The well is located on the basalt slope at elevation of 520m. The well depth is 54m. The formation consists of loam (mud flow deposits) and strongly weathered basalt lava. From the surface to 10m, it is composed of weathered mud flow deposits. Weakly consolidated weathered basalt is found from the depth of 11m to 38m. Hard basalt underlies from the depth of 38m to 54m. The basalt lava forms an aquifer, however, its productivity is not so high because of weathering. Its groundwater level shows 20m below ground surface. It will drop to 29m in the dry season.

(3) Groundwater levels in the test wells

Groundwater levels were measured periodically during the dry season from December 1994 to January 1995. The results of measurements are presented in Tables 4.2.1 (1) and 4.2.1 (2) and Figures 4.2.3a and 4.2.3b. The followings are suggested from the observation of water levels:

a) Groundwater levels of the test wells range from 4m to 21m.
b) In the basalt slope of the Bolaven Plateau (C-44,49,S-84,100), it ranges from 8m to 21m.
c) Groundwater levels in the erosion hill and plain are generally shallower than the basalt slope. It ranges from 4m to 10m.
d) Groundwater levels have declined during the above mentioned measurement period.

The rate of decline is 0.06m/day in the basalt slope ,while it shows 0.02m/day in the erosion hill and plain. The lowest groundwater levels in the dry season, which is mentioned previously, was estimated by multiplying this rate to number of remaining days of the dry season.

4.3 Pumping Tests

The pumping tests for 20 test wells were conducted by using the submersible pump. The step draw down, the constant discharge rate and the recovery tests were performed in order to obtain aquifer constants.

(1) Structure of the well

The structure of the test well is illustrated in Figures 4.3.1. The depth, screen position, natural water level before pumping, lithology etc. are presented in Table 4.3.1. The average depth of the test well is 50m, while the well depth was 180m in C-8 (B.Houaxe), 25m in C-44 (B.Thongsala) and 60m in S-84 (B. Beng). The well bore was cased by the 150mm diameter PVC or steel pipe with perforated screen. The annular space around the screen was filled with gravel.

(2) Method of pumping test

(a) Step draw down test

The step draw down test was conducted at 4 steps in 2 hours interval. The step number and discharge rate were determined by using a maximum pumping rate estimated at preparatory pumping. Two teams of the contractor carried out the pumping tests. They commenced the work December 20, 1994 and finished January 25, 1995. (Figure 4.3.2)

(b) Constant discharge rate test

The continuous pumping test was conducted at a constant discharge rate for 24 hours after the step draw down test. The draw down curves are presented in Figure 4.3.3.

(c) Recovery test

After the constant discharge rate test, pumping was stopped and the recovery of groundwater level was measured for 12 hours. The water level recovery is shown in Figure 4.3.3.

(3) Results of analysis

(a) Jacob's method

The drawdown (s) versus time (t) is plotted on the semi logarithmic axis (Figure 4.3.3). The linear relation between (s) and (t) can be taken as σs for one logarithmic cycle. Then, the following equations are derived.

$$\mathbf{T=0.1832Q} \quad (4.1)$$
$$\mathbf{k=T/m} \quad (4.2)$$
$$\mathbf{S=2.25Tt_0/r^2} \quad (4.3)$$

where, **T**:coefficient of transmissivity, **Q**:pumping rate, **k**: permeability coefficient, **m**: aquifer thickness , **S**: storage coefficient, $\mathbf{t_0}$: time at s=0 ,which can be obtained by extending the line "s-log **t**", **r**: the distance from the pumping well

The results of analysis is shown in Table 4.3.2.

(b) Jaeger's method

The draw down (**s**) at the constant pumping rate (**Q**) in the aquifer of transimissivity (**T**) and storativity (**S**) can be expressed as follows:

$$\mathbf{s=QW(u)/4\pi T} \quad (4.4)$$
$$\mathbf{u=r^2S/4Tt} \quad (4.5)$$

where **W(u)** is the well function.

Expressing the draw down (s) at time $\mathbf{t_0}$ as s_0, the draw down ($\mathbf{sNt_0}$) at **N** times of $\mathbf{t_0}$ is derived by using Equation (3.4) as follows:

$$\mathbf{s(Nt_0)/s(t_0)} \quad \mathbf{=W(r^2S/4Tnt_0)/W(r^2S/4Tt_0)} \quad (4.6)$$
$$\mathbf{=W(u)/W(Nu)} \quad (4.7)$$

The ratio of the well function (Equation (4.7)) can be obtained by giving the draw down at $\mathbf{t_0}$ and $\mathbf{Nt_0}$.

The results of analysis are shown in Table 4.3.2.

(c) Huntush's method (**t-s** curve method)

Considering the supplementary leakage through the aquitard, the Huntush's method can be applied for the analysis. This method was adopted to C-65,79 and S-75. The results of analysis are shown in Table 4.3.2.

(d) Huntush-Jacob's method (standard curve method)

This method also considers the leakage and applied for the test wells at 11 villages (Figure 4.3.4). The results are presented in Table 4.3.2.

(e) Recovery method

The results of analysis are shown in Table 4.3.2.

(4) Summary of aquifer constants

Table 4.3.2 presents the aquifer constants (Transmissivity (**T**), Permeability (**k**) and Storativity (**S**)) by method of analysis. The mean constant was calculated by using the results of analysis by leakage method and recovery method. The mean aquifer constants of other test wells, which were not analyzed by the leakage method, were calculated using all values obtained by other methods of analysis. (Table 4.3.3)

The transimissivity changes place to place ranging from 0.8 m^2/day to 1,500 m^2/day. (Figure 4.3.4). It shows 1,500m^2/day in B. Beng, 800m^2/day in B.Thongsala. Both of these villages are located on the basalt slope in the Bolaven Plateau. The lowest transmissivity was found at B. Hountai and Nongphai showing 0.8m^2/day. In B. Nogkhe and B. Phonphai, it shows 200m^2/day, while it ranges from 1.5 to 40 m^2/day in other villages.

(5) Specific capacity

The specific capacity (**Sc**) is expression of the unit discharge per one meter draw down. The productivity of the aquifer and the well can be easily evaluated from the specific capacity. It was calculated by using the draw-down and the pumping rate at stable conditions during the pumping test.

The highest specific capacity was found at B.Thongsala and B.Beng ranging from 1,700 to 1,900 m^3/day/m, while the lowest was 1 m^3/day/m in B.Nongpahi , 1/1,900 of the highest, showing big regional difference. Rather high values were found at B.Nogkhe and B.Phonphai showing 128 and 165 m^3/day/m respectively. The specific capacity of other test wells ranges 2.6 to 45 m^3/day/m.

(6) Optimum Discharge

An optimum discharge rate of the test well was evaluated by using the step draw-down test data (Table 4.3.6). Taking the critical water level found on the linear relation between the pumping rate (Q) and the draw-down (s), the critical pumping rate can be determined (Figures 4.3.5). In addition to this, a stable water level and a time for recovery during the pumping test were considered. An optimum discharge rate was calculated by multiplying the draw-down to the specific capacity.

The results show that the 3,800 m^3/day of pumping is possible in B.Beng and 1,700m^3/day in B.Thongsala. The optimum pumping of more than 150m^3/day is found at B.Nongkhe, B.Chong and B.Phonphai. It ranges from 9 to 140m^3/day in other 15 villages. The lowest optimum discharge was found at B.Nongphai showing 9 m^3/day. This well may be dried up even if discharged by a hand pump.

(7) Aquifer and hydraulic constants

The hydraulic constants by aquifer is presented in Table 4.3.4 and Figure 4.3.6. The Study Area is geologically divided into 4 units: (1) Jurassic formations consisting of sandstone, red shale and mudstone, (2) basalt in the Bolaven Plateau, (3) acidic tuff of Triassic age and (4) slate and sandstone of Paleozoic age. Groundwater occurs mainly in the fracture of sandstone, basalt, acidic tuff and slate.

(a) Jurassic sandstone, red shale and mudstone (alternating beds)

The formation forms the basement of the plain along the Mekong River and Sedon River and small hill.

T:	0.78-219 m^2/day	
k:	1.59E-02-3.26E-5 cm/sec	
S:	0.04-0.7*	*physically meaningless
Sc:	1.0-165 m3/day/m	

(b) Basalt zone

The basalt lava, volcanic ash and loam are distributed in the north and west of the Bolaven Plateau.

T:	0.74-1,500 m^2/day
k:	7.76E-02-3.58E-5 cm/sec
S:	0.1-0.8*
Sc:	2.9-1,900 m^3/day/m

The specific capacity value obtained at B.Beng and B.Thongsala ranges 1,700 to 1,900 m^3/day/m. This formation intercalates two to three layers of basalt lava (autobrecciated lava, vNg). Other two wells show very small specific capacity ranging from 2.9 to 19.7 m^3/day/m at B.Lak 21 and B.Hountai. The basalt in this area is strongly weathered and the weathered bed is thick. The aquifer constants varies widely place to place in the basalt zone.

(c) Acidic tuff of Triassic age

This formation is distributed in the south, the left bank of the Mekong River, of the Study Area and consists of acidic tuff (dacitic welded tuff).

T:	3.04 m^2/day
k:	1.47E-04 cm/sec
S:	0.047

Sc: 4.6 m^3/day/m

Groundwater occurs in the fracture of rocks. The specific capacity becomes higher in those area where the faults and farcture are abundant.

(d) Palaeozoic slate

This formation is distributed in the most southern part of the Study area. The formation is composed of hard slate and sandstone partly intercalating calcareous rocks. Groundwater occurs in the fracture.

T: 23.1 m^2/day
k: 9.53E-04 cm/sec
S: 0.18
Sc: 37 m^3/day/m

Table 4.1.1 Quantities of Drilling and Test

No	Location	Drill Depth(m)	Well Depth(m)	S.W.L (GL-m)	Logg sp	Logg Short	Logg Lon	Logg Gamma	Geo Logg	P/Test S	P/Test Continuous	P/Test Recovery
C-4	B.NONGPHAI	50	49	9	*	*	*	*	-	4	24 h	12 h
C-8	B.HOUAXE	182	180	17.75	*	*	*	*	*	4	24 h	12 h
C-16	B.LOUY	48	48	6.52	*	*	*	*	*	4	24 h	12 h
C-44	B.THONGSALA	43	25	8.8	*	*	*	*	*	4	24 h	12 h
C-49	B.LAK-21	60	45	13.45	*	*	*	*	*	4	24 h	12 h
C-65	B.LAK-24	50	49	7.12	*	*	*	*	*	4	24 h	12 h
C-75	B.NONGKHE	50	50	3.06	*	*	*	*	*	4	24 h	12 h
C-79	B.SAMKHANABOUA	45	43	7.5	*	*	*	*	*	4	24 h	12 h
C-88	B.MAISIVILAI	50	50	10	*	*	*	*	*	4	24 h	12 h
C-89	B.NASENPHAN	50	50	5.78	*	*	*	*	*	4	24 h	12 h
S-4	B.HOUAYKAPHO	45	42	8.67	*	*	*	*	*	4	24 h	12 h
S-12	B.NONGSANO	50	50	6.5	*	*	*	*	*	4	24 h	12 h
S-24	B.DONMUANG	50	50	10.18	*	*	*	*	*	4	24 h	12 h
S-38	B.NONGNGONG	50	49	7.55	*	*	*	*	*	4	24 h	12 h
S-50	B.SAMIA	50	49.5	7.05	*	*	*	*	*	4	24 h	12 h
S-56	B.CHONG	50	49	4.29	*	*	*	*	*	4	24 h	12 h
S-64	B.PHONPHAI	50	50	9.85	*	*	*	*	*	4	24 h	12 h
S-75	B.NAKASAO	53	50	5.7	*	*	*	*	*	4	24 h	12 h
S-84	B.BENG	66	60	17.26	*	*	*	*	*	4	24 h	12 h
S-100	B.HOUN-TAI	54	52	19.4	*	*	*	*	*	4	24 h	12 h
		1146	1090.5									

G

Table 4.1.2 Well Design Of Test Wells

No.	Location	Elevation	Drill. Method	Drill. Depth	Water Level	Well Depth	Casing Dia.	Casing Pipe	Screen(G.L.-m)			Geo. Type	Aquifer	Pump Type	Bellows Pump	Date:Completed
		(m)		(m)	(G.L-m)*	(m)	(mm)		(m)	Total(m)	Open. Area(%)				(G.L.-m)	
C-4	B. Nongphai	115	Top-300. D.H.	50	12	49	150	P.V.C.	11-31	20	6.7	Eh	Jura. sandstone	India M3	33	Feb/'95
C-8	B. Houaxe	120	Top-500. D.H.	182	19	180	150. 100	Steel	66-72. 90-96. 108-132. 156-180	60	15	Eh	Jura.-Creta. Sandstone	*	84	Feb/'95
C-16	B. Louy	150	Top-300. D.H.	48	10	48	150	P.V.C.	6-10. 14-22. 38-46	19	6.7	Eh	Jura. Sandstone. Conglo.	India M3	27	Feb/'95
C-44	B. Thongsala	220	Top-300. D.H.	43	13	25	150	P.V.C.	11-23.	12	6.7	Ba2	N-Q Basalt	India M3	21	Feb/'95
C-49	B. Lak-21	442	Top-300. D.H.	60	22	45	150	P.V.C.	23-35	12	6.7	Ba1	N-Q Basalt	India M3	36	Feb/'95
C-65	B. Lak-24	100	Top-500. D.H.	50	10	49	150	P.V.C.	11-15. 19-23. 39-47	16	6.7	Ep	Jura. Sandstone	India M3	30	Feb/'95
C-75	B. Nongkhe	95	Top-500. D.H.	50	7.5	50	150	P.V.C.	16-20. 28-36. 40-48	20	6.7	Qf	Q Sand. Jura. SandyShale	India M3	24	Feb/'95
C-79	B. Samkhanaboua	96	Top-300. D.H.	45	10	43	150	P.V.C.	9-13. 17-29. 37-41	20	6.7	Ep	Jura. Sandy Shale	India M3	30	Feb/'95
C-88	B. Maisivilai	85	Top-500. D.H.	50	16	50	150	P.V.C.	20-48	28	6.7	Et	Paleozoic Slate	India M3	33	Feb/'95
C-89	B. Nasenphan	88	Top-500. D.H.	50	7.4	50	150	P.V.C.	16-20. 28-48	24	6.7	Et	Triassic Acidic Tuff	India M3	30	Feb/'95
S-4	B. Houaykapho	160	Top-300. D.H.	45	13	42	150	P.V.C.	12-28. 36-40	20	6.7	Eh	Jura.-Creta. Sandstone	India M3	27	Feb/'95
S-12	B. Nongsano	160	Top-300. D.H.	50	9	50	150	P.V.C.	12-20. 24-28. 32-48	28	6.7	Eh	Jura. Sandstone	India M3	30	Feb/'95
S-24	B. Donmuang	130	Top-500. D.H.	50	13	50	150	P.V.C.	28-44	16	6.7	Qf	Jura. Sandstone	India M3	24	Feb/'95
S-38	B. Nongngong	140	Top-500. D.H.	50	10	49	150	P.V.C.	23-35. 39-43	16	6.7	Ep	Jura. Sandstone	India M3	24	Feb/'95
S-50	B. Samia	145	Top-500. D.H.	50	10	49.5	150	P.V.C.	22.5-43.5	21	6.7	Qf	Q Sand. Jura. Sandstone	India M3	27	Feb/'95
S-56	B. Chong	170	Top-500. D.H.	50	7.5	49	150	P.V.C.	15-23. 31-43	20	6.7	Ba3	N-Q Basalt. Jura. Sandsto	India M3	27	Feb/'95
S-64	B. Phonphai	190	Top-500. D.H.	50	12.2	50	150	P.V.C.	20-24. 32-44	16	6.7	Ep	Jura. Sandstone	India M3	30	Feb/'95
S-75	B. Nakasao	194	Top-500. D.H.	53	7	50	150	P.V.C.	12-16. 28-48	24	6.7	Ep	Jura. Sandstone	India M3	27	Feb/'95
S-84	B. Beng	308	Top-500. D.H.	66	24.4	60	150	Steel	18-48	30	15	Ba2	N-Q Basalt	**	51	Feb/'95
S-100	B. Houn-Tai	520	Top-500. D.H.	54	28.6	52	150	P.V.C.	9-21. 34-46	24	6.7	Ba1	N-Q Basalt. Loam	India M3	42	Feb/'95

D.H. =Down-the Hole Hammer . *Dryseason(Presumed)
R.T. =Rotary Tricon. Bit.

* GRUNDFOS SP5A-21. H=82m. 2.2kw. 5m^3/h. 2830R/min
** GRUNDFOS SP14A-10. H=48m. 3.7kw. 14m^3/h. 2830R/min

Table 4.2.1 (1/2) Groundwater Level of Test Wells (G.L.-m)

DATE	c-4 Nongbai	c-8 Houaie	c-16 Louy	c-44Thongsala	C-49LAK-21	c-65 Lak24	c-75 Nongthe	c-79 Samkhanabouu	c-88 Naisivilai	c-89 Nasonphan
17/ 11/94					-11.29					
18/ 11					-11.38					
21/ 11				-7.18	-11.42					
28/ 11				-7.39	-11.76					
12/ 12				-7.65	-12.32					
15/ 12				-8.00	-12.80					
17/ 12				-8.07	-12.92					
22/ 12				-8.21	-13.17					
23/ 12			-6.69							
24/ 12			-6.44		-13.21					
27/ 12	-11.65		-6.44	-8.37	-13.44					
30/ 12	-8.66		-6.49	-8.44	-13.43					
01/01/95										
04/ 01	-7.74		-6.60	-8.59	-13.86					
05/ 01	-7.66	-15.05								
09/ 01	-9.75	-18.43	-6.95	-8.71	-14.13					
14/ 01	-3.32	-15.47	-6.87	-8.80	-14.45	-7.12	-5.12			
18/ 01	-8.01	-14.65	-6.93	-8.85	-14.68	-7.45				
19/ 01						-7.35	-3.20	-7.50	-10.18	-5.42
23/ 01	-7.67	-14.32	-6.92	-8.95	-14.95					
25/ 01						-7.27	-3.30	-7.63		
26/ 01									-9.46	-5.30
30/ 01		-14.67							-9.34	-5.29
31/ 01						-7.43	-3.41	-7.80		

Table 4.2.1 (2/2) Groundwater Level of Test Wells

s-4 Houaykapho	s-12 Nongsano	s-24 Donmiang	s-38 Nongngong	s-50Samla	s-56 Chong	s-64Phonphai	s-75 Kakasao	s-84Beng	s-100Bom-Tal
								-16.16	-18.72
							-4.22	-16.32	-18.65
						-9.50	-3.95	-16.49	-18.84
						-9.55	-3.87	-16.62	-18.95
		-12.77			-4.30	-9.58	-3.87	-16.87	-19.18
		-10.59		-6.51					
		-10.35							
		-10.25	-6.61	-6.64	-4.29	-9.88	-3.97	-17.16	
		-10.24	-6.80	-6.66	-4.33	-9.91	-4.14	-17.33	-19.22
		-10.73	-7.30	-6.75	-4.50	-9.97	-4.36	-17.58	-19.85
-10.00	-6.95	-10.40	-6.95	-6.98	-4.76	-10.00	-4.34	-17.81	-20.13
-9.38	-6.50	-10.30	-6.95	-6.98	-4.76	-10.19	-4.37	-18.10	-20.80
-8.90	-6.40	-10.30	-6.95	-6.90	-4.80	-10.14	-4.46	-18.31	-20.62
-8.85	-6.32	-10.30	-6.87	-6.84	-4.77	-10.04	-4.40	-18.54	-20.78
-8.87	-6.43		-6.33	-6.93	-4.95	-10.30	-4.62	-18.98	

