Table 5-3-3 Number of Blocks by Aquifer Depths

Aquifer Depth (m)	0~ 49	50~ 99	100~ 149	150~ 199	200~ 299	>=300	Unknown	Total
Chuquisaca	349	268	351	155	79	21	-	1,223
South of La Paz	160	35	450	117	-	-	-	762
Oruro	23	224	228	52	17	-	-	544
Tarija	-	197	150	5	94	2	63	511
Santa Cruz	4	580	371	115	70	79	6	1,225
Total	536	1,304	1,550	444	260	102	69	4,265

Table 5-3-4 Distribution by Department of the Number of Blocks by Topographical Divisions

Topographical Divisions	Altiplano	Valley		Plain			Total
		Cordillera Zone	Seranias Zone	Eastern Plain	Escudo Central	Chaco Plain	
Chuquisaca	-	1,039	171	-	-	13	1,223
South of La Paz	689	73	-	-	-	-	762
Oruro	384	160	-	-	-	-	544
Tarija	-	315	130	-	-	66	511
Santa Cruz	-	-	295	732	167	31	1,225
Total	1073	1,587	596	732	167	110	4,265

5.3.3 Project Implementation Case Study

1) Objectives and Procedures

The conditions to realized the groundwater development project can be summarized as follows:

a. Urgent needs for groundwater development (water scarcity, no alternative water sources.)
b. Availability of groundwater development (aquifer with sustainable productivity.)
c. Financial feasibility of the project (procurement of investment funds.)
d. Willingness and technical ability of the organization concerned.
e. Sustainability for operation and maintenance of the system (community commitment, supporting system.)
f. Effectiveness of the project.

A case study was carried out in order to examine the plan targets and project implementation strategy of the groundwater development project in the Study Area. After

determined the target coverages, project implementation strategies, and project forms for the groundwater development project in each Department, the applicable project was selected, and the necessary equipment, term of drilling, and investment amount were determined. The appropriate project scale, plan targets, and project implementation strategies were then examined upon assessing the feasibility of the project in financial, technological, and organizational aspects based on the results of the case study. Figure 5-3-1 shows the procedures for carrying out the case study.

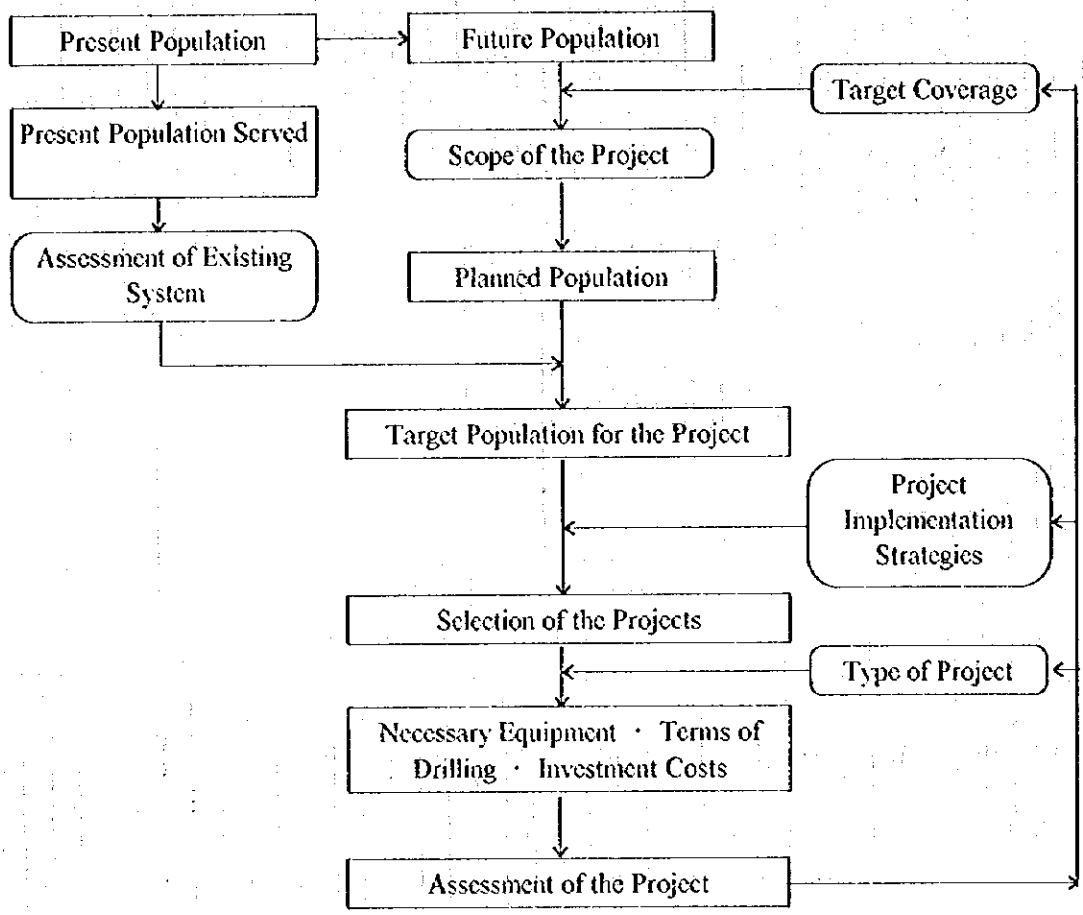


Figure 5-3-1 Procedures for the Case Study

2) Target Population

The target population was determined by subtracting the population served by existing facilities from the planned population served for the target year. The population served by existing facilities was determined for each water supply block by multiplying the present population served by the obsolescence factor of existing equipment. Next, the population to be

targeted by the groundwater development project was determined by taking into consideration the factor of effectiveness after the start of provision of service to the applicable population.

Target population = [Planned population served] - [Population served by existing facilities]
Planned population served = [Population in the Study Area] × [Target coverage]
Population served by existing facilities = [Present population served] × [Obsolescence factor of existing water supply facility]
Target population of the project = [Applicable population] ÷ [Effectiveness factor]

Table 5-3-5 shows the results of calculating the target population of the groundwater development project for different target coverages set in 10% increments for the rural areas of each Department and subjecting only rural blocks with a coverage of less than 60%. Here, it was assumed that the present coverage level will be maintained as a whole in the target year in cities with a population of 2,000 or more and in rural blocks in which the present coverage has reached 60% or more.

Table 5-3-5 Target Population of the Groundwater Development Project (Targeting only the rural areas.)

Department	Present Coverage	Target Coverage (Year 2000)				
		20%	30%	40%	50%	60%
Chuquisaca	15.9%	20,019	56,928	93,836	130,746	167,655
South of La Paz	16.4%	5,955	19,863	33,770	47,677	61,585
Oruro	21.3%	-	16,095	28,626	41,158	53,689
Tarija	36.8%	-	-	11,845	30,801	49,758
Santa Cruz	25.1%	-	43,095	98,155	153,215	208,274

Note: The effectiveness of the project was presumed to be 80%.

3) Selection of Water Supply Blocks of the Project

The development priority of the groundwater development project is considered to be high for districts with a large beneficiary population, districts with low present coverage, and districts where water source development is easy and has a high possibility of success. Besides these, the willingness of the inhabitants to participate, the accessibility, the efficiency of moving drilling equipment, work efficiency must also be considered.

In the case study, the water supply blocks of the project were selected upon setting up the following three project implementation strategies using the three indices of present population, present coverage, and estimated aquifer depth, which were used as indices for water supply block classification.

[1] Priority is placed on blocks with larger population unserved (economic efficiency).

[2] Priority is placed on blocks without existing water supply systems (basic human need).

[3] Priority is placed on blocks with shallower aquifer (drilling efficiency).

The numbers of selected blocks are shown according to target coverage and project implementation strategy for each Department in Tables 5-3-6 to 5-3-10. While the number of blocks will be the fewest with project implementation strategy [1], blocks will be included which, due to having a large population, are given high priority despite being high in coverage. With project implementation strategy [2], since only the blocks with a present coverage of 0% are selected, the number of blocks will be considerably high depending on the Department and blocks with an extremely low population will also be included. With project implementation strategy [3], areas in which it is difficult to obtain water from sources other than deep groundwater are excluded since blocks with a low drilling construction cost per inhabitant are selected.

4) Cost Estimation and Term of Drilling

The groundwater development project can be divided into the procurement of equipment, well drilling work, water supply facility construction, survey/design/control activities, etc. The following project forms can be considered with regard to the method of execution of the project in view of the division of domestic funds and foreign funds.

[A] Construction is carried out by Bolivia on its own. The project is executed by commissioning work to domestic private constructor.

[B] Well drilling is executed through grant aids, and the Bolivian side carries out the water supply facility work.

[C] Well drilling equipment are procured through grant aids and the Bolivian side carries out the works.

Tables 5-3-6 to 5-3-10 show the results of calculating the project cost and the term of drilling work according to project form upon setting the target coverage and project implementation strategy for each Department and selecting the blocks to be targeted by the project.

[Setting of Conditions]

The term of drilling work was calculated respectively for the case where the work is to be commissioned to and carried out by domestic private firms, the case where a foreign aid agency procures equipment from the corresponding nation and carries out the work, and the case where Bolivian engineers are to carry out the work using equipment procured from overseas. The project cost was estimated upon dividing it into the drilling equipment procurement cost, drilling work

cost, water supply equipment procurement cost, water supply facility construction cost, and drilling work staff cost and setting unit costs for each water supply block classification package. The unit cost for the drilling work cost was set as a per meter unit cost, that for the procurement cost of water supplying equipment, such as well casings, screens, lift pump, generator, etc., was set as a per site unit cost, and that for the water supply construction cost including piping, tanks, etc. was set as a per person unit cost.

Table 5-3-6 Results of Project Implementation Case Study (Department of Chuquisaca)

Target Coverage	Project Implementation Strategy	Number of Blocks	Target Population	Form of Project	Number of Drilling Equipment	Project Cost (million US$)			Project Cost per Person (US$)		Term of Drilling (Year)	Evaluation
						External Funds	Domestic Funds	Total	External Funds	Domestic Funds		
20%	[1]	22	20,391	[A] Commission	1 set	–	3.2	3.2	–	156	1.6	×
				[B] Cooperate in DW	1 set	1.8	1.5	3.3	86	72	1.0	
				[C1] Cooperate in PE	1 set	5.1	2.0	7.1	252	97	1.3	
20%	[2]	27	20,094	[A] Commission	1 set	–	3.8	3.8	–	188	2.2	×
				[B] Cooperate in DW	1 set	2.5	1.5	4.0	124	77	1.4	
				[C1] Cooperate in PE	1 set	5.1	2.2	7.3	255	108	1.8	
20%	[3]	28	20,466	[A] Commission	1 set	–	3.3	3.3	–	161	1.4	×
				[B] Cooperate in DW	1 set	1.4	1.6	3.0	68	77	0.9	
				[C1] Cooperate in PE	1 set	5.1	2.1	7.2	251	103	1.1	
30%	[1]	94	56,995	[A] Commission	2 set	–	12.2	12.2	–	214	3.8	×
				[B] Cooperate in DW	5 set	8.6	4.7	13.3	151	83	1.0	
				[C1] Cooperate in PE	1 set	5.1	6.5	11.6	90	114	6.1	×
				[C2] Cooperate in PE	2 set	8.2	6.8	15.0	144	119	3.1	
30%	[2]	113	57,297	[A] Commission	2 set	–	14.5	14.5	–	253	4.9	×
				[B] Cooperate in DW	7 set	11.3	5.1	16.4	197	89	1.0	×
				[C1] Cooperate in PE	1 set	5.1	7.3	12.4	90	128	7.9	×
				[C2] Cooperate in PE	2 set	8.2	7.6	15.8	143	132	4.0	
30%	[3]	125	57,114	[A] Commission	2 set	–	12.8	12.8	–	224	3.2	×
				[B] Cooperate in DW	4 set	6.6	5.4	12.0	116	94	1.0	
				[C1] Cooperate in PE	1 set	5.1	7.2	12.3	90	126	4.9	
				[C2] Cooperate in PE	2 set	8.2	7.5	15.7	144	130	2.5	
40%	[1]	194	94,023	[A] Commission	4 set	–	24.3	24.3	–	259	4.1	×
				[B] Cooperate in DW	10set	18.4	8.6	27.0	196	91	1.0	×
				[C1] Cooperate in PE	1 set	5.1	12.1	17.2	55	129	12.9	×
				[C2] Cooperate in PE	3 set	10.0	12.7	22.7	106	135	4.3	×
40%	[2]	227	93,898	[A] Commission	4 set	–	27.7	27.7	–	295	4.8	×
				[B] Cooperate in DW	12set	21.9	9.2	31.1	233	98	1.0	×
				[C1] Cooperate in PE	1 set	5.1	13.4	18.5	55	143	15.3	×
				[C2] Cooperate in PE	4 set	11.8	14.2	26.0	126	151	3.9	×
40%	[3]	251	94,561	[A] Commission	3 set	–	25.5	25.5	–	270	4.7	×
				[B] Cooperate in DW	9 set	15.0	9.7	24.7	159	103	2.2	×
				[C1] Cooperate in PE	1 set	5.1	13.4	18.5	54	142	10.8	×
				[C2] Cooperate in PE	3 set	10.0	14.0	24.0	106	148	3.6	×

(Note)

[A] Commission private constructor

[B] Cooperation in drilling work

[C1] Cooperation in procurement of equipment : in the case where one unit of equipment is to be procured.

[C2] Cooperation in procurement of equipment - the number of units required for the completion of drilling in 5 years is indicated.

Indicates the unfavourable condition

Table 5-3-7 Results of Project Implementation Case Study (Southern Part of La Paz)

Target Coverage	Project Implementation Strategy	Number of Blocks	Target Population	Form of Project	Number of Drilling Equipment	Project Cost (million US$)			Project Cost per Person (US$)		Term of Drilling (Year)	Evaluation
						External Funds	Domestic Funds	Total	External Funds	Domestic Funds		
20%	[1]	7	6,083	[A] Commission	1 set	--	1.1	1.1	--	188	0.6	×
				[B] Cooperate in DW	1 set	0.6	0.4	1.0	102	73	0.4	
				[C1] Cooperate in PE	1 set	4.3	0.9	5.2	707	140	0.5	×
20%	[2]	10	6,096	[A] Commission	1 set	--	1.1	1.1	--	235	0.8	×
				[B] Cooperate in DW	1 set	0.9	0.5	1.4	146	83	0.5	
				[C1] Cooperate in PE	1 set	4.4	0.9	5.3	713	153	0.7	×
20%	[3]	11	6,081	[A] Commission	1 set	--	1.4	1.4	--	225	0.7	×
				[B] Cooperate in DW	1 set	0.7	0.5	1.2	110	86	0.4	
				[C1] Cooperate in PE	1 set	4.4	0.9	5.3	717	151	0.5	×
30%	[1]	45	20,012	[A] Commission	1 set	--	5.5	5.5	--	275	3.7	×
				[B] Cooperate in DW	3 set	4.1	1.9	6.0	207	95	0.8	
				[C1] Cooperate in PE	1 set	4.6	2.8	7.4	228	142	2.9	
30%	[2]	57	20,013	[A] Commission	1 set	--	6.7	6.7	--	333	4.7	×
				[B] Cooperate in DW	3 set	5.3	2.1	7.4	264	107	1.5	
				[C1] Cooperate in PE	1 set	4.6	3.3	7.9	228	164	3.7	×
30%	[3]	77	20,102	[A] Commission	1 set	--	7.5	7.5	--	373	4.6	×
				[B] Cooperate in DW	3 set	4.9	2.5	7.4	245	127	1.5	
				[C1] Cooperate in PE	1 set	4.6	3.8	8.4	227	190	3.6	×
40%	[1]	105	33,783	[A] Commission	2 set	--	12.2	12.2	--	360	4.3	×
				[B] Cooperate in DW	6 set	9.8	3.8	13.6	289	112	1.8	
				[C1] Cooperate in PE	1 set	4.6	5.8	10.4	135	171	6.9	×
				[C2] Cooperate in PE	2 set	7.1	6.0	13.1	210	179	3.4	×
40%	[2]	128	33,934	[A] Commission	3 set	--	15.0	15.0	--	441	3.7	×
				[B] Cooperate in DW	7 set	12.6	4.3	16.9	372	125	1.7	×
				[C1] Cooperate in PE	1 set	4.6	6.7	11.3	131	198	8.8	×
				[C2] Cooperate in PE	2 set	7.1	7.0	14.1	209	206	4.4	×
40%	[3]	180	33,799	[A] Commission	3 set	--	17.9	17.9	--	530	4.2	×
				[B] Cooperate in DW	8 set	14.1	5.3	19.4	417	157	1.0	×
				[C1] Cooperate in PE	1 set	4.6	8.3	12.9	135	246	10.0	×
				[C2] Cooperate in PE	2 set	7.1	8.6	15.7	209	254	5.0	×

(Note)

[A] Commission private constructor

[B] Cooperation in drilling work

[C1] Cooperation in procurement of equipment . in the case where one unit of equipment is to be procured.

[C2] Cooperation in procurement of equipment - the number of units required for the completion of drilling in 5 years is indicated.

Indicates the unfavourable condition

Table 5-3-8 Results of Project Implementation Case Study (Department of Oruro)

Target Coverage	Project Implementation Strategy	Number of Blocks	Target Population	Form of Project	Number of Drilling Equipment	Project Cost (million US$)			Project Cost per Person (US$)		Term of Drilling (Year)	Evaluation
						External Funds	Domestic Funds	Total	External Funds	Domestic Funds		
30%	[1]	20	16,427	[A] Commission	1 set	--	3.0	3.0	--	180	1.7	×
				[B] Cooperate in DW	2 set	1.9	1.2	3.1	116	74	0.6	
				[C1] Cooperate in PE	1 set	4.6	1.7	6.8	278	105	1.4	
30%	[2]	41	16,169	[A] Commission	1 set	--	5.5	5.5	--	338	4.0	×
				[B] Cooperate in DW	1 set	4.5	1.7	6.2	281	104	2.5	
				[C1] Cooperate in PE	1 set	4.6	2.7	7.3	282	164	3.2	×
30%	[3]	22	16,268	[A] Commission	1 set	--	3.0	3.0	--	185	1.7	
				[B] Cooperate in DW	1 set	1.8	1.3	3.1	112	77	1.1	
				[C1] Cooperate in PE	1 set	4.6	1.8	6.4	280	109	1.3	
40%	[1]	55	28,650	[A] Commission	1 set	--	7.1	7.1	--	248	4.8	×
				[B] Cooperate in DW	3 set	5.5	2.5	8.0	191	88	1.0	
				[C1] Cooperate in PE	1 set	4.6	3.7	8.3	159	128	3.9	
40%	[2]	113	28,650	[A] Commission	3 set	--	13.6	13.6	--	474	3.5	×
				[B] Cooperate in DW	7 set	11.9	3.7	15.6	416	129	0.9	×
				[C1] Cooperate in PE	1 set	4.6	5.9	11.0	159	208	8.3	×
				[C2] Cooperate in PE	2 set	8.2	6.2	14.4	286	217	4.2	×
40%	[3]	61	28,788	[A] Commission	1 set	--	7.3	7.3	--	252	4.6	×
				[B] Cooperate in DW	3 set	5.2	2.7	7.9	180	92	1.5	
				[C1] Cooperate in PE	1 set	4.6	3.8	8.9	158	133	3.7	
50%	[1]	108	41,314	[A] Commission	3 set	--	13.6	13.6	--	330	3.3	×
				[B] Cooperate in DW	6 set	11.2	4.2	15.4	272	102	1.0	×
				[C1] Cooperate in PE	1 set	4.6	6.4	11.0	110	154	7.8	×
				[C2] Cooperate in PE	2 set	7.1	6.6	13.7	171	161	3.9	×
50%	[2]	229	41,188	[A] Commission	5 set	--	26.1	26.1	--	633	4.1	×
				[B] Cooperate in DW	13 set	23.3	6.6	29.9	566	161	1.0	×
				[C1] Cooperate in PE	1 set	4.6	11.0	15.6	111	266	16.3	×
				[C2] Cooperate in PE	4 set	11.8	11.8	23.6	286	286	4.1	×
50%	[3]	118	41,261	[A] Commission	2 set	--	13.5	13.5	--	327	4.6	×
				[B] Cooperate in DW	7 set	10.4	4.4	14.8	251	107	1.5	×
				[C1] Cooperate in PE	1 set	4.6	6.6	11.2	111	159	7.3	×
				[C2] Cooperate in PE	2 set	7.1	6.8	13.9	172	166	3.7	×

(Note)

[A] Commission private constructor

[B] Cooperation in drilling work

[C1] Cooperation in procurement of equipment . in the case where one unit of equipment is to be procured.

[C2] Cooperation in procurement of equipment - the number of units required for the completion of drilling in 5 years is indicated.

