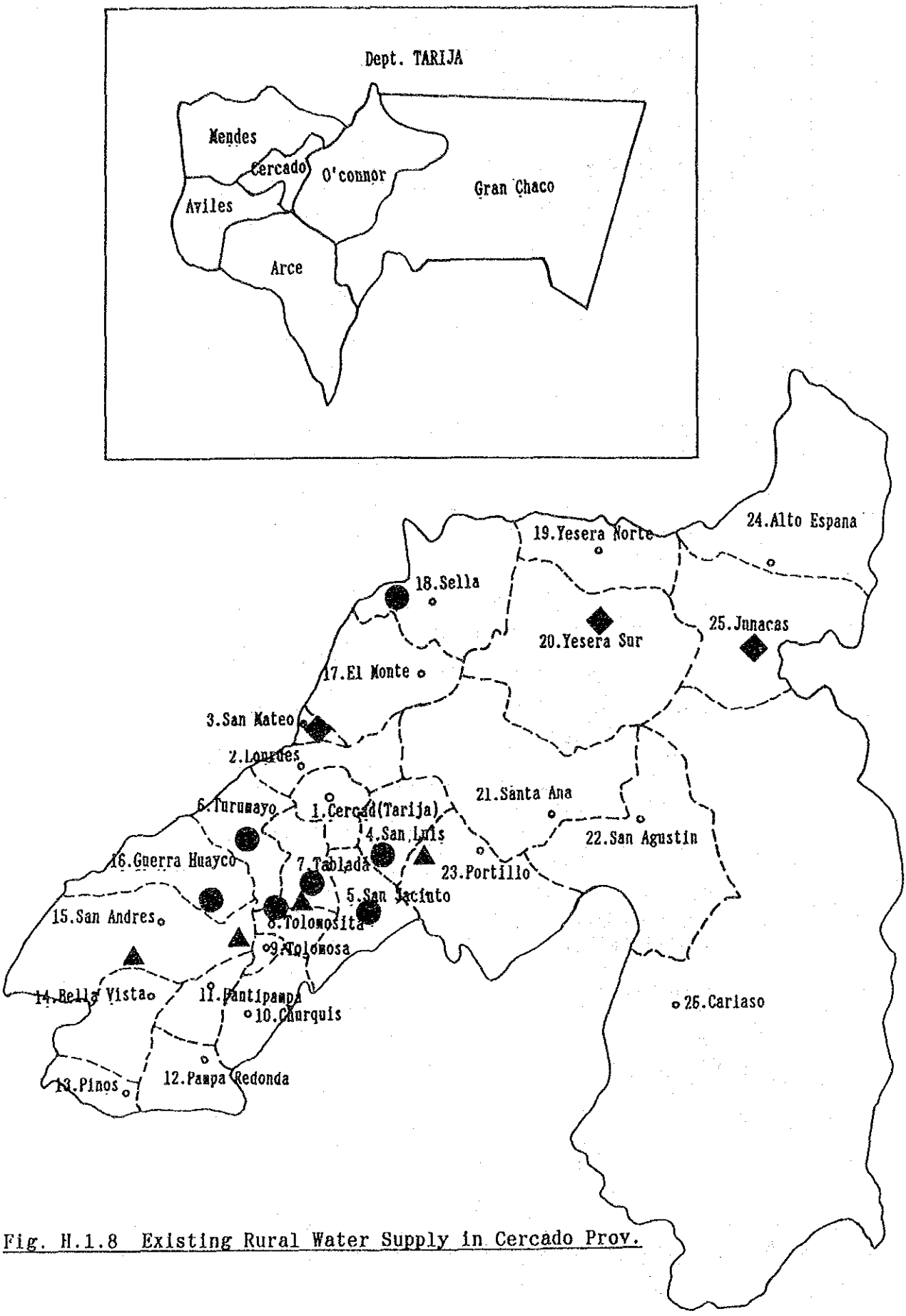


Fig. H.1.8 Existing Rural Water Supply in Cercado Prov.