Table 4.3.1 Pumping Test Wells

No.	Location	Elevation(m)	Well Depth(m)	Casing(mm)	Screen (G.L-m)	S.W. L (GL-m)	Aquifer	Pump	Generator	Date:Completed
:	CHAMPASAK									
C-4	B.NONGPHAI	115	49.0	150	11-31	9.00	Jura.Sandstone.	GRUNDFOS 1.5HP	3KW	07/Jan/95
C-8	B.HOUAXE	120	180.0	150	66-72,90-96,108-132,156-180	17.75	Jura-Creta.Sandstone	GRUNDFOS 2.2HP	5KW	11/Jan/95
C-16	B.LOUY	150	48.0	150	6-10,14-22,38-46	6.52	Jura.Sandst.Conglo.	GRUNDFOS 2.2HP	5KW	06/Jan/95
C-44	B.THONGSALA	220	25.0	150	11-23	8.80	N-Q Basalt.	GRUNDFOS 1.5HP	5KW	26/Dec/94
C-49	B.LAK-21	442	45.0	150	23-35	13.45	N-Q Basalt.	GRUNDFOS 2.2HP	5KW	30/Dec/94
C-65	B.LAK-24	100	49.0	150	11-15,19-23,39-47	7.12	Jura.Sandstone.	GRUNDFOS 2.2HP	5KW	15/Jan/95
C-75	B.NONGKHE	95	50.0	150	16-20,28-36,40-48	3.06	Q.Jura.Sandy shale.	GRUNDFOS 2.2HP	5KW	17/Jan/95
C-79	B.SAMKHANABOUA	96	43.0	150	9-13,17-29,37-41	7.50	Jura.Sandy shale.	GRUNDFOS 1.5HP	3.5KW	19/Jan/95
C-88	B.MAISIVILAI	85	50.0	150	20.0-48.0	10.00	Paleozoic Slate.	GRUNDFOS 1.5HP	3.5KW	22/Jan/95
C-89	B.NASENPHAN	88	50.0	150	16-20,28-48	5.78	Triassic Acidic Tuff	GRUNDFOS 2.2HP	5KW	25/Jan/95
:	SARAVAN									
S-4	B.HOUAYKAPHO	160	42.0	150	12-28,36-40	8.67	Jura-Creta.Sandstone	GRUNDFOS 2.2HP	5KW	13/Jan/95
S-12	B.NONGSANO	160	50.0	150	12-20,24-28,32-48	6.50	Jura.Sandstone.	GRUNDFOS 1.5HP	3KW	14/Jan/95
S-24	B.DONMUANG	130	50.0	150	28-44	10.18	Jura.Sandstone.	GRUNDFOS 2.2HP	5KW	04/Jan/95
S-38	B.NONGNGONG	140	49.0	150	23-35,39-43	7.55	Jura.Sandstone.	GRUNDFOS 1.5HP	3KW	04/Jan/95
S-50	B.SAMIA	145	49.5	150	22.5-43.5	7.05	Q.Jura.Sandstone.	GRUNDFOS 1.5HP	3KW	02/Jan/95
S-56	B.CHONG	170	49.0	150	15-23,31-43	4.29	N-Q Ba.Jura.Sandst.	GRUNDFOS 2.2HP	5KW	02/Jan/95
S-64	B.PHONPHAI	190	50.0	150	20-24,32-44	9.85	Jura.Sandstone.	GRUNDFOS 1.5HP	3KW	31/Dec/94
S-75	B.NAKASAO	194	50.0	150	12-16,28-48	5.70	Jura.Sandstone.	GRUNDFOS 1.5HP	3KW	30/Dec/94
S-84	B.BENG	308	60.0	150	18-48	17.26	N-Q Basalt.	GRUNDFOS 2.2HP	5KW	31/Dec/94
S-100	B.HOUN-TAI	520	52.0	150	9-21,34-46	19.40	N-Q Basalt.	GRUNDFOS 1.5HP	5KW	27/Dec/94

Table 4.3.2 Coefficients of Test Wells

No.	Location	1 Jacob.			2 Jaeger.			3 'Hantush&Jacob.			4 Hantush t-s.			5 Recovery.	
		T1	k1	S1	T2	k2	S2	T3	k3	S3	T4	k4	S4	T5	k5
		(cm^2/s)	(cm/s)		(cm^2/s)	(cm/s)		(cm^2/s)	(cm/s)		(cm^2/s)	(cm/s)		(cm^2/s)	(cm/s)
C-4	B. Nongphai	1.80E-01	8.98E-05	2.24E-01	2.23E-01	1.12E-04	8.18E-02	1.07E-01	5.34E-05	3.42E-01	*	*	*	7.36E-02	3.68E-05
C-8	B. Houaxe	1.60E-01	2.66E-05	2.68E-01	1.62E-01	2.71E-05	2.90E-01	*	*	*	*	*	*	2.64E-01	4.40E-05
C-16	B. Louy	3.04E+00	1.60E-03	1.31E-01	2.61E+00	1.27E-03	5.23E+00	3.65E-01	1.92E-04	7.45E-01	*	*	*	3.44E+00	1.81E-03
C-44	B. Thongsala	*	*	*	5.54E+01	4.62E-02	3.71E+00	*	*	*	*	*	*	1.31E+02	1.09E-01
C-49	B. Lak21	2.14E+00	1.78E-03	1.95E-02	2.12E+00	1.76E-03	3.14E-02	6.72E-01	5.60E-04	4.41E-01	*	*	*	5.45E-01	4.54E-04
C-65	B. Lak24	2.35E-01	1.47E-04	8.47E-02	2.40E-01	1.50E-04	1.27E-01	*	*	*	2.55E-01	1.59E-04	7.21E-02	1.67E-01	1.04E-04
C-75	B. Nongkhe	6.50E+01	3.25E-02	1.87E+01	1.52E+01	7.60E-03	2.58E-01	2.90E+00	1.45E-03	1.47E-01	*	*	*	4.35E+01	2.17E-02
C-79	B. Samkhanaboua	4.77E+00	2.39E-03	2.29E-04	5.14E+00	2.57E-03	5.00E-04	*	*	*	2.39E+00	1.19E-03	9.63E-02	6.94E+00	3.47E-03
C-88	B. Maisivilai	1.52E+00	5.43E-04	3.72E+00	3.63E+00	1.30E-03	1.79E-01	8.56E-01	3.06E-04	6.09E+00	*	*	*	4.49E+00	1.60E-03
C-89	B. Nasenphan	4.31E-01	1.79E-04	4.34E-02	4.24E-01	1.77E-04	4.97E-02	*	*	*	*	*	*	2.02E-01	8.43E-05
S-4	B. Houaykapho	1.87E+00	9.35E-04	3.41E-02	1.85E+00	9.25E-04	1.77E-01	*	*	*	*	*	*	2.53E+00	1.26E-03
S-12	B. Nongsano	4.02E+00	1.43E-03	1.93E-07	3.83E+00	1.37E-03	3.88E-06	1.46E-01	5.21E-05	9.96E-01	*	*	*	9.60E-01	3.43E-04
S-24	B. Donmuang	4.92E+00	3.07E-03	6.49E-02	5.21E+00	3.26E-03	2.86E-01	*	*	*	*	*	*	4.26E+00	2.66E-03
S-38	B. Nongngong	6.52E-01	4.08E-04	2.35E-01	9.91E-01	6.19E-04	1.27E+00	4.61E-01	2.88E-04	2.89E-01	*	*	*	3.11E+00	1.95E-03
S-50	B. Samia	7.93E-01	3.78E-04	2.11E+00	9.63E-01	4.59E-04	1.95E+00	1.11E-02	5.27E-06	4.72E-02	*	*	*	1.55E+00	7.38E-04
S-56	B. Chong	7.20E-01	3.60E-04	4.32E-01	8.21E-01	4.11E-04	8.10E-03	3.88E-01	1.94E-04	6.37E-01	*	*	*	6.08E-01	3.04E-04
S-64	B. Phonphai	3.22E+01	2.02E-02	7.74E-05	2.48E+01	1.55E-02	4.04E-01	*	*	*	*	*	*	1.92E+01	1.20E-02
S-75	B. Nakasao	2.52E-01	1.05E-04	4.83E-01	7.03E-01	6.14E-04	9.19E-02	1.09E-01	4.53E-05	4.55E-01	3.08E-01	1.28E-04	1.38E-01	1.23E-01	5.14E-05
S-84	B. Beng	3.17E+02	1.06E-01	2.28E-04	1.41E+02	4.71E-02	1.67E+00	*	*	*	*	*	*	6.30E+01	2.10E-02
S-100	B. Houn-Tai	5.18E-01	2.16E-04	5.59E-04	4.83E-01	2.01E-04	3.43E-02	8.69E-02	3.62E-05	1.16E-01	*	*	*	8.48E-02	3.53E-05

Table 4.3.3 Coefficient Of Test Wells

No.	Location	Average				
		T	T	K	S	Sc
		(cm^2/s)	(m^2/day)	(cm/s)		(m^3/day/m)
C-4	B. Nongphai	9.03E-02	7.80E-01	4.51E-05	3.42E-01	1.0
C-8	B. Houaxe	1.95E-01	1.69E+00	3.26E-05	2.79E-01	2.6
C-16	B. Louy	1.90E+00	1.64E+01	1.00E-03	7.45E-01	16.2
C-44	B. Thongsala	9.32E+01	8.05E+02	7.76E-02	*	1728.0
C-49	B. Lak21	6.09E-01	5.26E+00	5.07E-04	4.41E-01	19.7
C-65	B. Lak24	2.11E-01	1.82E+00	1.32E-04	7.21E-02	3.3
C-75	B. Nongkhe	2.32E+01	2.00E+02	1.16E-02	1.47E-01	127.9
C-79	B. Samkhanaboua	4.67E+00	4.03E+01	2.33E-03	9.63E-02	30.0
C-88	B. Maisivilai	3.63E+00	3.14E+01	1.30E-03	1.79E-01	36.9
C-89	B. Nasenphan	3.52E-01	3.04E+00	1.47E-04	4.66E-02	4.6
S-4	B. Houaykapho	2.08E+00	1.80E+01	1.04E-03	1.06E-01	17.3
S-12	B. Nongsano	5.53E-01	4.78E+00	1.98E-04	9.96E-01	16.0
S-24	B. Donmuang	4.80E+00	4.14E+01	3.00E-03	1.75E-01	44.6
S-38	B. Nongngong	1.79E+00	1.54E+01	1.12E-03	2.89E-01	13.9
S-50	B. Samia	7.81E-01	6.74E+00	3.72E-04	4.72E-02	14.4
S-56	B. Chong	4.98E-01	4.30E+00	2.49E-04	6.37E-01	19.1
S-64	B. Phonphai	2.54E+01	2.19E+02	1.59E-02	2.02E-01	165.3
S-75	B. Nakasao	1.80E-01	1.56E+00	7.49E-05	2.97E-01	4.4
S-84	B. Beng	1.74E+02	1.50E+03	5.80E-02	8.35E-01	1900.8
S-100	B. Houn-Tai	8.59E-02	7.42E-01	3.58E-05	1.16E-01	2.9

Table 4.3.4 Coefficients of Aquifers

No.	Location	Average					Geo. Type	Aquifer	
		T	T	K	S	Sc			symbol
		(cm^2/s)	(m^2/day)	(cm/s)		(m^3/day/m)			
C-4	B. Nongphai	9. 03E-02	7. 80E-01	4. 51E-05	3. 42E-01	1. 0	Eh	Jura. sandstone.	Js
C-8	B. Houaxe	1. 95E-01	1. 69E+00	3. 26E-05	2. 79E-01	2. 6	Eh	Jura-Creta. Sandstone.	JCs
C-16	B. Louv	1. 90E+00	1. 64E+01	1. 00E-03	7. 45E-01	16. 2	Eh	Jura. Sandstone. Conglo.	Jsg
C-44	B. Thongsala	9. 32E+01	8. 05E+02	7. 76E-02	*	1728. 0	Ba2	N-Q Basalt Lava.	Ba
C-49	B. Lak21	6. 09E-01	5. 26E+00	5. 07E-04	4. 41E-01	19. 7	Ba1	N-Q Basalt Lava.	Ba
C-65	B. Lak24	2. 11E-01	1. 82E+00	1. 32E-04	7. 21E-02	3. 3	Ep	Jura. Sandstone.	Js
C-75	B. Nongkhe	2. 32E+01	2. 00E+02	1. 16E-02	1. 47E-01	127. 9	Qf	Q Sand. Jura. SandyShale.	QsJsh
C-79	B. Samkhanaboua	4. 67E+00	4. 03E+01	2. 33E-03	9. 63E-02	30. 0	Ep	Jura. Sandy Shale.	Jsh
C-88	B. Maisivilai	3. 63E+00	3. 14E+01	1. 30E-03	1. 79E-01	36. 9	Et	Paleozoic Slate.	Psl
C-89	B. Nasenphan	3. 52E-01	3. 04E+00	1. 47E-04	4. 66E-02	4. 6	Et	Triassic Asidic Tuff.	Tt
S-4	B. Houaykapho	2. 08E+00	1. 80E+01	1. 04E-03	1. 06E-01	17. 3	Eh	Jura-Creta. Sandstone.	JCs
S-12	B. Nongsano	5. 53E-01	4. 78E+00	1. 98E-04	9. 96E-01	16. 0	Eh	Jura. Sandstone.	Js
S-24	B. Donmuang	4. 80E+00	4. 14E+01	3. 00E-03	1. 75E-01	44. 6	Qf	Jura. Sandstone.	Js
S-38	B. Nongngong	1. 79E+00	1. 54E+01	1. 12E-03	2. 89E-01	13. 9	Ep	Jura. Sandstone.	Js
S-50	B. Samia	7. 81E-01	6. 74E+00	3. 72E-04	4. 72E-02	14. 4	Qf	Q Sand. Jura. Sandstone.	QsJs
S-56	B. Chong	4. 98E-01	4. 30E+00	2. 49E-04	6. 37E-01	19. 1	Ba3	N-Q Basalt. Jura. Sandstone.	BaJs
S-64	B. Phonphai	2. 54E+01	2. 19E+02	1. 59E-02	2. 02E-01	165. 3	Ep	Jura. Sandstone.	Js
S-75	B. Nakasao	1. 80E-01	1. 56E+00	7. 49E-05	2. 97E-01	4. 4	Ep	Jura. Sandstone.	Js
S-84	B. Beng	1. 74E+02	1. 50E+03	5. 80E-02	8. 35E-01	1900. 8	Ba2	N-Q Basalt.	Ba
S-100	B. Houn-Tai	8. 59E-02	7. 42E-01	3. 58E-05	1. 16E-01	2. 9	Ba1	N-Q Basalt. Loam.	Balm

Table 4.3.5 Specific Capacity of Test Wells

No.	Location	Q	Drawdown	Sc	Q	Dd	Sc	Sc	s'(safty)	Py(optimum discharge)	
		1/min	(m)	1/min/m	cm^3/s	(cm)	cm^3/s/cm	m^3/day/m	(m)	S c * s'	(m^3/day)
C-4	B. Nongphai	20	27.5	0.73	333.333	2750	0.12	1.0	9	9.4	9
C-8	B. Houaxe	30	16.5	1.82	500	1650	0.30	2.6	9	23.6	23
C-16	B. Louy	101.4	9	11.27	1690	900	1.88	16.2	4.5	73.0	73
C-44	B. Thongsala	120	0.1	1200.00	2000	10	200.00	1728.0	1	1728.0	1700+
C-49	B. Lak21	198	14.5	13.66	3300	1450	2.28	19.7	6.5	127.8	127
C-65	B. Lak24	30.6	13.5	2.27	510	1350	0.38	3.3	11.5	37.5	37
C-75	B. Nongkhe	198	2.23	88.79	3300	223	14.80	127.9	3	383.6	380+
C-79	B. Samkhanaboua	50	2.4	20.83	833.333	240	3.47	30.0	2.3	69.0	69
C-88	B. Maisivilai	100	3.9	25.64	1666.67	390	4.27	36.9	3.5	129.2	129
C-89	B. Nasenphan	30.6	9.5	3.22	510	950	0.54	4.6	7	32.5	32
S-4	B. Houaykapho	120	10	12.00	2000	1000	2.00	17.3	2	34.6	34
S-12	B. Nongsano	50	4.5	11.11	833.333	450	1.85	16.0	4	64.0	64
S-24	B. Donmuang	198	6.4	30.94	3300	640	5.16	44.6	3	133.7	133
S-38	B. Nongngong	132	13.7	9.64	2200	1370	1.61	13.9	8	111.0	111
S-50	B. Samia	132	13.2	10.00	2200	1320	1.67	14.4	10	144.0	144
S-56	B. Chong	198	14.95	13.24	3300	1495	2.21	19.1	14	267.0	267
S-64	B. Phonphai	132	1.15	114.78	2200	115	19.13	165.3	1	165.3	165+
S-75	B. Nakasao	40	13	3.08	666.667	1300	0.51	4.4	4	17.7	17
S-84	B. Beng	198	0.15	1320.00	3300	15	220.00	1900.8	2	3801.6	3800+
S-100	B. Houn-Tai	20	10	2.00	333.333	1000	0.33	2.9	7	20.2	20

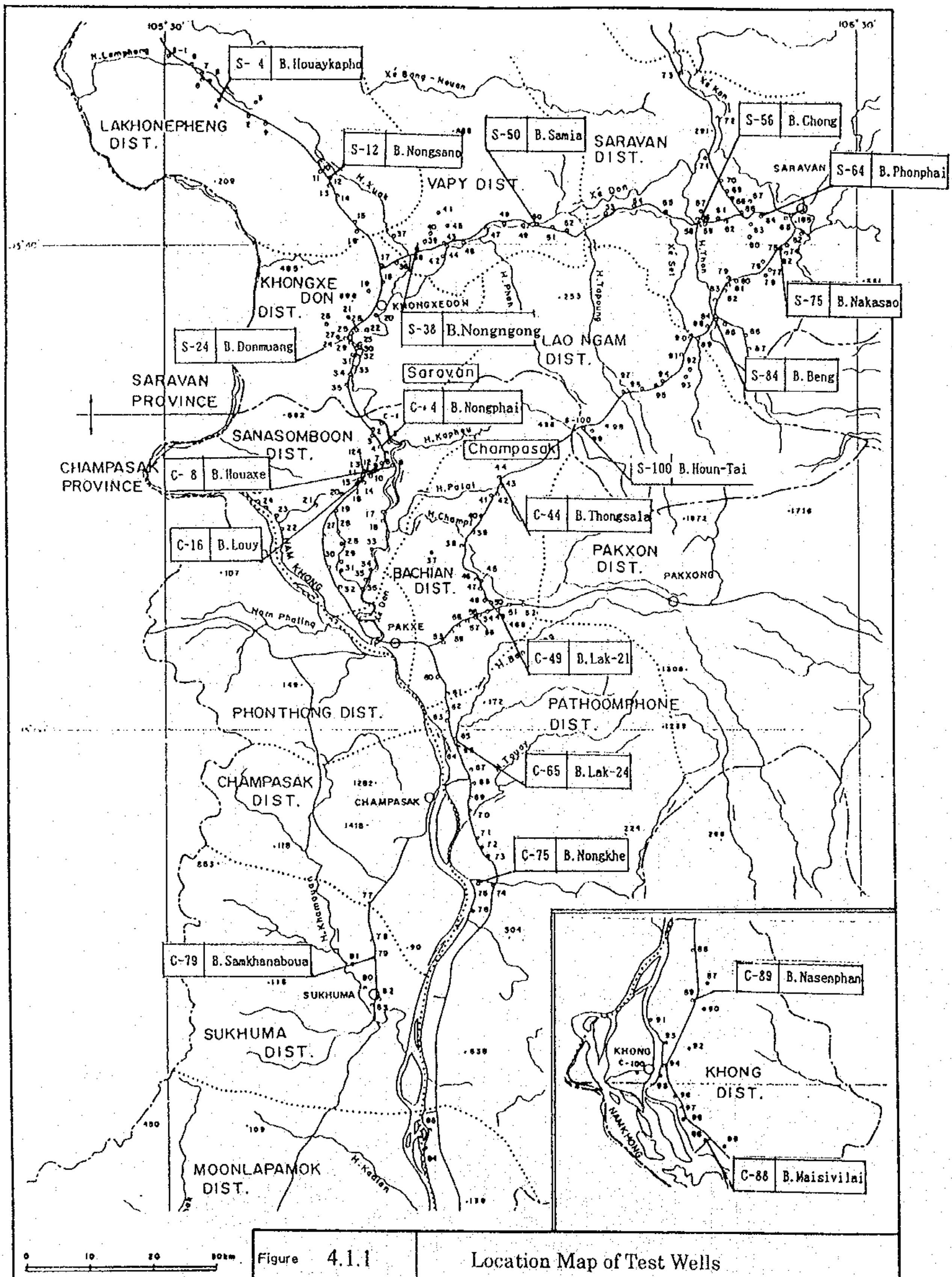


Figure 4.1.1	Location Map of Test Wells
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.