Indicates the unfavourable condition

Table 5-3-9 Results of Project Implementation Case Study (Department of Tarija)

Target Coverage	Project Implementation Strategy	Number of Blocks	Target Population	Form of Project	Number of Drilling Equipment	Project Cost (million US$)			Project Cost per Person (US$)		Term of Drilling (Year)	Evaluation
						External Funds	Domestic Funds	Total	External Funds	Domestic Funds		
40%	[1]	16	12,245	[A] Commission	1 set	--	2.8	2.8	--	233	2.1	×
				[B] Cooperate in DW	2 set	2.5	0.9	3.4	205	76	0.7	
				[C1] Cooperate in PE	1 set	4.5	1.5	6.0	366	123	1.8	×
40%	[2]	22	11,912	[A] Commission	1 set	--	3.2	3.2	--	269	2.3	×
				[B] Cooperate in DW	2 set	2.7	1.0	3.7	223	87	0.7	
				[C1] Cooperate in PE	1 set	4.6	1.6	6.2	383	138	1.9	×
40%	[3]	21	12,105	[A] Commission	1 set	--	2.8	2.8	--	232	1.8	×
				[B] Cooperate in DW	2 set	2.0	1.0	3.0	161	85	0.6	
				[C1] Cooperate in PE	1 set	4.6	1.5	6.6	377	128	1.4	×
50%	[1]	59	30,983	[A] Commission	2 set	--	8.9	8.9	--	286	3.4	×
				[B] Cooperate in DW	5 set	8.0	2.7	10.7	259	88	0.9	
				[C1] Cooperate in PE	1 set	4.6	4.1	8.7	147	134	5.6	×
				[C2] Cooperate in PE	2 set	8.2	4.4	12.6	265	143	2.8	
50%	[2]	89	30,825	[A] Commission	2 set	--	11.2	11.2	--	362	4.2	×
				[B] Cooperate in DW	6 set	9.6	3.3	12.9	312	108	0.9	×
				[C1] Cooperate in PE	1 set	4.6	5.2	9.8	146	167	6.7	×
				[C2] Cooperate in PE	2 set	8.2	5.4	13.6	266	176	3.4	×
50%	[3]	72	30,905	[A] Commission	2 set	--	8.9	8.9	--	286	3.0	×
				[B] Cooperate in DW	4 set	6.7	3.0	9.7	216	97	1.0	
				[C1] Cooperate in PE	1 set	4.6	4.4	9.0	148	142	4.7	
				[C2] Cooperate in PE	2 set	8.2	4.7	12.9	265	151	2.4	×
60%	[1]	120	49,938	[A] Commission	3 set	--	16.4	16.4	--	328	4.2	×
				[B] Cooperate in DW	8 set	14.6	4.9	19.5	293	98	2.0	×
				[C1] Cooperate in PE	1 set	4.6	7.5	12.6	91	150	10.1	×
				[C2] Cooperate in PE	3 set	10.0	8.0	18.0	200	161	3.4	×
60%	[2]	185	45,184	[A] Commission	4 set	--	22.1	22.1	--	489	4.3	×
				[B] Cooperate in DW	11 set	19.7	6.0	25.7	436	132	1.0	×
				[C1] Cooperate in PE	1 set	4.6	9.6	14.7	104	212	13.7	×
				[C2] Cooperate in PE	3 set	10.0	10.1	20.1	221	224	4.6	×
60%	[3]	134	49,765	[A] Commission	3 set	--	16.3	16.3	--	328	3.9	×
				[B] Cooperate in DW	8 set	13.2	5.2	18.4	264	104	0.9	×
				[C1] Cooperate in PE	1 set	4.6	7.7	12.8	92	155	9.2	×
				[C2] Cooperate in PE	2 set	8.2	8.0	16.2	165	160	4.6	×

(Note)

[A] Commission private constructor

[B] Cooperation in drilling work

[C1] Cooperation in procurement of equipment , in the case where one unit of equipment is to be procured.

[C2] Cooperation in procurement of equipment - the number of units required for the completion of drilling in 5 years is indicated.

Indicates the unfavourable condition

Table 5-3-10 Results of Project Implementation Case Study (Department of Santa Cruz)

Target Coverage	Project Implementation Strategy	Number of Blocks	Target Population	Form of Project	Number of Drilling Equipment	Project Cost (million US$)			Project cost per Person (US$)		Term of Drilling (Year)	Evaluation
						External Funds	Domestic Funds	Total	External Funds	Domestic Funds		
30%	[1]	45	43,322	[A] Commission	1 set	--	6.8	6.8	--	156	3.8	×
				[B] Cooperate in DW	3 set	4.4	3.1	7.5	100	71	1.0	
				[C1] Cooperate in PE	1 set	5.1	4.0	9.1	118	93	3.1	
30%	[2]	61	43,454	[A] Commission	1 set	--	8.8	8.8	--	202	2.7	×
				[B] Cooperate in DW	4 set	6.0	3.4	9.4	138	78	0.9	
				[C1] Cooperate in PE	1 set	5.1	4.6	9.7	118	107	4.2	
30%	[3]	49	43,520	[A] Commission	1 set	--	6.0	6.0	--	138	3.6	
				[B] Cooperate in DW	3 set	4.0	3.2	7.2	91	73	0.8	
				[C1] Cooperate in PE	1 set	5.1	4.1	9.2	118	94	2.8	
40%	[1]	145	98,354	[A] Commission	3 set	--	20.2	20.2	--	204	4.2	×
				[B] Cooperate in DW	8 set	14.5	7.8	22.3	147	79	1.0	×
				[C1] Cooperate in PE	1 set	5.1	10.6	15.7	52	107	10.1	×
				[C2] Cooperate in PE	3 set	10.0	11.1	21.1	101	113	3.4	
40%	[2]	179	98,341	[A] Commission	4 set	--	23.5	23.5	--	239	3.9	×
				[B] Cooperate in DW	10 set	17.8	8.5	26.3	181	86	1.0	×
				[C1] Cooperate in PE	1 set	5.1	11.9	17.0	52	121	12.4	×
				[C2] Cooperate in PE	3 set	10.0	12.4	22.4	102	126	4.2	
40%	[3]	154	98,417	[A] Commission	3 set	--	19.6	19.6	--	199	3.8	×
				[B] Cooperate in DW	8 set	12.9	8.0	20.9	131	81	0.9	×
				[C1] Cooperate in PE	1 set	5.1	10.7	15.8	52	109	9.1	×
				[C2] Cooperate in PE	2 set	8.2	10.9	19.1	83	111	4.6	
50%	[1]	275	153,248	[A] Commission	5 set	--	36.5	36.5	--	238	4.9	×
				[B] Cooperate in DW	16 set	28.3	13.2	41.5	185	86	1.0	×
				[C1] Cooperate in PE	1 set	5.1	18.4	23.5	33	120	19.7	×
				[C2] Cooperate in PE	4 set	11.8	19.2	31.0	77	125	5.0	×
50%	[2]	337	153,503	[A] Commission	7 set	--	43.4	43.4	--	283	4.4	×
				[B] Cooperate in DW	19 set	35.7	14.4	50.1	232	94	1.0	×
				[C1] Cooperate in PE	1 set	5.1	20.8	25.9	33	136	21.8	×
				[C2] Cooperate in PE	5 set	14.2	21.9	36.1	153	143	5.0	×
50%	[3]	297	153,497	[A] Commission	5 set	--	36.1	36.1	--	235	4.5	×
				[B] Cooperate in DW	14 set	25.3	13.6	38.9	165	89	1.0	×
				[C1] Cooperate in PE	1 set	5.1	18.7	23.8	33	122	17.3	×
				[C2] Cooperate in PE	4 set	11.8	19.8	31.6	77	129	4.5	×

(Note)

[A] Commission private constructor

[B] Cooperation in drilling work

[C1] Cooperation in procurement of equipment , in the case where one unit of equipment is to be procured.

[C2] Cooperation in procurement of equipment - the number of units required for the completion of drilling in 5 years is indicated.

Indicates the unfavourable condition

5) Evaluation of the Case Study

The supply-side restriction conditions for the realization of the groundwater development project include ① that the project can be expected to be completed within the planned term, ② that the project matches the funds provided and the financial ability of the bearing organization, ③ that the investment efficiency is not poor, and ④ that the project is feasible both in terms of organization and technology. The evaluation standards for the case study were thus set as follows:

[Evaluation Standards]

① In order to achieve the plan targets in 5 years, the term of drilling work is set to 5 years or less.

② The total investment amount of foreign funds is 10 million dollars or less per Department.

③ The total investment amount of domestic funds does not exceed the amount of funds estimated to be investable into the water supply department in the next 5 years. The amounts investable were estimated as shown in Table 5-3-11 based on the actual amounts invested to the basic sanitation department of each Department and the actual budget amounts of the former CORDES.

④ The investment amount per inhabitant is 500 dollars or less of foreign funds and 150 dollars of less of domestic funds.

Table 5-3-11 Estimation of the Annual Amounts Investable into the Water Supply Department

(Unit: 1000 dollars/year)

	Actual amount invested for basic sanitation (A)	Own funds of former CORDES (B)	Estimated amount investable (B×2)
Chuquisaca	3,352	882	1,760
South of La Paz	1,345	417	830
Oruro	3,472	476	950
Tarija	3,415	864	1,730
Santa Cruz	8,720	2,163	4,330
Total	20,304	4,802	9,600

Note: The actual amount invested for basic sanitation and the own funds of the former CORDES are averages for 1992-94.

The investment amount for the southern part of La Paz was calculated for 16% (proportion of population) of the entire Department of La Paz.

The case study results can be analyzed and evaluated as follows:

(1) In all of the cases, the project cost per person becomes higher as the target coverage is

raised.

(2) The upper limits of the planned target coverage for which the project can be completed feasibly within 5 years are 30% for Chuquisaca, 30% for the southern part of La Paz, 40% for Oruro, 50% for Tarija, and 40% for Santa Cruz. With higher targets, the extent of the project will be too great and will be difficult to realize in terms of funds, organization, technology, and time.

(3) For the case where the above target coverages are set, the minimum number of units of drilling equipment necessary for the completion of the project in 5 years will be 2 units for Chuquisaca, 1 unit for the southern part of La Paz, 1 unit for Oruro, 2 units for Tarija, and 3 units for Santa Cruz.

(4) A comparison of the project cost of each project implementation strategy shows that the project cost will be lowest with strategy [1] in most cases.

(5) A comparison of the case where foreign aid is restricted to drilling work (no provision of equipment) (form of project [B]) and the case where drilling equipment are provided by foreign aid and the Bolivian side carries out the drilling work (form of project [C]) shows that the total project cost will be lower for [B] in most cases. However, the difference is not significant and in terms of effective use of drilling equipment in the future, [C] is preferable as the project form.

5.4 Proposed Project

5.4.1 Selection of Blocks Targeted by the Plan

Upon analyzing the results of the project implementation case study, it was decided that a high priority should be placed on blocks with a high population and low present coverage. The blocks to be targeted by the plan were selected from among blocks with a present coverage of less than 30% and in the order starting from blocks of higher unserved population.

The selected blocks are shown in Tables 5-4-1 to 5-4-5. The number of blocks is 98 for Chuquisaca, 46 for the southern part of La Paz, 72 for Oruro, 85 for Tarija, and 155 for Santa Cruz or 456 in total. However, since this selection of blocks to be targeted by the plan is based on the water supply database and the intentions and willingness of the inhabitants to participate are not taken into consideration, a detailed field study should be carried out prior to starting the project for reevaluating, modifying, and finalizing the selection. Figures 5-4-1 to 5-4-5 show the locations of the selected blocks.

Table 5-4-1 List of Selected Blocks for the Department of Chuquisaca

Number	Block Number	Block Name	Population in 1994	W. Served Population in 1994	W. Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop. in 2000	Expected Water Unserved Pop. in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
a	b	c	d	e	f	g	h	i	j	m	n
101 Province OROPEZA											
1	101010120	UÑALA	361	0	0%	434	0	434	B	30	3
2	101010203	SAN ANTONIO	641	0	0%	673	0	673	B	61	1
3	101010901	POTOLO	563	24	4%	525	22	503	A	47	3
4	101011301	MARAGUA	588	0	0%	687	0	687	A	62	1
5	101011405	CKOCHIS	451	100	22%	516	60	456	A	46	3
6	101011406	THACOS	432	0	0%	494	0	494	A	35	1
7	101020113	PANGORAHUASI	394	0	0%	416	0	416	B	29	3
8	101020201	HUAÑOMA H. BAJA	415	0	0%	426	0	426	A	30	1
		Total	3,845	124	3%	4,171	82	4,089		340	
102 Province AZUROUY											
9	102010305	RODEO GRANDE	293	0	0%	409	0	409	C	29	4
10	102010319	TABLA MAYU	361	0	0%	504	0	504	C	45	4
11	102010324	MOLLE MOLLE	356	0	0%	497	0	497	C	35	4
12	102010326	TABLANI	339	0	0%	473	0	473	C	33	4
13	102020102	CRUZ MAYU	387	0	0%	423	0	423	C	30	4
14	102020307	CAPAJTALA	473	0	0%	503	0	503	C	45	4
15	102020320	JOSE DE TROJE	524	0	0%	558	0	558	C	50	4
16	102020330	KOLLPA PAMPA	495	0	0%	527	0	527	C	47	4
		Total	3,228	0	0%	3,894	0	3,894		314	
103 Province ZUDAÑEZ											
17	103010102	HUANCARANI	429	0	0%	445	0	445	B	31	3
18	103010103	CAPILLA LLAVE	555	0	0%	575	0	575	B	52	3
19	103010121	SAYANCHACA	647	0	0%	671	0	671	C	60	3
20	103010122	MANDINGA	406	0	0%	420	0	420	C	29	3
21	103030102	REDENCION PAMPA	921	0	0%	975	0	975	C	88	1
22	103030106	YACAMBE	455	28	6%	482	23	459	C	34	3
23	103030115	EL POZO	483	0	0%	512	0	512	C	46	3
24	103030116	SAN JORGE	386	0	0%	409	0	409	B	29	3
25	103030131	QUIVALE	418	0	0%	443	0	443	B	31	3
26	103040118	JATUN MAYU	584	0	0%	635	0	635	C	57	3
27	103040125	CHAHUARANI	452	0	0%	492	0	492	C	34	3
28	103040126	THACO PAMPA	537	0	0%	584	0	584	C	53	3
		Total	6,272	28	0%	6,643	23	6,620		544	
104 Province TOMINA											
29	104010145	LAMPASILLOS	515	116	22%	565	90	475	D	51	5
30	104020107	THURUMAYU	415	0	0%	492	0	492	C	34	4
31	104020115	FUERTE RUA	447	0	0%	530	0	530	C	48	4
32	104020122	PAMPAS ABAJO	425	0	0%	503	0	503	D	45	5
33	104030102	MAMAHUASI	416	0	0%	424	0	424	C	30	5
34	104030104	AMANCAYA	441	0	0%	450	0	450	C	32	4
35	104030117	PAMPAS DEL CARMEN	601	0	0%	613	0	613	D	55	4
36	104050203	LA REVUELTA	386	0	0%	469	0	469	B	42	4
		Total	3,646	116	3%	4,046	90	3,956		337	
105 Province HERNANDO SILES											
37	105010105	CERRILLOS	554	143	26%	625	131	494	D	69	5
38	105010107	S. PEDRO DEL PARAPETI	428	56	13%	483	51	432	E	43	5
39	105010211	SAN JUAN DEL PIRAY AD	914	0	0%	890	0	890	D	98	2
40	105010305	PUCA MAYU	595	0	0%	613	0	613	B	67	2
41	105010329	VALLE NUEVO	982	200	20%	1,011	177	834	B	111	2
42	105020306	ATIRIMBA	409	0	0%	443	0	443	D	40	5
		Total	3,882	399	10%	4,065	359	3,706		429	
106 Province YAMPARAEZ											
43	106010124	SURIMA GRANDE	392	0	0%	430	0	430	B	30	3
44	106010172	CHOQUERI	386	0	0%	424	0	424	B	30	3
45	106010179	PAMPA LUPIARA	900	0	0%	988	0	988	C	89	1
46	106010189	JUCHU LUPIARA	504	136	27%	553	112	441	C	50	3
47	106020102	THOLA HUANCA	498	0	0%	503	0	503	A	45	1
48	106020136	PATA SAN JUAN	526	0	0%	531	0	531	B	48	3
49	106020143	COROMA	541	0	0%	546	0	546	B	49	3
		Total	3,747	136	4%	3,975	112	3,863		341	
107 Province NOR CINTI											
50	107010210	LADERAS	501	0	0%	493	0	493	A	35	1
51	107010505	QUISQUIRA	453	0	0%	522	0	522	A	47	1
52	107010705	PALQUI PAMPA	447	0	0%	506	0	506	A	46	1
53	107010801	CANTON MUYUQUIRI	1,338	252	19%	1,309	207	1,102	A	118	2
54	107020108	YAPUSIRI	390	0	0%	459	0	459	C	32	4
55	107020109	RODEO CANCHA	407	0	0%	479	0	479	C	34	4
56	107020403	PAYACOTA DEL C. AD	804	0	0%	839	0	839	A	76	1
57	107020501	PIRHUANI	392	0	0%	409	0	409	C	29	4
58	107020504	CHUNCHO	399	0	0%	417	0	417	C	29	4
59	107020505	OJEDO	574	0	0%	599	0	599	C	54	2
60	107020506	SACAWILLQUE	1,162	0	0%	1,213	0	1,213	C	109	1
61	107020605	TOKHO KHASA	444	0	0%	455	0	455	C	32	4
62	107020710	LAJA KHASA	556	0	0%	569	0	569	A	51	1
63	107020711	KHOCHA PATA	930	52	6%	953	44	909	A	86	2

Table 5-4-1 List of Selected Blocks for the Department of Chuquisaca (continue)

Number	Block Number	Block Name	Population in 1994	W. Served Population in 1994	W. Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop. in 2000	Expected Water Unserved Pop. in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
64	107020712	OCURICUCHO	956	0	0%	1,010	0	1,010	A	91	1
65	107020802	PASLA	438	0	0%	457	0	457	C	32	4
66	107030103	PALCA PATA	777	96	12%	855	70	785	A	77	2
67	107030104	ALPAJA ALTA	918	152	17%	1,010	135	875	A	91	2
68	107030105	HUANCARANI BAJO	707	100	14%	778	90	688	A	70	2
69	107030107	CHUNCHULI	969	172	18%	1,066	153	913	A	96	2
70	107030109	JOLENCIA	923	52	6%	1,015	42	973	A	91	2
71	107030111	PUEBLO ALTO	422	0	0%	464	0	464	A	32	1
72	107030112	SULTACA BAJA	746	80	11%	821	71	750	A	74	2
73	107030113	SULTACA ALTA	480	16	3%	528	16	512	A	48	2
74	107030114	ALPAJA BAJA	818	32	4%	900	23	877	A	81	2
75	107030201	PUCARA DE YATINA	730	0	0%	762	0	762	A	69	1
76	107030202	TAPENTACA	407	0	0%	425	0	425	A	30	1
77	107030308	SACANI	438	0	0%	457	0	457	A	32	1
78	107030402	EL FUERTE	541	0	0%	606	0	606	C	55	2
79	107030403	QUEMADA	634	16	3%	710	10	700	A	64	2
80	107030405	LAMPASAR	454	0	0%	508	0	508	C	46	2
81	107030501	LA BOMBONA	455	0	0%	506	0	506	A	46	1
		Total	20,675	1,019	5%	22,100	860	21,240		1,899	
108 Province BELISARIO BOETO											
82	108010210	MONTE GRANDE	418	0	0%	434	0	434	C	30	4
		Total	418	0	0%	434	0	434		30	
109 Province SUD CINTI											
83	109020102	CHARCOMA	401	0	0%	451	0	451	A	32	2
84	109020103	TODOSA	397	0	0%	447	0	447	A	31	2
85	109020104	YAQUINA BAJA/ALTA	418	20	5%	471	11	460	A	33	2
86	109020106	EL TOLAR	863	0	0%	971	0	971	A	87	2
87	109020107	LA BANDA	657	0	0%	740	0	740	A	67	2
88	109020115	SAN LORENZO	521	0	0%	586	0	586	A	53	2
89	109020118	CENTRO	617	0	0%	694	0	694	A	62	2
90	109020301	EL PALMAR	656	0	0%	635	0	635	C	57	2
91	109020502	EL MONTE	433	0	0%	419	0	419	A	29	2
92	109020802	SALVIANI	400	0	0%	428	0	428	A	30	2
93	109020903	PUCA PAMPA AD	390	0	0%	417	0	417	A	29	2
		Total	5,753	20	0%	6,259	11	6,248		511	
110 Province LUIS CALVO											
94	110010204	CARATINDI	452	0	0%	472	0	472	E	42	5
95	110010405	EL MESON	430	0	0%	506	0	506	D	56	5
96	110030402	IPATI	405	0	0%	1,331	0	1,331	F	146	5
97	110030405	HACIENDA SIN NOMBRE	135	0	0%	444	0	444	F	40	5
98	110030501	NANCORAINZA	472	0	0%	493	0	493	F	44	5
		Total	1,894	0	0%	3,246	0	3,246		329	
		Grand Total	53,360	1,841	3%	58,833	1,538	57,295		5,073	

Table 5-4-2 List of Selected Blocks for the Southern Part of La Paz

Number	BNum.	Nombre Bloque	Population in 1994	W.Served Population in 1994	W.Served Ratio in 1995	Estimated Population in 2000	Expected Water Served Pop. in 2000	Expected Water Unserved Pop. in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
a	b	c	d	e	f	g	h	i	j	k	l
203 Province PACAJES											
1	203000502	Jankho Khatani	404	0	0%	365	0	365	D	18	5
2	203001101	Huayllapanta	378	0	0%	343	0	343	D	17	5
3	203002402	Zona Poke	363	0	0%	328	0	328	D	16	5
4	203002403	Tejpuna Centro	358	0	0%	324	0	324	D	16	5
5	203002404	Tejpuna Centro B	980	0	0%	882	0	882	D	62	4
6	203002406	Villa Viluyo B	450	0	0%	405	0	405	D	20	4
7	203002703	Cmd. Acero Marca II	430	0	0%	387	0	387	C	19	3
8	203002801	Cmd. Villa Anta	625	0	0%	565	0	565	C	40	2
9	203004715	Kella Kella Alta	314	0	0%	284	0	284	C	14	4
10	203005401	Cmd. Phina	341	0	0%	308	0	308	C	15	4
11	203005501	Charana	1,125	104	9%	1,017	62	954	C	71	2
12	203005901	Ladislao Cabrera	350	0	0%	316	0	316	C	16	3
13	203006301	Canuta	368	0	0%	333	0	333	C	17	3
		Total	6,486	104	2%	5,857	62	5,795		342	
213 Province AROMA											
14	213000402	Cmd.Chuacollo Grande	348	0	0%	347	0	347	A	17	1
15	213000502	Chica Belen	421	108	26%	420	99	321	A	21	2
16	213000601	Cala Cala	874	220	25%	872	132	740	A	61	2
17	213000602	Conani	550	8	1%	549	7	542	A	38	2
18	213000603	Huana Kollo	401	18	4%	400	0	400	A	20	2
19	213000606	Vilaque	314	0	0%	313	0	313	A	16	2
20	213000607	Catavi	307	0	0%	306	0	306	A	15	2
21	213000608	Taruca	299	0	0%	298	0	298	C	15	4
22	213000801	Panduro	421	0	0%	420	0	420	A	21	1
23	213001106	Machacamarca	300	0	0%	299	0	299	C	15	4
24	213001202	Tolerani	296	0	0%	295	0	295	D	15	5
25	213002002	Quilloma Yanamuyo	385	44	11%	400	41	359	A	20	2
26	213002301	Collana Tolar	376	0	0%	322	0	322	A	16	2
27	213002302	Jara Kollu	316	0	0%	315	0	315	A	16	2
28	213002401	Ecia. Chicanchata	289	0	0%	288	0	288	D	14	5
29	213002601	Cmd. Cañuma Pampa	416	0	0%	415	0	415	C	21	3
30	213002702	Ecia. Panzuri	275	0	0%	274	0	274	C	14	4
31	213002901	Ecia. Cusmini	340	0	0%	339	0	339	C	17	3
32	213003001	Ecia. Chocorosi	696	0	0%	694	0	694	A	49	1
33	213003002	Ecia. calluyo	658	0	0%	656	0	656	A	46	1
34	213003003	Ecia. Choritotora	458	0	0%	457	0	457	A	23	1
35	213003402	Cauchi Tuiri	472	0	0%	471	0	471	C	24	3
36	213003403	Arajllanga	470	0	0%	469	0	469	C	23	3
37	213003404	Talpillanga Sud	437	0	0%	436	0	436	C	22	3
38	213003410	Tarumaya	271	0	0%	270	0	270	C	14	4
39	213003602	Jisuhakhollo	387	0	0%	386	0	386	A	19	1
40	213003701	Montecani	310	0	0%	309	0	309	C	15	3
41	213004401	Viscachani	206	0	0%	316	0	316	A	16	2
42	213004402	Ecia. Aroma	287	0	0%	286	0	286	A	14	2
43	213004502	Viluyo	391	0	0%	390	0	390	D	20	5
44	213005202	Machacamarca	1,049	0	0%	1,046	0	1,046	C	73	1
45	213006301	S. de Llallagua	1,300	217	17%	1,297	188	1,109	C	91	2
46	213006801	Hichuraya Chico	271	0	0%	270	0	270	C	14	4
		Total	14,591	614	4%	14,628	466	14,162		834	
		Grand Total	21,077	718	3%	20,485	528	19,957		1,176	