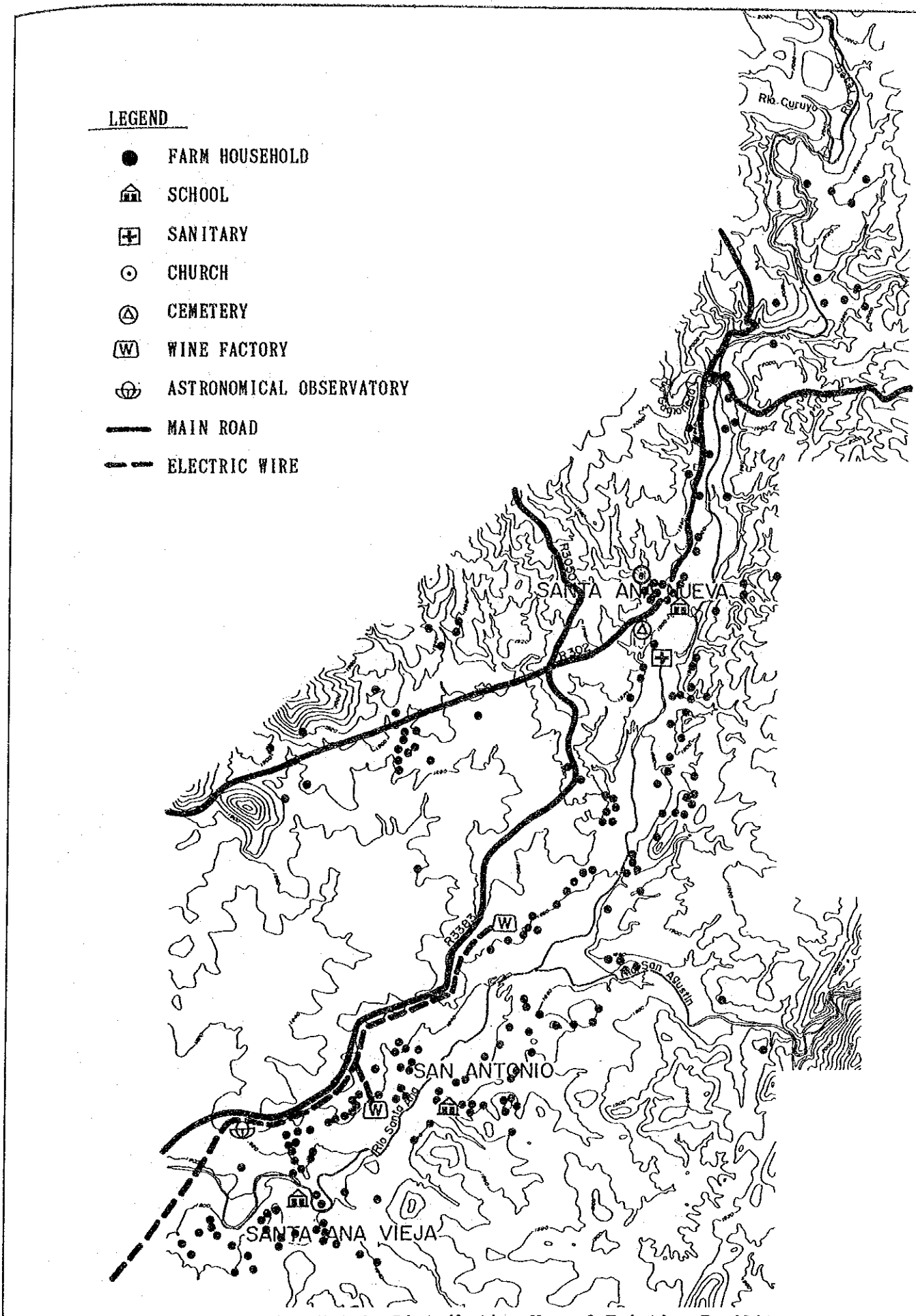


Fig. H.1.9 Distribution Map of Existing Facility

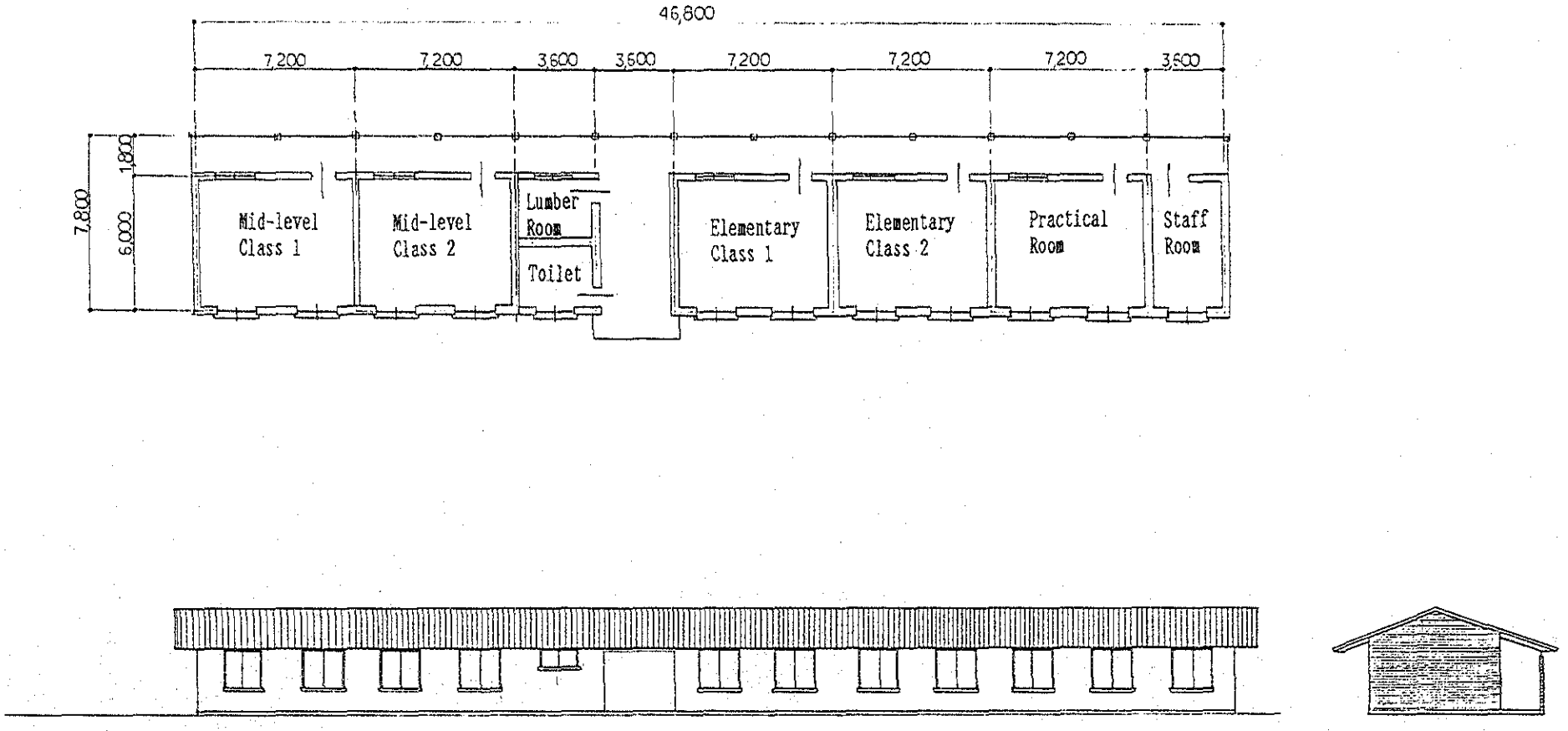


Fig. H.2.1 Plan of Elementary School

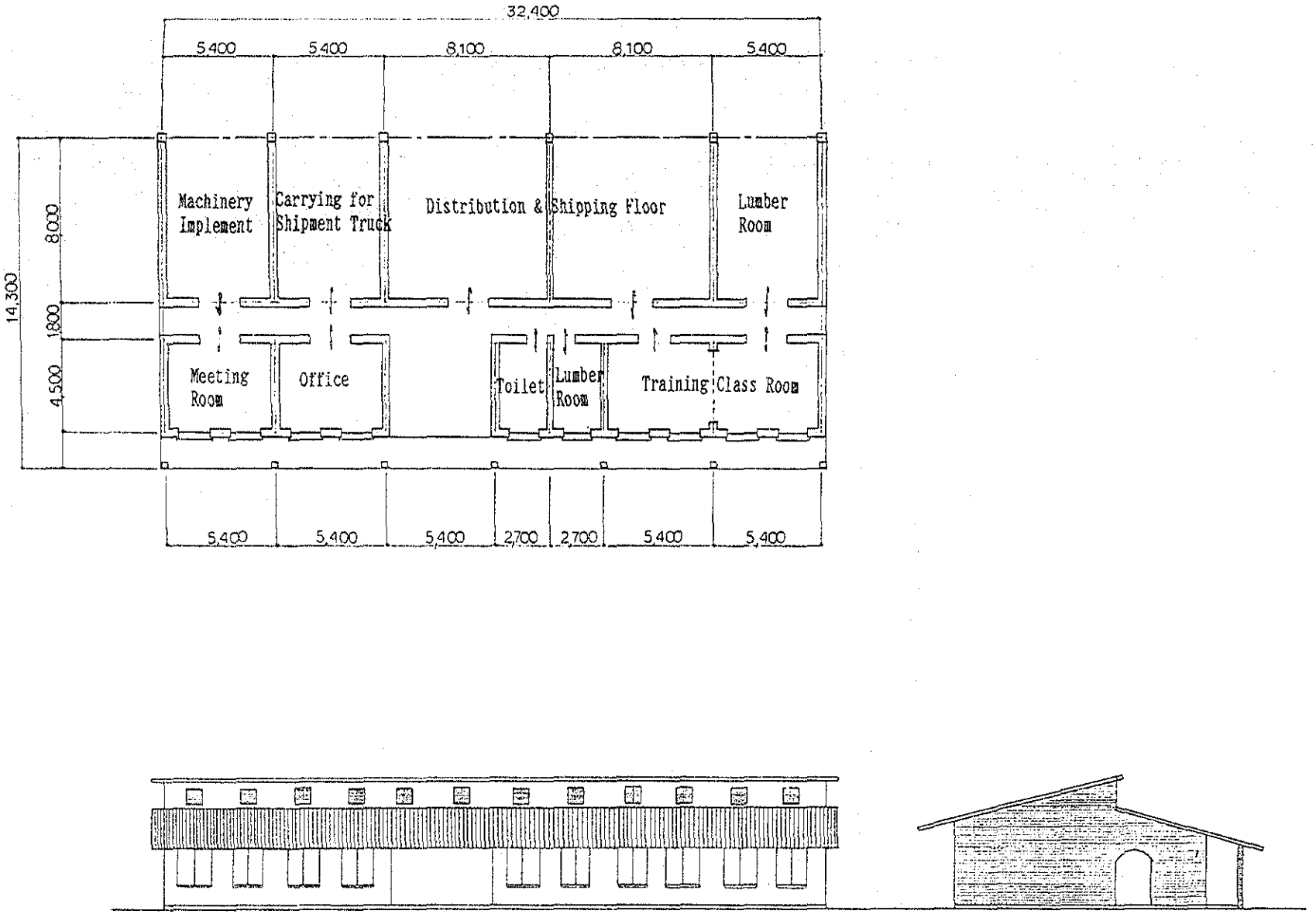


Fig. H.2.2 Plan of Main Agricultural Extension Office

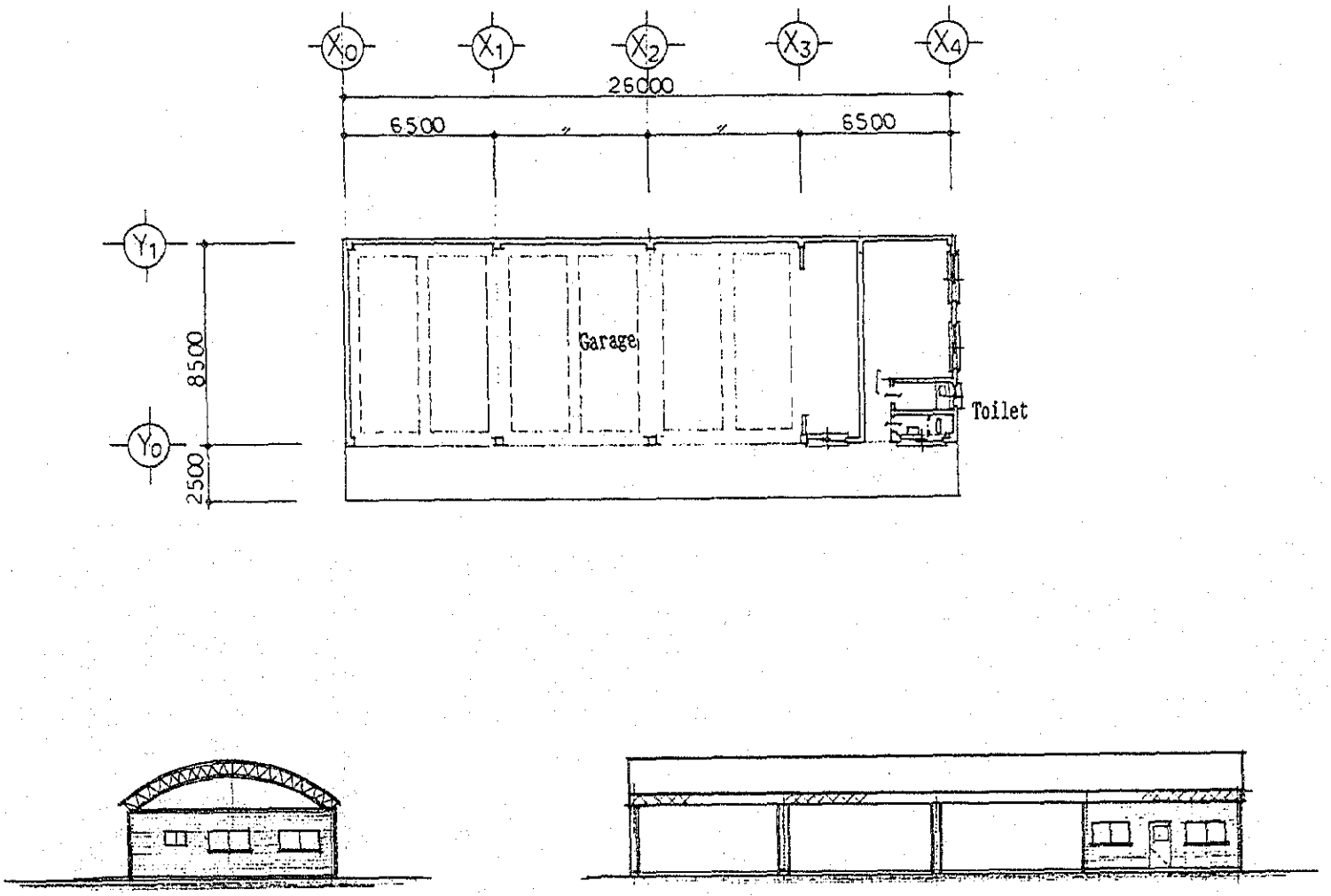


Fig. H.2.3 Plan of Garage for Main Office

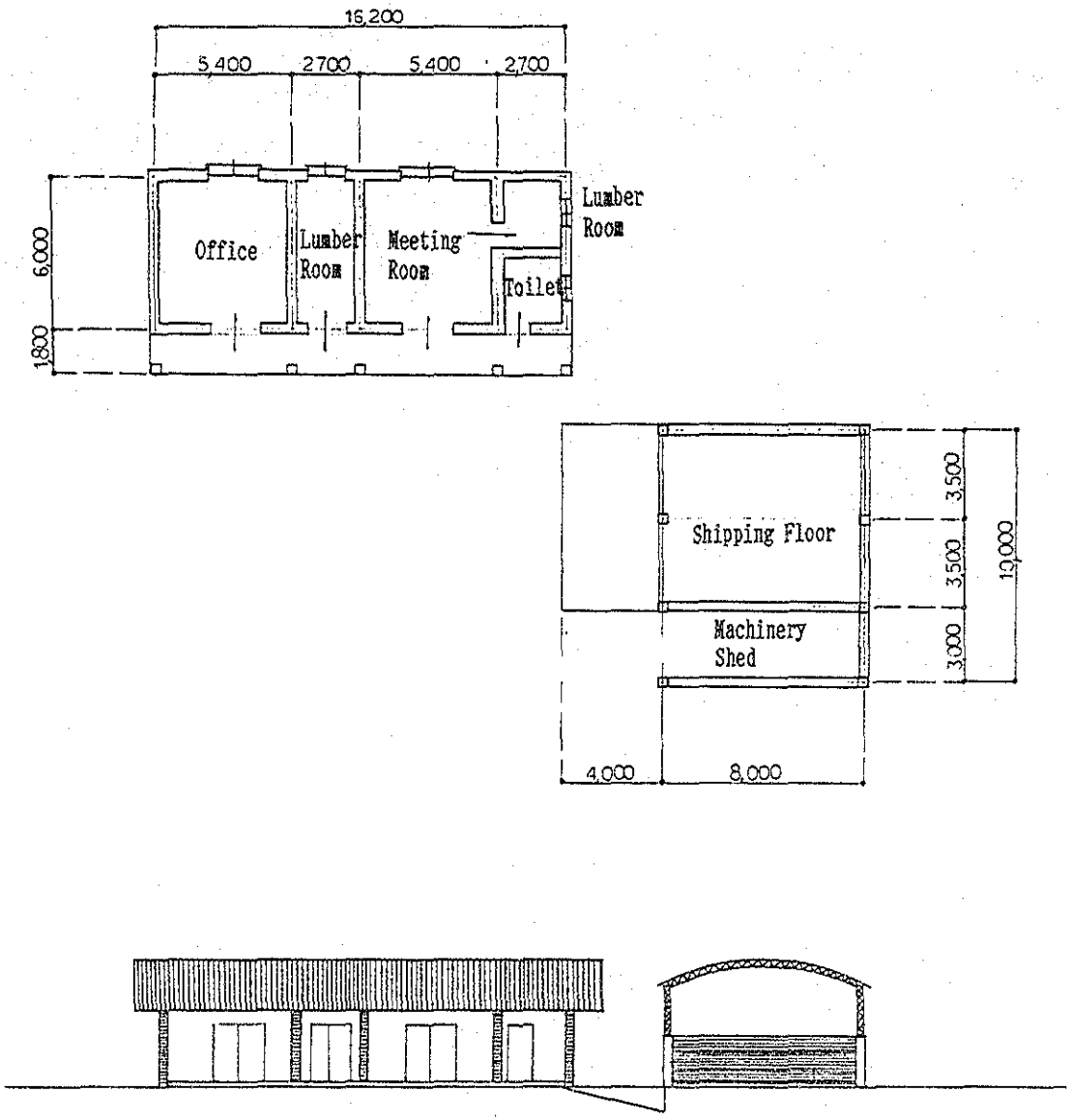


Fig. H.2.4 Plan of Sub Agricultural Extension Office

ANNEX I COST ESTIMATE

ANNEX I COST ESTIMATE

CONTENTS

LIST OF TABLES

ANNEX I COST ESTIMATE

I.1 Cost Estimate

1.1 General

Cost estimate of the project is made on the basis of proposed implementation schedule, construction plan, unit price and quantities estimated during the study. The cost estimate is carried out at the price level as of beginning of January in 1990 dividing it into foreign and local currency portions. The exchange rate used for the cost estimate is US$1.00=Bs.0.333. For all works, the cost is estimated first at the price level based on the work quantities estimated for each components of the project. Duties and taxes on the materials, machinery and equipment to be imported from abroad are deemed to be exempted. The cost for the civil works includes the contractor's overhead and profit which are assumed at 33% of the direct cost.

1.2 Project Cost

The project cost consists of the following items:

(1) Construction Cost
(2) Land Acquisition & Compensation Cost
(3) O & M Equipment Cost
(4) Consulting Service Cost
(5) Administration Cost
(6) Physical Contingency

Estimated results for each items are shown as follows:

(1) Total Project Cost ..... Table I.1.1
(2) Construction Cost ..... Table I.1.2 to I.1.7
(3) Land Acquisition & Compensation Cost .. Table I.1.8
(4) O & M Equipment Cost ..... Table I.1.9
(5) Consulting Service Cost ..... Table I.1.10
(6) Administration Cost ..... Table I.1.11
(7) Physical Contingency ..... Table I.1.1

The Break down of the costs is tabulated as follows:

(1) Wages of Laborer ..... Table I.1.12
(2) Price of Major Material ..... Table I.1.13
(3) Depreciation Cost for Mach./Equi..... Table I.1.14
(4) Hourly Operation Cost for Mach./Equi... Table I.1.15
(5) Unit Price ..... Table I.1.16

1.3 Operation and Maintenance Cost

Based on the guidance of Santa Ana office of CODETAR, operation and maintenance will be performed by the Farmers'Association at the site. O & M cost composes wages and salary for concerned personnels and direct cost for maintenance such as material and machinery. The break down of the O & M cost is shown in Table I.1.17.

I.2 Disbursement Schedule

Disbursement schedule of the project is shown in Table I.2.1. The schedule is decided taking the construction schedule into account.