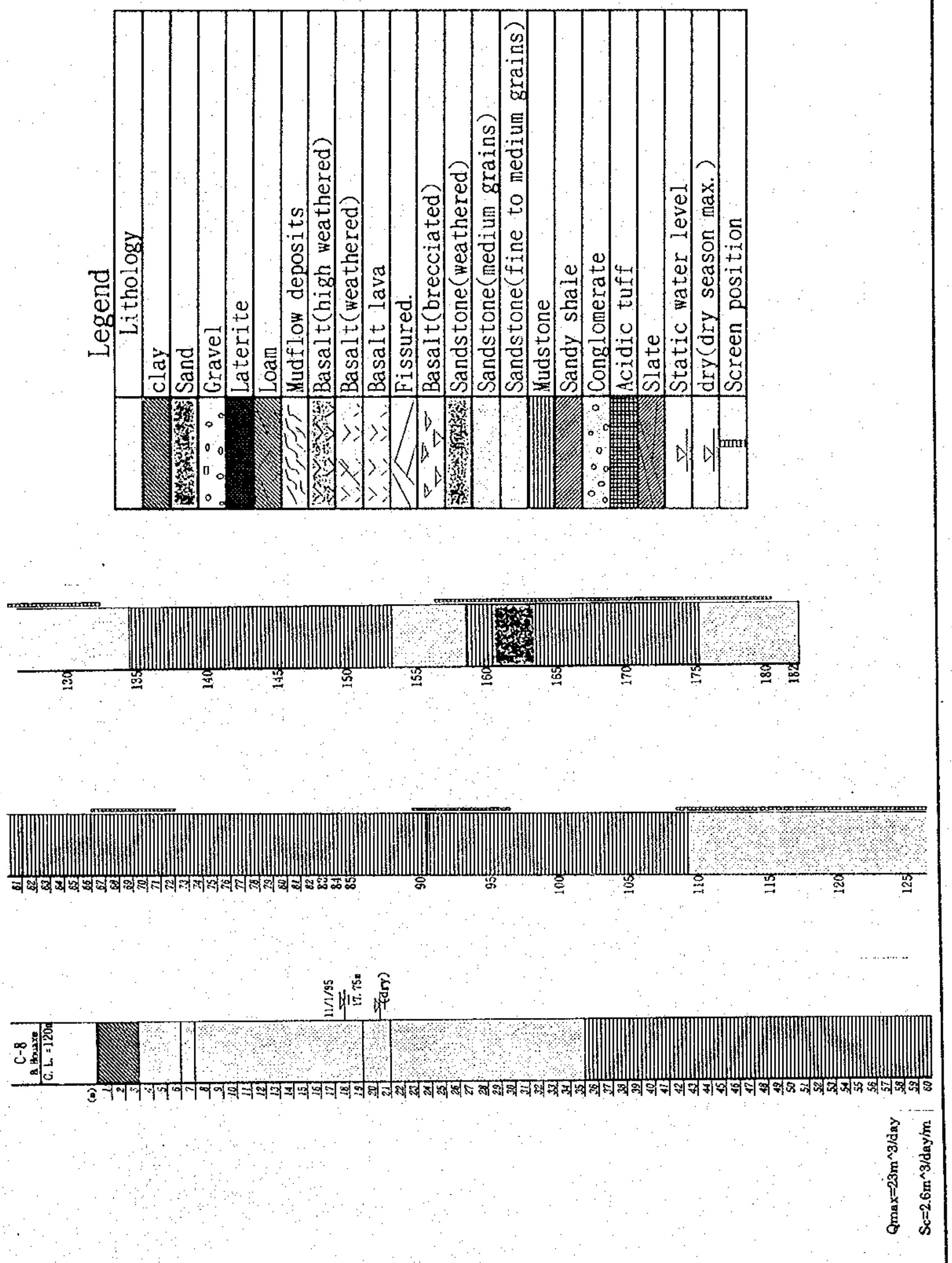


Figure 4.2.1a Lithology and Specific Capacity of Test Wells

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA) | KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.

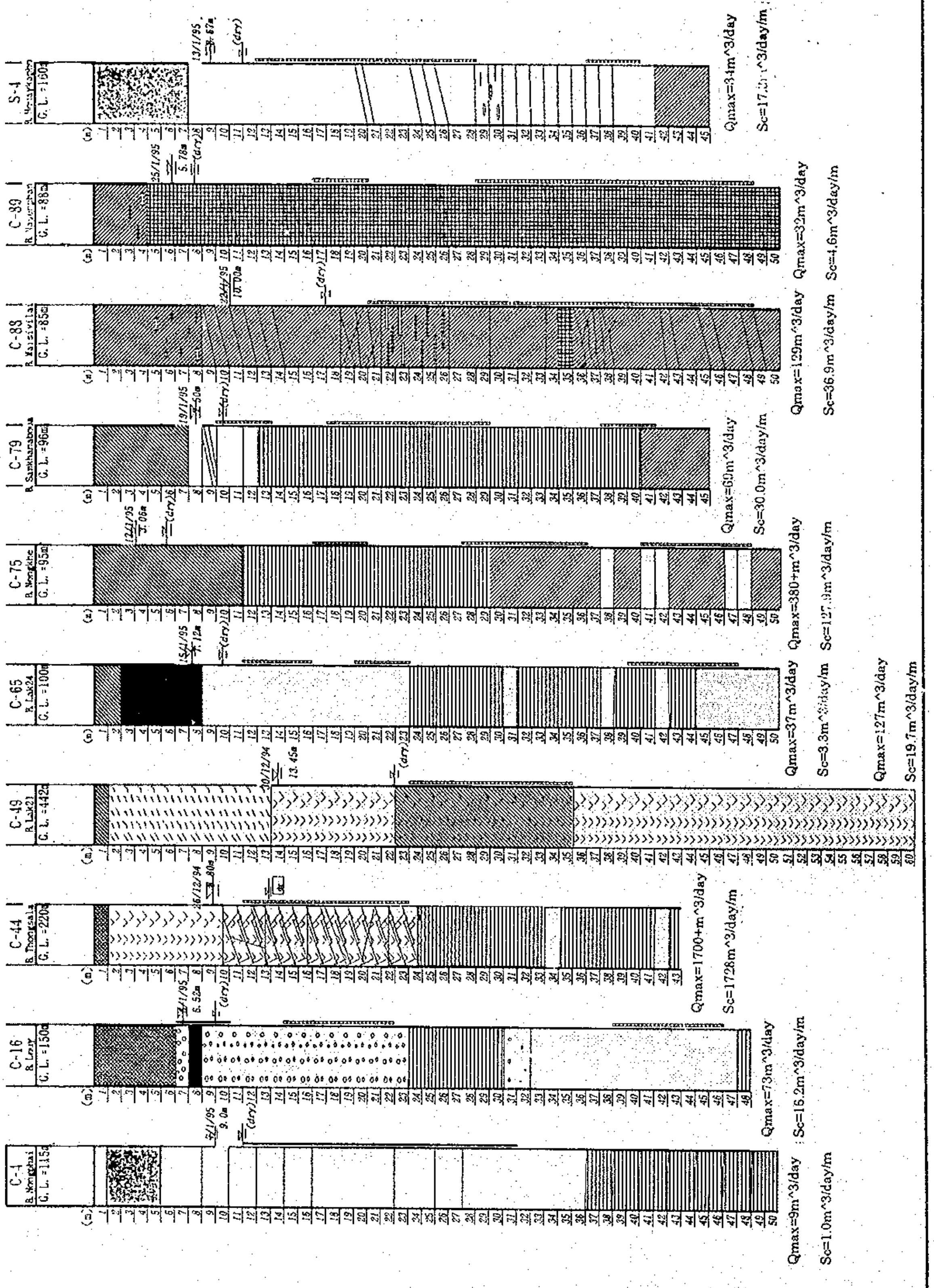


Figure 4.2.1b	Lithology and Specific Capacity of Test Wells

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA) | KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.

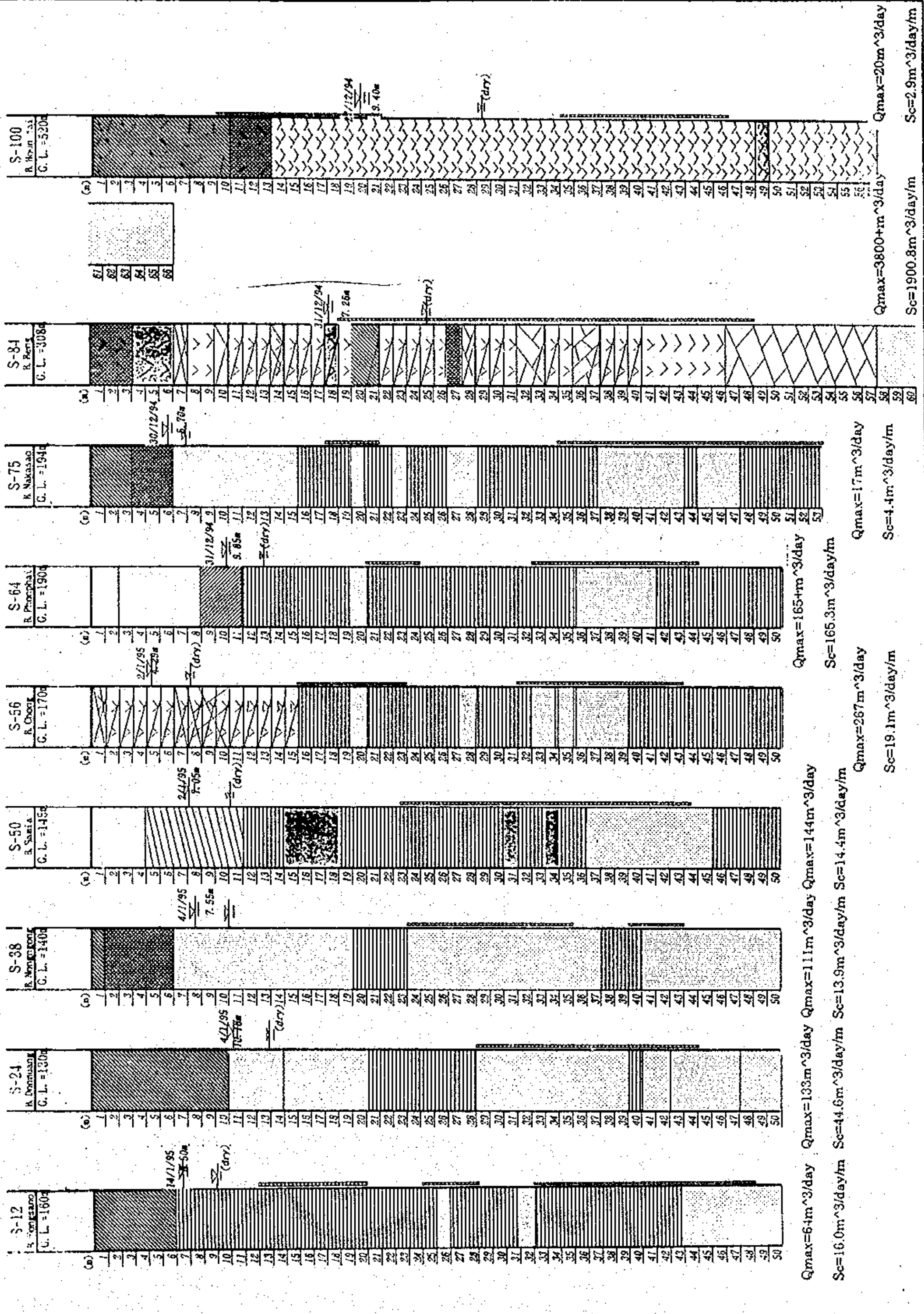


Figure 4.2.1c Lithology and Specific Capacity of Test Wells

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA) | KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.

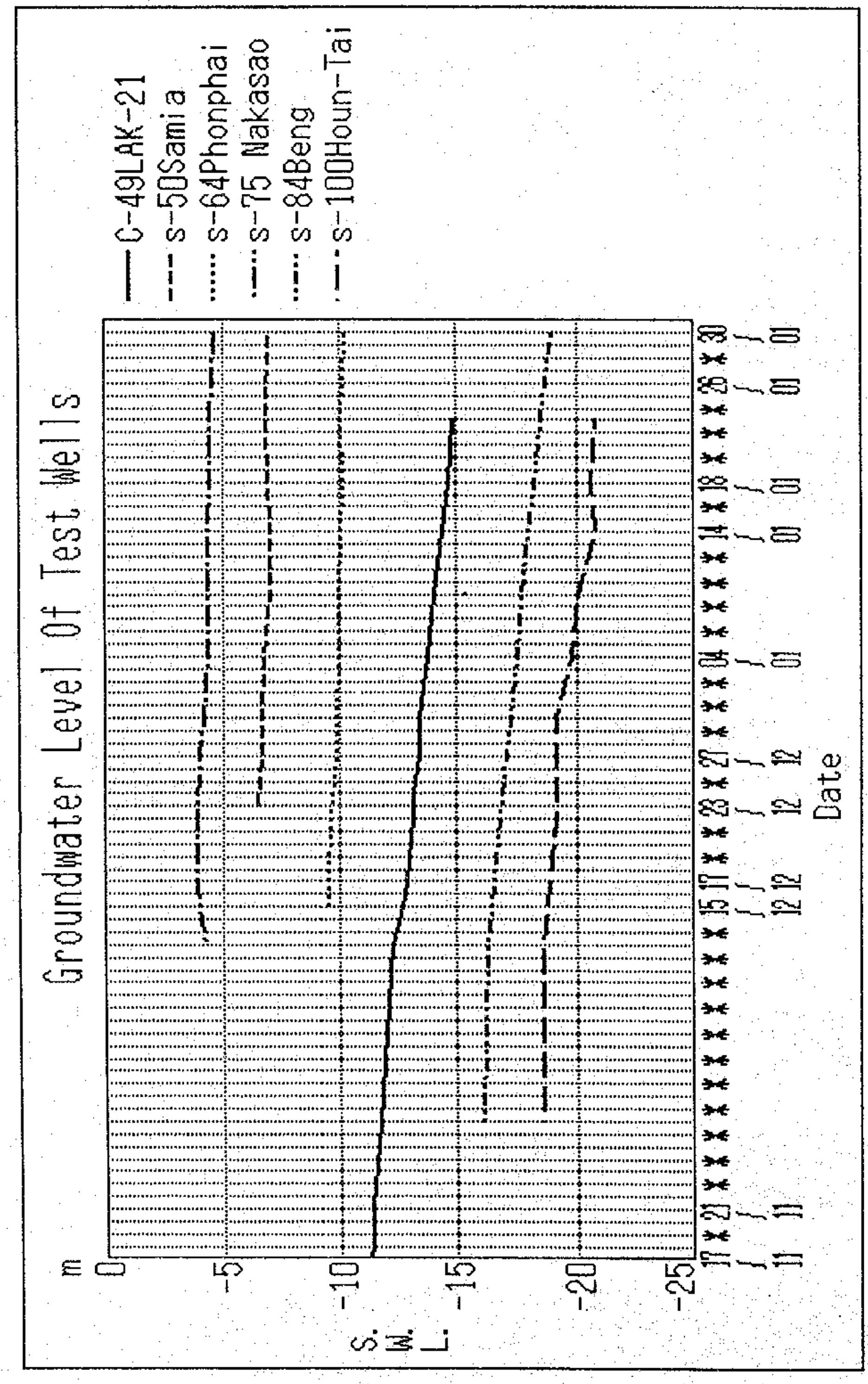
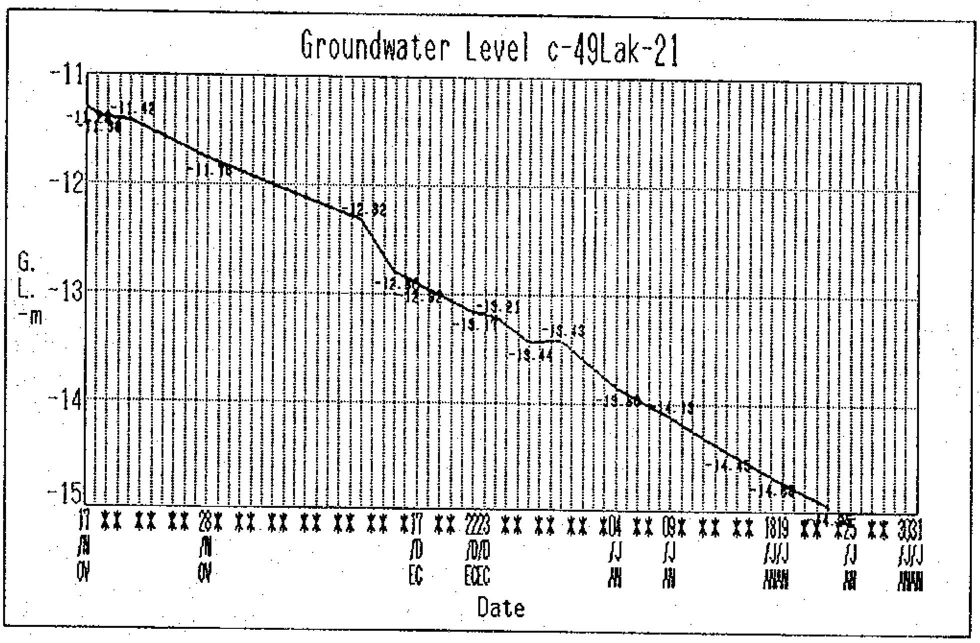


Figure 4.2.3a	Groundwater Level of Test Wells

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA) | KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.