Table 5-4-3 List of Selected Blocks for the Department of Oruro

Number	Block Number	Block Name	Population in 1994	W.Served Population in 1994	W.Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop. in 2000	Expected Water Unserved Pop. in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
a	b	c	d	e	f	g	h	i	j	k	l
401 Province CERCADO											
1	401000107	Ventilla Umani	234	0	0%	236	0	236	B	12	1
2	401000302	Cala Cala	1,413	218	15%	1,454	131	1,323	C	102	3
3	401000401	Paria	230	0	0%	232	0	232	C	12	4
4	401000402	Soracachi	422	0	0%	426	0	426	C	21	3
5	401000403	Angocariri	247	0	0%	249	0	249	C	12	4
6	401000404	Obrajes	250	15	6%	253	0	253	C	13	4
7	401000405	San Juan Pampa	550	0	0%	556	0	556	C	39	3
8	401000407	Canllapampa	280	0	0%	283	0	283	C	14	3
9	401000409	Cala Pata	347	0	0%	350	0	350	C	18	3
10	401000410	Ocotavi	239	0	0%	241	0	241	C	12	4
11	401000412	Jachuma	462	0	0%	467	0	467	C	23	3
12	401000413	Iruma	438	0	0%	442	0	442	C	22	3
13	401000420	Condor Chinoca	365	6	2%	369	0	369	C	18	3
14	401000424	Jachuyo	300	0	0%	303	0	303	C	15	3
15	401001002	Cohani	430	0	0%	434	0	434	C	22	3
16	401001102	Jankho Nuño	355	0	0%	359	0	359	B	18	1
17	401001201	Choro	320	0	0%	323	0	323	B	16	1
18	401001301	Challacollo	1,500	0	0%	1,544	0	1,544	B	108	1
19	401001902	Chitika	603	0	0%	609	0	609	C	43	1
20	401001805	Thola Palca Chico	2,230	0	0%	2,295	0	2,295	C	184	1
21	401001606	Huaylla'ra	251	0	0%	254	0	254	C	13	4
		Total	11,466	239	2%	11,679	131	11,548		736	
402 Province CHALLAPATA O AVAROA											
22	402000601	Cruce Culta	320	15	5%	323	0	323	C	16	2
		Total	320	15	5%	323	0	323		16	
403 Province CARANGAS											
23	403000107	Jhanko khala	250	0	0%	253	0	253	B	13	2
24	403000201	San antonio de Nor Cala	300	6	2%	303	0	303	D	15	5
25	403000301	San Jose de Kala	254	5	2%	257	4	253	E	13	5
26	403000801	Opoqueri	236	0	0%	238	0	238	E	12	5
27	403001501	San pedro de Huaytloco	385	78	20%	389	47	342	D	19	4
28	403002201	Villa Turucachi	272	0	0%	275	0	275	B	14	2
29	403002301	Choquecota	381	19	5%	385	12	373	B	19	2
		Total	2,078	108	5%	2,100	62	2,038		105	
404 Province SAJAMA											
30	404000201	Sajama	490	18	4%	495	16	479	C	25	3
31	404000504	Ecia. Titiri	300	0	0%	303	0	303	B	15	1
32	404000703	Ecia. Pampa Magachi	478	137	29%	483	82	401	C	24	3
		Total	1,268	154	12%	1,281	98	1,183		64	
405 Province LITORAL											
33	405000306	Huachacalla	983	278	28%	993	0	993	B	70	2
		Total	983	278	28%	993	0	993		70	
406 Province POOPO											
34	406000201	Venta y Media	300	7	2%	303	5	298	C	15	4
35	406000207	Ecia. Carajara	356	0	0%	360	0	360	C	18	1
36	406000701	Peñas	1,000	161	16%	1,010	104	906	C	71	2
37	406000801	Totoral	1,197	84	7%	1,232	54	1,178	B	86	2
38	406000804	Campamento Colon	230	0	0%	232	0	232	B	12	1
39	406001001	Urmiri	366	96	26%	370	66	304	C	19	4
		Total	3,449	347	10%	3,507	229	3,278		220	
407 Province PANTALEON DALENCE											
40	407000106	Ecia. HuflaTiri	249	0	0%	251	0	251	C	13	4
41	407000206	Campamento Florida	229	0	0%	231	0	231	D	12	4
42	407000207	Ecia. Paco Pampa	280	0	0%	283	0	283	C	14	4
		Total	758	0	0%	765	0	765		38	
408 Province LADISLAO CABRERA											
43	408000101	Salinas de Garci Mendoza	405	97	24%	409	0	409	A	20	2
44	408000105	Lia	250	0	0%	253	0	253	A	13	2
45	408000108	Tauca	380	0	0%	384	0	384	B	19	2
46	408000116	Callahalika	315	0	0%	318	0	318	C	16	3
47	408000201	Chatacota	234	6	3%	236	0	236	E	12	5
48	408000401	Jirira	258	0	0%	261	0	261	B	13	2
49	408000501	Ucumasi	323	90	28%	326	72	254	E	16	5
50	408000804	Kañavicota	300	0	0%	303	0	303	C	15	3
51	408001101	Pampa Ullagas	464	2	0%	469	2	467	B	23	2
52	408001106	Huayllas	236	0	0%	238	0	238	B	12	2
		Total	3,165	195	6%	3,197	74	3,123		160	
409 Province ATAHUALLPA											
53	409000101	Sabaya	260	4	2%	263	0	263	A	13	2
54	409002301	Coipasa	314	0	0%	317	0	317	C	16	3
55	409002601	Ayparavi	240	0	0%	242	0	242	E	12	5
		Total	814	4	1%	822	0	822		41	
410 Province SAUCARI											
56	410000101	Toledo	757	0	0%	765	0	765	C	54	1
57	410000701	Cetuyo	235	0	0%	237	0	237	C	12	3

Table 5-4-3 List of Selected Blocks for the Department of Oruro (continue)

Number	Block Number	Block Name	Population in 1994	W.Served Population in 1994	W.Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop. in 2000	Expected Water Unserved Pop. in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
58	410001702	Alto Saucari	259	0	0%	262	0	262	B	13	1
		Total	1,251	0	0%	1,264	0	1,264		79	
411 Province TOMAS BARRON											
59	411000201	Quelcata	596	17	3%	602	0	602	B	42	1
		Total	596	17	3%	602	0	602		42	
412 Province SUD CARANGAS											
60	412000201	Orinoca	743	101	14%	750	81	669	C	53	2
61	412000301	Belen de Andamarca	269	2	1%	272	2	270	D	14	5
62	412000601	real Machacamarca	284	0	0%	287	0	287	D	14	5
		Total	1,296	104	8%	1,309	83	1,226		80	
413 Province SAN PEDRO DE TOTORA											
63	413000109	Ecia. Hirpoyoco	360	55	15%	364	0	364	B	18	1
64	413000601	Calazaya	456	108	24%	461	0	461	B	23	1
65	413000701	Ecia. Concepcion Culta	362	0	0%	366	0	366	B	18	1
		Total	1,178	163	14%	1,191	0	1,191		60	
414 Province SEBASTIAN PAGADOR											
66	414000701	Ecia. Wichaj Lupi	364	56	15%	368	48	320	B	18	2
67	414001301	Ecia. Castilluma	246	0	0%	248	0	248	C	12	4
68	414001701	Ecia. Guadalupe	322	0	0%	325	0	325	C	16	4
69	414002001	Santuario de Quillacas	374	63	17%	378	50	328	B	19	2
		Total	1,306	119	9%	1,319	99	1,220		66	
416 Province NOR CARANGAS											
70	416000101	Huayllamarca	267	49	18%	270	0	270	B	14	2
71	416000102	Chajña Uma	900	0	0%	909	0	909	B	64	1
72	416000112	Ecia. Chillcani	250	0	0%	253	0	253	B	13	2
		Total	1,417	49	3%	1,432	0	1,432		90	
		Grand Total	31,345	1,792	6%	31,784	775	31,009		1,867	

Table 5-4-4 List of Selected Blocks for the Department of Tarija

No.	Block Number	Block Name	Population in 1994	Water Served Population in 1994	Water Served Ration in 1994	Estimated Population in 2000	Expected W.Served Population in 2000	Unserved Population in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
a	b	c	d	e	f	g	h	i	j	k	l
601 Province CERCADO											
1	601010103	SELLA CANDELARIA RUNI CUACHA	449	0	0%	449	0	449	B	31	1
2	601010501	SANTA ANA NUEVA, SAN PEDRITO	961	173	18%	961	0	961	E	86	4
3	601010505	Santa Ana La Vieja y San Antonio	473	383	9%	478	0	478	B	33	3
4	601010602	TOLOMOSA GRANDE (ZONAS 1,2,3,4,5)	518	219	58%	525	219	306	D	47	3
5	601010705	YESERA SUD HORNOS LAJAS EL MONT	587	158	27%	633	151	482	C	57	3
6	601010802	SAN AGUSTIN SUD	318	0	0%	353	0	353	B	25	1
7	601011804	PAPA CHACRA	299	0	0%	299	0	299	B	21	3
8	601012001	CMD. BELLA VISTA (ZONAS 1,2,3)	672	0	0%	752	0	752	C	68	1
9	601012401	TURUMAYO (ZONA 1,2)	596	53	9%	658	0	658	C	59	3
10	601012501	SAN JACINTO SUD	283	0	0%	319	0	319	C	22	3
11	601012801	CHURQUIS	504	76	15%	504	76	428	C	45	3
		Total	5,600	1,062	19%	5,931	446	5,485		496	
602 Province ARCE											
12	602010201	Cmd. Co'pana y Zona Centro	669	669	0%	669	0	669	C	60	2
13	602010203	CMD. CANCHAS MAYU	433	4	1%	622	0	622	C	56	2
14	602010506	ALIZOS DEL CARMEN	280	0	0%	377	0	377	C	26	4
15	602010801	ZONA CABILDO	362	0	0%	362	0	362	B	25	2
16	602010901	LOC. TACUARA	407	0	0%	463	0	463	C	32	2
17	602011001	CMD. GARRAPATAS	253	0	0%	274	0	274	B	19	4
18	602011101	CMD. SAN JOSE	350	0	0%	390	0	390	C	27	4
19	602011202	LOC. QUEBRADA DE CANAS	335	0	0%	335	0	335	B	23	2
20	602021802	Cmd. El Chorro	286	286	0%	219	35	184	D	15	4
21	602022101	Cmd. Tatita	289	289	0%	235	0	235	C	16	4
22	602022102	LOC. PORCELANA BORDO	470	75	16%	577	68	509	E	52	4
23	602022103	LOC. PORCELANA BAJO	831	125	15%	1,018	114	904	E	92	2
24	602022104	LOC. CAMPO GRANDE	1,188	0	0%	1,453	0	1,453	E	131	2
25	602022105	LOC. NARANJITOS	389	0	0%	477	0	477	E	33	4
26	602022204	LOC. ARROZALES	369	0	0%	369	0	369	C	26	4
27	602022802	CMD. TREMENTINAL	468	468	0%	713	0	713	B	64	2
		Total	7,379	1,916	26%	8,553	217	8,336		700	
603 Province GRAN CHACO											
28	603010304	CMD. BUSUY CMD. TIMBOY	340	333	2%	273	0	273	C	19	5
29	603010305	CMD. SAIBALITO ECTAS SIMBOLAR	220	0	0%	274	0	274	E	19	5
30	603021501	CMD. SANTA ROSA	286	0	0%	320	0	320	C	22	5
31	603021602	URENDA CHINCHILLA BERETI	320	317	1%	299	0	299	C	21	5
32	603021704	CMD. NANCAHUAZU ASTILLERO	360	0	0%	365	0	365	C	26	5
33	603021905	CMD. SIDRAS LECHERONAL	226	0	0%	264	0	264	C	18	5
34	603022001	CMD. FUERTE VIEJO	373	0	0%	400	0	400	D	28	5
35	603022101	CMD. CAMPO LARGO LAS TIPAS	475	461	3%	398	0	398	D	28	5
36	603022502	QUEBRACHAL SIMLOBAR ALGARROBAL	328	321	2%	281	0	281	D	25	5
37	603032801	CMD. PUESTO CHICO	344	0	0%	459	0	459	E	32	5
38	603033201	LOC. COTOTO-IBOPETY	211	0	0%	346	0	346	E	24	5
39	603033602	MISION MATACOS YUCHAN CMD. CREV	654	131	20%	695	115	580	E	76	5
40	603033603	ECIA. LA ENVIDIA BAJADA TUSCA CAMP	413	326	21%	388	0	388	D	35	5
41	603034004	LOC. IGUIRARO LAGUNITAS IGUEMBE	608	365	40%	416	0	416	D	29	5
42	603034301	CHIMEI	256	56	22%	532	54	478	E	48	5
		Total	5,414	2,310	43%	5,710	169	5,541		452	
604 Province AVILEZ											
43	604010401	COLON NORTE	300		3%	300	0	300	C	21	4
44	604010403	LAS BARRANCAS	270	0	0%	448	0	448	C	31	2
45	604010404	GUARANGUAY NORTE (MONTES MONT	217	0	0%	329	0	329	B	23	2
46	604010405	GUARANGUAY SUD	208	0	0%	374	0	374	B	26	1
47	604010801	RUJERO	424	8	2%	544	7	537	C	49	2
48	604022501	CAMPO ANTIGAL	254	0	0%	290	0	290	B	20	2
49	604022502	ALIZOS	349	0	0%	398	0	398	B	28	1
50	604022601	VIZCARRA	239		0%	239	0	239	B	17	2
51	604023402	CALDERAS CENTRO TRANCAS	273	0	0%	280	0	280	B	20	2
		Total	2,534	8	0%	3,202	7	3,195		235	
605 Province MENDEZ											
52	605010203	CMD. ALTO CAJAS	268	0	0%	307	0	307	B	21	2
53	605010302	COMARCA CHAMATA	94		0%	420	0	420	C	29	2
54	605010701	CMD. SAN PEDRO DE LAS PENAS	333	0	0%	333	0	333	B	23	2
55	605010903	CMD. CHAUPICANCHA	267	0	0%	288	0	288	C	20	4
56	605010904	CMD. SELLA LAS QUEBRADAS	227		83%	214	0	214	B	15	4
57	605010907	CMD. MONTE MENDEZ	286	0	0%	308	0	308	E	22	4
58	605011407	CMD. EL ROSAL	411		5%	325	0	325	B	23	2
59	605012201	CMD. SANTA BARBARA	280	0	0%	329	0	329	C	23	4
60	605012202	CMD. JARCA CANCHA	260	0	0%	305	0	305	B	21	2
61	605023011	CMD. SAN ROQUE	246		0%	200	0	200	B	14	4
62	605023013	SANTA ANA DE AGUA RICA	254	0	0%	303	0	303	C	21	4
		Total	2,926	0	0%	3,332	0	3,332		233	
606 Province BURNET O' CONNOR											
63	606010201	CMD. HUAYCO CENTRO	345	10	3%	345	0	345	B	24	3
64	606010303	LOC. SAN DIEGO CENTRO	373	0	0%	403	0	403	B	28	1
65	606010901	CANTON CHIQUIACA	774	0	0%	995	0	995	C	90	1

Table 5-4-4 List of Selected Blocks for the Department of Tarija (continue)

No.	Block Number	Block Name	Population in 1994	Water Served Population in 1994	Water Served Ration in 1994	Estimated Population in 2000	Expected W.Served Population in 2000	Unserved Population in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
66	606010901	CANTON CHIQUIACA	995	0	0%	995	0	995	C	90	1
67	606010902	LOC. LOMA ALTA	230	0	0%	297	0	297	B	21	3
68	606011002	SALINAS	273	0	0%	273	0	273	B	19	3
69	606011201	ECIA. MACHIGUA	224	0	0%	303	0	303	B	21	3
70	606011204	ECIA. AGUA BUENA	200	0	0%	271	0	271	B	19	3
71	606011205	TIMBOY	394	12	3%	394	0	394	B	28	1
72	606011206	ECIA. NAURENDA	243	0	0%	328	0	328	B	23	3
73	606011403	ZONA ALTO SAN JOSE	250	0	0%	273	0	273	B	19	3
74	606011404	SAN JOSECITO CENTRO	279	0	0%	305	0	305	B	21	3
75	606011405	ZONA CALDERILLA	340	0	0%	371	0	371	B	26	1
76	606011406	ZONA LA REA	306	0	0%	334	0	334	B	23	1
77	606011407	ECIA. ROSARIO	273	0	0%	298	0	298	B	21	3
78	606011601	CMD. NARANJOS	482	0	0%	644	0	644	B	58	1
79	606012001	CMD. VALLE DEL MEDIO	308	12	4%	308	0	308	B	22	3
80	606012201	CMD. PENA NEGRA	301	0	0%	310	0	310	B	22	3
81	606012601	ECIA. LAS TRAMPAS	356	0	0%	389	0	389	B	27	1
82	606012702	SUPITIN	322	0	0%	362	0	362	B	25	1
83	606013601	CMD. LIMAL	262	0	0%	262	0	262	B	18	3
84	606013602	LOC. SERERE SUD	313	0	0%	313	0	313	B	22	3
85	606013801	ECIA. GUARIPITINAL	427	0	0%	466	0	466	C	33	3
		Total	8,270	34	0%	9,239	0	9,239		699	
		Grand Total	32,123	5,330	17%	35,967	839	35,128		2,815	