Table I.1.1 Total Project Cost

(Unit: US$1,000)

ITEM	PROJECT COST			REMARK
	F. C	L. C	TOTAL	
Irrigation Facilities				
1. Dam	3,148	2,734	5,882	
2. Sabo Dams	1,141	1,403	2,544	
3. Canal	873	885	1,758	
4. Reservoir	447	433	880	
5. On Farm	188	55	243	A part of farmers do.
Sub-Total	5,797	5,510	11,307	
Rural Infrastructure Improvement				
6. Center Facilities	10	93	103	
7. Road	65	436	501	
8. Electricitiy	13	51	64	
9. Water Supply	14	3	17	
10. Sanitary Facilities	29	21	50	
11. Educational Facilities	5	45	50	
Sub-Total	136	649	785	
12. Land Aqui. & Cmpen. Cost	0	31	31	
13. O/M Cost	421	22	443	
14. Consulting Sevices Cost	673	182	855	
15. Adominstration Cost	45	420	465	
Sub-Total	1,139	655	1,794	
Total	7,072	6,814	13,886	
16. Physical Contingency	650	649	1,299	
Ground Total	7,722	7,463	15,185	
(Percentage)	51%	49%	100%	

Table I.1.2 Construction Cost for Dam Works

DESCRIPTION OF WORKS	UNIT	Q'TY	UNIT PRICE (US$)			COST (US$)			REMARK
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
DAM WORKS									
(1) MAIN WORKS									
EXCAVATION FOR ROCK	M3	14,400	7.06	2.61	9.67	101,700	37,500	139,200	
EXCAVATION FOR SOIL	M3	9,600	3.71	1.38	5.09	35,600	13,200	48,800	
FINISHING FOR ROCK	M3	3,300	3.95	1.49	5.44	13,000	4,900	17,900	
CLEANING FOR ROCK	M3	3,300	0.27	3.17	3.44	900	10,500	11,400	
CONCRETE FOR MAIN BODY	M3	28,700	31.68	47.29	78.97	909,200	1,357,200	2,266,400	
RC CONCRETE	M3	1,400	20.26	46.29	66.55	28,400	64,800	93,200	
FORM	M3	8,700	35.32	29.94	65.26	307,300	260,500	567,800	
REINFORCEMENT BAR	M3	10	1515.85	198.78	1714.63	15,200	2,000	17,200	
OPERATION DECK	M2	210	744.8	186.2	931.00	156,400	39,100	195,500	
GATE & STEEL PIPE	L.S.					266,000	66,500	332,500	
SUB TOTAL						1,834,000	1,856,000	3,690,000	
(2) ENERGY DISSIPATOR WORKS									
EXCAVATION FOR ROCK	M3	4,800	7.0604	2.6059	9.67	33,900	12,500	46,400	
FINISHING FOR ROCK	M2	1,000	3.9491	1.4933	5.44	3,900	1,500	5,400	
R.C. CONCRETE	M3	2,600	20.26	46.29	66.55	52,700	120,400	173,100	
CONCRETE	M3	230	19.76	41.77	61.53	4,500	9,600	14,100	
REINFORCEMENT BAR	T	26	1515.85	198.78	1714.63	39,400	5,200	44,600	
FORM	M2	1,440	35.32	11.17	46.49	50,900	16,100	67,000	
SUB TOTAL						185,000	165,000	351,000	
(3) GROUT WORKS									
CONTACT GROUT									
BORING	M	6,000	11.18	16.34	27.52	67,100	98,000	165,100	
GROUTING	M	3,000	0.52	0.88	1.40	1,600	2,600	4,200	
CURTAIN GROUT									
BORING	M	3,630	11.18	16.34	27.52	40,600	59,300	99,900	
GROUTING	M	3,330	0.52	0.88	1.40	1,700	2,900	4,600	
SUB TOTAL						111,000	163,000	274,000	
TOTAL						2,130,000	2,184,000	4,315,000	
(4) TEMPORARY WORKS									
ACCESS ROAD	M2	17,500	0.96	0.36	1.32	16,800	6,300	23,100	
TEMPORARY BRIDGE	T	23	766.08	191.52	957.60	17,600	4,400	22,000	
CRANE FACILITY									
FIX, REMOVE &TRANSPORT	L.S.					546,000	234,000	780,000	
CONCRETE PLANT									
FIX, REMOVE &TRANSPORT	L.S.					118,300	50,700	169,000	
ELECTRIC FACILITY	KM	15	2,192	8,767	10,958	32,900	131,500	164,400	
OTHERS	L.S.					286,300	122,700	409,000	
TOTAL						1,017,900	549,600	1,567,500	
GRAND TOTAL						3,148,000	2,734,000	5,882,000	

Table I.1.3 Construction Cost for Sabo Dam Works

DESCRIPTION OF WORKS	UNIT	Q'TY	UNIT PRICE (US$)			COST (US$)			REMARK
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
SABO DAMS (All of 5 sites)									
(1) MAIN WORKS									
EXCAVATION FOR ROCK	M3	5,300	7.06	2.61	9.67	37,400	13,800	51,200	
EXCAVATION FOR SOIL	M3	3,540	3.71	1.38	5.09	13,100	4,900	18,000	
FINISHING FOR ROCK	M3	4,300	3.95	1.49	5.44	17,000	6,400	23,400	
CLEANING FOR ROCK	M3	2,830	0.27	3.17	3.44	800	9,000	9,800	
CONCRETE (H-225a)	M3	2,900	31.68	47.29	78.97	91,900	137,100	229,000	
CONCRETE (H-150)	M3	11,700	20.26	46.29	66.55	237,000	541,600	778,600	
FORM	M3	4,500	35.32	29.94	65.26	158,900	134,700	293,600	
MASONRY	M3	4,740	5.14	27.51	32.65	24,400	130,400	154,800	
SUB TOTAL						581,000	978,000	1,558,000	
(2) ENERGY DISSIPATOR WORKS									
EXCAVATION FOR ROCK	M3	4,270	7.06	2.61	9.67	30,100	11,100	41,200	
FINSHING FOR ROCK	M2	2,280	3.95	1.49	5.44	9,000	3,400	12,400	
R.C.CONCRETE	M3	3,210	20.26	46.29	66.55	65,000	148,600	213,600	
MASONRY	M3	2,080	5.14	27.51	32.65	10,700	57,200	67,900	
REINFORCEMENT BAR	T	32	1515.85	198.78	1714.63	48,500	6,400	54,900	
FORM	M2	1,700	35.32	29.94	65.26	60,000	50,900	110,900	
SUB TOTAL						223,000	278,000	501,000	
(3) TEMPORARY WORKS									
ACCESS ROAD	M2	53,000	0.96	0.36	1.32	50,900	19,100	70,000	
CROSSING WORKS	M	24	448.05	427.28	875.33	10,800	10,300	21,100	
OTHERS	L.S.					275,100	117,900	393,000	
SUB TOTAL						336,800	147,300	484,100	
GRAND TOTAL						1,141,000	1,403,000	2,544,000	

Table I.1.4 Construction Cost for Canal Works

DESCRIPTION OF WORKS	UNIT	Q'TY	UNIT PRICE (US$)			COST (US$)			REMARK
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
CANAL WORKS									
(1) MAIN CANAL									
EXCAVATION FOR ROCK	M3	4,300	7.06	2.61	9.67	30,400	11,200	41,600	
EXCAVATION FOR SOIL	M3	17,400	3.71	1.38	5.09	64,500	24,000	88,500	
EMBANKMENT	M3	9,700	1.67	0.64	2.31	16,200	6,200	22,400	
FINISHING FOR BANK	M2	15,000	0	0.71	0.71	0	10,700	10,700	
CONCRETE LINING	M3	2,700	8.38	40.23	48.61	22,600	108,600	131,200	
FORM	M2	12,550	0.93	2.28	3.21	11,700	28,600	40,300	
SUB TOTAL						145,000	189,000	335,000	
(2) SECONDARY CANAL									
EXCAVATION FOR ROCK	M3	2,100	7.06	2.61	9.67	14,800	5,500	20,300	
EMBANKMENT	M3	5,700	1.67	0.64	2.31	9,500	3,600	13,100	
FINISHING FOR BANK	M2	32,600	0	0.71	0.71	0	23,100	23,100	
MAINSORY	M3	4,400	5.14	27.51	32.65	22,600	121,000	143,600	
SUB TOTAL						47,000	153,000	200,000	
TOTAL						192,000	342,000	535,000	
(3) RELATED STRUCTURE									
EXCAVATION FOR ROCK	M3	4,500	7.06	2.61	9.67	31,800	11,700	43,500	
EXCAVATION FOR SOIL	M3	16,200	3.71	1.38	5.09	67,500	25,100	92,600	
BACK FILLING	M3	39,700	1.49	0.53	2.02	59,200	21,000	80,200	
RC CONCRETE	M3	3,900	8.88	44.76	53.64	34,600	174,600	209,200	
REINFORCEMENT BAR	T	14	1515.85	198.78	1714.63	20,500	2,700	23,200	
FORM	M2	9,900	0.93	2.28	3.21	9,200	22,600	31,800	
CONCRETE FOR BASE	M3	80	7.98	33.53	41.51	600	2,700	3,300	
RC PIPE (φ800)	M	0	342.17	46.23	388.40	0	0	0	
PVC PIPE(φ600)	M	2,200	98.5	27.52	126.02	216,700	60,500	277,200	
CORRUGATED PIPE (φ1200)	M	200	41.66	11.82	53.48	8,300	2,400	10,700	
GATE (0.5×0.5)	T	35	212.80	53.20	266.00	7,400	1,900	9,300	
〃 (1.0×0.8)	T	14	744.80	186.20	931.00	10,400	2,600	13,000	
TOTAL						466,000	328,000	794,000	
GRAND TOTAL						803,000	859,000	1,664,000	