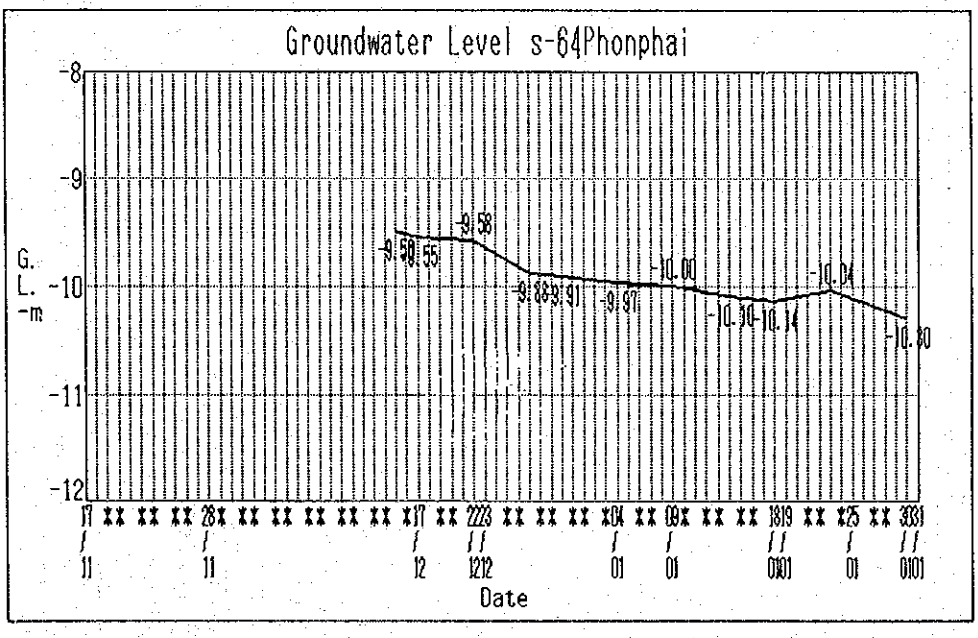


Figure 4.2.3b	Groundwater Level of Test Wells

THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA) | KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 01 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN NONGPHAI	FIELD BOOK NO.	C-4
	PROVINCE CHAMPASAK	TOTAL DEPTH(m)	50.0
DRILLING COMPANY	SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	115
RIG TYPE & NUMBER	TOP-300	DATE BEGUN	23/12/'94
DRILLING METHOD	Direct Rotary circulation	DATE COMPLETED	26/12/'94
	Down The Hole Hammer(D.H.M)		
FIELD PARTY	UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST	S.OHMORI		

STATIC WATER LEVEL (B.L.S) After Boring			
Depth(m)	8.66	8.32	7.67
Time			
Date	30/12/'94	14/01/'94	23/01/'94

DEPTH (m)	LITHOLOGY DESCRIPTION
1–5	Weathered Sandstone. Yellowish Brown, Fine to medium. Soft layer.
6–12	Sandstone. Dark Grayish Brown, Medium Grains, Hard. (Jurassic Sandstone)
13–16	Fine to Medium. Hard.
17–25	Fine to Medium. Hard.
26–30	Fine to Medium. Hard.
31–36	Calcite layer. Calcite layer. Calcite layer.
37–50	Sandy Shale, Mudstone. Reddish Purple, Hard. (Jurassic shale)
50	50.0m

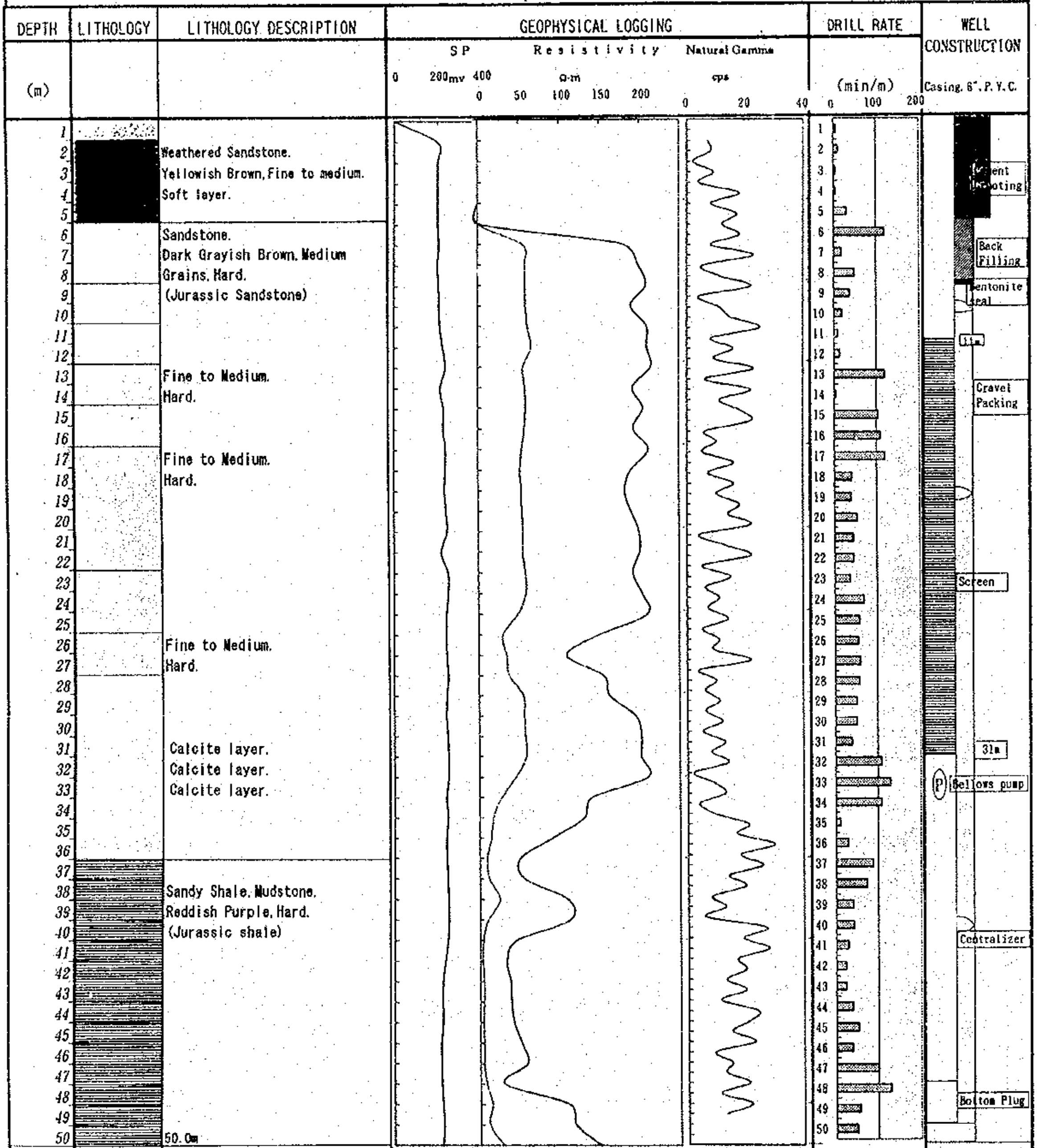


Figure 4.3.1(1)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 02 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	HOUAXE	FIELD BOOK NO.	C-8
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	182.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	120
RIG TYPE & NUMBER		TOP-500	DATE BEGUN	23/12/'94
DRILLING METHOD		Direct Rotary circulation	DATE COMPLETED	08/01/'94
		Down The Hole Hammer(D.H.H)		
FIELD PARTY		UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring			
Depth(m)	18.43	15.47	14.32
Time			
Date	09/01/'95	14/01/'95	23/01/'95

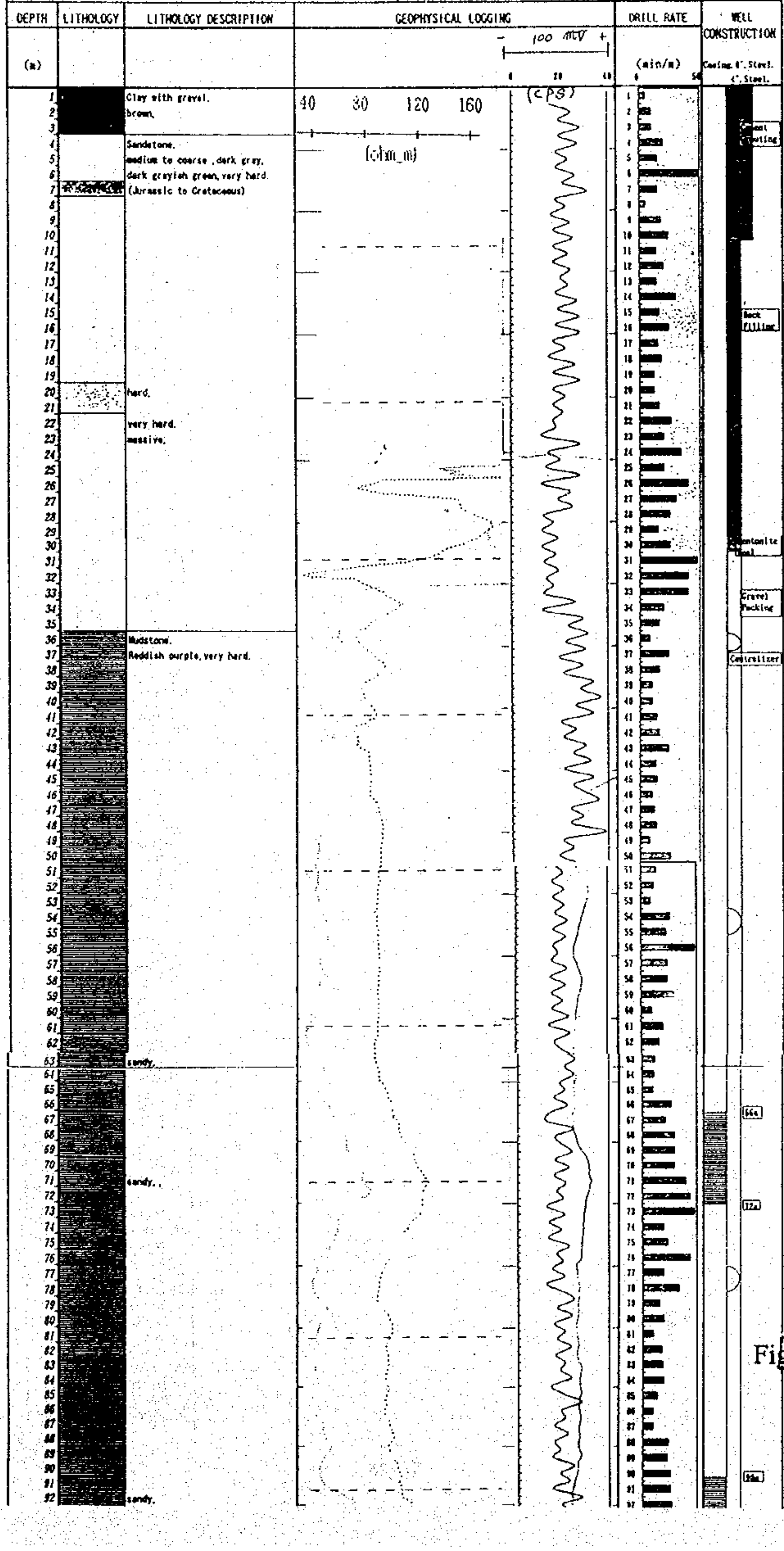
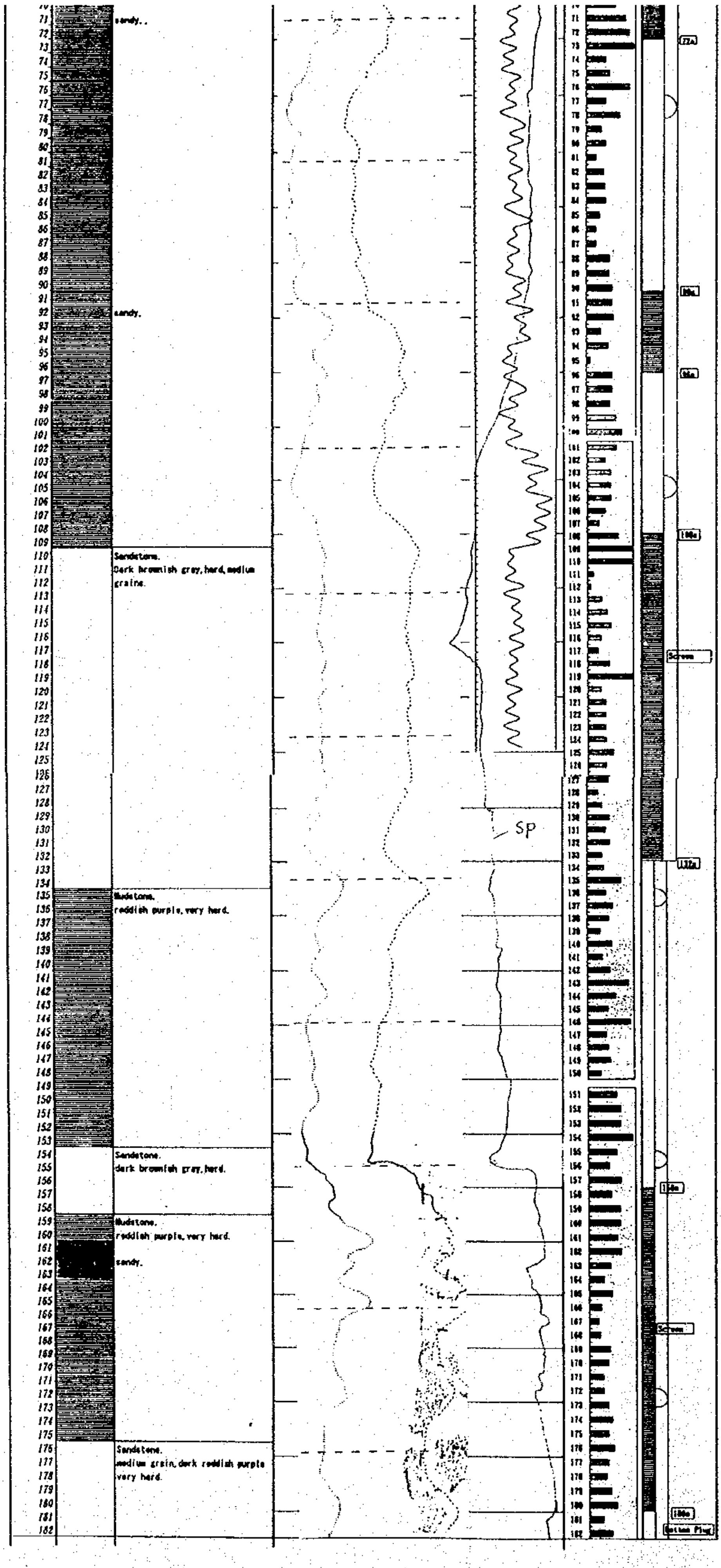


Figure 4.3.1(2)


sandy..
sandy.
Sandstone.
Dark brownish gray, hard, medium grains.
Mudstone.
reddish purple, very hard.
Sandstone.
dark brownish gray, hard.
Mudstone.
reddish purple, very hard.
sandy.
Sandstone.
medium grain, dark reddish purple very hard.
SP
72m
90m
96m
108m
Screen
132m
156m
Screen
180m
Bottom Plug

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 03 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	LOUY
	PROVINCE	CHAMPASAK
DRILLING COMPANY		SIAM TONE Co.,LTD.
RIG TYPE & NUMBER		TOP-300
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)
FIELD PARTY		UTAIRAAT
GEOLOGIST		S.OHMORI

FIELD BOOK NO.	C-16
TOTAL DEPTH(m)	48
GROUND SURFACE ELEVATION(m)	150
DATE BEGUN	19/12/'94
DATE COMPLETED	22/12/'94

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	6.69	6.6	6.92
Time			
Date	23/12/'94	04/01/'95	23/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
1–6	Clay with Gravel. Loosed, Light to Medium Brown, Gravel in some parts.
7	Gravel, unconsolidated.
8	Laterite soil. Reddish Brown.
9–23	Conglomerate. Pale Brown, semi-consorideted. Grains Dia. about1-2cm of Quarts. very round, and medium sphericity, max. dia. 4cm. poor matrix. (Jurassic to Cretaceous)
24–30	Mudstone, Sandy shale. Dark Brown to Reddish Brown, hard (Jurassic)
31–32	Medium Sandstone, gravel rich. Dark Brown, hard .
33–47	Sandstone. Dark grayish Brown, medium to fine grains, hard , laminated.
48	Mudstone. Dark brown, hard. 48.0m

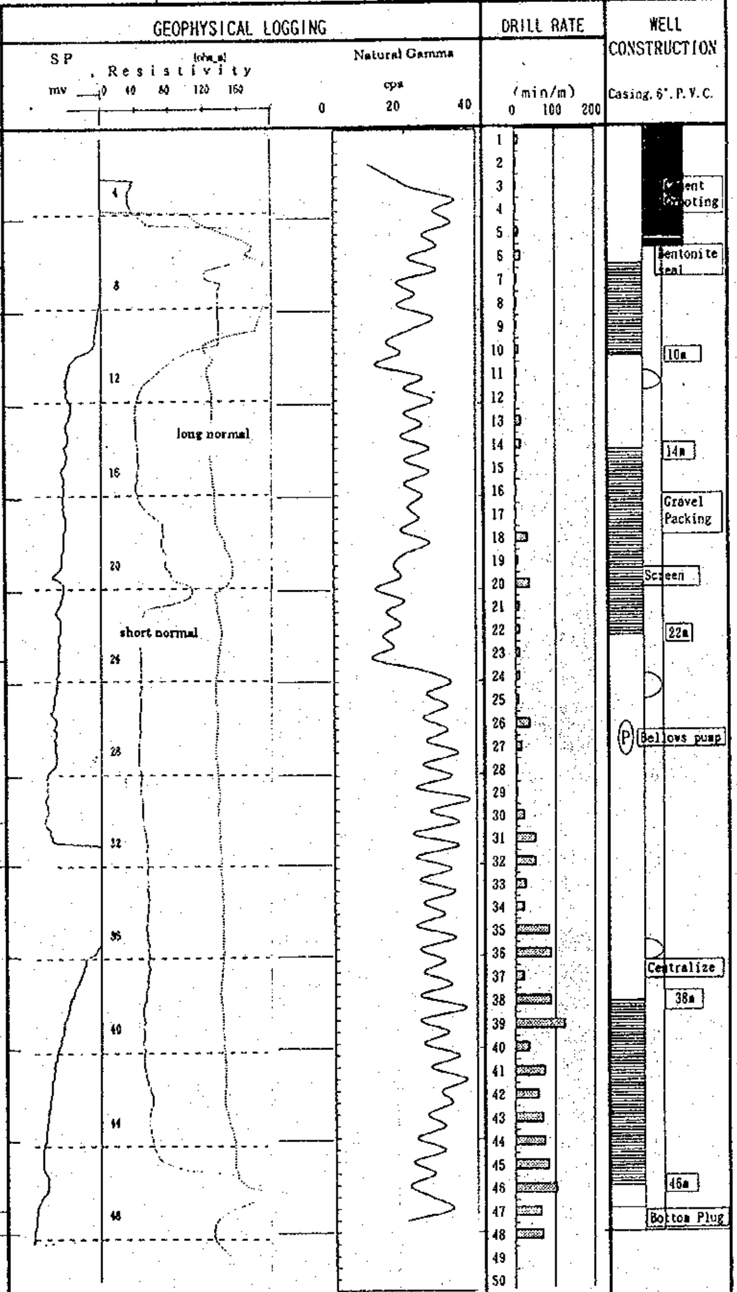


Figure 4.3.1(3)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 04 /20

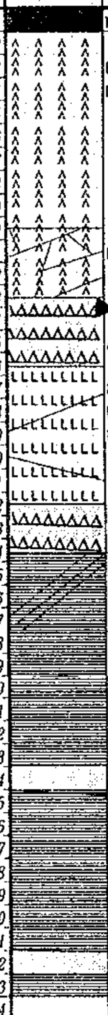
PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES , LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	THONGSALA	FIELD BOOK NO.	C-44
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	43.0
DRILLING COMPANY		SIAM TONE Co,.LTD.	GROUND SURFACE ELEVATION(m)	220
RIG TYPE & NUMBER		TOP-300	DATE BEGUN	18/11/'94
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	20/11/'94
FIELD PARTY		UTAIRAAT		
GEOLOGIST		S.OHMORI		