Table 5-4-5 List of Selected Blocks for the Department of Santa Cruz

No	Block Number	Block Name	Population in 1994	W.Served Population in 1994	W.Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop.in 2000	Expected Water Unserved Pop.in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
a	b	c	d	e	f	g	h	i	j	k	l
701 Province ANDRES IBAÑEZ											
1	701010208	CMD. CLARA SERRANO	487	0	0%	738	0	738	C	81	1
2	701010210	CMD. MAPAISO DE LAS PI	575	145	25%	871	0	871	B	96	3
3	701010212	COL. MENONITA CHOROVI	458	0	0%	694	0	694	B	76	1
4	701010214	ECIA. STA. BARBARA	320	0	0%	485	0	485	B	44	1
5	701010215	CMD. ITAPAQUI	323	0	0%	489	0	489	C	44	4
6	701010217	ECIA. LOS CHACOS	377	0	0%	570	0	570	C	63	3
7	701010221	CMD. EL TAROPE	528	45	9%	799	0	799	C	88	3
8	701010222	CMD. LA CRUCENA	355	0	0%	538	0	538	C	59	3
9	701010225	EL PARAISO DE LA SACAC	311	0	0%	470	0	470	C	42	4
10	701010226	CMD. CALLEJAS	509	0	0%	770	0	770	C	85	1
11	701010313	VILLA FLOR	525	0	0%	794	0	794	B	87	1
12	701010403	HDA. EL DORADO	647	0	0%	979	0	979	B	108	1
13	701010505	CMD. LOS CUCHISAS	450	0	0%	683	0	683	C	75	3
14	701010509	CAMPOS 72-73	401	0	0%	606	0	606	B	67	1
15	701010512	CAMPOS 77-80-84-86-81	314	0	0%	476	0	476	B	43	3
16	701020102	CMD. LOMAS URUBO	341	91	27%	516	0	516	C	57	3
17	701020104	ECIA. LOS OJOS	312	0	0%	472	0	472	C	42	4
18	701020105	ECIA. GUAPURUSITO	332	87	26%	503	0	503	C	55	3
19	701020205	CMD. CHACO GUEMBE	325	0	0%	492	0	492	C	44	4
20	701020213	SIND. SANTA FE	446	0	0%	674	0	674	C	74	3
21	701030115	QUEBRADA LEON	344	0	0%	519	0	519	b	57	1
22	701030116	EL PLAYON	355	0	0%	538	0	538	b	59	1
23	701030124	ECIA. KM 12 - VILLA SI	549	0	0%	831	0	831	b	91	1
24	701030126	VILLA ROSARIO	315	0	0%	477	0	477	b	43	1
25	701030127	CMD. RANCHO CHICO	444	0	0%	672	0	672	b	74	1
26	701030130	CMD. SAN CARLOS	381	0	0%	576	0	576	b	63	1
27	701030131	CMD. LA MELEA	311	0	0%	470	0	470	b	42	3
28	701030133	VILLA BARRIENTOS	440	0	0%	666	0	666	b	73	1
29	701030136	CMD. VILLA TUNAVI	368	0	0%	557	0	557	b	61	1
30	701030139	TIKIPAYA	849	0	0%	1,286	0	1,286	b	141	1
31	701030141	ECIA. QUEBRADA - VILLA	418	0	0%	633	0	633	b	70	1
32	701030142	PARABANO	428	0	0%	647	0	647	b	71	1
33	701030145	EL SALAO	346	0	0%	523	0	523	b	58	1
34	701030148	ELVIRA	344	0	0%	519	0	519	b	57	1
35	701030502	LOS AGUAISES	378	0	0%	571	0	571	d	63	5
36	701030503	ECIA. NARANJILLOS	359	0	0%	544	0	544	d	60	5
37	701030504	CMD. MONTE GRANDE	332	0	0%	503	0	503	d	55	5
38	701030506	CMD. SAN MIGUEL DEL RO	548	0	0%	830	0	830	d	91	5
39	701030510	CMD. BASILIO	732	0	0%	1,108	0	1,108	d	122	5
40	701030512	CMD. CANAVERAL	720	0	0%	1,090	0	1,090	d	120	5
		Total	17,297	368	2%	26,179	0	26,179		2,803	
702 Province WARNES											
41	702010102	STA ROSITA	536	103	19%	596	0	596	B	66	2
42	702010202	AZUSAQUI	453	119	26%	503	0	503	B	55	2
43	702010203	HDA. LA CUTA	517	0	0%	575	0	575	B	63	2
44	702010206	NARANJAL DON BOSCO	478	0	0%	531	0	531	B	58	2
45	702010634	ECIA. SAN ANCELMO	450	0	0%	500	0	500	B	45	2
46	702010638	COL. MONTE CRISTO	477	0	0%	530	0	530	B	58	2
		Total	2,911	222	8%	3,235	0	3,235		346	
703 Province VELASCO											
47	703010102	SAN JAVIERITO	669	0	0%	872	0	872	B	96	4
48	703010103	CARMEN DE RUIZ UV-1	498	0	0%	649	0	649	B	71	4
49	703010105	SAN ANTONIO	445	0	0%	581	0	581	B	64	4
50	703010301	SANTA ROSA DE ROCA	754	0	0%	984	0	984	B	108	4
51	703010303	COL. GUADALUPE - SAN M	520	0	0%	678	0	678	B	75	4
52	703010307	CMD. CRUZ DE SOLIZ	442	0	0%	577	0	577	B	63	4
53	703010401	CAMPAMENTO UV-1 UV-2 U	637	12	2%	832	0	832	b	92	4
54	703010501	PISO FIRME	443	8	2%	579	0	579	b	64	4
55	703010503	CMD. PORVENIR - HDA. T	451	0	0%	588	0	588	b	65	4
56	703020105	CMD. SAPOCO	705	0	0%	921	0	921	B	101	4
57	703020108	CMD. ALTAMIRA	364	0	0%	475	0	475	B	43	4
58	703020113	CMD. LAS CASITAS - RCH	415	0	0%	541	0	541	B	60	4
59	703020201	SAN JUAN DE LOMERIO	362	0	0%	472	0	472	B	42	4
60	703030106	RCHO. SAN NICOLAS - CM	368	0	0%	479	0	479	B	43	4
61	703030501	CMD. CERRITO	485	0	0%	633	0	633	b	70	4
62	703030504	CMD. ESPIRITU SANTO	510	0	0%	666	0	666	b	73	4
63	703030506	CMD. SAN VICENTE	685	0	0%	893	0	893	b	98	4
64	703030507	7 [BUENA HORA]	415	0	0%	541	0	541	b	60	4
		Total	9,168	20	0%	11,961	0	11,961		1,287	
704 Province ICHILO											
65	704010104	CMD. LA ARBOLEDA (CENT	670	0	0%	766	0	766	C	84	4
66	704010118	SIND. EL CARMEN	577	0	0%	659	0	659	C	72	4
67	704010120	SIND. RECOMPENSA I	419	0	0%	479	0	479	C	43	4
68	704010121	CAMINO HUAYTU	905	141	16%	1,034	0	1,034	C	114	2

Table 5-4-5 List of Selected Blocks for the Department of Santa Cruz (continue)

No.	Block Number	Block Name	Population in 1994	W.Served Population in 1994	W.Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop.in 2000	Expected Water Unserved Pop.in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
69	704020107	SAN GERMAN DE YAPACANI	824	15	2%	941	0	941	b	104	2
70	704020108	VILLA CHORE	425	0	0%	486	0	486	b	44	2
71	704020109	EL PALMAR UV-1, UV-2	552	0	0%	631	0	631	b	69	2
72	704020135	SAN CARLOS - BUENA VIS	482	0	0%	551	0	551	c	61	4
73	704020145	VILLA CHORE - EL PALMA	444	0	0%	507	0	507	C	56	4
		Total	5,298	156	3%	6,054	0	6,054		647	
705 Province CHIQUITOS											
74	705010104	CMD. QUITUQUINA	433	0	0%	485	0	485	d	44	5
75	705010110	CAMPO #12	419	0	0%	470	0	470	c	42	3
76	705010112	CAMPO #1	452	0	0%	507	0	507	c	56	2
77	705010202	BUENA VISTA	431	0	0%	483	0	483	b	43	2
78	705020306	SIND. SINAI	474	0	0%	531	0	531	c	58	3
79	705020307	COL. CUPESI	442	0	0%	497	0	497	c	45	3
80	705020308	PUESTO PAZ	589	0	0%	661	0	661	c	73	2
81	705020309	PROP. EL PALMAR	535	0	0%	600	0	600	D	66	5
82	705020314	COL.	451	0	0%	506	0	506	c	56	2
83	705020315	LAS PIEDRAS #1 - BELIC	464	0	0%	520	0	520	c	57	2
84	705020321	COOP. FATIMA	445	0	0%	500	0	500	c	45	2
85	705020322	COL. MENONITA CANADIEN	435	0	0%	487	0	487	c	44	3
86	705020323	EMPRESA EL CAMBA - HDA	437	0	0%	489	0	489	c	44	3
87	705030105	ECIA. EL TRIUNFO	418	30	7%	469	0	469	b	42	2
		Total	6,425	30	0%	7,205	0	7,205		715	
706 Province SARAH											
88	706010408	[PETEORO]	1,145	286	25%	1,167	0	1,167	c	128	2
		Total	1,145	286	25%	1,167	0	1,167		128	
707 Province CORDILLERA											
89	707020504	CMD. YUQUERETI	398	0	0%	503	0	503	D	45	5
90	707030501	MORA	683	14	2%	864	12	852	E	95	5
91	707030507	CAMPO 99-100	398	0	0%	503	0	503	D	55	5
92	707030510	CAMPO 107-108-111-112	394	0	0%	499	0	499	B	45	2
93	707030511	CAMPO 105-106	390	0	0%	494	0	494	B	44	2
94	707030512	CAMPO 60-61	370	0	0%	468	0	468	B	42	2
95	707030514	CAMPO 2-8	378	0	0%	479	0	479	B	43	2
96	707030522	CAMPO 26-31	434	0	0%	549	0	549	C	60	2
97	707030525	CAMPO 4-12	423	0	0%	536	0	536	C	59	2
98	707030526	CAMPO 19-20	503	0	0%	636	0	636	D	70	5
99	707030532	CAMPO 29-30	370	0	0%	468	0	468	D	42	5
100	707050106	CMD. PALMARITO	410	45	11%	518	0	518	F	47	5
101	707060103	CMD. GUINARAPE	390	0	0%	494	0	494	F	35	5
102	707060304	ITANAMBICUA	627	0	0%	793	0	793	I	71	5
103	707060405	CMD. CAPIRENDA	493	0	0%	625	0	625	F	56	5
104	707060418	IBAMIRAPINTA (LADO B)	426	6	1%	539	0	539	F	49	5
		Total	7,087	65	1%	8,968	12	8,956		859	
710 Province OBISPO SANTIESTEBAN											
105	710020102	CHANE EL PUENTE	751	110	15%	845	88	757	C	93	2
106	710020111	S JUAN DE LOS AMARILLO	464	0	0%	522	0	522	C	57	2
107	710020112	FAJA SAN SALVADOR	458	0	0%	514	0	514	C	57	2
108	710030104	CHANE INDEPENDENCIA	1,768	156	9%	1,988	62	1,926	b	219	2
109	710030105	CHANE MAGALLANES	689	35	5%	775	14	761	b	85	2
110	710030144	NARANJOS UNAGRO	843	0	0%	947	0	947	C	104	2
		Total	4,973	301	6%	5,591	164	5,427		615	
711 Province NUFLO DE CHAVEZ											
111	711010124	CMD. CANDELARIA	363	0	0%	485	0	485	B	44	4
112	711010301	SAN ANTONIO	795	14	2%	1,061	0	1,061	B	117	4
113	711010304	CMD. LA ASUNTA	356	0	0%	476	0	476	B	43	4
114	711010316	CMD. CRISTO REY	357	0	0%	477	0	477	B	43	4
115	711020112	ECIA. SAN JUAN	357	0	0%	477	0	477	B	43	4
116	711020113	ECIA. SAN MATIAS	402	90	22%	536	0	536	B	59	4
117	711020115	ECIA. PERSEVERANCIA	368	0	0%	491	0	491	B	44	4
118	711030206	4 CAÑADAS	841	53	6%	1,121	0	1,121	B	123	3
119	711030209	LINARES	454	0	0%	605	0	605	B	67	3
120	711030221	CENTRAL ILLIMANI	359	0	0%	479	0	479	B	43	3
121	711030227	SAN MARTIN	405	0	0%	541	0	541	B	60	3
122	711030247	COL. D/NOR.CAMP.50-1-3	410	0	0%	547	0	547	B	60	3
123	711030248	COL. D/NOR.CAMP.52-4-6	355	0	0%	474	0	474	B	43	3
124	711030249	COL.VILL.ESP.202-3-25	463	0	0%	617	0	617	B	68	3
125	711030250	COL.VALL.ESP.201-26-27	531	0	0%	708	0	708	B	78	3
126	711030251	COL.VALL.ESP.205-4-9	368	0	0%	491	0	491	B	44	3
127	711030254	COL.VALL.ESP.206-7-8	368	0	0%	491	0	491	B	44	3
128	711030256	SIND. PUERTO RICO	394	0	0%	525	0	525	B	58	3
129	711030258	SIND. LOS OLIVOS	369	0	0%	492	0	492	B	44	3
130	711030261	COL.NUEVA HOLANDA	569	0	0%	759	0	759	B	83	3
131	711030263	ECIA. CAMBERRA	478	0	0%	636	0	636	B	70	3
132	711030265	CMD. VILLA PRIMAVERA	406	0	0%	541	0	541	B	60	3
133	711030268	SIND. 2 DE AGOSTO	353	0	0%	472	0	472	B	42	3
134	711030270	ECIA. SAN MARTIN	545	0	0%	728	0	728	B	80	3

Table 5-4-5 List of Selected Blocks for the Department of Santa Cruz (continue)

No.	Block Number	Block Name	Population in 1994	W.Served Population in 1994	W.Served Ratio in 1994	Estimated Population in 2000	Expected Water Served Pop.in 2000	Expected Water Unserved Pop.in 2000	Estimated Well Depth (F-GW)	Planned Water Supply Quantity (m3/day)	Stage Plan Year
135	711030272	SIND. EL PORVENIR	592	0	0%	790	0	790	B	87	3
136	711030274	SIND. NUEVO AMANECER	626	0	0%	837	0	837	B	92	3
137	711030275	CMD. SAN JOSE	352	0	0%	471	0	471	B	42	3
138	711030287	SIND. MIRAFLORES	427	0	0%	570	0	570	B	63	3
139	711030298	NUCLEO 14 NUEVA VIDA	376	0	0%	502	0	502	B	55	3
140	711030242	CRUCE CASARABE	559	0	0%	786	0	786	B	86	3
141	711030281	SIND. AREA-5	673	0	0%	898	0	898	B	99	3
142	711030283	ECIA. LOS TRONCOS-EL C	463	0	0%	617	0	617	B	68	3
		Total	14,766	157	1%	19,702	0	19,702		2,052	
712 Province ANGEL SANDOVAL											
143	712010201	STO. CORAZON UV-1	648	18	3%	745	14	731	B	82	4
144	712010301	ASENCION	877	60	7%	1,009	0	1,009	b	111	4
		Total	1,525	78	5%	1,754	14	1,740		193	
713 Province MANUEL MARIA CABALLERO											
145	713010501	SAN JOSE DE LA CAPILLA	424	23	5%	469	0	469	D	33	5
146	713010502	PULQUINA	580	18	3%	642	0	642	D	58	5
147	713010601	SAN ISIDRO	1,183	26	2%	1,311	0	1,311	C	118	4
148	713010605	LA PALIZADA	427	89	21%	472	0	472	C	33	4
149	713010806	RCHO. SAGUINTAL	483	4	1%	535	0	535	C	48	4
		Total	3,097	160	5%	3,429	0	3,429		290	
715 Province GUARAYOS											
150	715010101	ASCENCION	8,350	1,798	22%	11,139	1,798	9,341	B	2,228	2
151	715010104	CAMPAVENTO CERRO CHICO	539	0	0%	719	0	719	B	79	2
152	715020101	URUBICHA	2,586	691	27%	3,450	691	2,759	A	414	2
153	715020102	YAGUARU	1,555	6	0%	2,074	0	2,074	A	249	2
154	715030101	EL PUENTE	1,105	129	12%	1,474	106	1,368	B	162	2
155	715030102	YOTAU	810	5	1%	1,080	0	1,080	B	119	2
		Total	14,945	2,629	18%	19,936	2,595	17,341		3,251	
		Grand Total	88,637	4,472	5%	115,181	2,785	112,396		13,185	