Table I.1.5 Construction Cost for Reservoir Works

DESCRIPTION OF WORKS	UNIT	Q'TY	UNIT PRICE (US$)			COST (US$)			REMARK
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
RESERVOIR WORKS									
EXCAVATION FOR SOIL	M3	54,160	3.71	1.38	5.09	200,900	74,600	275,500	
BANK	M3	84,200	1.67	0.64	2.31	140,600	53,900	194,500	
FINISHING	M2	17,100	0.00	0.71	0.71	0	12,100	12,100	
RIP RAP	M2	16,550	0.00	15.56	15.56	0	257,500	257,500	
RC CONCRETE	M	220	8.88	44.76	53.64	2,000	9,800	11,800	
REIFORCEMENT	T	22	1515.85	198.78	1714.63	33,300	4,400	37,700	
FORM	M2	1,500	0.93	2.28	3.21	1,400	3,400	4,800	
GATE	T	14	1489.60	372.40	1862.00	20,900	5,200	26,100	
PVC PIPE (ϕ300)	M	700	67.83	17.07	84.9	47,500	11,900	59,400	
TOTAL						447,000	433,000	880,000	

Table I.1.6 Construction Cost for On Farm Works

DESCRIPTION OF WORKS	UNIT	Q'TY	UNIT PRICE (US$)			COST (US$)			REMARK
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
SMALL CANAL ON FARM									
CONECTED BETWEEN FARM	M3/HA	590	74.48	31.92	106.40	43,900	18,800	62,700	
TO FARM	M3/HA	500	288.00	72.00	360.00	144,000	36,000	180,000	
TOTAL						188,000	55,000	243,000	

Table I.1.7 Construction Cost for Rural Infrastructure

DESCRIPTION OF WORKS	UNIT	Q'TY	UNIT PRICE (US$)			COST (US$)			REMARK
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
RURAL IFRASTRUCTION IMPROVEMENT									
1. ROAD (20.2 KM)									
MAIN	M2	70,700	0.08	5.39	5.47	5,700	381,100	386,800	
CROSSING WORKS	NO.	33	448.05	427.28	875.33	14,800	14,100	28,900	
BRIDGE	M	331	133.68	125.08	258.76	44,200	41,400	85,600	
SUB TOTAL						64,700	436,600	501,300	
2. MAIN-CENTER	M2	680	10	90	100	6,800	61,200	68,000	
3. SUB-CENTER (2 PLACES)	M2	350	10	90	100	3,500	31,500	35,000	
4. WELL FACILITY (15 SETS)									
EXCAVATION	M	165	53.33	13.33	66.66	8,800	2,200	11,000	
HAND PUMP	NO.	15	369	41	410.00	5,500	600	6,100	
SUB TOTAL						14,300	2,800	17,100	
5. ELECTRIC SUPPLY									
LOW TENTION (220V)	KM	10	1269.352	5077.40	6346.76	12,700	50,800	63,500	
6. SANITARY (2 PLACES)									
BUILDING	M2	200	10	90	100	2,000	18,000	20,000	
AMBULANCE	NO.	1	20700	2300	23000	20,700	2,300	23,000	
SUB TOTAL						22,700	20,300	43,000	
7. RADIO FACILITY	NO.	6	1080	120	1200	6,500	700	7,200	
8. SCHOOL FACILITIES (2 PLACES)	M2	500	10	90	100	5,000	45,000	50,000	
TOTAL						136,200	648,900	785,100	

Table I.1.8 Land Acquisition & Compensation Cost

DESCRIPTION	UNIT	Q'TY	Unit Price		Price	
			F/C	L/C	F/C	L/C
Land Adquisition						
Reservoir	ha	46.3	-	500	0	23,150
Canal	ha	15.1	-	500	0	7,550
Office	ha	0.2	-	500	0	100
Sub-total					0	30,800
Land Compensation						
House	L.S	1	-	1,000	0	1,000
Sub-total					0	1,000
Total					0	31,800

Table I.1.9 O & M Equipment Cost

(1,000 US$)

DISCRIPTION OF ITEM	UNIT	Q'TY	UNIT RATE			AMOUNT			REMARKS
			F.C	L.C	TOTAL	F.C	L.C	TOTAL	
EQUIPMENT COST FOR O & M									
Bulldozer 11t	NO.	1	128.3	6.8	128.3	128.3	6.8	135.0	
Tractor-shovel 0.6m3	NO.	1	47.5	2.5	47.5	47.5	2.5	50.0	
Backhoe 0.3m3	NO.	1	162.5	8.6	162.5	162.5	8.6	171.0	
Dump-truck 4t	NO.	1	44.7	2.4	44.7	44.7	2.4	47.0	
Sub-total						382.9	20.2	403.0	
SPARE PARTS (10 %)						38.0	2.0	40.0	
TOTAL						420.9	22.2	443.0	

Table I.1.10 Consulting Service Cost

(UNIT:US$)

DISCRIPTION OF ITEM	UNIT	Q'TY	UNIT RATE			AMOUNT		
			F.C	L.C	TOTAL	F.C	L.C	TOTAL
1. Detailed Design								
(1) Remuneration								
Foreign Enginner	Man-Month	36	7,500		7,500	270,000	0	270,000
Local Enginner		8		1,000	1,000	0	8,000	8,000
Sub-Total						270,000	8,000	278,000
(2) Direct Cost								
Air Freight	Time	9	4,000		4,000	36,000	0	36,000
Equipments	L.S					6,000	0	6,000
Miscellaneous	L.S					4,200		4,200
Sub-Total						46,200	0	46,200
(3) Indirect Cost								
Hotel Charges	Man-Month	24		1,500	1,500	0	36,000	36,000
Domestic Air Fright	Time	14		200	200	0	2,800	2,800
Transportation Charge		10		1,000	1,000	0	10,000	10,000
Office supplies	Month	10		500	500	0	5,000	5,000
Printing		3		500	500	0	1,500	1,500
Miscellaneous	L.S					0	5,500	5,500
Sub-Total						0	60,800	60,800
Total						316,200	68,800	385,000
2. Construction Supervision								
(1) Remuneration								
Foreign Enginner	Man-Month	42	7,500		7,500	315,000	0	315,000
Local Enginner		30		1,000	1,000	0	30,000	30,000
Sub-Total						315,000	30,000	345,000
(2) Direct Cost								
Air Freight	Time	8	4,000		4,000	32,000	0	32,000
Equipments	L.S					6,000	0	6,000
Miscellaneous	L.S					3,800		3,800
Sub-Total						41,800	0	41,800
(3) Indirect Cost								
Hotel Charges	Man-Month	42		1,500	1,500	0	63,000	63,000
Domestic Air Fright	Time	25		200	200	0	5,000	5,000
Office supplies	Month	30		500	500	0	15,000	15,000
Miscellaneous	L.S							
Sub-Total				2,200	2,200	0	83,000	83,000
Total						356,800	113,000	469,800
Grand Total						673,000	181,800	854,800

Table I.1.11 Administration and O/M Cost at Santa Ana Office

(Unit: US$)

Year	Salary	Preparation 1st		Preparation 2nd		Construction 3rd		Construction 4th		Total	Operation 5th		Operation 6th	
Direction Section														
Director	12,000	1	12,000	1	12,000	1	12,000	1	12,000	48,000	0.1	1,200	0.1	1,200
Secretary	3,000	1	3,000	1	3,000	1	3,000	1	3,000	12,000	0.1	300	0.1	300
Driver	3,000	1	3,000	1	3,000	1	3,000	1	3,000	12,000	0.1	300	0.1	300
Sub-total		3	18,000	3	18,000	3	18,000	3	18,000	72,000	0.3	1,800	0.3	1,800
Engineering Section														
Chief	8,000	1	8,000	1	8,000	1	8,000	1	8,000	32,000	0.1	800	0.1	800
Topo.	4,000	2	8,000	1	4,000	1	4,000		0	16,000		0		0
Topo. Assistant	4,000	6	24,000	3	12,000	3	12,000		0	48,000		0		0
Irri. Eng.	6,000	2	12,000	3	18,000	3	18,000	3	18,000	66,000	0.2	1,200	0.2	1,200
Irri. Assistant	4,000	1	4,000	2	8,000	2	8,000	1	4,000	24,000		0		0
Draft man	3,000	1	3,000	2	6,000	2	6,000		0	15,000		0		0
Driver	3,000	2	6,000	2	6,000	2	6,000	2	6,000	24,000		0		0
Operation														
Chief Operator	5,000										0.5	2,500	0.5	2,500
Dam Operator	3,000									0	1	3,000	1	3,000
Canal Operator	3,000									0	2	6,000	2	6,000
Driver														
Heavy Mach.	3,000										2	6,000	2	6,000
Sub-total		15	65,000	14	62,000	14	62,000	7	36,000	225,000	5.8	19,500	5.8	19,500
Administration Section														
Chief	8,000	1	8,000	1	8,000	1	8,000	1	8,000	32,000		0	0	0
Assistant	5,000	1	5,000	1	5,000	1	5,000	1	5,000	20,000		0	0	0
Secretary	3,000	1	3,000	1	3,000	1	3,000	1	3,000	12,000		0	0	0
Lawyer	6,000	1	6,000	1	6,000	1	6,000	1	6,000	24,000		0	0	0
Sub-total		4	22,000	4	22,000	4	22,000	4	22,000	88,000	0	0	0	0
Investment										0				0
Vehicle	15,000	1	15,000			1	15,000			30,000	0.3	4,500	0.3	4,500
Motorcycle	5,000							3	15,000	15,000				0
Office			5,000		5,000		5,000		5,000	20,000				0
Sub-total			20,000		5,000		20,000		20,000	65,000		4,500		4,500
O/M Cost of Equip.														
Vehicle	2,000	1	2,000	1	2,000	2	4,000	2	4,000	12,000				
Motorcycle	1,000							3	3,000	3,000	3	3,000	3	3,000
Heavy Machine	2,000										4	8,000	4	8,000
Sub-total			2,000		2,000		4,000		7,000	15,000		11,000		11,000
Total			127,000		109,000		126,000		103,000	465,000		36,800		36,800
(F/C)			15,000		0		15,000		15,000	45,000				
(L/C)			112,000		109,000		111,000		88,000	420,000				