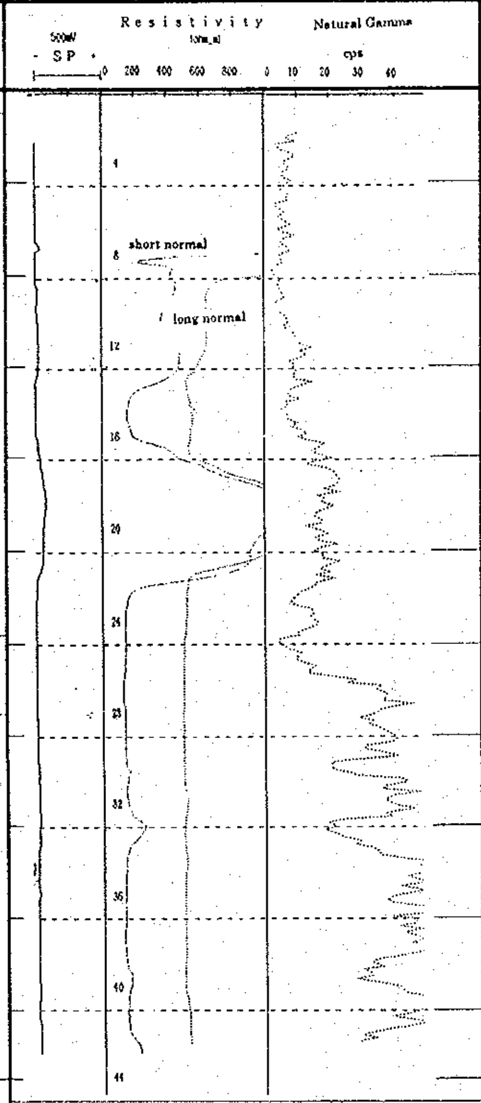
STATIC WATER LEVEL(B.L.S) After Boring			
Depth(m)	7.18	8.21	8.8
Time			
Date	21/11/'94	22/12/'94	14/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
1	Weathered Basalt. Brown, Porous.
3–5	Basalt, lava flow, low weathered, Dark gray to bluish gray, hard. (Paleogene to Quaternary.)
11	Fractured.
14–15	Basalt. Auto-brecciated lava, high porous
17–19	Basalt. Low Weathered, Lava flow gray colored.
23	Basalt. Auto-brecciated lava.
25–27	Mudstone. Weathered clayey layer, reddish purple collared. (Jurassic).
29–34	Sandy shale. Reddish purple color, hard rock. Sandstone, Mudstone, shale, interbeded. (Jurassic rock) Sandy, mica rich.
42–43	Sandy. very fine to fine, purple. shale.
44	43.0m

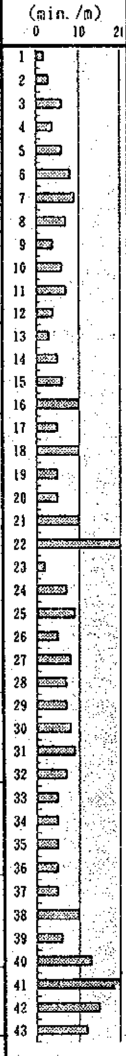
LITHOLOGY



GEOPHYSICAL LOGGING



DRILL RATE (min./m) 0 10 21



WELL CONSTRUCTION Casing, 6", P.V.C.

Figure 4.3.1(4)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 05 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	LAK-21	FIELD BOOK NO.	C-49
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	60.0
DRILLING COMPANY		SIAM TONE Co,.LTD.	GROUND SURFACE ELEVATION(m)	442
RIG TYPE & NUMBER		TOP-300	DATE BEGUN	15/11/'94
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	17/11/'94
FIELD PARTY		UTAIRAAT		
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring			
Depth(m)	11.29	12.8	14.68
Time			
Date	17/11/'94	15/12/'94	18/01/'94

DEPTH (m)	LITHOLOGY DESCRIPTION
1	Weathered Clay.
2–13	Weathered Basaltic mud flow . Clay, Silt with Gravel. Dark brown color, high plasticity. (Neogene to Quaternary)
13–22	High Weathered Basalt Lava. Blackish brown color, low strength.
22–35	High to Medium weathered Basalt. Dark brown color, low strength in some parts.
35–60	High to Medium weathered basalt, or mud flow deposits with basalt boulder in some parts. dark brown to brown color. 60.0m

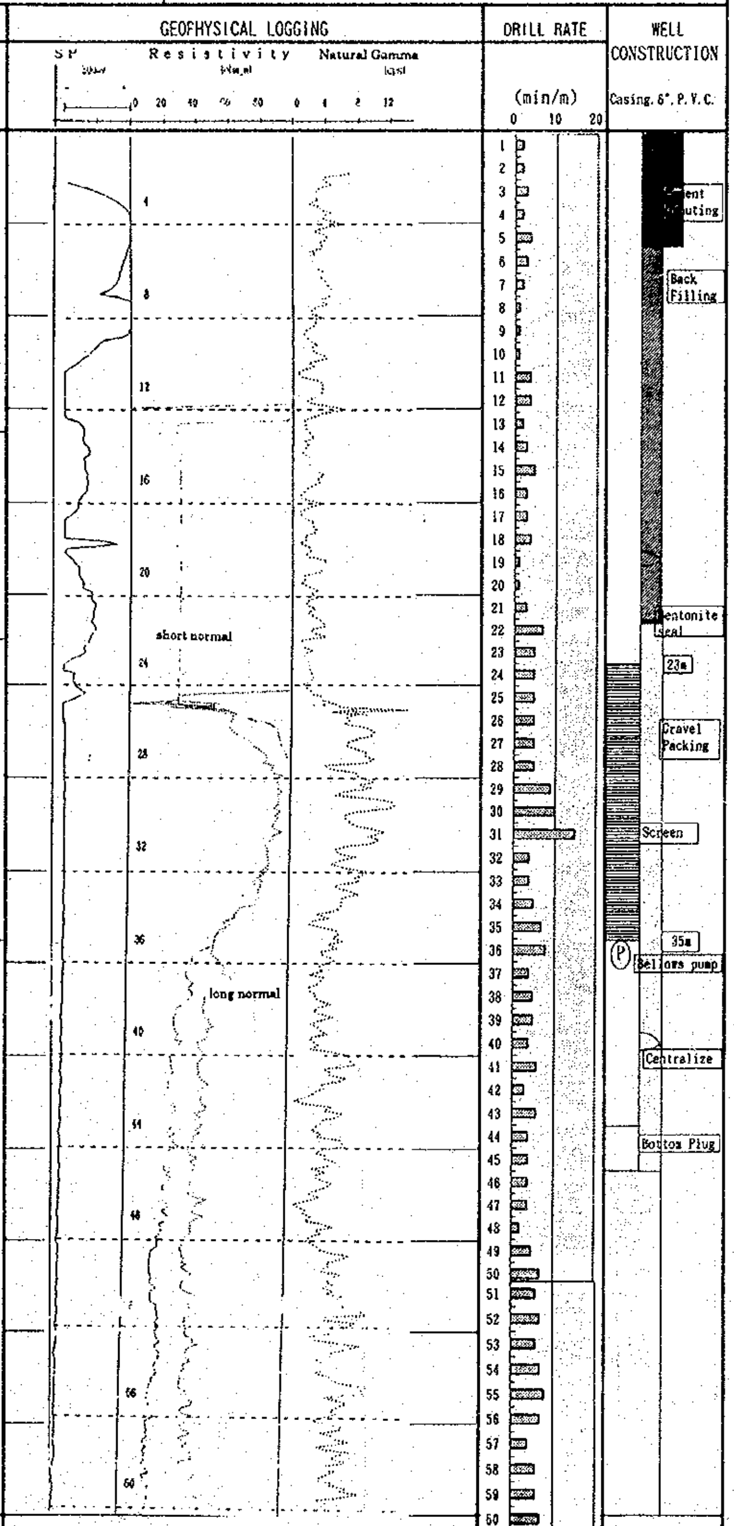


Figure 4.3.1(5)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES , LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	LAK-24
	PROVINCE	CHAMPASAK
DRILLING COMPANY		SIAM TONE Co.,LTD.
RIG TYPE & NUMBER		TOP-500
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)
FIELD PARTY		UTAIRAAT
GEOLOGIST		S.OHMORI

FIELD BOOK NO.	C-65
TOTAL DEPTH(m)	50.0
GROUND SURFACE ELEVATION(m)	100
DATE BEGUN	09/01/'95
DATE COMPLETED	10/01/'95

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	7.12	7.35	7.43
Time			
Date	14/01/'95	19/01/'95	31/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
0–2	Clay. soft, yellowish brown.
2–8	Laterite. Reddish brown.
8–23	Sandstone. Dark brown, medium grains. (Jurassic)
23–44	Mudstone, Sandy shale. Reddish purple, hard.
30–31	Sandy.
37–38	Sandy.
41–42	Sandy.
44–50	Sandstone. Fine to Medium grains. Dark grey, hard.
50	50.0m

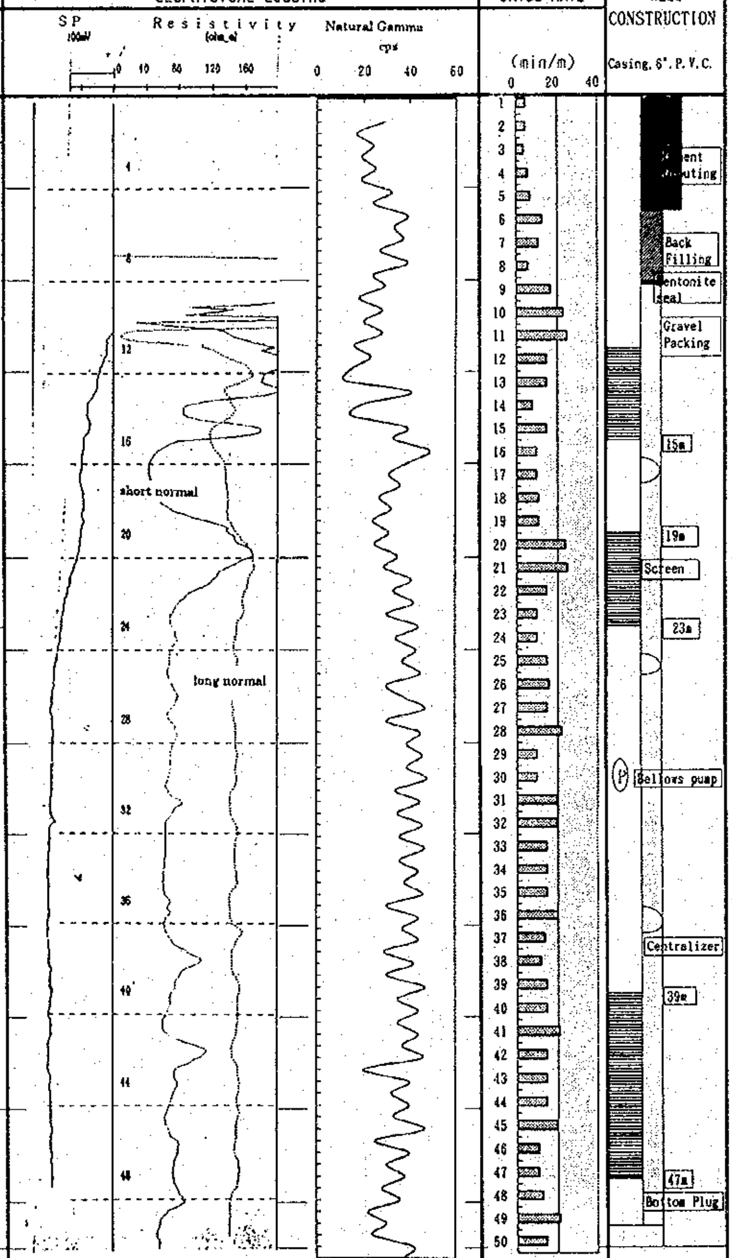


Figure 4.3.1(6)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 07 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	NONGKHE	FIELD BOOK NO.	C-75
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	50.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	95
RIG TYPE & NUMBER		TOP-500	DATE BEGUN	11/01/'95
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	12/01/'95
FIELD PARTY		UTAIRAAT		
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	5.12	3.2	3.41
Time			
Date	14/01/'95	19/01/'95	31/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
1–11	Sandy clay. soft to semi-consolidated. Yellowish to reddish brown, high plasticity. Terrace deposits. (Quaternary)
12–29	Hard shale. Dark reddish purple. (Jurassic)
30–36	Sandy shale. Reddish brown to grayish brown, very hard, high fissility.
37	calcareous.
38	Sandy.
42	Sandy.
50	50.0m

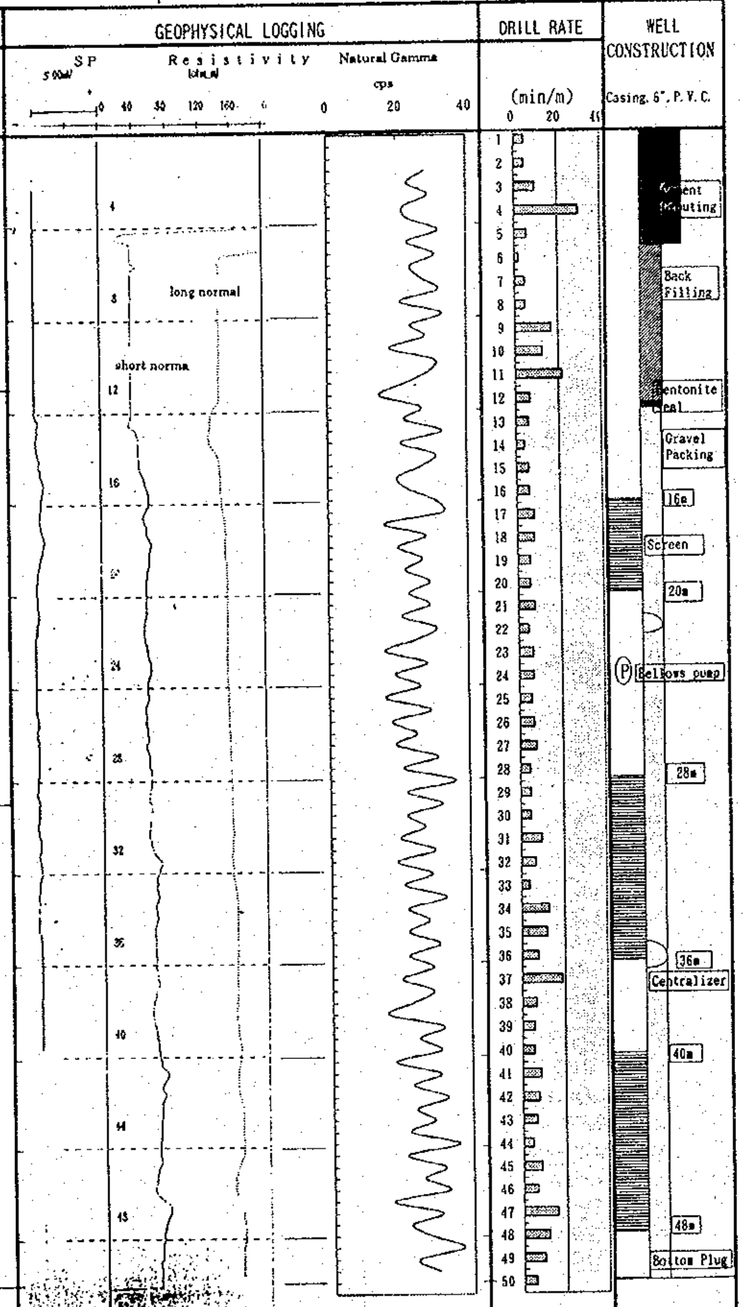


Figure 4.3.1(7)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 08 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	SAMKHANABOUA	FIELD BOOK NO.	C 79
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	45.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	96
RIG TYPE & NUMBER		TOP-300	DATE BEGUN	15/01/'95
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	17/01/'95
FIELD PARTY		UTAIRAAT		
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	7.5	7.63	7.8
Time			
Date	19/01/'95	25/01/'95	31/01/'95

DEPTH (m)	LITHOLOGY	LITHOLOGY DESCRIPTION
1–7		Sandy clay. Yellowish brown to gray, soft, high plasticity. eolian deposits. (Quaternary)
8–12		Sandstone. High weathered fine to very fine sandstone. brown to dark grayish brown. (Jurassic)
13–40		Hard shale. Dark reddish purple. sandstone interbeded in some parts, hard. (Jurassic)
41–45		Sandy shale. Dark grayish green ,very hard, high fissibility. 45.0m.

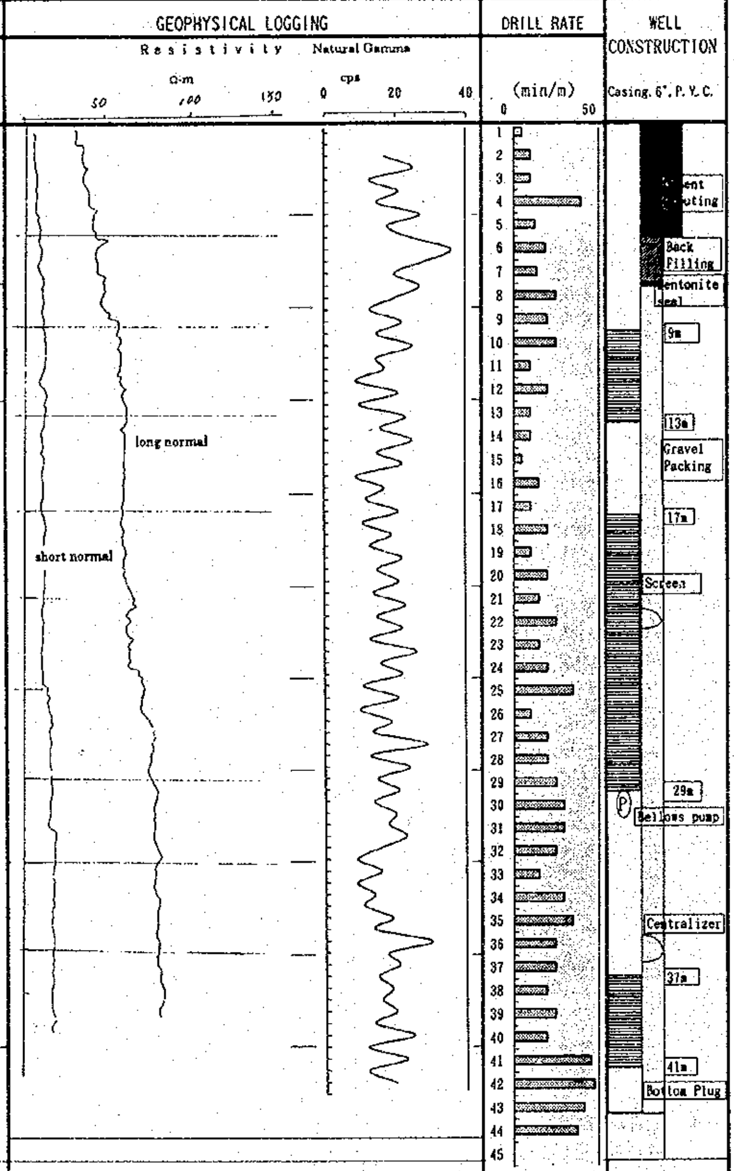


Figure 4.3.1(8)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 09 /20

PROJECT NAME ; THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	MAISIVILAI	FIELD BOOK NO.	C-88
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	50.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	85
RIG TYPE & NUMBER		TOP-500	DATE BEGUN	17/01/'95
DRILLING METHOD		Direct Rotary circulation	DATE COMPLETED	19/01/'95
		Down The Hole Hammer(D.H.M)		
FIELD PARTY		UTAIRAAT		
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring				
	Depth(m)	10.18	9.46	9.34
	Time			
	Date	19/01/'95	26/01/'95	30/01/'95