Figure 5-4-1 Locations of Selected Blocks for the Department of Chuquisaca

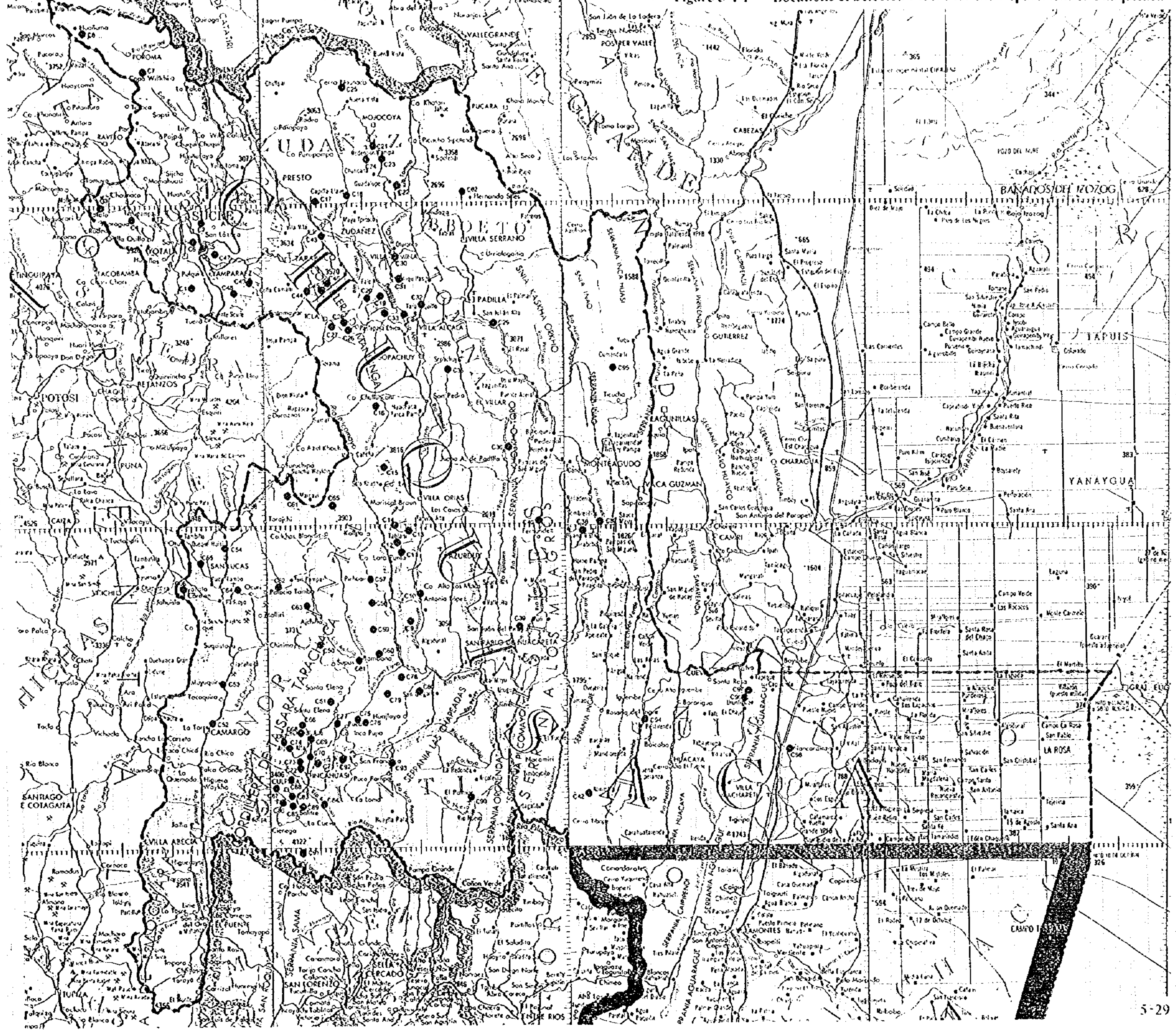


Figure 5-4-2 Locations of Selected Blocks for the Southern Part of La Paz

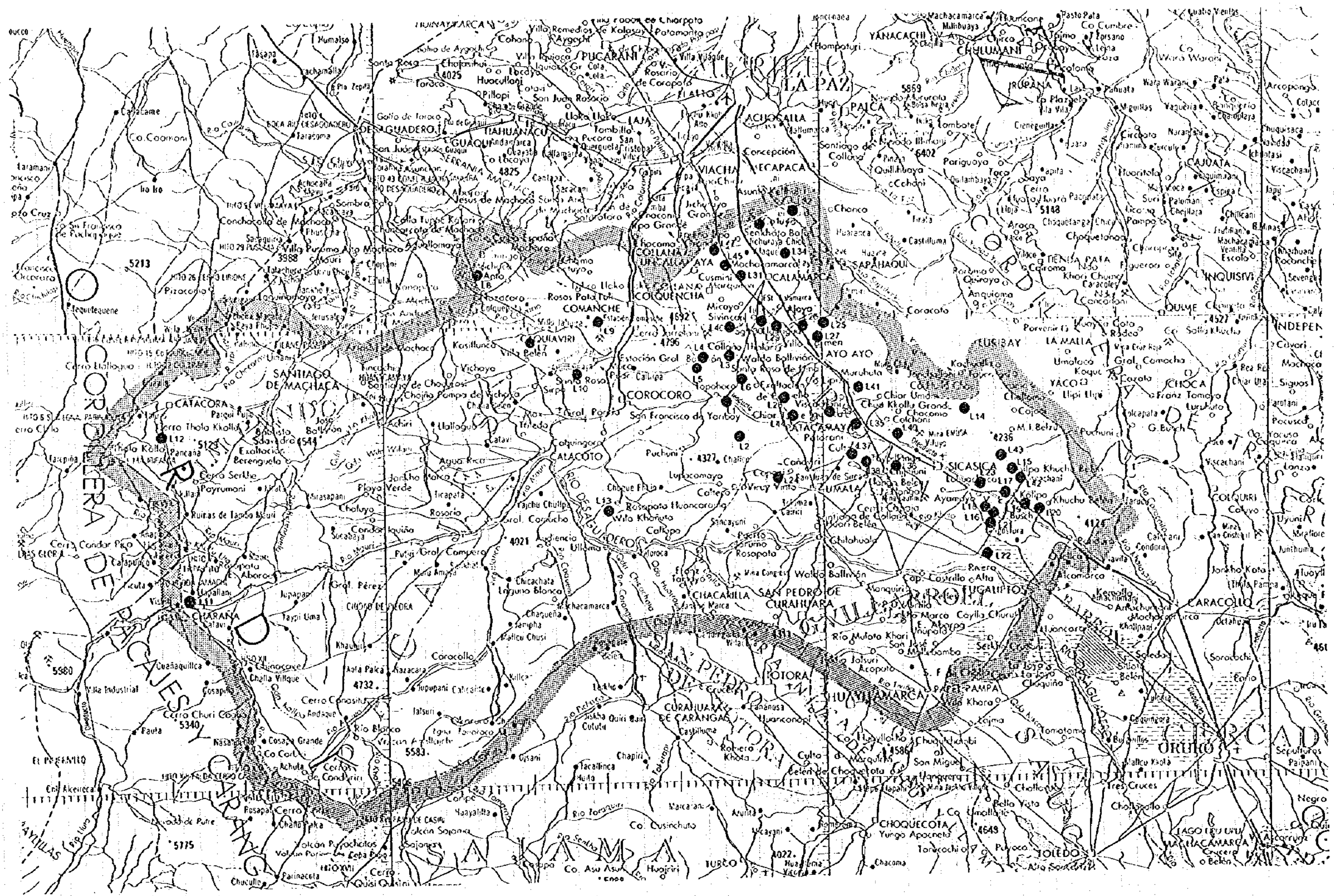


Figure 5-4-3 Locations of Selected Blocks for the Department of Oruro

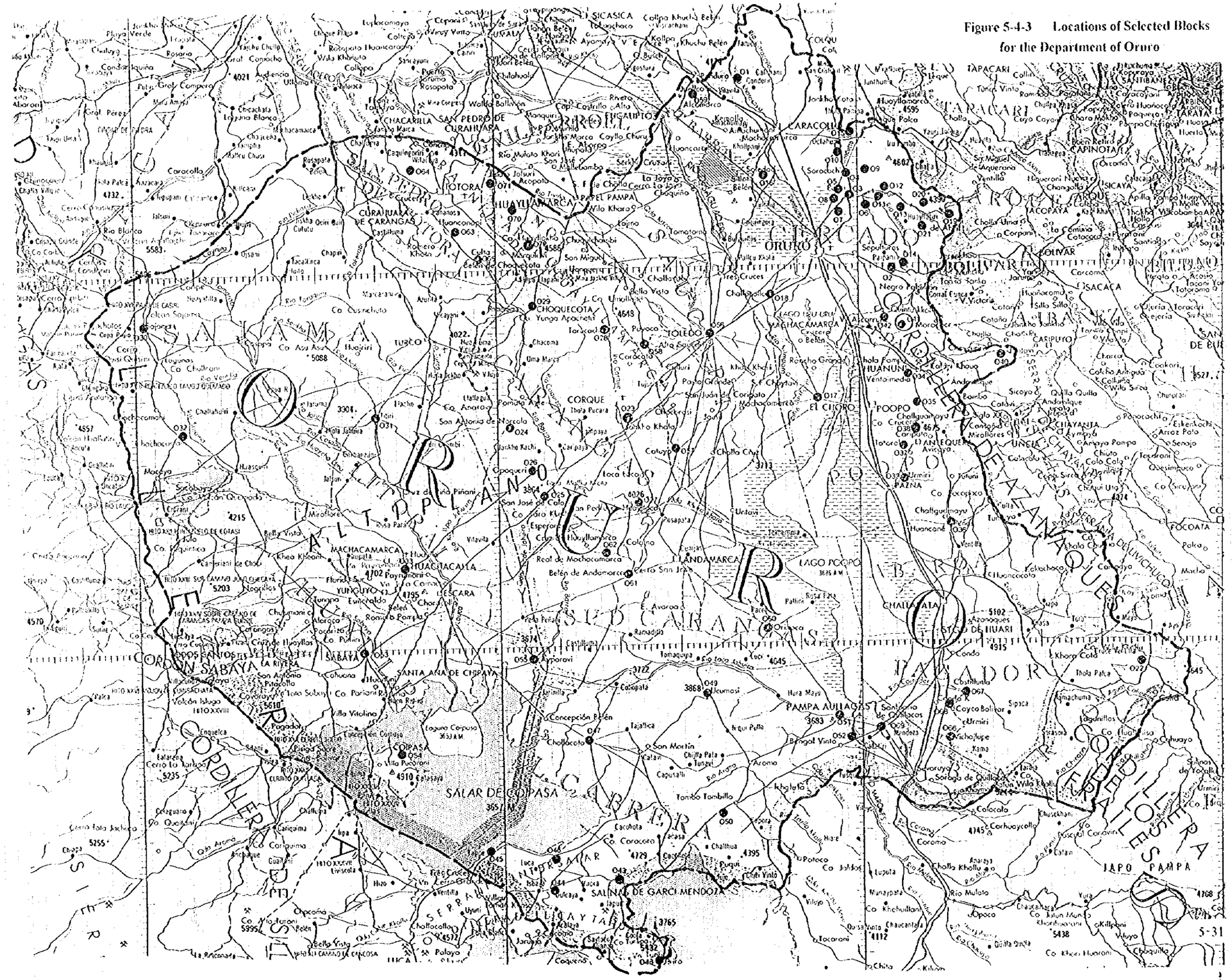


Figure 5-4-4 Locations of Selected Blocks for the Department of Tarija

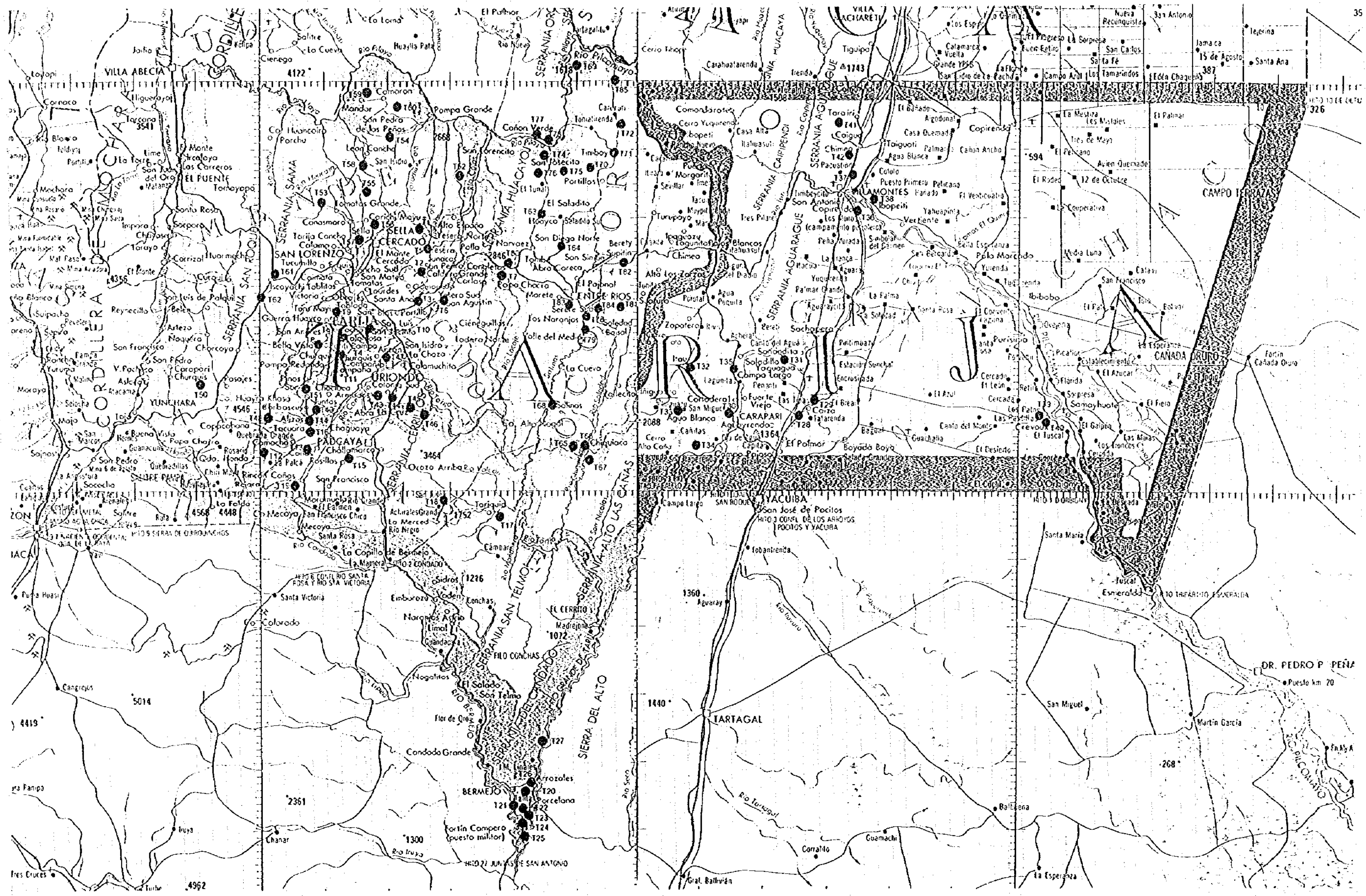
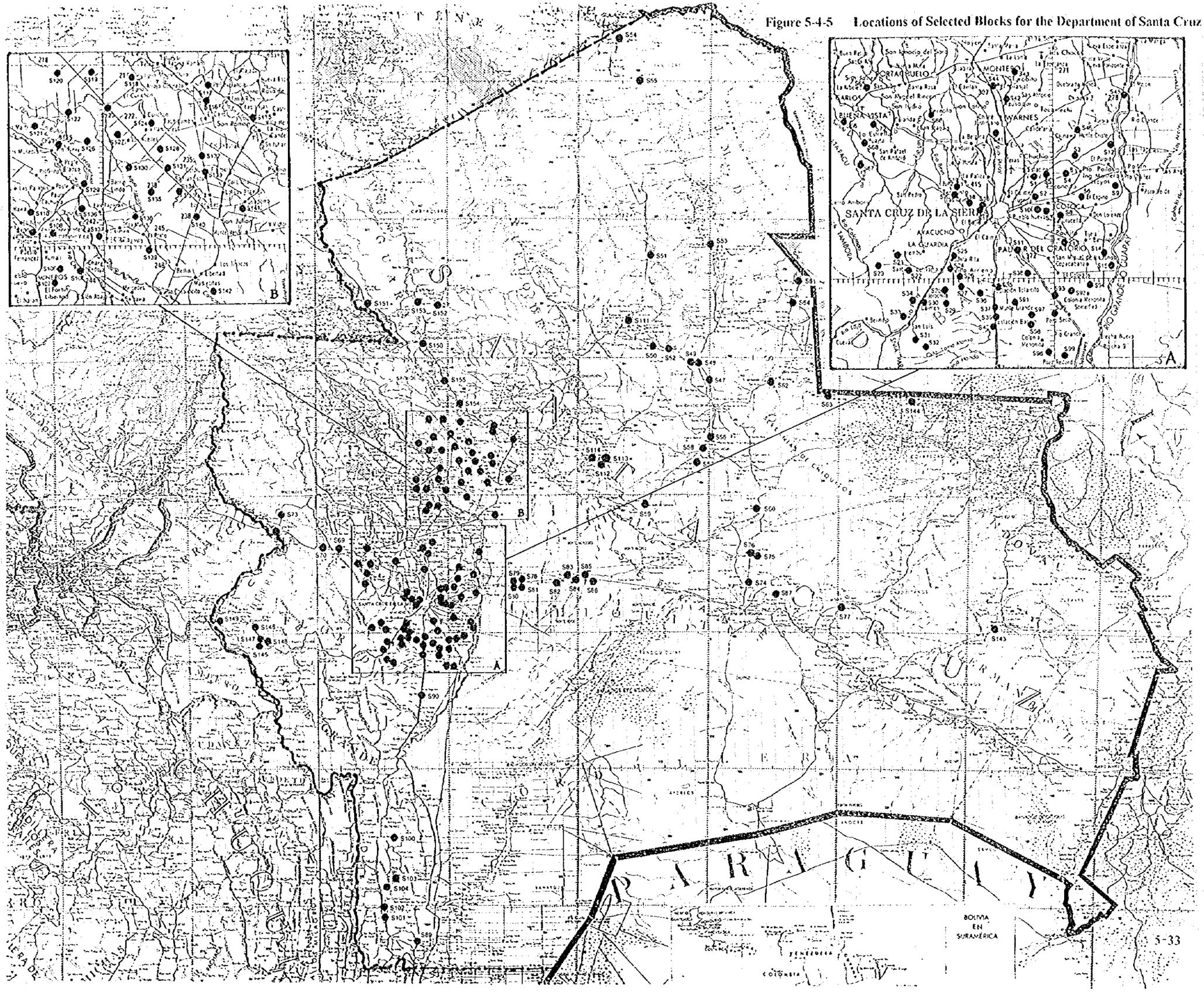


Figure 5-4-5 Locations of Selected Blocks for the Department of Santa Cruz



The targeted populations and the number and extent of the wells drilled are summarized according to Department in Table 5-4-6.

Table 5-4-6 Outline of the Proposed Project

Department	Number of Blocks	Target Population	Number of Wells	Total Drilling Depth (m)	Distribution of Drilling Depths (m)					
					0~50	~100	~150	~200	~300	>=300
Chuquisaca	98	57,295	98	11,600	38	14	34	7	2	3
South of La Paz	46	19,957	46	5,450	17		20	9		
Oruro	72	31,009	73	10,400	3	25	35	5	5	
Tarija	85	35,128	85	12,750		40	27	7	11	
Santa Cruz	155	112,396	158	20,650	4	95	39	14	1	5
Total	456	255,785	460	60,850	62	174	155	42	19	8

5.4.2 Form of Project

As a result of the hydrogeological survey, it has been judged that the development potential for deep groundwater is high in the Study Area.

Also, the results of the project implementation case study show that although the promotion of groundwater development is difficult given the current organizational system and financial conditions of Bolivia, groundwater development in rural areas will be feasible if international cooperation is provided in an effective manner under clear governmental policies.

Since the Bolivian government is judged to have the willingness and ability to promote the groundwater development project, the form of project is proposed in which the Bolivian side will carry out the well drilling work and the water supply facility work. In order to realize the procurement of drilling equipment, it is considered that, in addition to financial cooperation, education and training on groundwater prospecting techniques and drilling techniques must be provided to Bolivian engineers over a period of half a year to a year.

The proposed project is one which will provided the government agencies of Bolivia with the ability to resolve the problems of regional water supply improvement on their own and one by which long-term effects can be anticipated.

5.4.3 Implementation Organization

There are two aspects to the groundwater development project, the "public aspect," under which the project is put into operation from the standpoint of the essential objective of public welfare, and the "commercial aspect," for which the manifestation of economy is the fundamental

principle. The groundwater development project must be put into operation upon balancing these two aspects.

With regard to the executing organization for the well drilling work, it is necessary for a public agency to provide direct management because of the difficulty of recovering project costs and because private enterprises are underdeveloped and low in skill level. It is proposed that the Department is most suited for this purpose since the Department is positioned among the various relevant organizations of Bolivia to be the planning and execution agency for public investment in regional areas and has the best grasp on the circumstances and hydrogeological information of the water supply blocks in the regional areas. The basic sanitation department of each Department (UNASBA) has maintained a constant level of experience and skill related to well drilling work and water supply work since the days of the former CORDES and it is judged that UNASBA can establish reliability as an executing agency for the operation and control of the project and the operation and maintenance of equipment and materials through organizational, financial, and technical fortification, and cooperation and adjustment with the central government.

The mutual utilization of drilling equipment and materials among several Departments is considered to be difficult because the required project burden is immense for each Department and because of the geographical conditions and circumstances of roads in Bolivia.

5.4.4 Required Number of Equipment and Project Cost

The numbers of well drilling equipment (rigs) necessary for accomplishing the proposed project in 5 years are calculated to be 2 units each for Chuquisaca and Tarija, 1 unit each for the southern part of La Paz and Oruro, and 3 units for Santa Cruz.

Table 5-4-7 shows the calculated project cost. A total of 71.3 million dollars, of which 39.5 million dollars are external funds and 31.8 million dollars are domestic funds, are required for the five Departments.

Table 5-4-7 Estimated Project Cost

(Unit: million dollars)

Department	Investment Amount			Breakdown of Project Cost				Term of Drilling (years)	Number of Rigs
	External Funds	Domestic Funds	Total	Procure-ment of Rig	Water Supply Equip-ment	Drilling Work	Water Supply Work		
Chuquisaca	9.0	6.9	15.9	7.8	3.2	2.0	2.9	3.1	2
South of La Paz	4.5	3.0	7.5	4.1	1.4	1.0	1.0	2.9	1
Oruro	5.7	4.4	10.1	4.2	2.3	2.0	1.6	4.8	1
Tarija	9.0	5.4	14.4	7.8	2.7	2.1	1.8	3.0	2
Santa Cruz	11.3	12.1	23.4	9.6	4.9	3.3	5.6	3.6	3
Total	39.5	31.8	71.3	33.5	14.5	10.4	12.9	-	9

(Note) The rigs shall be procured and the drilling work for the 1st year shall be carried out with foreign funds. The drilling work for the next year onward shall be carried out by the Bolivian side.

5.4.5 Stage Plan of the Projects

With regard to the project execution schedule, the policy of starting the project from regions with high potential for groundwater development and good access and gradually expanding the project towards peripheral areas was taken and the annual plans were formulated upon evening out the term of drilling and project cost for each year. The year in which the project is to be executed is shown for each block in Tables 5-4-1 to 5-4-5 and Table 5-4-8 shows the number of blocks in which the project is to be executed according to Department and year.

Table 5-4-8 Stage Plan of the Project

Department		1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
Chuquisaca	Number of blocks	19	28	20	20	11	98
	Beneficiary population	12,512	19,382	9,826	9,558	6,017	57,295
	Number of wells drilled	19	28	20	20	11	98
	Total drilling depth (m)	1,300	2,050	2,300	3,000	2,950	11,600
South of	Number of blocks	7	14	9	9	7	46
La Paz	Beneficiary population	4,006	6,848	3,480	3,680	1,943	19,957
	Number of wells drilled	7	14	9	9	7	46
	Total drilling depth (m)	450	1,000	1,350	1,450	1,200	5,450
Oruro	Number of blocks	16	19	16	13	8	72
	Beneficiary population	9,990	8,417	7,008	3,511	2,083	31,009
	Number of wells drilled	17	19	16	13	8	73
	Total drilling depth (m)	1,950	1,900	2,400	2,050	2,100	10,400
Tarija	Number of blocks	14	19	21	16	15	85
	Beneficiary population	7,213	9,334	7,322	5,718	5,541	35,128
	Number of wells drilled	14	19	21	16	15	85
	Total drilling depth (m)	1,550	2,600	2,450	2,900	3,250	12,750
Santa Cruz	Number of blocks	20	36	40	39	20	155
	Beneficiary population	13,510	36,933	24,273	24,907	12,773	112,396
	Number of wells drilled	20	39	40	39	20	158
	Total drilling depth (m)	2,100	4,350	4,600	4,500	5,100	20,650
Total	Number of blocks	76	116	106	97	61	456
	Beneficiary population	47,231	80,914	51,909	47,374	28,357	255,785
	Number of wells drilled	77	119	106	97	61	460
	Total drilling depth (m)	73,500	11,900	13,100	13,900	14,600	60,850

CHAPTER 6 THE PILOT PROJECT

6.1 Outline of the Pilot Project Communities

In the pilot project, studies on the water source development potential were conducted in 4 water supply block communities by constructing test water supply systems and conducting experiments on water supply system operation and maintenance education and sanitation education.

The communities subjected to the pilot project were Campo Leon in the Department of Chuquisaca, Corque in the Department of Oruro, La Chosa in the Department of Tarija, and San Carlos in the Department of Santa Cruz. Table 6-1-1 shows an outline of the communities based on field studies and questionnaire surveys.

Campo Leon, in the Department of Chuquisaca, is a typical dispersed type rural community located in the central part of the Plain of Chaco and has a population of 237 that comprise 44 households. Most of the inhabitants are engaged in livestock farming. Due to the hot, dry climate, there is a significant shortage of water throughout the year and all inhabitants, as well as the livestock, depend on water from irrigation ponds or rainwater.

Corque, in the Department of Oruro, is a rural community with a population of 1,558 persons and 364 households located in the central part of the Altiplano, 75 km southwest of Oruro City. A highly concentrated community is formed on the slope of a hill. This community has a water distribution network that uses a spring 15 km away to the north as the water source and the current water supply coverage is 86%. However, the water source dries up in the dry season and domestic water tends to be in shortage due to restriction or interruption of the water supply.

La Chosa, in the Department of Tarija, is a rural community with a population of 371 and 85 households located 20 km southeast of Tarija City. The community is formed on a slope between the Pan American Highway and Tarija River. Whereas 42% of the inhabitants use water from a hand-dug well supplied by means of a hand pump, etc., the rest of the inhabitants collect river water downstream. Although a water supply system diverted from the nearby community of San Isidro was scheduled to be constructed, since the quantity of water taken in from the water source was low, the diversion could not be provided and part of the distribution tanks and distribution piping that were constructed have become unusable.

San Carlos, in the Department of Santa Cruz, is a rural community with a population of 480 and 106 households located 25 km southwest of Santa Cruz City. A long community is formed along a road. This community does not have a water supply system and the inhabitants obtain domestic water either by collecting water from an irrigation pond or by collecting rainwater.

Table 6-1-1 Outline of the Pilot Project Communities

Item	Campo Leon	Corque	La Chosa	San Carlos
Number of houses (excluding vacant houses)	41	322	76	100
Number of households	44	364	85	106
Total population	237	1,558	371	480
Average number of persons per household	5.4	4.3	4.4	4.5
Proportion of population below the age of 15	43.7%	34.9%	23.5%	45.6%
Illiteracy of persons of age 15 and above	9.0%	9.8%	22.6%	14.6%
Proportion of workers by occupation (Male; age 15 and above)				
a) Agriculture	6.5%	22.3%	83.9%	77.1%
b) Livestock farming	55.7	8.1	0.0	0.8
c) Mining · construction	19.7	24.6	8.9	16.7
f) Commerce	0.0	13.5	0.0	0.8
e) Service · salary earners	6.6	30.5	6.3	2.3
g) Unemployed, etc.	11.5	1.0	0.9	2.3
Employment rate of women of age 15 and above	21.1%	38.0%	14.8%	17.7%
Language used at home				
a) Spanish only	90.2%	8.8%	100%	79.0%
b) Spanish and another language	--	82.2	--	20.0
b) Another language only	9.8 (Guarani)	9.0 (Aymara/ Quechua)	--	1.0 (Quechua)
Source of domestic water				
a) Water service	--	85.9%	--	--
b) Well	--	2.8	41.5%	3.0%
c) River	--	--	49.6	--
d) Irrigation pond	100%	--	--	69.0
f) Others	--	11.3	8.9	25.0
Monthly household income				
a) Less than 100 Bs	9.1%	14.4%	11.8%	60.0%
b) 100-200 Bs	48.2	23.8	30.9	15.0
c) 200-500 Bs	36.4	54.7	35.3	16.0
d) 500 Bs or more	6.1	7.1	22.1	9.0

6.2 Construction of Pilot Project Facilities

1) Outline of Construction Works

In order to carry out education on the operation and maintenance of water supply systems and sanitation education and to make effective use of test wells, lift pumps and other water supply equipment were experimentally installed in the 4 pilot project communities, one in each of the Departments except for the Department of La Paz.

Among the test equipment, the lift pump and electric generator were purchased and sent from Japan. The installation of the lift pump and electric generator, the construction of the generator room and water tank, and the piping work were commissioned to and carried out by local construction firms.

In the construction of the test facilities, the outline of the test facilities, the construction schedule, the methods of inhabitant education, etc. were explained and cooperation was requested of the counterparts of the former CORDES of each Department and the inhabitants of each community. Guidance was also provided on the organization of a water cooperative for carrying out the operation, maintenance, and management of the test facilities.

After the completion of the facilities, trial runs were performed and the facilities were handed over to each Department upon providing education on facility operation and other operation and maintenance methods to the engineers of each Department and the inhabitants.

2) Outline of the Pilot Project Facilities

With the exception of Corque, the test facilities were those for a simple water supply system of level II (public faucet system). Table 6-2-1 shows an outline of the facilities. As test facilities, a submersible motor pump was installed in the test well, a water tank and a generator room were constructed nearby, and public faucets were installed. A diesel engine generator was used as the power source for the pump.