Table I.1.12 Wages of Laborer

CODE NO.	WORKMAN	UNIT	WAGES BS	WAGES US$	REMARK
1	Tradesman	day	12.20	4.07	1 BS= 0.33 US$
2	Mason	day	10.60	3.53	1 day= 8 hr
3	Skilled Laborer	day	9.10	3.03	
4	Ordinary Laborer	day	7.60	2.53	
5	Electoric Worker	day	18.16	6.05	2.27bs/1hr
6	Reinforced Worker	day	18.16	6.05	2.27bs/1hr
7	Welder	day	18.16	6.05	2.27bs/1hr
8	Special Driver	day	21.12	7.04	2.64bs/1hr
9	Ordinary Driver	day	13.36	4.45	1.67bs/1hr
10	Driller	day	35.04	11.68	4.38bs/1hr
11	Carpenter	day	26.16	8.72	3.27bs/1hr
12	Pipe Fitter	day	20.88	6.96	2.61bs/1hr
13	Form Worker	day	18.16	6.05	2.27ba/1hr
14	Asistant	day	7.60	2.53	
15	Mechanic	day	18.16	6.05	2.27hr/1hr

Table I.1.13 Price of Major Material

CODE NO.	MATERIAL	UNIT	PRICES		COMPONENT		PRICES (US$)		REMARK
			BS	US$	F.C	L.C	F.C	L.C	
									1BS=0.333 US$
	FUEL & LUBRICANT								
1	GASOLINE	LIT.	0.89	0.30	10	90	0.03	0.27	
2	LIGHT OIL	LIT.	0.89	0.30	10	90	0.03	0.27	
3	GEAR-OIL	LIT.	4.00	1.33	80	20	1.07	0.27	
4	GREASE	KG	4.50	1.50	80	20	1.20	0.30	
5	LUBRICANT	LIT.	3.70	1.23	80	20	0.99	0.25	
	EXPLOSIVE								
6	DINAMAITE	KG	-	0.53	90	10	0.48	0.05	
7	ELECTRIC DETONATOR	SET	-	0.47	90	10	0.42	0.05	
8	GUIDE CABLE	M	-	0.32	90	10	0.29	0.03	
	CONCRETE								
10	SAND FOR CONCRETE	M3	14.00	4.66	0	100	0.00	4.66	
11	GRAVEL FOR CONCRETE	M3	23.00	7.66	0	100	0.00	7.66	
12	CEMENT (50KG)	NO	10.50	3.50	10	90	0.35	3.15	
13	AIR CONTRAINED AGENT	10KG	-	22.50	90	10	20.25	2.25	
14	FORM	M2	12.00	4.00	70	30	2.80	1.20	
	ELECTRIC								
17	ELECTRIC LIGHT (100W)	NO.	1.50	0.50	80	20	0.40	0.10	
18	ELECTRIC LIGHT (500W)	NO.	13.00	4.33	80	20	3.46	0.87	
19	ELECTRIC CABLE	M	4.17	1.39	80	20	1.11	0.28	
20	ELECTRIC SUPPLY	100KW	7.83	2.61	80	20	2.09	0.52	
21	HIGH TENTION (24.9KV)	KM	-	8,239	20	80	1,648	6,591	
22	LOW TENTION (380W)	KM	-	5,500	20	80	1,100	4,400	
23	LOW TENTION (220W)	KM	-	4,772	20	80	954	3,818	
									1BS=0.333 US$
	PIPE MATERIAL								
25	PVC PIPE (ϕ50)	M	4.83	1.61	80	20	1.29	0.32	
26	〃 (ϕ150)	M	26.32	8.76	80	20	7.01	1.75	105.28bs/4m
27	〃 (ϕ200)	M	100.10	33.33	80	20	26.67	6.67	600.61bs/6m
28	〃 (ϕ250)	M	141.925	47.26	80	20	37.81	9.45	851.55bs/6m
29	〃 (ϕ300)	M	187.698	62.50	80	20	50.00	12.50	1126.19bs/6m
30	〃 (ϕ350)	M	-	78.76	90	10	70.90	7.88	
31	〃 (ϕ400)	M	-	104.54	90	10	94.09	10.45	
32	〃 (ϕ450)	M	-	122.72	90	10	110.45	12.27	
33	〃 (ϕ500)	M	-	146.96	90	10	132.26	14.70	
34	RC PIPE (ϕ600)	M	-	88.46	79	21	69.67	18.79	
35	〃 (ϕ700)	M	-	96.50	79	21	76.00	20.50	
36	〃 (ϕ800)	M	-	102.35	79	21	80.61	21.74	
37	ELBOW OF PVC (ϕ50-90°)	NO.	30.00	10.00	80	20	8.00	2.00	
38	CORRUGATED PIPE (36"×24")	M	91.35	30.45	80	20	24.36	6.09	54.81bs/0.6m
39	〃 (48"×24")	M	117.45	39.15	80	20	31.32	7.83	70.47bs/0.6m
41	〃 (42"×32")	M	68.25	22.75	80	20	18.20	4.55	54.60bs/0.8m
42	〃 (48"×32")	M	88.18	29.39	80	20	23.51	5.88	70.54bs/0.8m
43	DCIP (ϕ100)	M	-	16.67	90	10	15.00	1.67	50$/3m
44	〃 (ϕ150)	M	-	28.33	90	10	25.50	2.83	85$/3m
45	〃 (ϕ300)	M	-	83.14	90	10	74.83	8.31	499$/6m
46	〃 (ϕ500)	M	-	168.571	90	10	151.71	16.86	1011$/6m
47	〃 (ϕ600)	M	-	225.714	90	10	203.14	22.57	1354$/6m
	OTHERS								
49	WATER TANK (2000 lit)	NO.	729.00	243.00	80	20	194.40	48.60	
50	GABION (e=2.7mm)	M2	-	3.00	80	20	2.40	0.60	
51	LAND PRICE AT SANTA ANA	HA	-	500.00	0	100	0.00	500.00	
52	EXCAVATION OF WELL FOR ROCK	M	200.00	66.67	80	20	53.33	13.33	
53	EXCAVATION OF WELL FOR SOIL	M	100.00	33.33	80	20	26.67	6.67	
54	CAR (GEEP TYPE)	NO.	-	23,000	90	10	20,700	2300.00	
55	BUILDING	M3	-	100.00	10	90	10	90.00	
56	RADIO FACILITY	NO.	-	1,200	90	10	1,080	120.00	
57	IRON MATERIAL	T	3,183	1,061	90	10	955	106.10	
58	HAND PUMP (ϕ30 mm)	NO.	-	410.00	90	10	369.00	41.00	
59	TRANSPORT FEE	T・KM	-	1.1	0	100	0.00	1.10	