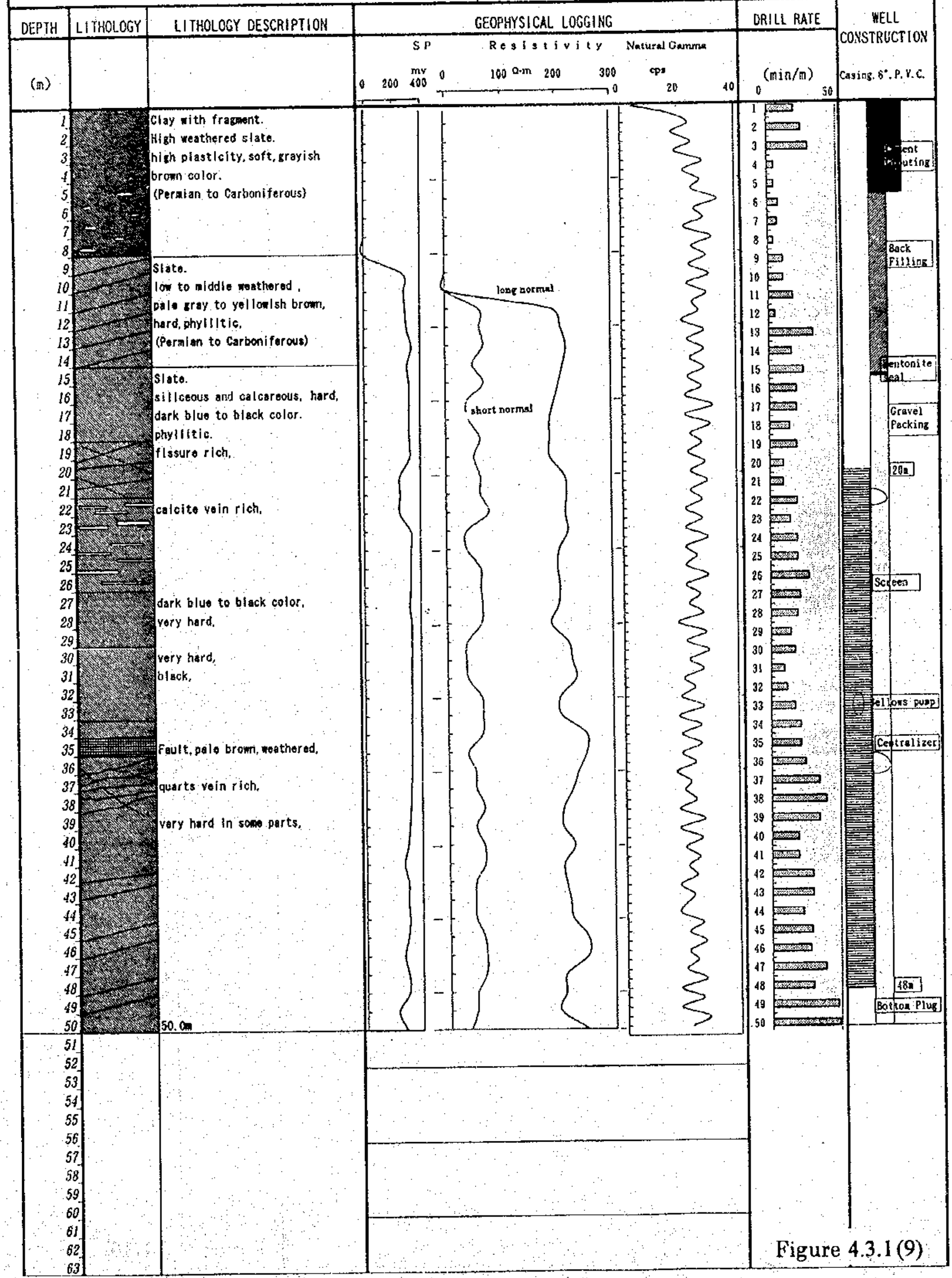


Figure 4.3.1(9)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 10 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	NASENPHAN	FIELD BOOK NO.	C-89
	PROVINCE	CHAMPASAK	TOTAL DEPTH(m)	50.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	88
RIG TYPE & NUMBER		TOP-500	DATE BEGUN	13/01/'95
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	16/01/'95
FIELD PARTY		UTAIRAAT		
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring				
	Depth(m)	5.42	5.3	5.29
	Time			
	Date	19/01/'95	26/01/'95	30/01/'95

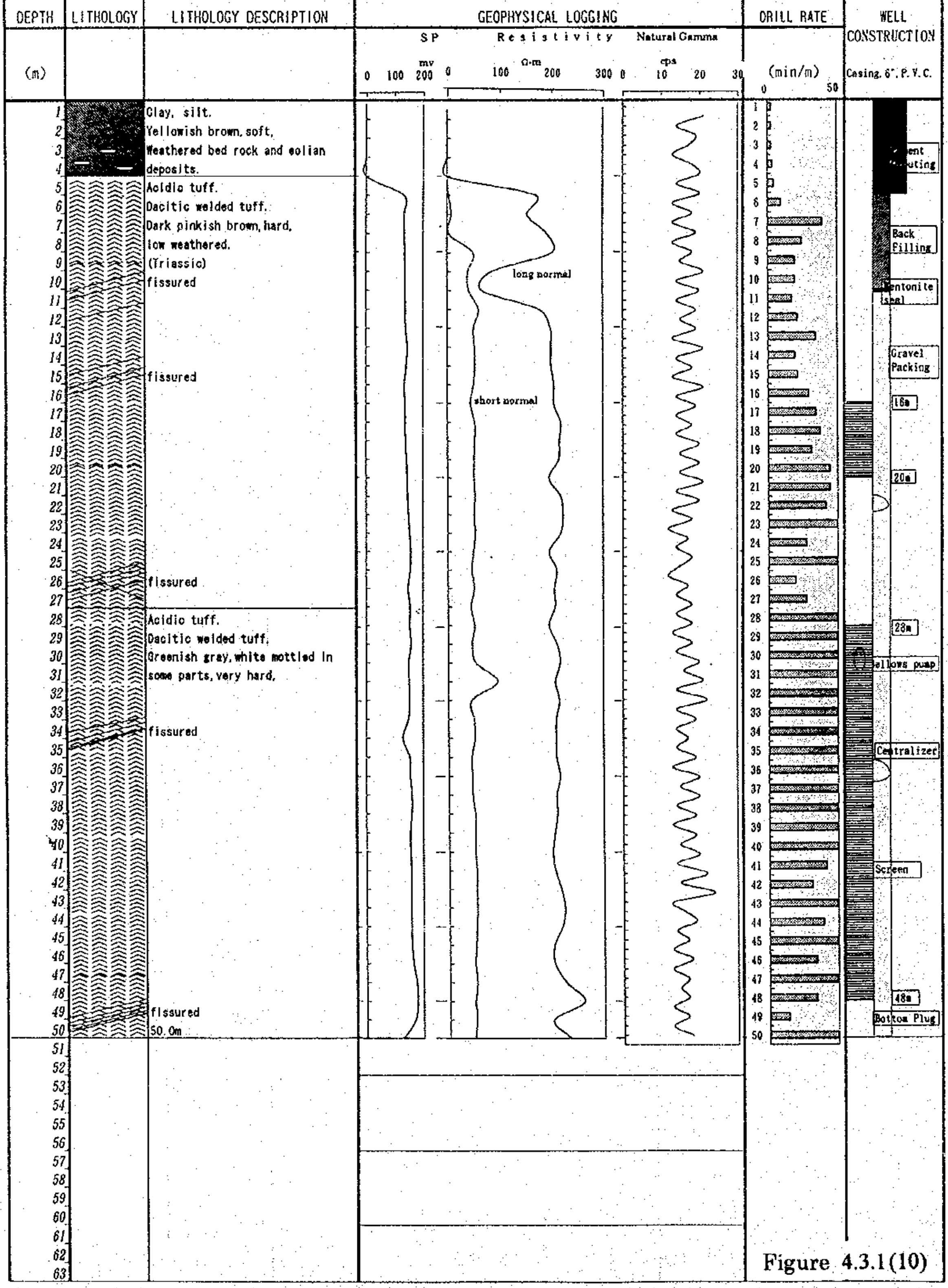


Figure 4.3.1(10)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 11 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN HOUAYKAPHO	FIELD BOOK NO.	S-4
	PROVINCE SARAVAN	TOTAL DEPTH(m)	45.0
DRILLING COMPANY	SIAM TONE Co,.LTD.	GROUND SURFACE ELEVATION(m)	160
RIG TYPE & NUMBER	TOP-300	DATE BEGUN	05/01/'95
DRILLING METHOD	Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	08/01/'95
FIELD PARTY	UTAIRAAT		
GEOLOGIST	S.OHMORI		

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	13.52	8.9	8.87
Time	0.590278		
Date	08/01/'95	18/01/'95	30/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
0–7	Sandstone. High weathered , fine to medium sandstone, grayish brown color. (Jurassic)
7–41	Sandstone. Medium grains, dark gray to gray color sandstone, hard. (Jurassic)
20	Fracture.
24	Fracture.
29–30	Calcareous , very hard.
31	fine to medium.
41–45	Mud stone, sandy shale. Reddish purple, very hard.
45	45.0m.

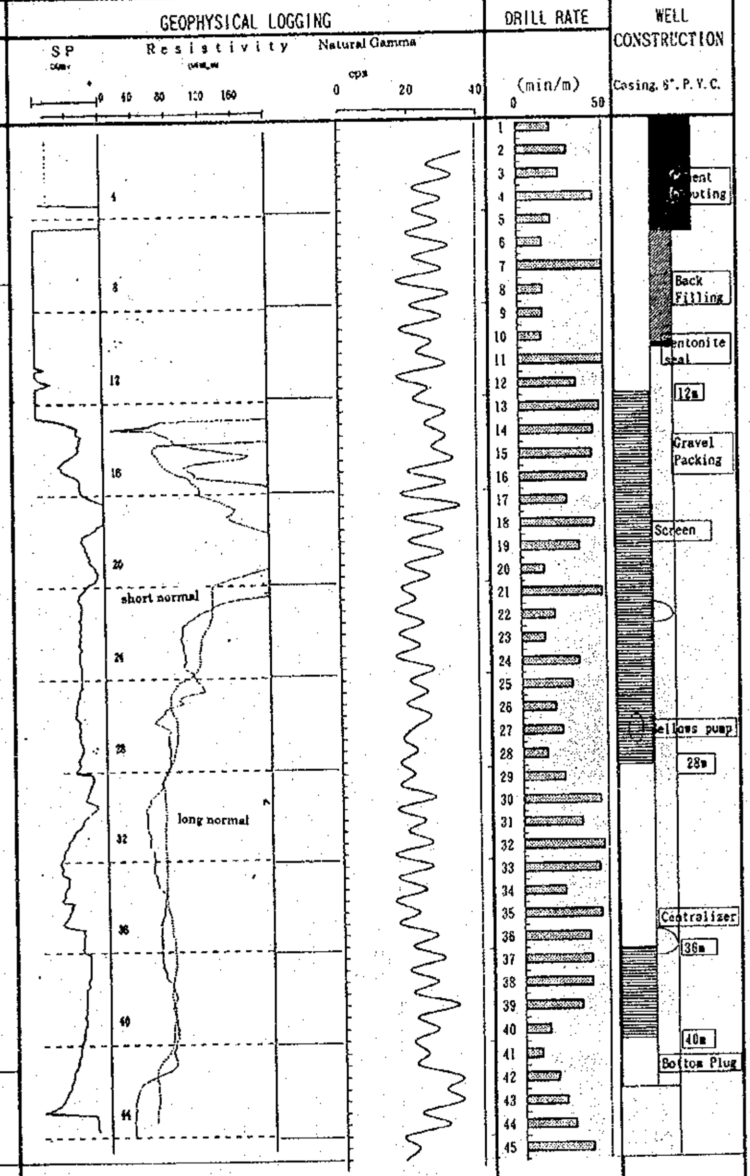


Figure 4.3.1(11)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 12 /20

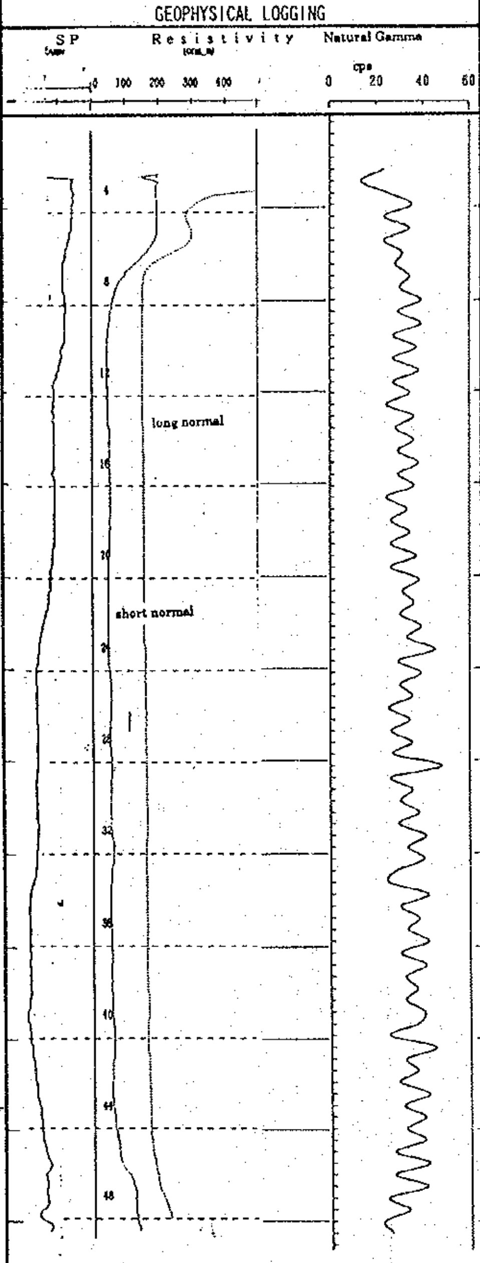
PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION : BAN	NONGSANO	FIELD BOOK NO.	S-12
PROVINCE	SARAVAN	TOTAL DEPTH(m)	50.0
DRILLING COMPANY	SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	160
RIG TYPE & NUMBER	TOP-300	DATE BEGUN	09/01/'95
DRILLING METHOD	Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	12/01/'95
FIELD PARTY	UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST	S.OHMORI		

STATIC WATER LEVEL			
Depth(m)	6.95	6.5	6.43
Time			
Date	09/01/'95	14/01/'95	30/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
0–6	Clay. light brown, high plasticity, soft. Weathered Mudstone.
6–43	Mud stone, sandy shale. Reddish purple, very hard. Sandstone interbeded in some parts. (Jurassic)
43–50	Sandstone. Medium grains, dark gray color, hard. (Jurassic) 50.0m

GEOPHYSICAL LOGGING



DRILL RATE / WELL CONSTRUCTION

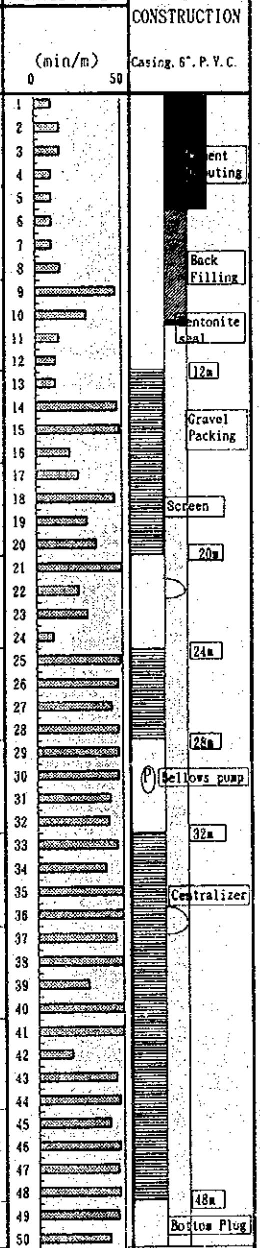


Figure 4.3.1(12)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 13 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION BAN	DONMUANG	FIELD BOOK NO.	S-24
PROVINCE	SARAVAN	TOTAL DEPTH(m)	50.0
DRILLING COMPANY	SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	130
RIG TYPE & NUMBER	TOP-500	DATE BEGUN	21/12/'94
DRILLING METHOD	Direct Rotary circulation	DATE COMPLETED	22/12/'94
	Down The Hole Hammer(D.H.M)		
FIELD PARTY	UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST	S.OHMORI		

STATIC WATER LEVEL (B.L.S) After Boring			
Depth(m)	12.77	10.24	10.3
Time			
Date	22/12/'94	30/12/'94	23/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
0–10	Clay. light brown, high plasticity, soft. Terrace deposits. (Quaternary)
10–14	Sandstone. weathered, dark grayish brown, fine to medium grains.
14–20	Sandstone. low weathered, dark brownish gray, medium grains, hard. (Jurassic)
20–28	Mud stone, sandy shale. Reddish purple, hard. (Jurassic)
28–39.5	Sandstone. dark brownish gray, medium grains, very hard. (Jurassic)
39.5–40	Mudstone. reddish purple, hard.
40–50	Sandstone. dark brownish gray, medium grains, very hard. (Jurassic) fine grains, medium grains, 50.0m

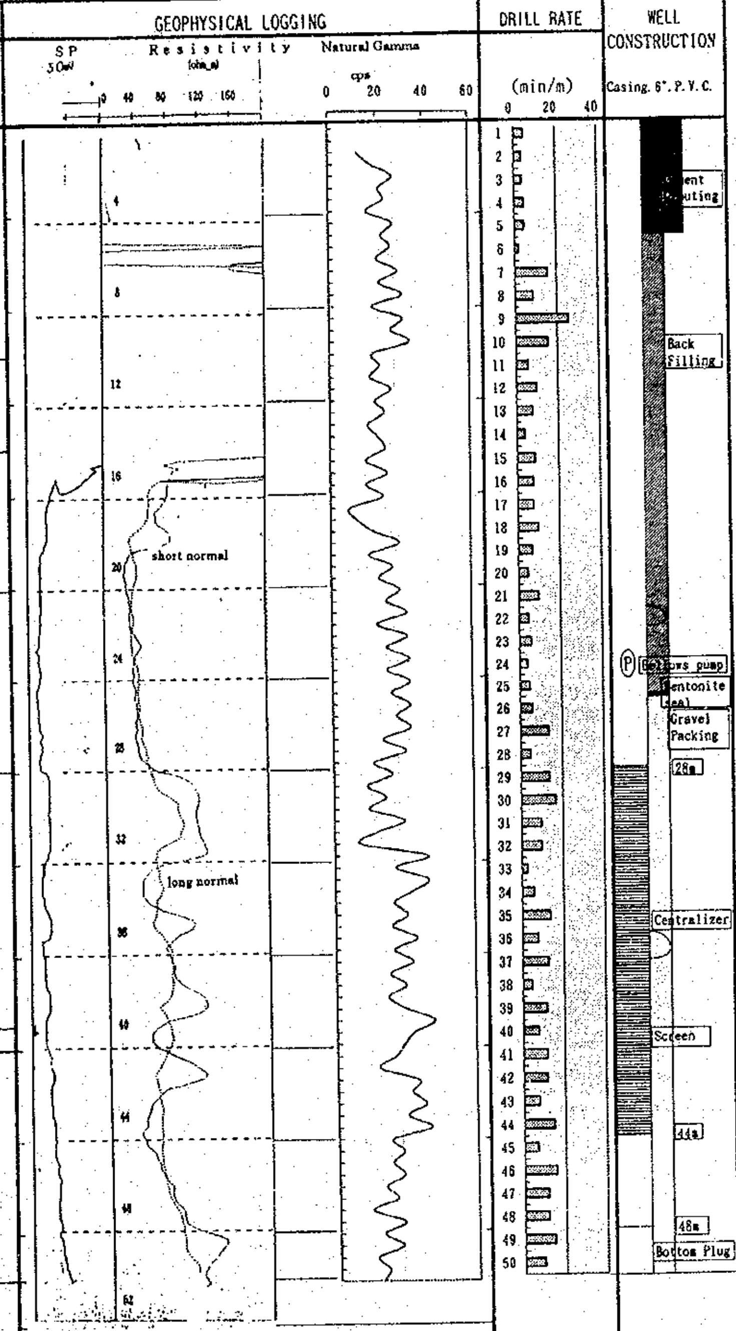


Figure 4.3.1(13)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 14 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	NONGNGONG	FIELD BOOK NO.	S-38
	PROVINCE	SARAVAN	TOTAL DEPTH(m)	50.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	140
RIG TYPE & NUMBER		TOP-500	DATE BEGUN	19/12/'94
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	20/12/'94
FIELD PARTY		UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL (B.L.S) After Boring			
Depth(m)	6.61	6.95	6.33
Time			
Date	27/12/'94	09/01/'95	30/01/'95