In the case of Corque (Department of Oruro), since the community was approximately 1 km away from the test well, a waterpipe was laid to the existing distribution tank (capacity: approx. 50 cubic meters) in view of future water source utilization. A water tank and a public faucet were not provided. Also, in the case of La Chosa (Department of Tarija), since the test well was artesian, the lift pump was installed in a newly erected water tank and used for pumping water to the existing distributing tank (approx. 20 cubic meters).

Table 6-2-1 Outline of the Pilot Project Facilities

Point	JC-6	JC-2	JC-8	JC-4
Department	Chuquisaca	Oruro	Tarija	Santa Cruz
Community	Campo Leon	Corque	La Chosa	San Carlos
Water Pump				
Diameter	50mm	40mm	32mm	32mm
Pump discharge	17 l/min.	100 l/min.	33 l/min.	83 l/min.
Pump head	350 m	50 m	50 m	150 m
Power	11 kW	1.5 kW	0.75 kW	3.7 kW
Generator				
Model	Diesel engine	Diesel engine	Diesel engine	Diesel engine
Output	35kVA	10kVA	10kVA	15kVA
Water tank				
Structure	Reinforced concrete	--	Reinforced concrete	Reinforced concrete
Capacity	3 m^3	--	8 m^3	15 m^3
Generator house				
Structure	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
Area	15 m^2	15 m^2	15 m^2	15 m^2
Piping				
Material	PVC	PVC	PVC	PVC
Diameter	1 inches	4 inches	3 inches	3 inches
Length	100 m	1,000 m	100 m	100 m
Public faucet				
Number of locations	1 set	--	3 sets	1 set
Structure	Reinforced concrete	--	Reinforced concrete	Reinforced concrete
Number of faucets	4 faucets	--	12 faucets	6 faucets

Table 6-2-2 shows the demand for domestic water in each community, the yield limits of the test wells, and the pumping capacities of the installed pumps. The safe yield of each well exceeds the demand for water in the corresponding community and the necessary water supply quantity can be provided with one test well in each case. It can be seen that the yield is such that the water consumption requirement can be satisfied by 3 hours of pumping operation a day in Campo Leon, 13 hours of pumping operation a day in Corque, and 7 hours of operation a day in San Carlos.

Table 6-2-2 Comparison of Water Demands of Communities, Safe Yields, and Pump Capacities

Community	Campo Leon	Corque	La Chosa	San Carlos
Current population	237 persons	1,558 persons	371 persons	48 persons
Mean water consumption per head per day	90 l/person.day	70 l/person.day	70 l/person.day	90 l/person.day
Daily mean water consumption	21 m^3/day	109m^3/ day	26m^3/ day	43m^3/ day
Safe yield of well	2.25 l/ s	2.0 l/ s	7.55 l/ s	10.0 l/ s
Daily maximum yield per day	194 m^3/day	173 m^3/day	652 m^3/day	864 m^3/day
Lift pump capacity	120 l/min.	140 l/min.	--	105 l/min.
Hourly yield	7.2 m^3/hour	8.4 m^3/hour	--	6.3 m^3/hour

(Note) The mean water consumption per head per day was determined in accordance with the Water Service Facility Design Standards of Bolivia.
The lift pump capacities are corrected on the basis of the installation depths of the respective pumps and the pump performance curves.

3) Lessons and Problems

Several problems were found in the process of installing the test facilities. These should be of reference and taken into further consideration in the full-fledged execution of the groundwater development project. These problems are summarized below.

(1) The survey of individual communities, that was conducted in the present study, has shown that the populations of the communities differ considerably from the results of the national census of 1992. One of the reasons is considered to be the inconsistency of the national census definition of the range of a community with the actual circumstances. Community population surveys must therefore be conducted for the implementation plan.

(2) With small water supply blocks, there is also a problem in directly identifying the administrative unit of the community (town or village) as an independent water supply block. As a matter of fact, it has become clear that, for the 2 communities of San Carlos and La Chosa among the 4 communities in which test facilities were installed at this time, it is more rational in terms of a water supply system to set up a water supply block that includes several nearby communities.

(3) Information, on existing facilities, in particular, on tanks, pipes, and other equipment that have been constructed in the past as a part of a facility but have been abandoned due to the non-completion of the entire facility because of some reason or the other, have not been preserved in an organized manner and in many cases, such facilities are not discovered unless a field study is actually conducted.

In many cases, such existing facilities can be worthy of incorporating into the overall plan when planning new facilities. The collection and disclosure of such information is thus strongly desired.

(4) In all communities, the inhabitants demonstrated an extremely high demand for house-to-

house faucets. However, this demand cannot be considered to be realistic in districts with a dispersed residential pattern and efforts must be made to convince the inhabitants correctly.

6.3 Workshop

1) Outline of the Workshops

Workshops on methods of formulating groundwater development plans and water supply plans and on operation and maintenance methods for water supply systems were held for the engineers of each Department in order to contribute to the improvement of the surveying skills in each Department.

2) Workshops of Groundwater Development Technology

For technical transfer, on-the-job training on geophysical prospecting methods and on test boring techniques were provided through field survey work at each of the Departments. Seminars were also held on the methods of analyzing geophysical prospecting and test boring techniques, hydrogeological investigation methods, etc.

3) Workshops on Water Supply Planning and Operation and Maintenance Technology

Workshops on water supply planning were held in the form of seminars on methods of formulating regional water supply plans and water supply system operation and maintenance methods. Slides and educational materials prepared by the Study Team were used in these seminars. Also, these seminars were not limited to general lectures on water service techniques but included explanations on practical technical topics for water supply planners and laid a stress on the characteristics of regional water supply systems and the forms of technical support for water supply system operation and maintenance for regional communities.

Also, opinions on the classification of water supply blocks, methods of selecting high priority development areas, and other fundamental topics were exchanged freely between the participants and the Study Team.

4) Lessons and Problems

(1) The number of participants in the water supply planning seminars amounted to a total of 73 persons for the 5 Departments. These participants were generally enthusiastic and some have already attained a high level of knowledge. However, there is a shortage of staff for formulating plans and providing technical support effectively in the numerous water supply blocks dispersed in each Department. More planning engineers and staff who specialize in technical support should be secured and education and training programs should be expanded.

(2) There were many participants who did not have an adequate knowledge of the natural and social characteristics of the regions targeted for regional water supplying and the actual

circumstances of water supply in the individual water supply blocks. It is desired that information on the actual circumstances of water supply, etc. in each region in each Department be grasped accurately and accumulated as a common database and that such a database be used effectively as a planning tool.

(3) Although the participants have a considerable knowledge on water supply systems per se, they do not necessarily have adequate practical knowledge on facilities, such as pumps and piping, that are the key elements of water supply systems. Since the technical support provided to inhabitants will mainly consist of discussions concerning hardware facilities, the acquisition of knowledge in this field is important.

(4) The participants do not seem to use a common manual on regional water supply but seem to use reference materials which they have obtained under individual opportunities. Since a significant number of seminars seem to be held by international agencies and support groups, it is desirable for a manual that can be used in common for the entire nation or an entire Department be prepared by organizing the materials used in such seminars.

(5) There was the impression that the participants did not have a very strong feeling of urgency regarding the system of external technical support, which is a most important function for establishing a system of operation and maintenance of the water supply system by the inhabitants. It is clear that there is a shortage of staff, in terms of both quality and number, for the regional government and public agencies to serve this function in a practical manner. It is therefore desirable for the relevant persons of public agencies to make efforts towards actively opening up a way for using private firms and consultants.

6.4 Pilot Study

6.4.1 Education on Water Supply Facility Operation and Maintenance

1) Outline of Operation and Maintenance Education

Water supply system operation and maintenance education was provided aiming at members of water cooperatives and inhabitants who will be involved in the operation and maintenance of system s in the future in the 4 communities subjected to the pilot project. A total of 51 persons participated from the 4 water supply blocks. Slides, operation and maintenance manuals, and pamphlets with pictures were prepared as educational materials and guidance on operation methods were provided through actual demonstrations at the site.

2) Lessons and Problems

(1) Since the starting and stopping of pumps and engines are enabled by button operation, these did not present a problem for the inhabitants. There were no problems with the monitoring of fuel oil and cooling water as well. However, it is considered that in cases of an abnormal phenomenon, such as idle running of the pump due to lowering of the water level of the well or an overcurrent or overheating accident of a pump or engine, it is nearly

impossible for a inhabitant without experience to detect such phenomena immediately and take emergency measures.

(2) Although inhabitants can take emergency measures against leakage from piping or tank, the pursuing of the cause and the taking of fundamental measures are beyond the abilities of the inhabitants.

(3) Keeping the surroundings of the public water faucet clean is an extremely important daily habit and water washing and ditch clearing must be performed frequently. Although such work can be carried out by the inhabitants, it requires everyday efforts and cannot be carried out effectively without the aid of sanitation education.

(4) Although the bearing of operation costs will probably be accepted by the inhabitants without any problems, there is a strong tendency for inhabitants to cut the water supply instead of saving water in order to lower the operation costs. The problem will be serious if the water quantity required for keeping up a sanitary life is reduced and appropriate guidance is necessary.

(5) As has been described above, there are many problems which are difficult to resolve by the efforts of the inhabitants alone. External technical support is essential for the success of water supply systems and the systematic construction of channels for this purpose is desired.

6.4.2 Sanitation Education

1) Outline of Sanitation Education

The Study Team and the counterparts cooperated in performing sanitation education of the inhabitants in the 4 communities subjected to the pilot project. The total number of participants in the 5 Departments was approximately 650 and approximately half of the inhabitants participated. Videos, pamphlets (cartoons), and posters prepared in Spanish, Aymaran, and Quechuan were used as educational materials.

The education was aimed at making the inhabitants understand the dangers to health presented by the use of polluted water and the benefits of drinking water and at teaching daily habits, such as washing the hands before meals, bathing, etc., to thereby spread the recognition of the importance of water cooperatives for water supply system operation and maintenance and the paying of fees. The importance of the role of women in various stages of construction and operation and maintenance were also stressed.

2) Lessons and Problems

(1) Videos, pamphlets (cartoons), and posters prepared in Spanish, Aymaran, and Quechuan were used as educational materials. These materials were popular among the inhabitants as being easy to understand and it is considered that these can be used effectively in other regions as well.

(2) According to the questionnaire surveys held after the sanitation education's, most

participants has understood the importance of water and the need of operation and maintenance of the system. However, the changing of the sanitation habits of inhabitants is not something that can be accomplished in a short term and sanitation education should be introduced from the water supply system planning stages and should be continued for an appropriate term after construction while checking the response of the inhabitants. Education must therefore be incorporated in the water supply plan execution schedule.

(3) Dialog between the educator and the participants is necessary in carrying out education. The cooperation of schools and priests can also be obtained to incorporate sanitation education in the school education curriculum and messages delivered after prayers.

(4) Most women works inside their houses in the rural area and water drawing works are carried mostly by women and children in the Study Area. This particular works presumably requires a large proportion of their working hours. Women have so much interests in water supply projects, so that it is effective to focus on women for the operation and maintenance training and sanitary education program. In order to formulate effective water supply planning, it is necessary to incorporate the living pattern, needs and opinion of women as end users of water.

(5) Many inhabitants in rural area desire the construction of water supply system more than other infrastructure projects and improvement of education at present. Especially they hope the implementation of groundwater development which water would not dry up even in dry season. Many inhabitants have agreed the necessity of water tariff payment and the importance of operation and maintenance.

CHAPTER 7 WATER SUPPLY PLANNING FOR PILOT PROJECT

7.1 General

In the pilot project, public faucet type water supply facilities were constructed at four communities where the test well had been drilled. However, since these facilities were mainly constructed for the purpose of operation and maintenance education and sanitation education, they are inadequate as full-fledged facilities for future use. The objective of this chapter is to plan domestic water supply systems of a higher degree of completion for the 4 communities based on the information obtained from the pilot project and to examine the feasibility for executing the groundwater development project.

The water supply plans make the most use of the existing facilities and the facilities constructed in the pilot project. If it is possible to distribute water to the surrounding communities with gravity, the water diversion scheme shall be included in the combined water supply planning. However, the feasibility of the project shall be examined on the case where it was assumed that there are no existing facilities.

7.2 Water Supply Facility Plans

7.2.1 Campo Leon (Chuquisaca)

1) Outline of the Existing Facilities

There were no water supply facilities prior to the execution of the pilot project.

In the pilot project, a deep well was constructed, a submersible motor pump and electric generator were installed, and a non-elevated water tank and a generator house were constructed, and public faucets were installed at one location.

The safe yield of the test well was 194 cubic meters per day, the static water level was 190 m, and the dynamic water level was 283 meters. The water consumption in this community can be covered satisfactorily with this well alone.

2) Water Supply District and Planned Water Consumption

Table 7-2-1 shows the planned domestic water consumption. Although the water consumption will be twice that shown if water for livestock is included, the plan will be aimed only at domestic water here.

3) Facility Plan

If an elevated tank is installed near the test well and a distributing pipe is laid, the water can be distributed to the water supply districts by gravity flow. Since the lift pump installed in the pilot project has an adequate head, water is pumped directly to the elevated tank. The water

supply plan diagram is shown in Figure 7-2-1.

Table 7-2-1 Planned Water Consumption in Campo Leon

Current population	237 persons
Planned population	273 persons
Planned mean water consumption per head per day	90 l/person·day
Planned daily mean water consumption	25 m^3/day
Planned daily maximum water consumption	30 m^3/day
Planned hourly maximum water consumption	5 m^3/hour

Note : Hourly maximum ratio: 4.0

4) Required Facilities

① Well Existing

② Lift pump Existing; submersible motor pump, φ 50mm X 120l/min X 290m X 11kW)

③ Electric generator Existing; 35kVA

④ Elevated tank Structure : Reinforced concrete

Capacity : 20m^3

(equivalent to 16 hours of planned daily maximum water consumption)

⑤ Distributing pipe Specifications: PVC pipe, diameter ～50mm

Extension: approx. 4km

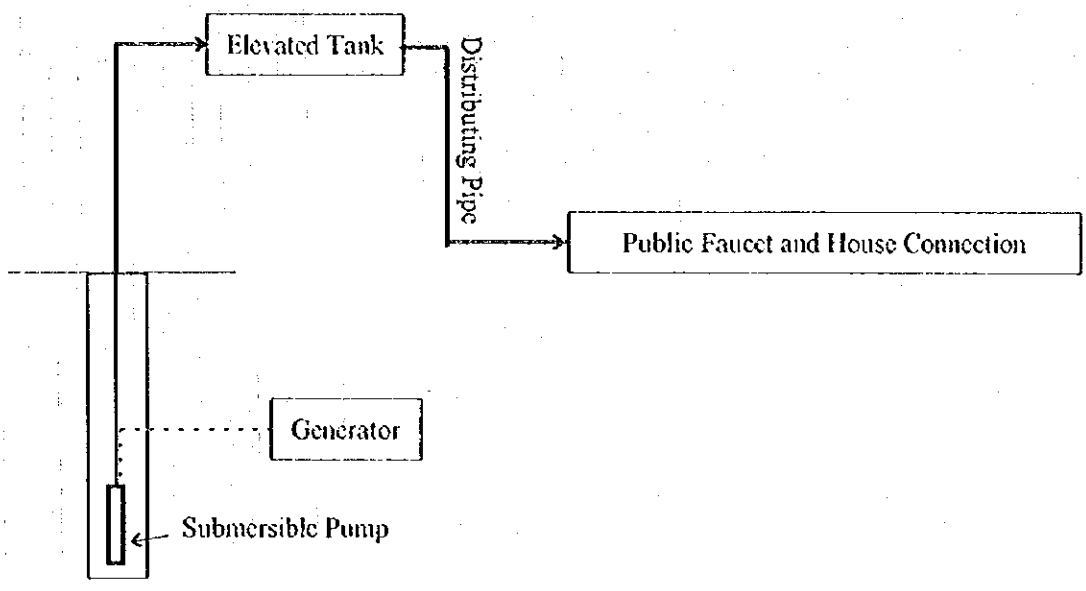


Figure 7-2-1 Water Supply Plan Diagram (Campo Leon)

7.2.2 Corque (Oruro)

1) Outline of the Existing Facilities

This community has a water supply system using a spring, located approximately 18 km north of the community, as a water source. A reinforced concrete distributing tank is installed at the hill side of the community and distributing pipes are laid to the community from this tank. However, although water can be obtained from the water source of the existing facility during the rainy season, the inflowing water quantity drops nearly to zero and water shortage occurs during the dry season.

In the pilot project, a deep well was constructed approximately 1 km east of the community, a submersible motor pump and electric generator were installed, and a waterpipe was laid to the existing distributing tank.

The safe yield of the test well was 173 cubic meters per day, the static water level was 7 m, and the dynamic water level was 29 meters. The water consumption can be covered with this well alone if the lift pump is operated 24 hours a day.

2) Water Supply District and Planned Water Consumption

Table 7-2-2 shows the planned domestic water consumption.

Table 7-2-2 Planned Water Consumption in Corque

Current population	1,558 persons
Planned population	1,792 persons
Planned mean water consumption per head per day	70 l/person·day
Planned daily mean water consumption	125m^3/day
Planned daily maximum water consumption	151 m^3/day
Planned hourly maximum water consumption	15.7 m^3/hour

Note : Hourly maximum ratio: 2.5

3) Facility Plan

Since the submersible pump installed in the pilot project is insufficient in capacity, a water tank shall be constructed near the tank and a conveying pump shall be installed to pump up water from this water tank to the existing distributing tank. With regard to the distributing tank and the distributing pipe, the existing facilities shall be used. Figure 7-2-2 shows the water supply plan diagram.

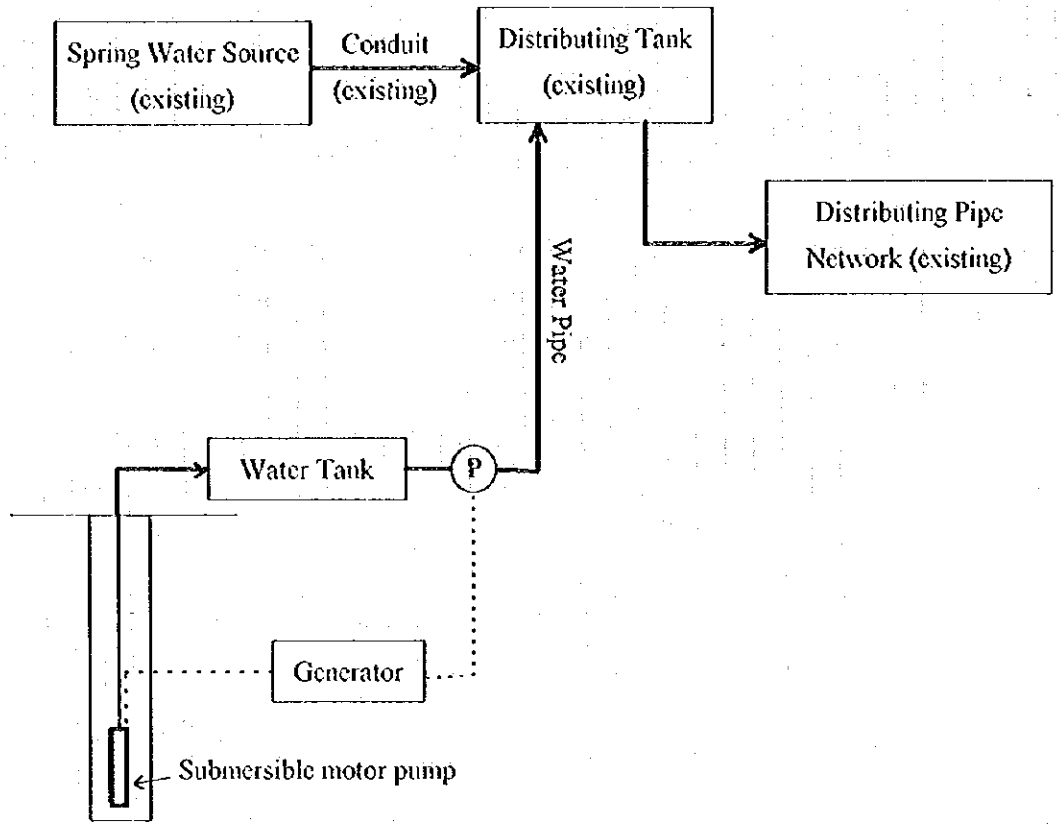


Figure 7-2-2 Water Supply Plan Diagram (Cerque)

4) Required Facilities

①	Well	Existing	
②	Lift pump	Existing	ϕ 40mm X 140l/min X 35m X 1.5kW
③	Electric generator	Existing	10kVA
		Addition:	15kVA
④	Water tank	Structure :	Reinforced concrete
		Capacity :	approx.16 m^3
⑤	Conveying pump	Model:	Volute pump
		Specifications :	ϕ 50mm X 265l/min X 50m X 7.5kW
			(operated 24 hours a day)
⑥	Waterpipe	Existing	ϕ 100mm X 1,300m
⑦	Distributing tank	Existing	30 m^3
		Addition:	30 m^3
		Total :	60 m^3
		(equivalent to 10 hours of planned daily maximum water consumption)	
⑧	Distributing pipe	Existing	

7.2.3 La Chosa (Tarija)

1) Outline of the Existing Facilities

On the premise that water will be diverted from the neighboring village of San Isidro, a distributing tank was installed on a hill at the western side of the Pan American Highway and a distributing pipe was laid from this tank. However, due to a shortage of the water source quantity in San Isidro, the distribution of water has become impossible and the water could not be supplied.

In the pilot project, a deep well was constructed, a submersible motor pump and electric generator were installed, and a non-elevated water tank, a generator house, and public faucets were constructed.

The test well is 120 m deep and one from which water flows out naturally. The artesian yield was 7.6 liters per second (655 cubic meters per day).

2) Water Supply District and Planned Water Consumption

Since the artesian yield is high and the water can be diverted by gravity flow to 3 neighboring villages, the water supply block shall be comprised of the 4 villages of La Chosa, Ventolera, Angostura, and Sanchu Waykho. Table 7-2-3 shows the planned water consumption.