Table I.1.14 Depreciation Cost for Machinaries and Equipment

CODE NO.	MACHINE / EQUIPMENT	INITIAL COST(US$)	DEPRECIATION RATE	UNIT	COST (US$) F.C	L.C	TOTAL
1	Ordinary-Truck (2.0t)	16,500	0.000238	hr	3.14	0.79	3.93
		16,500	0.001118	day	14.76	3.69	18.45
2	Ordinary-Truck (4.5t)	26,000	0.000208	hr	4.33	1.08	5.41
		26,000	0.001012	day	21.05	5.26	26.31
3	Dump-Truck (4t)	46,500	0.000221	hr	8.22	2.06	10.28
		46,500	0.000904	day	33.63	8.41	42.04
4	Dump-Truck (11t)	95,000	0.000174	hr	13.22	3.31	16.53
		95,000	0.000773	day	58.75	14.69	73.44
5	Bulldozer (11t)	135,000	0.000200	hr	21.60	5.40	27.00
		135,000	0.000659	day	71.17	17.79	88.97
6	Bulldozer (15t)	182,000	0.000200	hr	29.12	7.28	36.40
		182,000	0.000659	day	95.95	23.99	119.94
7	Bulldozer (21t)	247,000	0.000200	hr	39.52	9.88	49.40
		247,000	0.000659	day	130.22	32.55	162.77
8	Bulldozer w/Ripper (11t)	152,000	0.000208	hr	25.29	6.32	31.62
		152,000	0.000659	day	80.13	20.03	100.17
9	Bulldozer w/Ripper (15t)	204,000	0.000208	hr	33.95	8.49	42.43
		204,000	0.000659	day	107.55	26.89	134.44
10	Bulldozer w/Ripper (21t)	276,000	0.000208	hr	45.93	11.48	57.41
		276,000	0.000659	day	145.51	36.38	181.88
11	Tractor-Shovel (0.7m3)	60,000	0.000240	hr	11.52	2.88	14.40
		60,000	0.000806	day	38.69	9.67	48.36
12	Tractor-Shovel (1.2m3)	120,000	0.000213	hr	20.45	5.11	25.56
		120,000	0.000763	day	73.25	18.31	91.56
13	Back-Hoe (0.50m3)	171,000	0.000169	hr	23.12	5.78	28.90
		171,000	0.000593	day	81.12	20.28	101.40
14	Back-Hoe (0.78m3)	173,000	0.000169	hr	23.39	5.85	29.24
		173,000	0.000593	day	82.07	20.52	102.59
15	Concrete-Pump w/placing boom(45m3/hr)	125,000	0.000413	hr	41.30	10.33	51.63
16	Track-Crane (hydraulic 10~11t)	95,000	0.000263	hr	19.99	5.00	24.99
17	Submarged-Pump (18.5kw, ϕ100)	11,000	0.000875	day	7.70	1.93	9.63
18	Volute-Pump (0.75kw, ϕ50)	400	0.000781	day	0.25	0.06	0.31
19	Compressor (102ps, 83l/s)	30,000	0.000833	day	19.99	5.00	24.99
20	Compressor (55kw, 9l/s)	33,000	0.000061	hr	1.61	0.40	2.01
		33,000	0.000625	day	16.50	4.13	20.63
21	Vibrator (2kw, 55mm)	5,500	0.000850	day	3.74	0.94	4.68
22	Grout-Pump (3.7kw, 30~60l/min)	5,100	0.003648	day	14.88	3.72	18.60
23	Grout-Pump (7.5kw, 200l/min)	7,800	0.003648	day	22.76	5.69	28.45
24	Grout-Mixer (2.2kw, 200l×2)	4,400	0.003648	day	12.84	3.21	16.05
25	Grout-Mixer (5.5kw, 600l×2)	8,000	0.003648	day	23.35	5.84	29.18
26	Rubber-Tired-Roller (8~20t)	70,000	0.000188	hr	10.53	2.63	13.16
		70,000	0.000639	day	35.78	8.95	44.73
27	Boring-Machine (3.7kw, ϕ66mm)	11,000	0.002462	day	21.67	5.42	27.08
28	Vibratory-Roller (2.0~2.8t)	114,000	0.000479	hr	43.68	10.92	54.61
29	Tamper (60kg)	3,650	0.004133	hr	12.07	3.02	15.09
30	Crawler-Crane(50t hydraulic rope)	520,000	0.000162	hr	67.39	16.85	84.24
		520,000	0.000560	day	232.96	58.24	291.20
31	Jib-Crane (9.0 t fixed type)	2,160,000	0.000124	hr	214.62	53.65	268.27
32	Sand-Pump (5.5kw, ϕ100, H=10m)	3,800	0.000848	day	2.58	0.64	3.22
33	Belt-Conveyor(5.5kw, 15m, W=60cm)	13,750	0.000239	hr	2.53	0.63	3.16
		13,750	0.000591	day	6.50	1.62	8.12
34	Butcher-Plant (7.5kw×2, 0.75m3×2)	370,000	0.000219	hr	64.79	16.20	80.99
35	Cement-Silo (0.75kw, 100t, 30t/hr)	27,000	0.000775	day	16.74	4.19	20.93
36	Screw-Conveyor (5.5kw, 10m, 30t/hr)	8,300	0.000200	hr	1.33	0.33	1.66
37	Clamshell (0.8m3, hydrautic rope)	224,000	0.000332	hr	59.49	14.87	74.37
38	Pick-hammer (CA-7)	2,500	0.004808	day	9.62	2.40	12.02
39	Water-Tank (2000l)	243	0.000336	hr	0.07	0.02	0.08
40	Jaw-Crusher (600×900, 75kw)	148,000	0.000244	hr	28.94	7.23	36.17
41	Vibrating-Feeder(100t/hr, 0.60kw)	8,000	0.001546	hr	9.89	2.47	12.36
42	Sieving-Machine(1200×3000mm, 5.5kw)	33,000	0.000233	hr	6.16	1.54	7.70
43	Depreciation of Tire (4.5T)	1,200	0.002020	hr	1.94	0.48	2.42
44	Depreciation of Tire (6T)	1,632	0.002064	hr	2.69	0.67	3.37
45	Depreciation of Tire (11T)	1,728	0.002100	hr	2.90	0.73	3.63
46	Concrete Pump Car (40M3/hr 170kw)	138,000	0.000413	hr	45.60	11.40	56.99

Table I.1.15 Hourly Operation Cost for Machinaries and Equipment

NO.	MACHINE / EQUIPMENT	UNIT	COST (US$)			REMARK
			F.C	L.C	TOTAL	
1	Ordinary-Truck (2.0t)	hr	5.76	3.09	8.84	
2	Ordinary-Truck (4.5t)	hr	10.52	4.45	14.97	
3	Dump-Truck (4t)	hr	17.50	5.96	23.46	
4	Dump-Truck (10~11t)	hr	26.46	10.38	36.84	
5	Bulldozer (11t)	hr	36.18	13.17	49.35	
6	Bulldozer (15t)	hr	48.95	18.94	67.90	
7	Bulldozer (21t)	hr	66.25	23.61	89.86	
8	Bulldozer w/Ripper (11t)	hr	41.97	17.26	59.23	
9	Bulldozer w/Ripper (15t)	hr	57.33	22.17	79.50	
10	Bulldozer w/Ripper (21t)	hr	75.87	27.42	103.29	
11	Tractor-Shovel (0.7m3)	hr	20.62	8.48	29.10	
12	Tractor-Shovel (1.2m3)	hr	35.41	12.63	48.04	
13	Back-Hoe (0.50m3)	hr	39.77	14.75	54.52	
14	Back-Hoe (0.78m3)	hr	40.35	15.95	56.31	
15	Concrete-Pump w/Placing boom (45m3/hr)	hr	41.67	14.38	56.05	
16	Truck-Crane (hydraulic 10~11t)	hr	20.21	7.86	28.07	
17	Submarged-Pump (18.5kw, ϕ100)	mon.	385.69	1.13	386.82	
18		day	9.64	2.41	12.06	
19	Volute-Pump (0.75kw, ϕ50)	hr	0.21	0.02	0.24	
20	Compressor (102ps, 831/s)	day	20.18	1.78	21.96	
21	Compressor (55kw, 91/s)	hr	2.33	0.58	2.92	
22		day	2.33	0.58	2.92	
23	Vibrator (2kw, 55mm)	day	3.95	0.99	4.94	
24	Grout-Pump (3.7kw, 30~60l/min)	day	15.10	3.77	18.87	
25	Grout-Pump (7.5kw, 200l/min)	day	23.24	5.81	29.05	
26	Grout-Mixer (2.2kw, 200l×2)	day	12.98	3.24	16.22	
27	Grout-Mixer (5.5kw, 600l×2)	day	23.70	5.92	29.62	
28	Rubber-Tired-Roller (8~20t)	hr	19.66	7.81	27.48	
29	Boring-Machine (3.7kw, ϕ66mm)	day	45.21	22.03	67.24	
30	Vibratory-Roller (0.5~0.6t)	hr	-			
31	Vibratory-Roller (2.0~2.8t)	hr	-			
32	Tamper (60kg)	day	12.14	5.02	17.15	
33	Crawler-Crane(50t hydraulic rope type)	hr	114.61	37.71	152.32	
34	Jib-Crane (9.0 t fixed type)	hr	215.48	59.02	274.50	
35	Sand-Pump (5.5kw, ϕ100, H=10m)	day	3.16	0.79	3.95	
36	Belt-Conveyor(5.5kw, 15m, W=60cm)	day	6.93	1.73	8.66	
37	Screw-Conveyor (5.5kw, 10m, 30t/hr)	hr	0.99	0.25	1.24	
38	Concrete Pump Car (40M3/hr 170kw)	hr	45.97	14.74	60.71	