DEPTH (m)	LITHOLOGY	LITHOLOGY DESCRIPTION
1–6		Clay. light brown, medium plasticity, soft, with sand. Weathered sandstone.
7–19		Sandstone. low weathered, dark brownish gray, fine to medium grains, (Jurassic)
20–23		Mud stone, sandy shale. Reddish purple, hard. (Jurassic)
24–37		Sandstone. dark brownish gray, medium grains, very hard. (Jurassic)
38–40		Mudstone. reddish purple, hard.
41–50		Sandstone. dark brownish gray, medium grains and some parts fine grains, hard. (Jurassic) 50.0m

Depth scale: 1–63 m

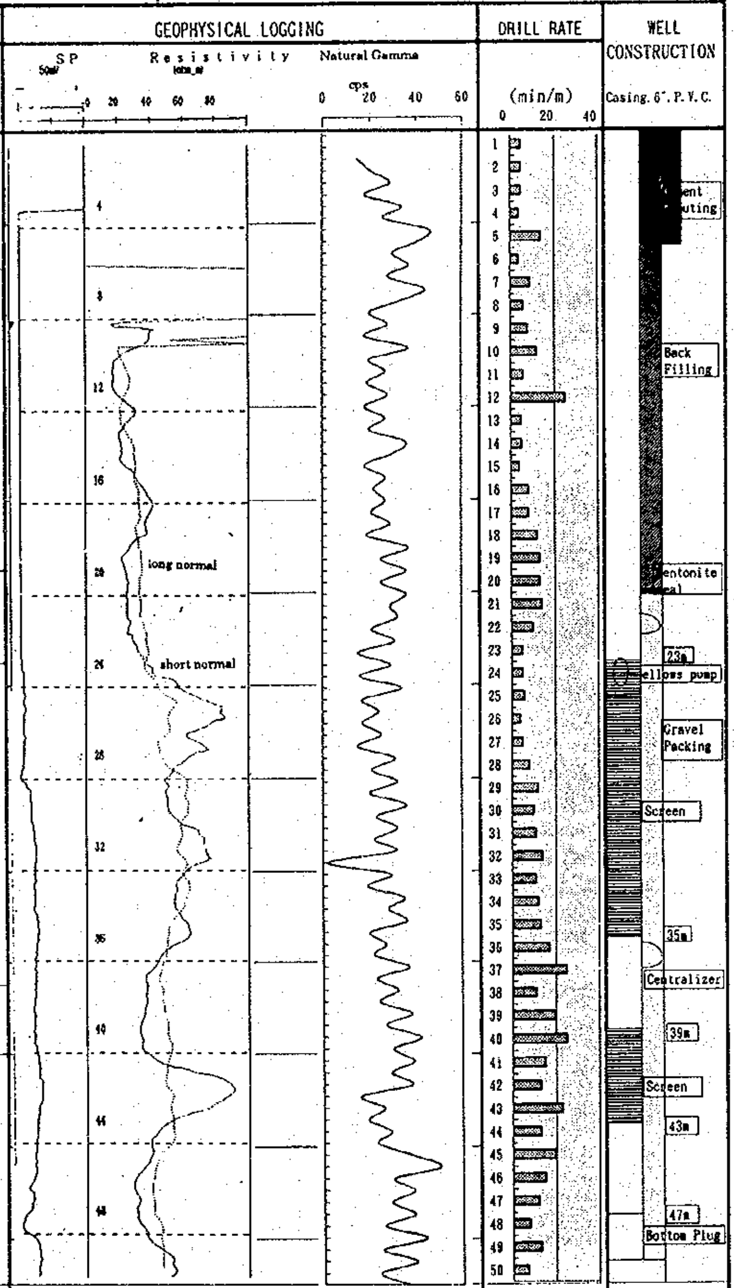


Figure 4.3.1(14)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 15 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	SAMIA
	PROVINCE	SARAVAN
DRILLING COMPANY		SIAM TONE Co.,LTD.
RIG TYPE & NUMBER		TOP-500
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)
FIELD PARTY		UTAIRAAT
GEOLOGIST		S.OHMORI

FIELD BOOK NO.	S-50
TOTAL DEPTH(m)	50.0
GROUND SURFACE ELEVATION(m)	145
DATE BEGUN	17/12/'94
DATE COMPLETED	18/12/'94

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	6.51	6.98	6.84
Time			
Date	23/12/'94	09/01/'95	23/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
1–4	Sand. fine to medium grains, loosed, Terrace deposits. (Quaternary)
5–11	Sandy clay. yellowish brown, soft, fine to medium sand in some parts. Terrace deposits. (Quaternary)
12–36	Mud stone, sandy shale. Reddish purple, hard. Sandstone interbeded in some parts. (Jurassic) sandy, (15–18)
31	sandy,
34	sandy,
37–45	Sandstone. dark brownish gray, medium grains, very hard. (Jurassic)
46–50	Mudstone, reddish purple, hard. Sandstone interbeded, hard. (Jurassic)
50	50.0m

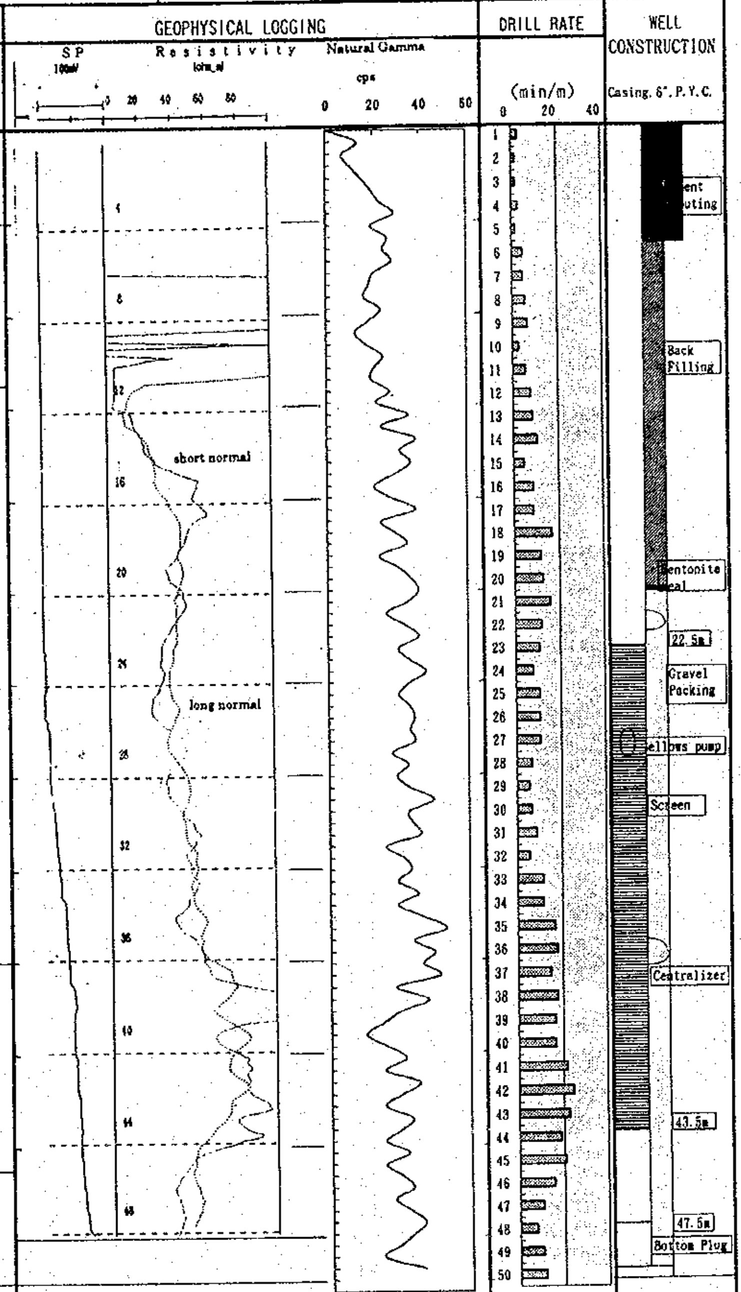


Figure 4.3.1(15)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 16 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN	CHONG	FIELD BOOK NO.	S-56
	PROVINCE	SARAVAN	TOTAL DEPTH(m)	50.0
DRILLING COMPANY		SIAM TONE Co.,LTD.	GROUND SURFACE ELEVATION(m)	170
RIG TYPE & NUMBER		TOP-500	DATE BEGUN	15/12/'94
DRILLING METHOD		Direct Rotary circulation	DATE COMPLETED	16/12/'94
		Down The Hole Hammer(D.H.M)		
FIELD PARTY		UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST		S.OHMORI		

STATIC WATER LEVEL			
Depth(m)	5	4.3	4.95
Time			
Date	16/12/'94	22/12/'94	30/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
1–6	Basalt. High weathered lava ,dark gray. (Neogene to Quaternary)
7–10	Basalt. weathered lava ,dark gray. (Neogene to Quaternary) yellowish brown,weathered.
11–15	Basalt. Auto-brecciated lava flow, dark gray. (Neogene to Quaternary)
16–32	Mud stone,sandy shale. Reddish purple, hard. Sandstone interbeded in some parts. (Jurassic)
28	sandy.
33–39	Sandstone. dark brownish gray, medium to fine grains,very hard. (Jurassic)
40–50	Mudstone,reddish purple,hard. Sandstone interbeded ,hard. (Jurassic)
50	50.0m

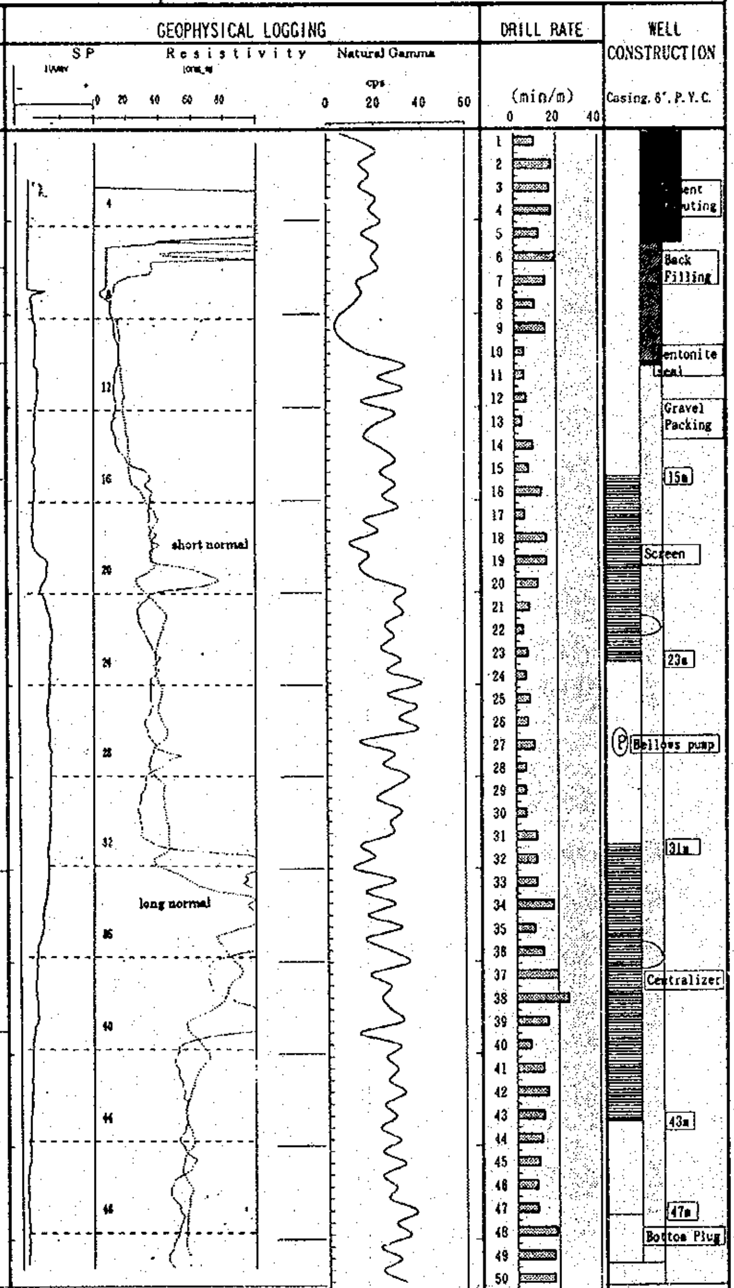


Figure 4.3.1(16)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 17 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION BAN	PHONPHAI
PROVINCE	SARAVAN
DRILLING COMPANY	SIAM TONE Co.,LTD.
RIG TYPE & NUMBER	TOP-500
DRILLING METHOD	Direct Rotary circulation Down The Hole Hammer(D.H.M)
FIELD PARTY	UTAIRAAT
GEOLOGIST	S.OHMORI

FIELD BOOK NO.	s-64
TOTAL DEPTH(m)	50.0
GROUND SURFACE ELEVATION(m)	190
DATE BEGUN	12/12/'94
DATE COMPLETED	:

STATIC WATER LEVEL(B.L.S) After Boring

Depth(m)	9.25	9.88	10.04
Time			
Date	13/12/'94	27/12/'94	23/01/'95

DEPTH (m)	LITHOLOGY	LITHOLOGY DESCRIPTION
1–2		Sandstone. High weathered, reddish brown.
3–8		Sandstone. medium grains, hard, dark brownish gray. (Jurassic)
9–11		Shale. reddish brown, low weathered. (Jurassic)
12–35		Sandy shale. dark reddish purple, hard. Sandstone interbeded in some parts. (Jurassic)
36–41		Sandstone. dark brownish gray, medium to fine grains, very hard. (Jurassic)
42–50		Mudstone. reddish purple, very fine sandy, sandstone interbeded in some parts. (Jurassic)
50		50.0m

GEOPHYSICAL LOGGING — SP, Resistivity (ohm-m), Natural Gamma (cps); DRILL RATE (min/m); WELL CONSTRUCTION (Casing, 6", P.V.C.)

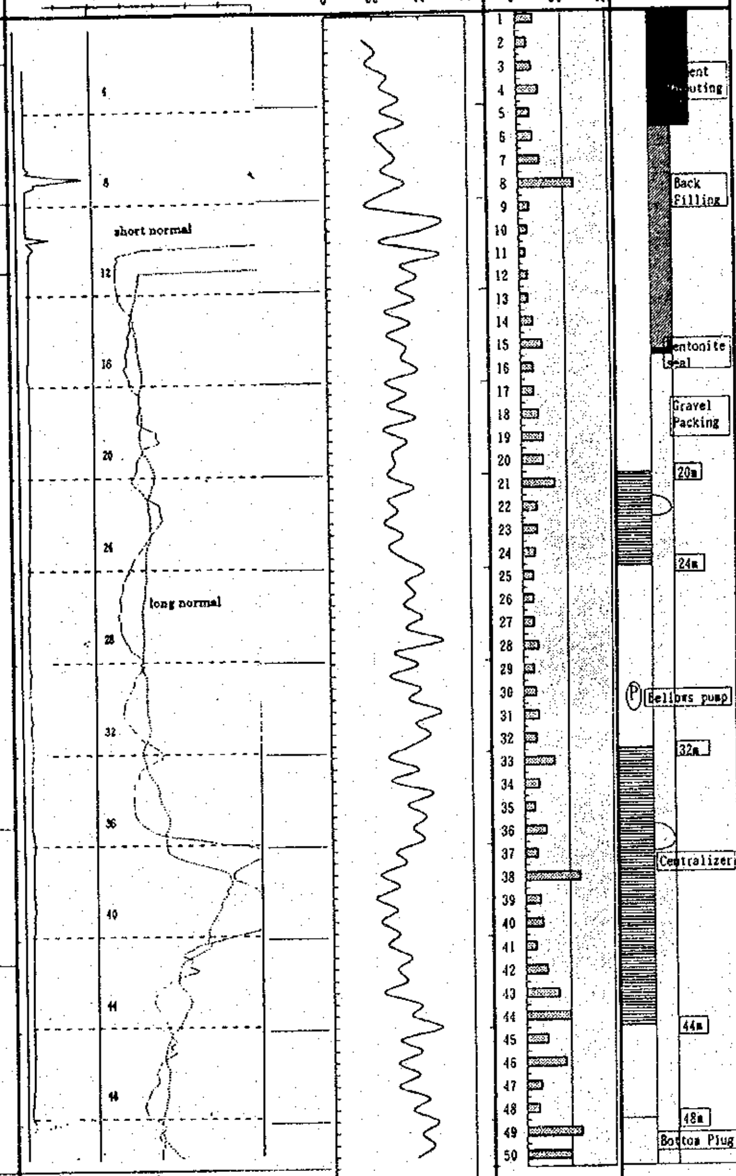


Figure 4.3.1(17)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 18 /20

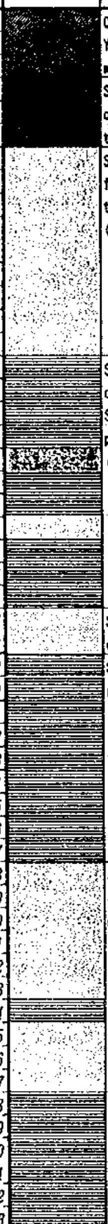
PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

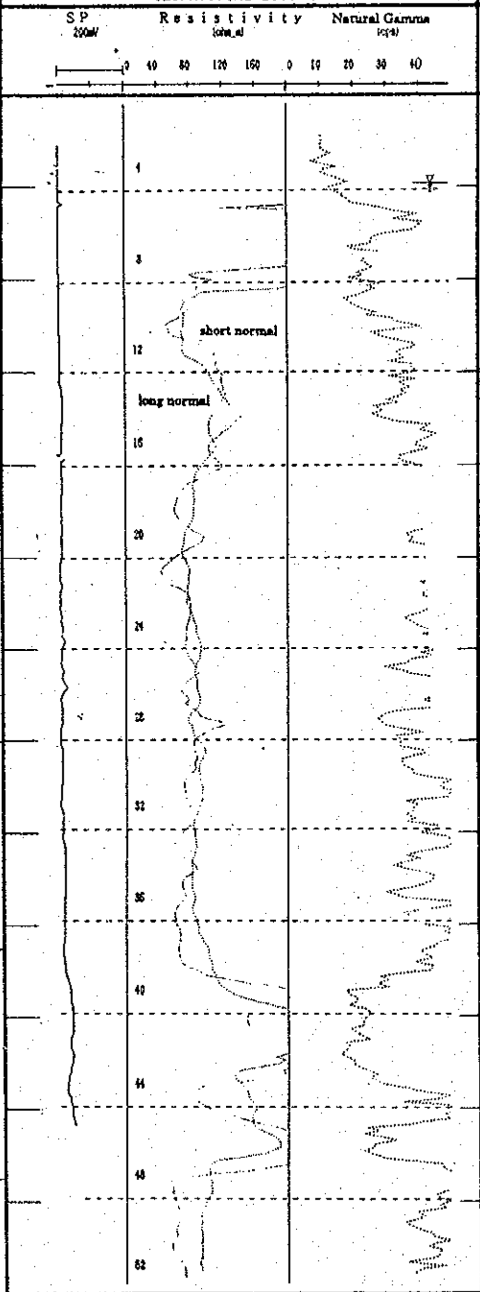
LOCATION	BAN	NAKASAO
	PROVINCE	SARAVAN
DRILLING COMPANY		SIAM TONE Co.,LTD.
RIG TYPE & NUMBER		TOP-500
DRILLING METHOD		Direct Rotary circulation Down The Hole Hammer(D.H.M)
FIELD PARTY		UTAIRAAT
GEOLOGIST		S.OHMORI