Table 7-2-3 Water Consumption in La Chosa and Other Districts

	La Chosa	Ventolera	Angostura	S. Waykho	Total
Current population (persons)	371	177	200	196	944
Planned population (persons)	425	200	225	220	1,070
Planned mean water consumption per head per day (l/day.person)	70	70	70	70	70
Planned daily mean water consumption (m^3/day)	30	14	16	15	75
Planned daily maximum water consumption (m^3/day)	36	17	19	18	90
Hourly maximum ratio	3.5	5.0	5.0	5.0	-
Planned hourly maximum water consumption (m^3/hour)	5.3	3.5	4.0	3.8	16.6
Distance from La Chosa	-	approx. 3.5 km	approx. 6 km	approx. 3 km	-

3) Facility Plan

The water tank installed in the pilot project shall be used as a relay tank, a conveying pump shall be installed to lift water to the existing distributing tank, and water shall be distributed within the La Chosa community from this tank using the existing distributing pipe.

Also, conduits to the three villages of Ventolera, Angostura, and Sanchu Waykho shall be installed anew and water shall be diverted by means of a gravity flow system. Figure 7-2-3 shows the water supply plan diagram.

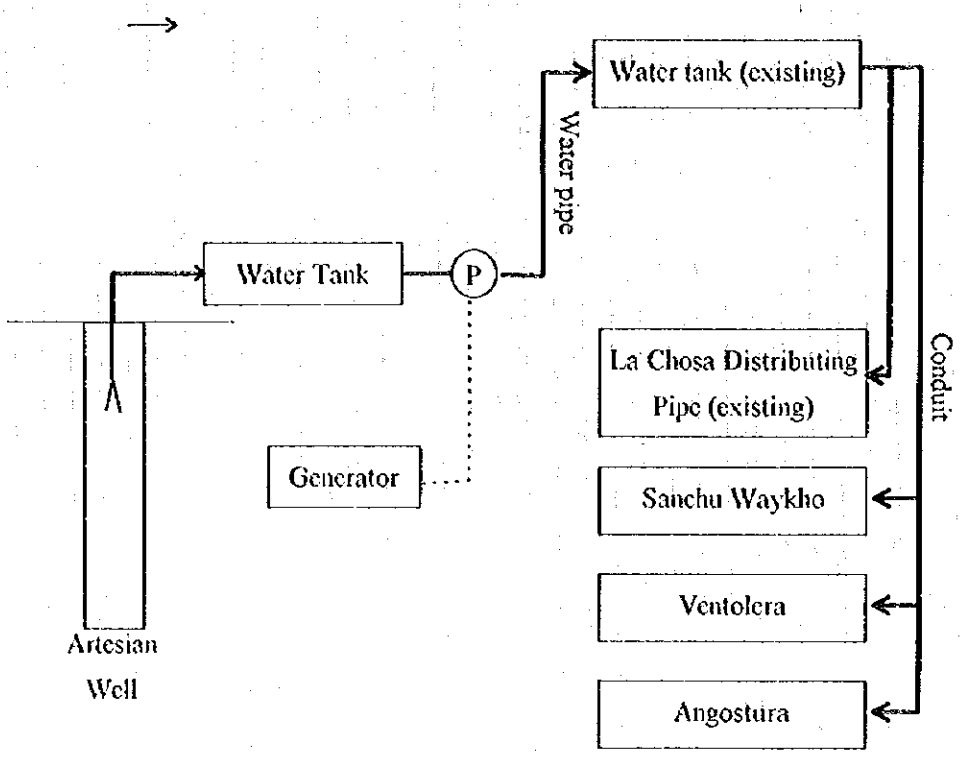


Figure 7-2-3 Water Supply Plan Diagram (La Chosa)

4) Required Facilities

①	Well	Existing	
②	Water tank	Existing	8m^3
③	Conveying pump	Model:	Volute pump
		Specifications :	ϕ 40mm X 280l/min X 50m X 3.7kW
④	Electric generator	Existing	10kVA
⑤	Waterpipe (from water tank to distributing tank)		
		Specifications :	PVC, ϕ 100mm
		Extension:	approx.300m
⑥	Distributing tank	Existing	30 m^3
		Addition	23 m^3
		Total :	53 m^3
		(equivalent to 14 hours of planned daily maximum water consumption)	
⑦	Distributing pipe	Existing	approx. 1km
⑧	Conduits (from distributing tank to neighboring 3 villages)		
		Specifications :	Steel pipe, ϕ 50-75mm
		Extension :	approx. 9km

7.2.4 San Carlos (Santa Cruz)

1) Outline of the Existing Facilities

There were no water supply facilities prior to the execution of the pilot project.

In the pilot project, a deep well was constructed, a submersible motor pump and electric generator were installed, and a non-elevated water tank, a generator house, and a public faucets were constructed.

The safe yield of the test well was 36.0 cubic meters per hour, the static water level was 58 m, and the dynamic water level was 93 meters. The planned water consumption can be covered satisfactorily with this well alone.

2) Water Supply District and Planned Water Consumption

Since the well has an abundant yield and the water can be diverted by gravity flow to 2 neighboring villages, the water supply block shall be comprised of the 3 villages of San Carlos, San Juan, and Villa Rosario. Table 7-2-4 shows the planned consumption.

Table 7-2-4 Planned Water Consumption in San Carlos and Other Districts

	San Carlos	San Juan	Villa Rosario	Total
Current population (persons)	480	100	250	830
Planned population (persons)	552	115	288	955
Planned mean water consumption per head per day (l/person·day)	110	90	90	90
Planned daily mean water consumption (m^3/day)	61	10	26	97
Planned daily maximum water consumption (m^3/day)	73	12	31	116
Hourly maximum ratio	3.5	5.0	4.0	
Planned hourly maximum water consumption (m^3/hour)	10.6	2.5	5.2	18.3
Distance from San Carlos	-	approx. 3km	approx. 3km	

3) Facility Plan

A distributing tank shall be installed anew at the hilltop part of San Carlos, a conveying pump for lifting water shall be newly installed next to the water tank installed in the pilot project, and a distributing pipe shall be laid for distribution of water by gravity within the community of San Carlos.

Also, a connection shall be made with distributing pipes and conduits shall be laid to divert water to the two villages of San Juan and Villa Rosario. Figure 7-2-4 shows the water supply plan diagram.

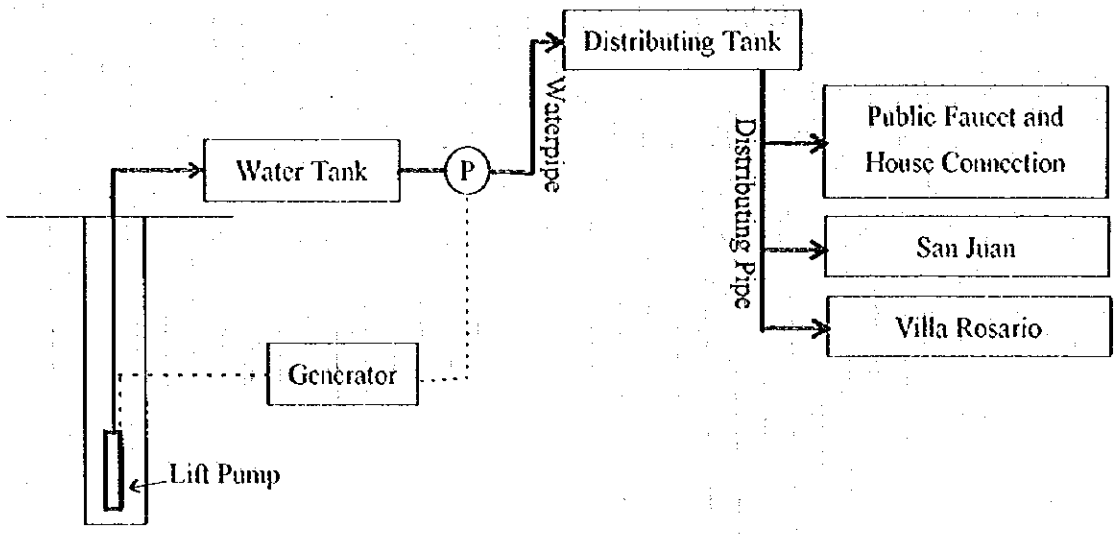


Figure 7-2-4 Water Supply Plan Diagram (San Carlos)

4) Required Facilities

① Well	Existing	
② Lift pump	Existing	ϕ 32mm X 105l/min X 100m X 3.7kW)
③ Water tank	Existing	15m^3
④ Conveying pump	Model:	Volute pump
	Specifications :	ϕ 50mm X 305l/min X 80m X 7.5kW
⑤ Electric generator	Existing	15kVA
	Addition	20kVA
	Total	35kVA
⑥ Waterpipe (from water tank to distributing tank)		
	Specifications :	PVC, ϕ 40mm
	Extension:	approx. 0.5km
⑦ Distributing tank	Structure :	Reinforced concrete
	Capacity:	approx. 70 m^3
	(equivalent to 16 hours of planned daily maximum water consumption)	
⑧ Distributing pipe	Specifications:	Steel pipe, ϕ 75-125mm
	Extension:	approx. 2km
⑨ Conduits (from distributing tank to neighboring 2 villages)		
	Specifications:	Steel pipe, ϕ 75mm
	Extension:	approx. 5km

7.3 Cost Estimation and Feasibility of the Project

7.3.1 Project Cost

Initial investment of the groundwater development and water supply project is composed of well drilling cost, construction cost of water supply facilities, land acquisition cost, and engineering cost for investigation, design and supervision. Among these, many beneficiary communities might carry the land acquisition cost and the labor cost for the facility construction.

The project costs for construction of water supply facilities are shown in Table 7-3-1, estimated according to the facility planning in the section 7.2 and the following conditions.

a. Well construction costs were estimated for the operation of drilling equipment, the procurement and installation for casing and strainer, and the field examination, excluding depreciation costs of the equipment and physical contingencies.

b. Construction costs for water supply facilities were estimated as far as distribution pipes and public water faucets, based on the contracts with private constructor.

c. Each costs were estimated upon multiplying the quantity of each facility and the unit prices of market, excluding reserve funds. To verify the total costs, the cost for construction of the existing facilities were also estimated on the current price bases.

d. Engineering and consulting costs were estimated at five percent of the total direct costs.

Table 7-3-1 Construction Costs

(Unit: dollar)

	Campo Leon	Corque	La Chosa	San Carlos
Well Drilling	48,100	11,100	13,400 (13,400)	24,000 (24,000)
Facility Construction				
Submersible Motor Pump	12,000	3,100		5,600 (5,600)
Lifting Pump	--	2,500	1,300 (1,300)	2,500 (2,500)
Transit Tank	--	3,000	1,200 (900)	2,300 (1,500)
Distribution Tank	4,500	9,000	7,500 (3,600)	10,500 (4,500)
Lifting Pipes	--	22,000	3,000 (3,000)	1,000 (1,000)
Distribution Pipes	25,000	82,000	10,000 (10,000)	20,000 (20,000)
Conduit Pipes to Other Communities	--	--	90,000 (0)	50,000 (0)
Distribution Pipes to Others	--	--	15,000 (0)	17,000 (0)
Generator	28,000	22,500	11,000 (11,000)	22,500 (22,500)
Generator House	3,000	3,000	3,000 (3,000)	3,000 (3,000)
Sub-total	120,600	158,200	155,400 (46,200)	158,400 (84,600)
Consulting Engineering	6,000	7,900	7,800 (2,300)	7,900 (4,200)
Total	126,600	166,100	163,200 (48,500)	166,300 (88,800)
Per Capita	464	93	153 (114)	174 (161)

Note: Figures in ( ) show the case of the individual planning.

Estimated construction costs of the facilities vary widely from $93 to $464 per person. Campo Leon is such a dispersed community with small population and deep groundwater level that the construction cost is comparatively high. The costs of Corque is the lowest because of greater population scale and shallow groundwater level. At La Chosa and San Carlos, the individual water supply planning costs lower than the combined planning with neighboring communities as a result of long distances.

7.3.2 Operation and Maintenance Cost

Operation and maintenance costs cover the energy costs for fuel, electricity and chemicals, the personnel expenses, the procurement expenses for expendables, the cost of materials and labor wages for repairing, and the depreciation expenses for facilities.

Table 7-3-2 shows the operation and maintenance costs in the pilot project communities, estimated upon the following conditions.

a. Fuel costs were estimated upon multiplying the average working hours of generator, fuel consumption rate and unit price.
b. Personnel expenses vary from the number of staff and the daily wages. Monthly expenditure were estimated for three days of daily allowance at Campo Leon, 20 days at Corque, and 10 days at La Chosa and San Carlos.
c. Annual repairing costs were estimated at 0.2 percent of the construction cost of facilities.
d. Depreciation costs of facilities and equipment were excluded in the cost estimation here.

Table 7-3-2 Operation and Maintenance Costs

(Unit: dollar/month)

	Campo Leon	Corque	La Chosa		San Carlos	
Fuel Consumption	132	248	56	(23)	376	(201)
Personnel Expenses	20	140	70	(70)	70	(70)
Repairing Cost	20	26	26	(8)	26	(14)
Total	172	414	152	(101)	472	(285)
Per Capita	0.63	0.23	0.14	(0.24)	0.49	(0.52)
Per Household	Bs 16	Bs 6	Bs 4	(6)	Bs 12	(13)

Note: Figures in ( ) show the case of the individual planning.

Estimated operation and maintenance costs ranges from Bs.4 to Bs.16 per household per month. Campo Leon is the most expensive, while Corque and La Chosa is comparatively inexpensive. Fuel costs account for 60 to 80 percent of the total operation and maintenance cost except for La Chosa where groundwater spouts to the ground with its pressure.

7.3.3 Feasibility for Water Supply Planning

1) Average monthly income is assumed to be around $40 to $100 per household in rural communities, which means the construction cost is equivalent to the income of all households for one year at Corque and five years at Campo Leon. The construction of water supply facilities should be charged to public investment because the project cost is far beyond the limit of the community's financial capacity.

2) Operation and maintenance cost was estimated at Bs.16 per household per month at Campo Leon, accounting for around eight percent of the monthly income. However, average monthly expenditure amounts to around Bs.10, some households charge up to Bs.20 per month for purchasing drinking water of tanker and many inhabitants said they could barely pay up to Bs.20 per month according to the questionnaire surveys. Therefore, it might be possible to charge the communities water tariff for operation and maintenance of water supply services.

3) The implementation of water supply projects planned in this Chapter will realize a stable water supply and improve the living condition of beneficiary communities. As the communities are considered to have strong wills and abilities to operate and maintain the water supply systems independently from the points of view in the pilot projects, the project is concluded to be viable after realization of an initial investment.

4) The simple technology employed in water supply planning must be adapted for rural communities to operate and maintain the system. However, supporting system should be constructed by the Prefectures, the Municipalities and private dealers to cope with the case of incident or disorder of the equipment.

CHAPTER 8 PROJECT IMPLEMENTATION PLAN

8.1 Outline of the Project

1) The planned project aims at developing groundwater for domestic use and supplying and distributing water for domestic use to 98 communities in Chuquisaca, 46 communities in the southern part of La Paz, 72 communities in Oruro, 85 communities in Tarija, and 155 communities in Santa Cruz, or a total of 456 communities which face serious shortage of domestic water due to delays of water resource development.

2) International aid shall be depended on for the procurement of the well drilling equipment (rigs) necessary to execute the present plan. In order to serve the additional purpose of guidance on equipment operation skills, the well drilling work for the first year shall be carried out in cooperation with engineers of each Prefecture, which are the project executing bodies and agencies to which the equipment are to be provided.

3) The respective Prefectures shall be fully responsible for carrying out the well drilling work from the second year onwards and all of the water supply system construction work while making adjustments with the relevant agencies in the central government, Prefecture, city, targeted community, etc.

4) The term of execution of the project is considered to be restricted by the project financing conditions, the financial circumstances of the central government and the respective Prefectures. Although it may take approximately half a year to a year for the equipment procurement formalities to be completed if international cooperation is to be depended on for part of the financing, plans were formulated so that the planning targets will be achieved in 5 years in view of the urgency of execution of the project.

8.2 Execution Schedule

Figure 8-2-1 shows the execution schedule for the project. In the first year, drilling equipment shall be procured, the project execution system shall be established, and preliminary field surveys, selection of applicable projects, and detailed field surveys shall be carried out. The drilling work for the first year shall be performed in an on-the-job training form for the acquisition of skills.

The water supply system construction work shall be performed upon making facility plans that take the population, water consumption, site conditions, groundwater level, yield, etc. into consideration.

	1st Year	2nd Year	3rd Year	4th Year	5th Year	Remarks
Project preparation						
Procurement of drilling equipment						
Selection of drilling points						Field survey
Well drilling work						Annual inspection
Detailed design of water supply facilities						
Construction of water supply facilities						

Figure 8-2-1 Project Execution Schedule

8.3 Water Supply Plan

8.3.1 Basic Policies

The procedures for water supply plan formulation are shown in Figure 8-3-1.

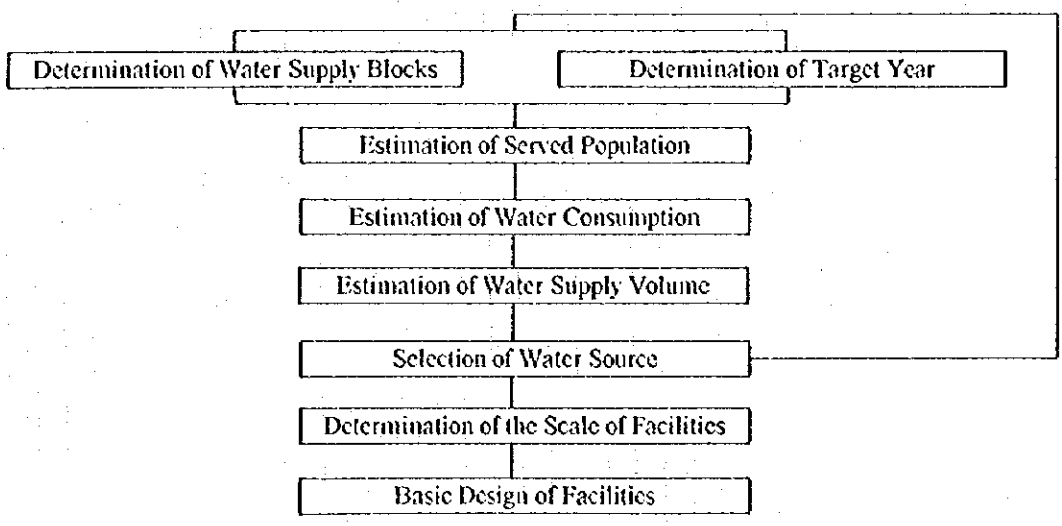


Figure 8-3-1 Procedures for Water Supply Plan Formulation

The water supply facility plan shall be formulated in accordance with the following basic policies.

① The planning and design of water supply facilities shall be carried out on the basis of the circumstances of existing water supply systems and the Design Standard of Water Supply Facility Design Standards in Bolivia.

② The scale of facilities and the improvement/expansion plan for existing systems shall be planned on the basis of the planned population for 10 years after the time of planning.

③ With regard to water sources, groundwater development by means of wells shall be given first consideration.

④ This development plan shall be planned for major facilities such as the water source facility, water conveying facility, distribution reservoir, distributing main, pipe.

⑤ In cases where the sustainable yield exceeds the water demand of the corresponding block, diversion of water to nearby blocks shall be considered.

⑥ In cases where water supply facilities exist already, improvement and expansion work shall be carried out to enable effective utilization of such facilities.

⑦ The capacities of each facility shall be designed for 8 hours of operation a day as standard.

8.3.2 Planned Water Volume

The mean water consumption per head per day have been set as shown in Table 8-3-1 based on the Water Supply Facility Design Standards in Bolivia and in accordance with the population of each water supply district and the zonal division.

Table 8-3-1 Planned Mean Water Consumption per Head per Day

(unit: l/person·day)

Zonal Division	Population of the Community			
	<=500	501~2,000	2,001~5,000	5,001~20,000
Altiplano	30~50	30~70	50~80	80~100
Valley	50~70	50~90	70~100	120~150
Plain	70~90	70~110	90~120	150~200

Table 8-3-2 shows the total water demand for the projects. Planned mean water consumption amounts to 24,116 cubic meters per day in total.

Table 8-3-2 Total Planned Water Volume in Each Department

(unit: m^3/day)

Item	Chuquisaca	South of La Paz	Oruro	Tarija	Santa Cruz	Total
Number of targeted blocks	98	46	72	85	155	456
Planned daily mean water consumption	5,073	1,176	1,867	2,815	1,3185	24,116
Planned daily maximum water consumption	6,088	1,411	2,240	3,378	15,822	28,939
Planned groundwater yield	6,696	1,552	2,464	3,716	17,404	31,832

Note Planned daily maximum water consumption = [Planned daily mean water consumption] X 1.2

Planned groundwater yield = [Planned daily maximum water consumption] X 1.1

8.3.3 Facility Plan

1) Water Supply System

Water supply systems using groundwater as the water source can be classified into the following four types according to the water intake method, the population of the targeted community, and the form of the community (Figure 8-3-2). Motorized pump system is applied for the water supply systems in this Project.

① Hand Pump System

This type of system can be adopted for shallow wells and deep wells with a water level at about 40 m or shallower and is applicable to districts where the number of households is about 20 or less. This type of system is the most inexpensive in terms of construction cost and operation and maintenance cost.

② Gravity Flow System

This type of system can be adopted in cases where spring water can be collected from an area that is higher in altitude than the targeted district. Since power will not be required if water intake facilities and conduits are constructed, the operation and maintenance cost will be inexpensive.