Table I.1.16 Unit Price

UNIT NO.	DISCRIPTION	UNIT	COST FOREIGN	COST LOCAL	COST TOTAL	REMARK
EARTH WORK						
1	EXCAVATION FOR SOIL (BULL. 21T)	100M3	370.92	137.76	508.68	
2	EXCAVATION FOR ROCK (BULL. 21T)	100M3	706.04	260.59	966.63	
3	FINISH WORK FOR ROCK	100M2	394.91	149.33	544.24	
4	EXCAVATION FOR ROCK BY BACK-HOE(0.5M3)	M3	3.79	1.40	5.19	
5	EXCAVATION FOR SOIL BY BACK-HOE(0.5M3)	M3	2.53	0.94	3.47	
6	EXCAVATION FOR ROCK BY BOCK-HOE(0.7M3)	M3	1.95	0.77	2.72	
7	EXCAVATION FOR SOIL BY BOCK-HOE(0.7M3)	M3	1.30	0.51	1.81	
8	BACK FILL (BULLDOZER 21T)	M3	1.49	0.53	2.02	
9	BACK FILL (BULLDOZER 15T)	M3	-	-	-	
10	BACK FILL (BULLDOZER 11T)	M3	1.32	0.48	1.80	
11	TRNSPORT BACK FILL (BULL 11T)	100M3	260.46	94.26	354.72	
12	BACK FILL FOR SOIL (BULL 11T)	M3	-	-	-	
13	BANK (BULL 15T)	M3	1.67	0.64	2.31	
14	SPOIL OF SOIL (1km)	100M3	173.70	65.61	239.31	
15	SPOIL OF ROCK (1km)	100M3	290.50	108.95	399.45	
16	CONSORIDATION GRAVEL	M3	0.16	13.10	13.26	
17	CLEANING & GRUBBING (BULLDOZER 11T)	100M2	30.32	11.17	41.49	
18	CLEANING FOR ROCK	100M2	26.77	317.26	344.03	
19	LAND GRANDING (BULLDOZER 11T)	100M2	3.99	1.45	5.44	
20	FINISHING FOR BANK	10M2	0.00	0.71	0.71	
21	FINISHING FOR CUT (SOIL)	10M2	0.00	1.31	1.31	
22	FINISHING FOR CUT (MIXED STONE)	10M2	0.00	1.79	1.79	
23	FINISHING FOR CUT (ROCK)	10M2	0.00	2.46	2.46	
24	DEWATERING (ϕ100)	day	12.83	9.07	21.90	
25	DISPORTION FOR REMAIN SOIL (L=100m)	100M3	201.84	78.03	279.87	
26	〃 (L=200m)	100M3	208.88	80.79	289.67	
27	〃 (L=300m)	100M3	219.44	84.93	304.37	
28	〃 (L=500m)	100M3	233.52	90.45	323.97	
CONCRETE WORK						
31	PLACING CONCRETE FOR DAM (H-225a)	M3	31.68	47.29	78.97	
32	PLACING R.C. CONCRETE FOR DAM (H-225)	M3	20.26	46.29	66.55	
33	PLACING CONCRETE FOR DAM (H-150)	M3	19.76	41.77	61.53	
34	PLACING CONCRETE FOR DAM (H-100)	M3	18.92	34.22	53.14	
35	TRANSPORT FOR CONCRETE (4.5T)	HR	16.55	4.91	21.46	
36	FORM OF MAIN CONCRETE FOR DAM	M2	35.32	29.94	65.26	
37	FORM OF GENERAL CONCRETE FOR DAM	M2	35.32	11.17	46.49	
38	FORM OF CONCRETE FOR GENERAL	M2	0.93	2.28	3.21	
39	JOINT & CUIRING	100M2	12.41	42.12	54.53	
40	PLACING REIN. CONCRETE FOR GENERAL (H-225)	M3	8.88	44.76	53.64	
41	PLACING CONCRETE FOR GENERAL (H-150)	M3	8.38	40.23	48.61	
42	PLACING CONCRETE FOR GENERAL (H-100)	M3	7.54	32.67	40.21	
43	EQUIVALIZATION CONCRETE	M3	7.98	33.53	41.51	
44	PAVINIG MORTAR (T=10cm)	M3	4.93	54.29	59.22	
45	PROCESSED REI. (D16≦)	T	1515.85	198.78	1714.63	
46	PROCESSED REI. (D13≧)	T	1515.85	219.47	1735.32	
47	ADJUSTMENT OF WATER STOP	M	28.50	3.10	31.60	
ROAD						
49	CONSTRUCTION OF GRAVEL ROAD	M2	0.08	5.39	5.47	
50	ACCESS ROAD	M2	0.96	0.36	1.32	
51	CROSSING	NO.	448.05	427.28	875.33	
52	BRIDGE UNDER WATER	M	133.68	125.08	258.76	
53	BORING	M	11.18	16.34	27.52	
54	GROUTING	M	0.52	0.88	1.40	
55	GABION WORKS	M3	19.39	15.80	35.19	
56	MASONRY WORKS	M3	5.14	27.51	32.65	
57	RIP RAP	M2	0.00	15.56	15.56	
58	PLAING OF PVC (ϕ200)	M	36.18	9.13	45.31	
59	〃 (ϕ250)	M	51.29	12.92	64.21	
60	〃 (ϕ300)	M	67.83	17.07	84.90	
61	〃 (ϕ350)	M	96.19	10.82	107.01	
62	〃 (ϕ400)	M	127.64	14.32	141.96	
63	〃 (ϕ450)	M	149.83	16.81	166.64	
64	〃 (ϕ500)	M	179.43	20.12	199.55	
65	PLAING OF R.C.PIPE (ϕ600)	M	98.50	27.52	126.02	
66	〃 (ϕ700)	M	107.37	29.98	137.35	
67	〃 (ϕ800)	M	113.89	32.53	146.42	
68	PLAING OF CORRUGATE PIPE (ϕ900)	M	32.40	8.96	41.36	
69	〃 (ϕ1050)	M	24.21	7.19	31.40	
70	〃 (ϕ1200)	M	41.66	11.82	53.48	
71	PLAING OF DCIP PIPE (ϕ300)	M	102.68	12.63	115.31	
72	〃 (ϕ500)	M	206.78	25.13	231.91	
73	〃 (ϕ600)	M	275.18	32.73	307.91	

Table I.1.17 O & M Cost for Farmers' Association

(Unit: US$)

Year	U.P	Preparation 1st	Preparation 2nd	Construction 3rd	Construction 4th	Total	Operation 5th	Operation 6th
Administration Cost								
Director	6,000						1 6,000	1 6,000
Clerk	4,000						3 12,000	3 12,000
Secretary	3,000						1 3,000	1 3,000
Driver	3,000						2 6,000	2 6,000
Sub-total							27,000	27,000
Investment								
Truck	15,000						1 15,000	0
Pick-up	12,000						2 24,000	0
Motorcycle	5,000						3 15,000	0
Office							1,000	1,000
Sub-total							55,000	1,000
O/M Cost								
Truck	2,000						1 2,000	1 2,000
Pick-up	2,000						2 4,000	2 4,000
Motorcycle	1,000						3 3,000	3 3,000
Sub-total							9,000	9,000
Total							91,000	37,000

Table I.2.1 Disbursement Schedule

(Unit: US$1,000)

ITEM	1st F/C	1st L/C	1st Total	2nd F/C	2nd L/C	2nd Total	3rd F/C	3rd L/C	3rd Total	4th F/C	4th L/C	4th Total	Total F/C	Total L/C	Total Total
1. Dam				944	820	1,764	1,731	1,504	3,235	473	410	883	3,148	2,734	5,882
2. Sabo-Dam							685	842	1,527	456	561	1,017	1,141	1,403	2,544
3. Canal							437	443	880	436	442	878	873	885	1,758
4. Reservoir							224	217	441	223	216	439	447	433	880
Sub-Total	0	0	0	944	820	1,764	3,077	3,006	6,083	1,588	1,629	3,217	5,609	5,455	11,064
5. Agricaltural Facilities							5	47	52	5	46	51	10	93	103
6. Road							33	218	251	32	218	250	65	436	501
7. Electricitiy							6	26	32	7	25	32	13	51	64
8. Water Supply							4	2	6	10	1	11	14	3	17
9. Sanitary Facilities							15	11	26	14	10	24	29	21	50
10. Educational Facilities							3	23	26	2	22	24	5	45	50
Sub-Total	0	0	0	0	0	0	66	327	393	70	322	392	136	649	785
11. Land Aqui. & Comsa.				0	31	31							0	31	31
12. O/M Equipment				421	22	443							421	22	443
13. Consulting Sevices	269	73	342	135	36	171	135	36	171	134	37	171	673	182	855
14. Adoainistration Cost	15	112	127	0	109	109	15	111	126	15	88	103	45	420	465
Sub-Total	284	185	469	556	198	754	150	147	297	149	125	274	1,139	655	1,794
Total	284	185	469	1,500	1,018	2,518	3,293	3,480	6,773	1,807	2,076	3,883	6,884	6,759	13,643
15. Physical Contingency	14	9	23	122	92	214	322	341	662	173	201	375	631	643	1,274
16. Price Escalation	9	6	15	97	67	164	325	344	669	238	273	511	669	690	1,359
Sub-Total	23	15	38	219	159	378	647	685	1,331	411	474	886	1,300	1,333	2,633
Ground Total	307	200	507	1,719	1,177	2,896	3,940	4,165	8,104	2,218	2,550	4,769	8,184	8,092	16,276