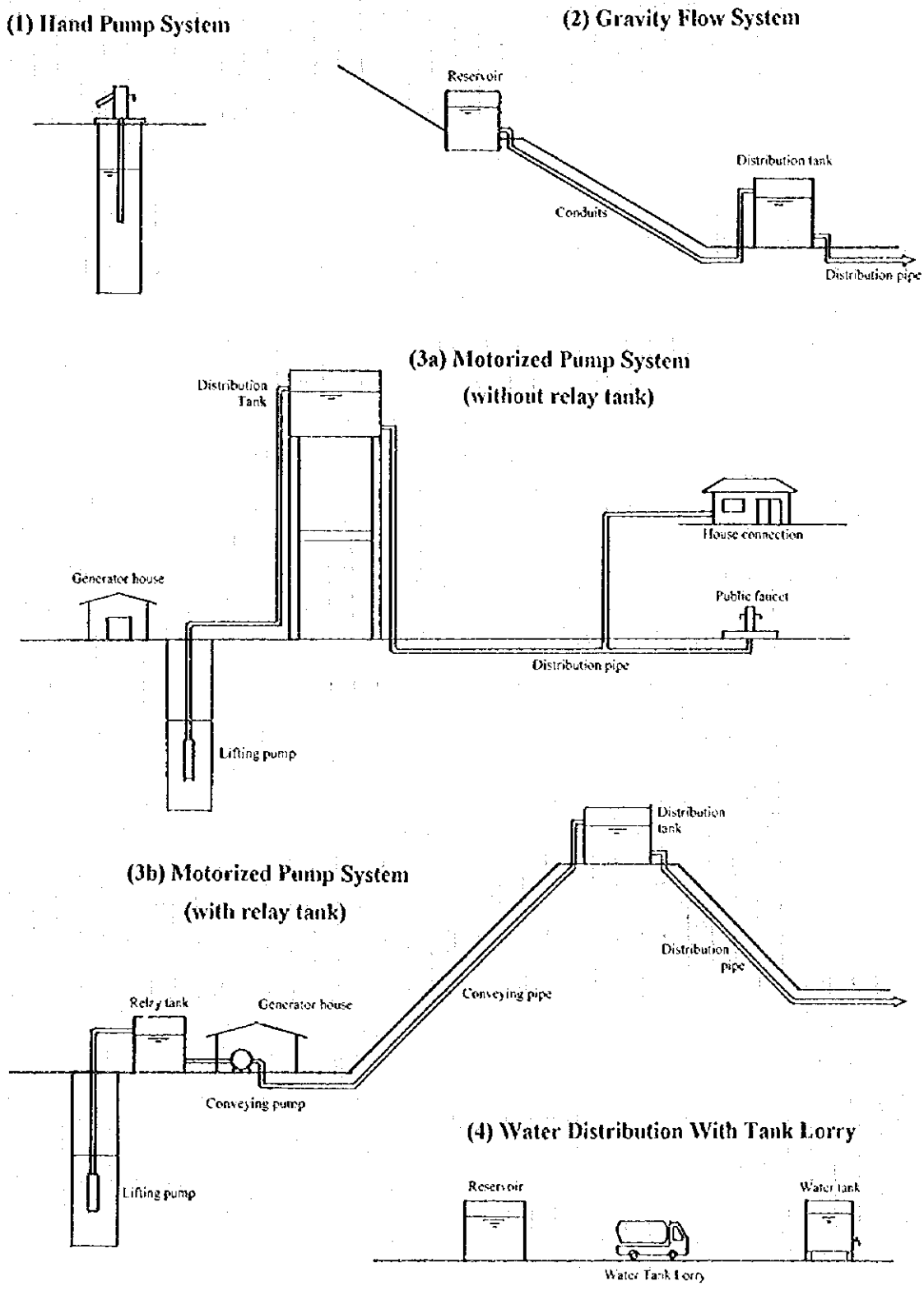


Figure 8-3-2 Basic Water Supply Systems

③ Motorized System

In this type of system, a power pump is used to pump up water from the well to a distribution tank (elevated water tank) where it is stored and then distributed by gravity. For the lift pump of a deep well, a submersible motor pump shall be used upon installing in a casing. In the case of a shallow well, operation and maintenance will be easier if a non-elevated centrifugal pump is used.

Depending on the location of the distribution tank, the water may be pumped up directly to an elevated tank by means of submersible pump or the water may be pumped up with a conveying pump to a distribution tank via a relay tank.

This type of system requires the appointment of a person responsible for management activities, including the operation of equipment, maintenance and inspection, prevention of excessive pumping, etc., and the provision of a support system for operation and maintenance. The operation and maintenance costs of this type of system are high.

④ Water Distribution with Tank Lorry

In this type of system, clean water collected from a water source in another district is transported by means of a water tanker and supplied to the targeted district. This type of system is applicable to districts in which satisfactory groundwater cannot be obtained or in which water supply facilities cannot be furnished due to high construction costs, operation and maintenance costs.

2) Required Facilities

The facilities required in each type of water supply system are shown in Table 8-3-3. Construction sites, access roads, and operation and maintenance facility, groundwater monitoring facility, and accessories are also required in addition to the items shown below.

Table 8-3-3 Required Facilities by Water Supply Systems

Water Supply System	Required Facilities
1) Hand pump system	Well, hand pump, foundation
2) Gravity flow of spring water	Catchment well, conduits, water storage tank, distribution pipe
3) Power pump system	Well, lift pump, electric generator, control house, distribution tank, distribution pipe (relay tank, conveying pump, conveying pipe)
4) Water distribution by transportation	Water tanker, water tank

Note: Depending on the water quality, disinfecting and filtration devices may also be necessary.

3) Planning Standards

The planning standards for motorized pump type water supply system are as follows.

① Well

The number of wells is determined based on the safe yield calculated based on the estimated water consumption and the pumping test results. The drilling method and well structure are described in section 8.4.

② Lift Pump

In the case of a deep well, a submersible motor pump shall be used. In the case of a shallow well or in the case where the water level is high, a non-elevated centrifugal pump shall be used and a low-level stoppage limit switch should be installed. Pumping pipes, submersible cables, control panel, power equipment, etc. will also be necessary. As a rule, the pump capacity should be calculated for 8 hours of operation a day. A pump room should be installed for housing the control panel.

③ Power Source

An engine generator should be installed in the case of a district without commercial power. Depending on the area, solar power generation may also be possible.

① Distribution Tank

An elevated tank shall be installed at a location and height that would enable the continuous supplying by gravity of the necessary quantity of water at a certain pressure or more to the area to be supplied. Depending on topographical and site conditions, a lift pump => relay tank => conveying pump => distributing tank arrangement shall be used. The structure shall be of reinforced concrete and the effective volume of the tank shall be set to an equivalent of 10 to 18 hours of the estimated daily maximum water consumption.

⑤ Distribution Pipe

Distribution pipes should have adequate resistance against water pressure and earth pressure and should be one by which the water will not be polluted or will not leak. The minimum water pressure for a distribution pipe shall be 1.5kg/cm^2 or more as standard. In terms of material, the pipe should be a galvanized steel pipe or polyvinyl chloride pipe and freezing should be considered for cold areas. In cases where a distributing pipe network already exists, the connection positions should be examined.

Table 8-3-4 shows an example of water supply system specifications calculated based on the above planning standards for communities of representative population scales.

Table 8-3-4 Model Designs for Water Supply Facilities

Population scale of community	200 persons	300 persons	500 persons	1,000 persons	2,000 persons
Mean water consumption per head per day (l/person·day)	80	80	80	100	120
Planned daily mean water consumption (m^3/day)	16	24	40	100	240
Planned daily maximum water consumption (m^3/day)	19	29	48	120	280
Hourly maximum ratio	5.5	4.5	4.0	3.0	2.5
Planned hourly maximum water consumption (m^3/hour)	4.4	5.4	8.0	15.0	30.0
Planned yield (l/min.)	>=22	>=32	>=53	>=132	>=317
Capacity of lift pump (l/min.)	46	67	111	275	661
Capacity of distributing tank (m^3)	15	20	28	60	120
Capacity of conveying pump (l/min.)	74	90	133	250	500
Capacity of relay tank (m^3)	5	6	8	15	30

Note: 8 hours of operation a day was presumed for the lift pump. Depending on the topographical conditions, the conveying pump and relay tank may not be necessary.

8.3.4 Facility Construction Plan

1) Procurement of Equipment and Materials

Among the water supply equipment, foreign products must be imported for the lift pump (submersible motor pump) and the diesel engine generator since there are no manufacturing factories in Bolivia for these items. It is considered that the other equipment can be procured in the domestic market. Standards and specifications should be standardized in the procurement process.

2) Construction Works

The water supply facility construction work should be undertaken as contracted work by a domestic construction firm. With regard to the labor force for the construction work, the cooperation of the residents of the district should be sought as much as possible and employment opportunities should be increased.

The design, cost estimation, and execution control should be carried out under the responsibility of the Prefecture.

8.4 Well Construction Plan

8.4.1 Basic Policies

The basic policies for the well construction plan are as follows.

① Water source of this project shall be deep groundwater in an artesian aquifer.

② In order to determine the drilling depth and drilling method for a drilling point, detailed field surveys must be executed and the hydrogeological structure of the planned position must be checked prior to the execution of the project.

③ The yield should be set within the safe yield range upon confirming the yield of the well and confirming that there will be no influences on water utilization in the surroundings.

8.4.2 Well Drilling Plan

1) Well Drilling Procedures

The procedures for executing the survey and work for well drilling are shown in Figure 8-4-1. In order to secure stable intake of water, adequate studies, including the collection and organization of existing materials, hydrogeological surveys, geophysical prospecting, etc., must be conducted to seek out a favorable aquifer and the formulation of a drilling plan suited for such an aquifer, the installation of screens, and the selection of a pump with a capacity that matches the existing groundwater quantity must be carried out. The drilling point should be set in consideration of the position and height relationships with respect to the district to which the water is to be supplied.

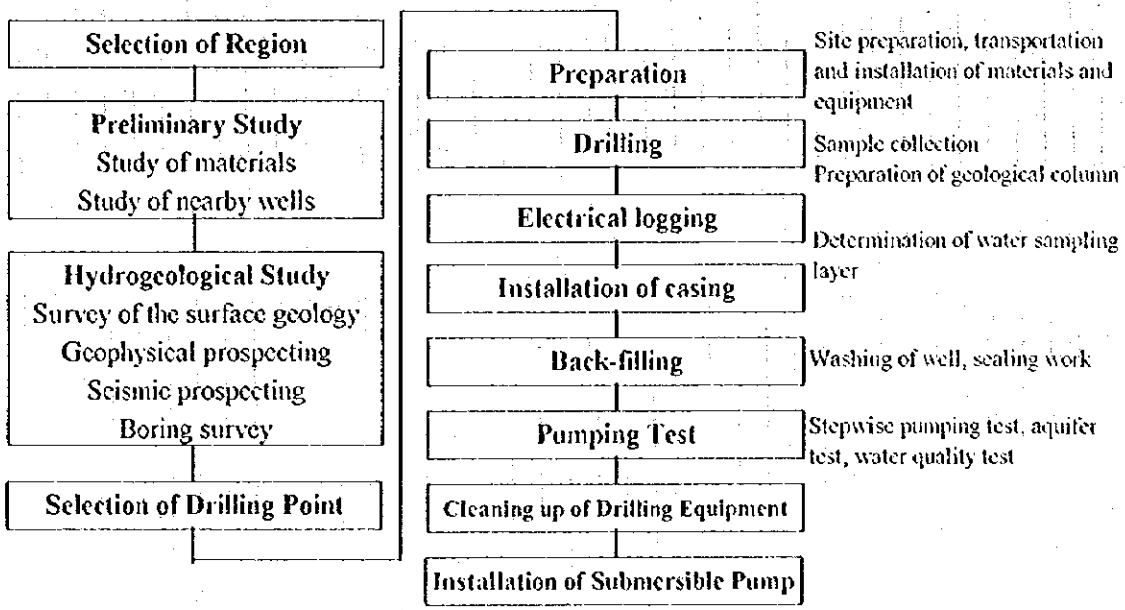


Figure 8-4-1 Flowchart of the Well Drilling Work

2) Drilling Method

Well drilling methods can be largely classified into open hole methods and cased hole methods. In open hole methods, the interior of the drilled hole is filled with slurry to prevent the collapsing of the hole and drilling is continued in the open hole condition up to a predetermined depth while making a mud wall. In cased hole methods, drilling is continued while inserting casings in order to prevent the collapsing of soft strata and using only clear water instead of slurry. Well drilling machines can be divided into the percussion type and the rotary type, and the type is selected according to the type of strata, the drilling depth, the site conditions, etc. With a percussion type well drilling machine, vertical motion is applied to a bit and the strata are crushed and drilled through by the impact force. Drilling is performed by applying a rotating force to the bit in a rotary type well drilling machine, which may be classified further into a spindle type, turntable type, reverse rotary type, etc.

The drilling method must be selected according to the type of strata, the drilling depth, the site conditions, etc.

3) Year-wise Drilling Plan

In consideration of the working and transport efficiency of the drilling equipment, the policy of starting the work from regions with high groundwater development potential and good access and then gradually expanding to peripheral areas shall be taken for the execution schedule for the well drilling work. Table 8-4-1 shows the number of locations drilled in each plan year in each Department.

4) Well Structure

The well structure must be determined in consideration of the planned depth, yield, and water level and water quality of the groundwater.

Figures 8-4-2 and 8-4-3 show standard cross sections of the well. As standard, the well drilling diameter shall be 10-12 inches and the casing diameter shall be 4-6 inches. Casings shall be made of steel and screens shall be made of stainless steel or FRP.

Table 8-4-1 Number of Locations Drilled in Each Plan Year in Each Department

Department	Drilling Year	Number of Drilling Wells by Planned Drilling Depth (m)							Drilling Extent (m)
		0~50	50~100	100~150	150~200	200~300	>=300	Total	
Chuquisaca	1st Year	15	1	3				19	1,300
	2nd Year	21	2	4	1			28	2,050
	3rd Year	2	10	8				20	2,300
	4th Year		1	18	1			20	3,000
	5th Year			1	5	2	3	11	2,950
	Total	38	14	34	7	2	3	98	11,600
South of La Paz	1st Year	6		1				7	450
	2nd Year	11		3				14	1,000
	3rd Year			9				9	1,350
	4th Year			7	2			9	1,450
	5th Year				7			7	1,200
	Total	17		20	9			46	5,450
Oruro	1st Year		12	5				17	1,950
	2nd Year	3	13	3				19	1,900
	3rd Year			16				16	2,400
	4th Year			11	2			13	2,050
	5th Year				3	5		8	2,100
	Total	3	25	35	5	5		73	10,400
Tarija	1st Year		11	3				14	1,550
	2nd Year		11	6		2		19	2,600
	3rd Year		15	5	1			21	2,450
	4th Year		3	8	1	4		16	2,900
	5th Year			5	5	5		15	3,250
	Total		40	27	7	11		85	12,750
Santa Cruz	1st Year		18	2				20	2,100
	2nd Year	4	22	13				39	4,350
	3rd Year		28	12				40	4,600
	4th Year		27	12				39	4,500
	5th Year				14	1	5	20	5,100
	Total	4	95	39	14	1	5	158	20,650
Total	1st Year	21	42	14				77	7,350
	2nd Year	39	48	29	1	2		119	11,900
	3rd Year	2	53	50	1			106	13,100
	4th Year		31	56	6	4		97	13,900
	5th Year			6	34	13	8	61	14,600
	Total	62	174	155	42	19	8	460	60,850

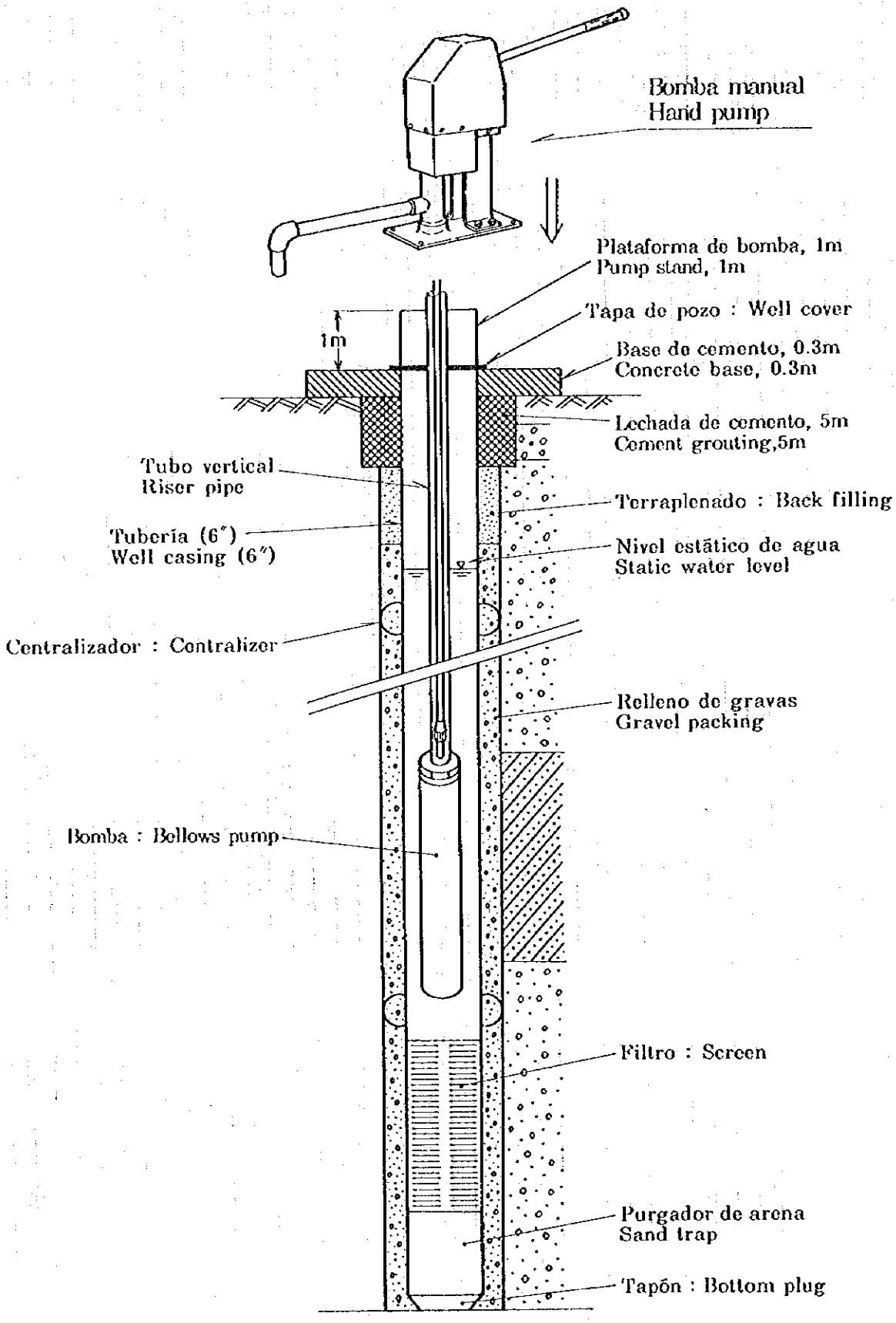


Figure 8-4-2 Designed Type of Well (in case of Hand Pump)

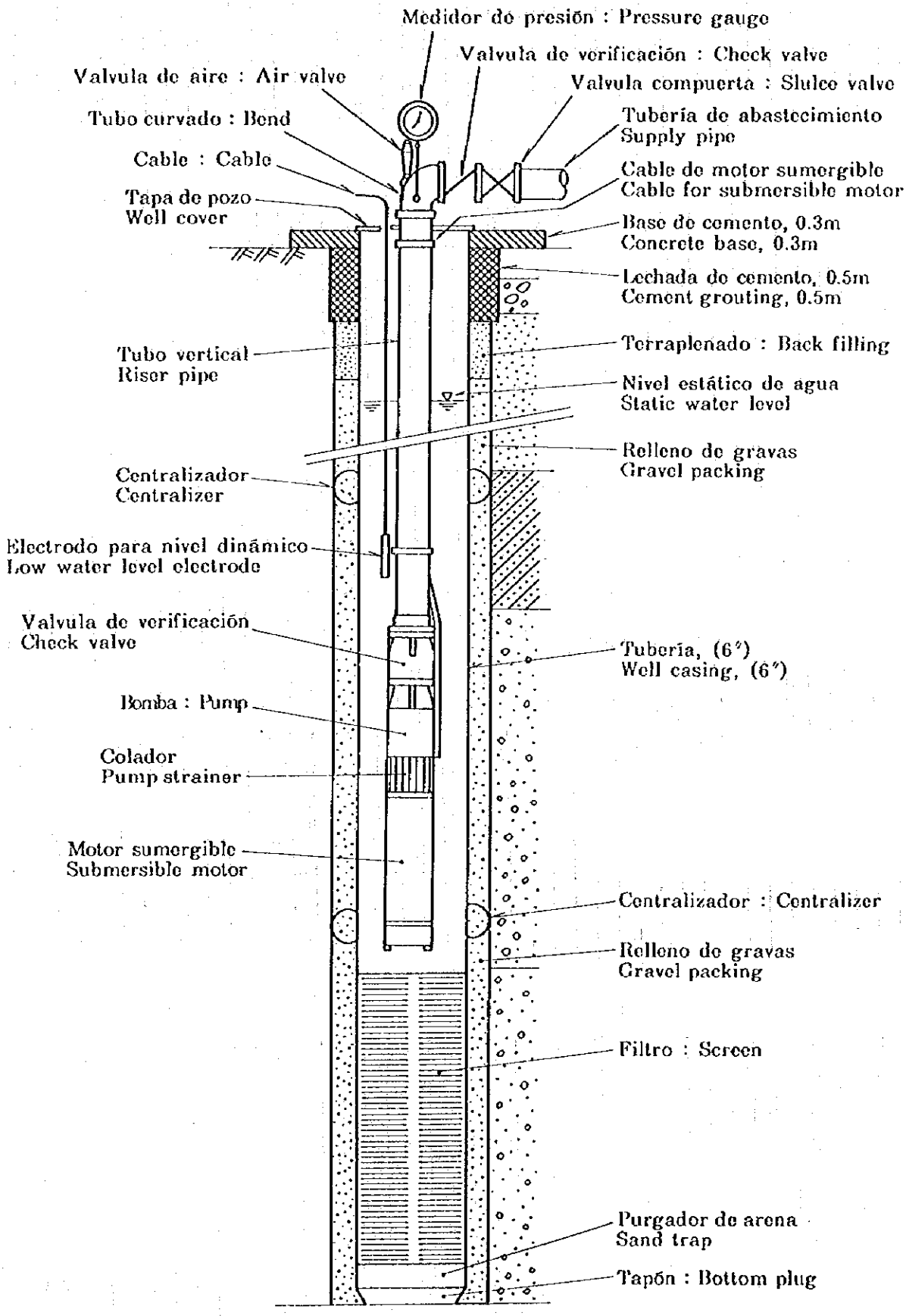


Figure 8-4-3 Designed Type of Well (in case of Submersible Pump)