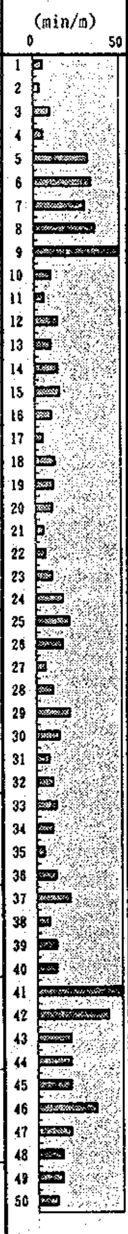
FIELD BOOK NO.	S-75
TOTAL DEPTH(m)	53.0
GROUND SURFACE ELEVATION(m)	194
DATE BEGUN	09/12/'94
DATE COMPLETED	11/12/'94

STATIC WATER LEVEL(B.L.S) After Boring				
	Depth(m)	4.22	4.36	4.62
	Time	13:00		
	Date	12/12/'94	04/01/'95	30/01/'95

DEPTH (m)	LITHOLOGY DESCRIPTION
1–3	Clay. Yellowish brown, soft clay. weathered sandstone.
4–6	Sandstone. dark brown, high weathered, fine to very fine . (Jurassic)
7–15	Sandstone. fine to medium grains, dark brown to reddish brown, very hard . (Jurassic)
16–26	Sandy shale. dark reddish purple, hard. Sandstone interbeded in some parts. (Jurassic)
27–28	Sandstone. dark gray, medium grains.
29–37	Sandy shale. reddish purple, hard.
38–47	Sandstone. dark brownish gray, medium to fine grains, very hard. (Jurassic)
48–53	Mudstone. reddish purple, very fine sandy, sandstone interbeded in some parts. (Jurassic)







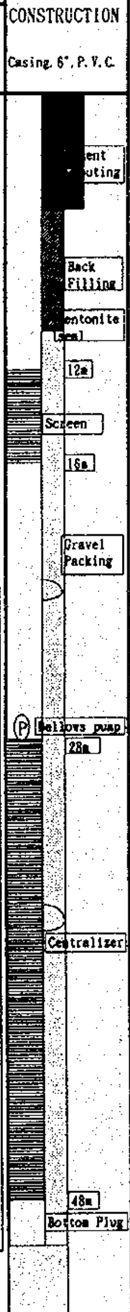


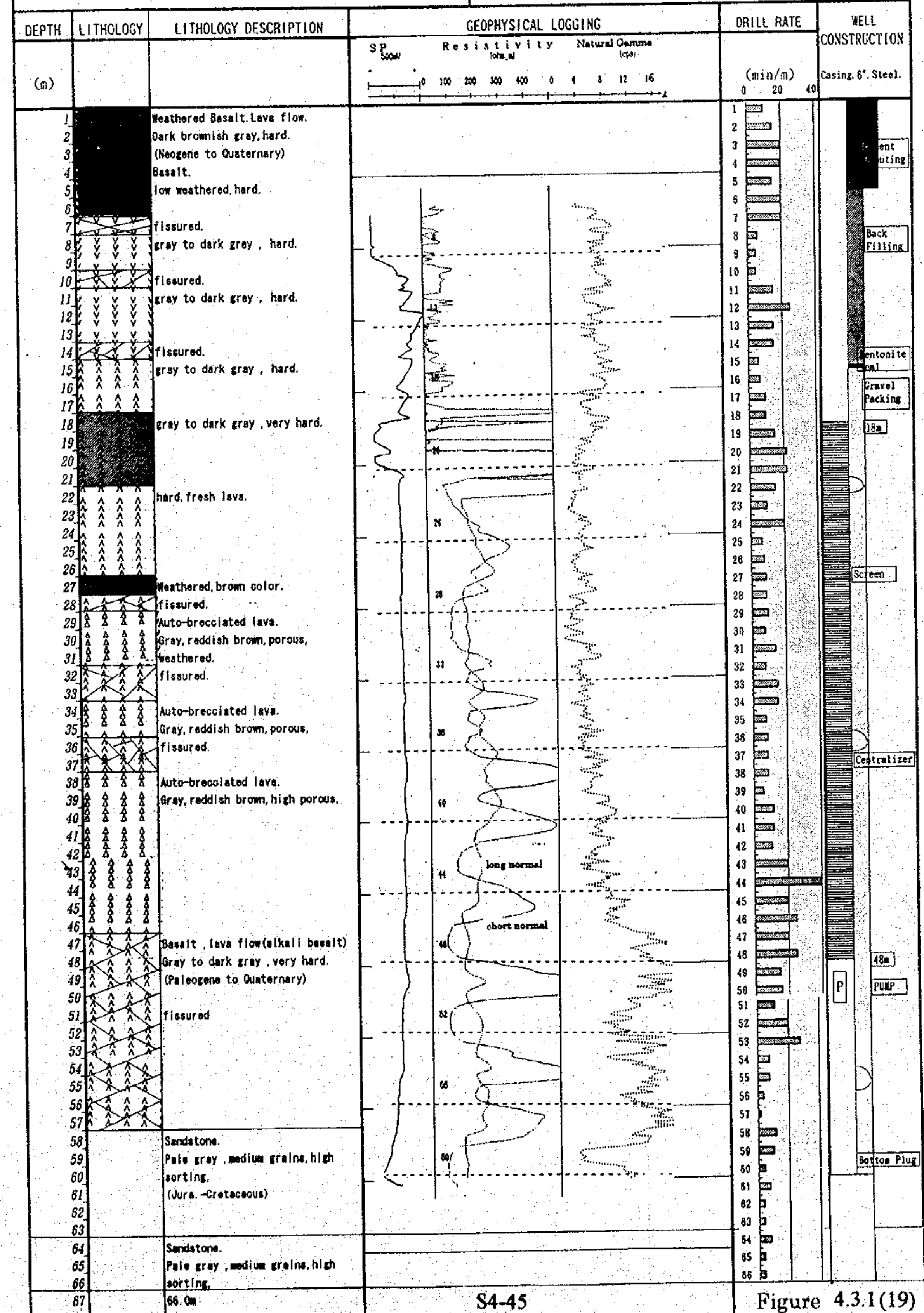
Figure 4.3.1 (18)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 19 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION BAN	BENG	FIELD BOOK NO.	S-84
PROVINCE	SARAVAN	TOTAL DEPTH(m)	66.0
DRILLING COMPANY	SIAM TONE Co,.LTD.	GROUND SURFACE ELEVATION(m)	308
RIG TYPE & NUMBER	TOP-500	DATE BEGUN	06/12/'94
DRILLING METHOD	Direct Rotary circulation Down The Hole Hammer(D.H.M)	DATE COMPLETED	08/12/'94
FIELD PARTY	UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST	S.OHMORI		

Depth(m)	16.16	17.3	18.98
Time			
Date	08/12/'94	30/12/'94	30/01/'95



S4-45

Figure 4.3.1(19)

LOG FORMAT	FIELD BOREHOLE LOG	BOREHOLE NUMBER JICA- 20 /20

PROJECT NAME : THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES ,LAO PEOPLE'S DEMOCRATIC REPUBLIC

LOCATION	BAN HOUN-TAI	FIELD BOOK NO.	S-100
	PROVINCE SARAVAN	TOTAL DEPTH(m)	54.0
DRILLING COMPANY	SIAM TONE Co,.LTD.	GROUND SURFACE ELEVATION(m)	520
RIG TYPE & NUMBER	TOP-500	DATE BEGUN	21/11/'94
DRILLING METHOD	Direct Rotary circulation Down The Hole Hammer(D.H.W)	DATE COMPLETED	5/12/'94
FIELD PARTY	UTAIRAAT	STATIC WATER LEVEL(B.L.S) After Boring	
GEOLOGIST	S.OHMORI		

Depth(m)	18.72	19.22	20.78
Time	10:00		
Date	12/12/'94	30/12/'94	23/01/'95

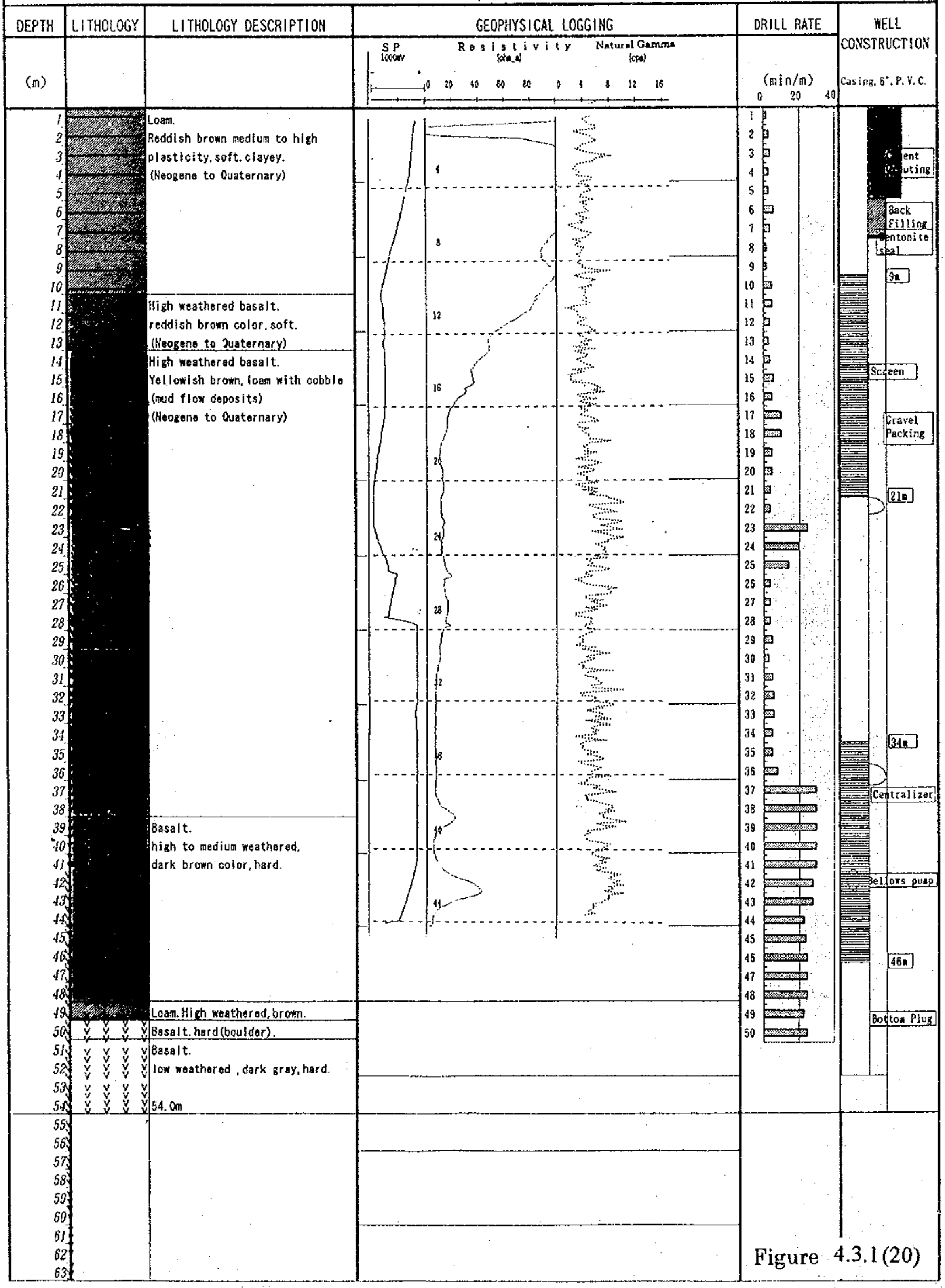


Figure 4.3.1(20)

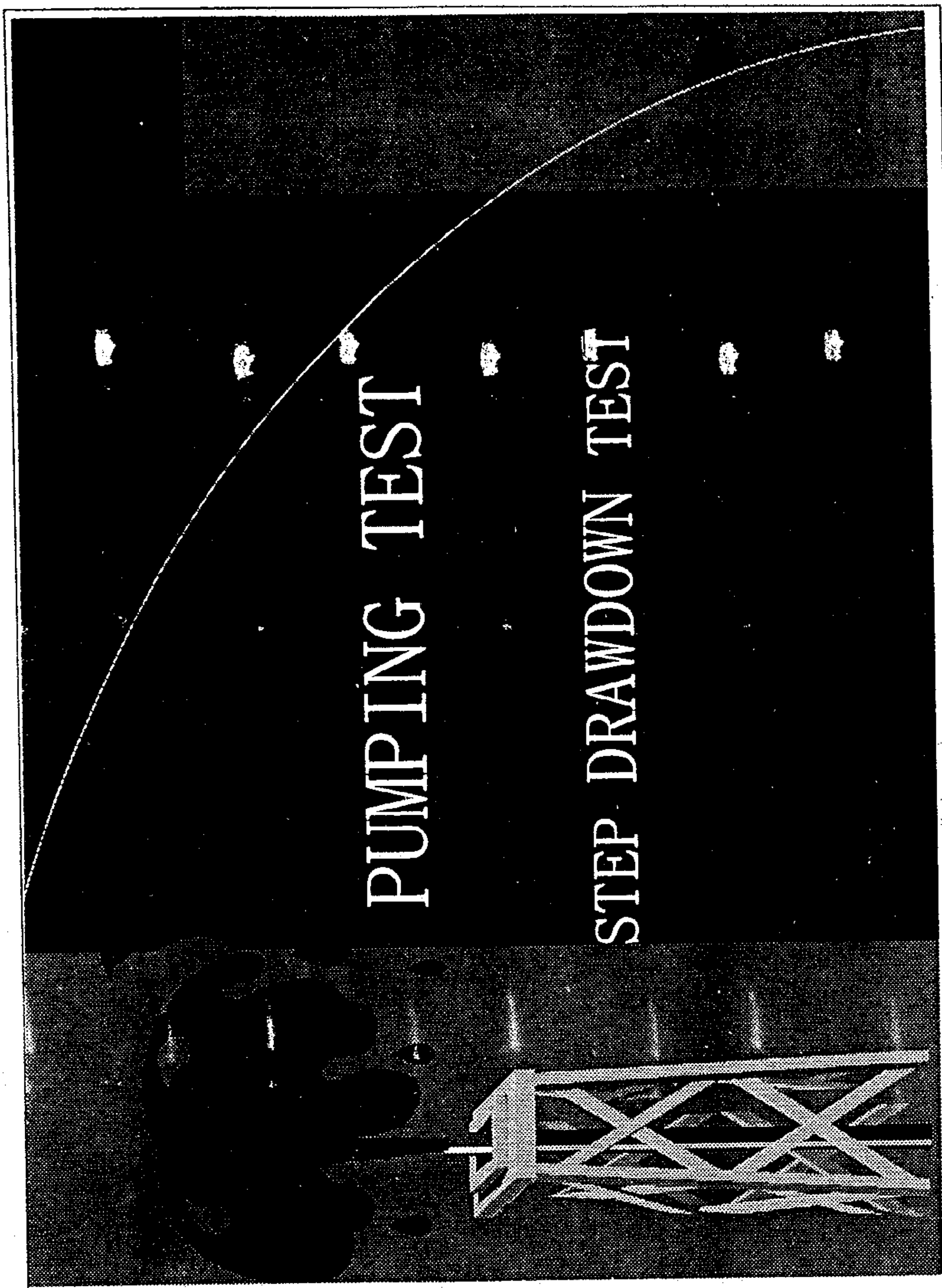
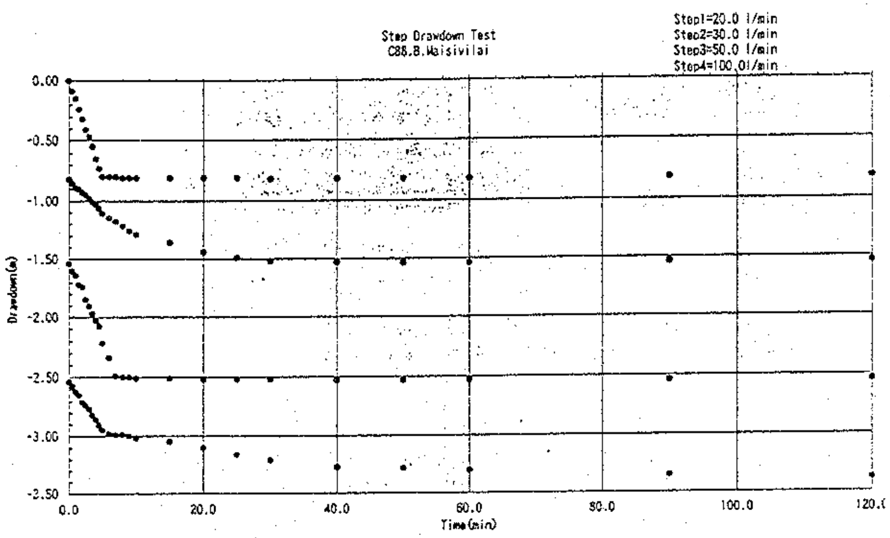
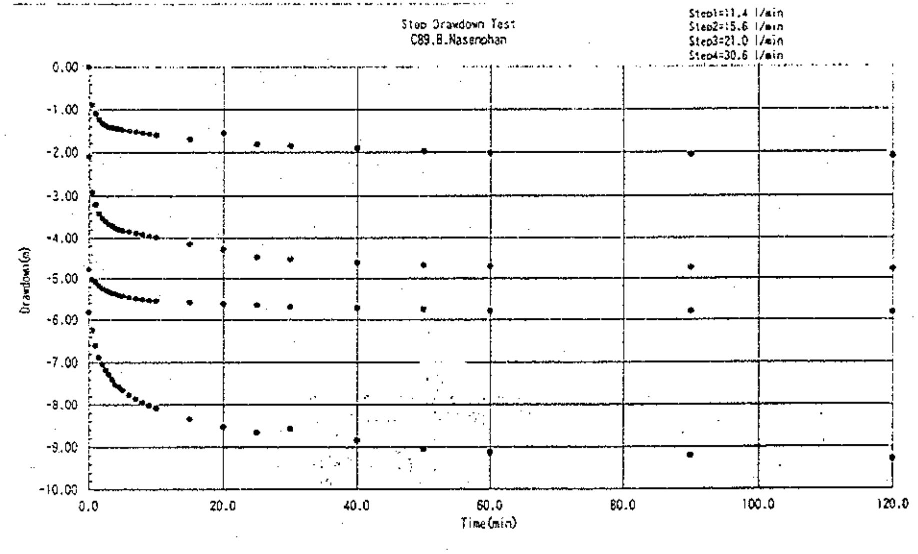


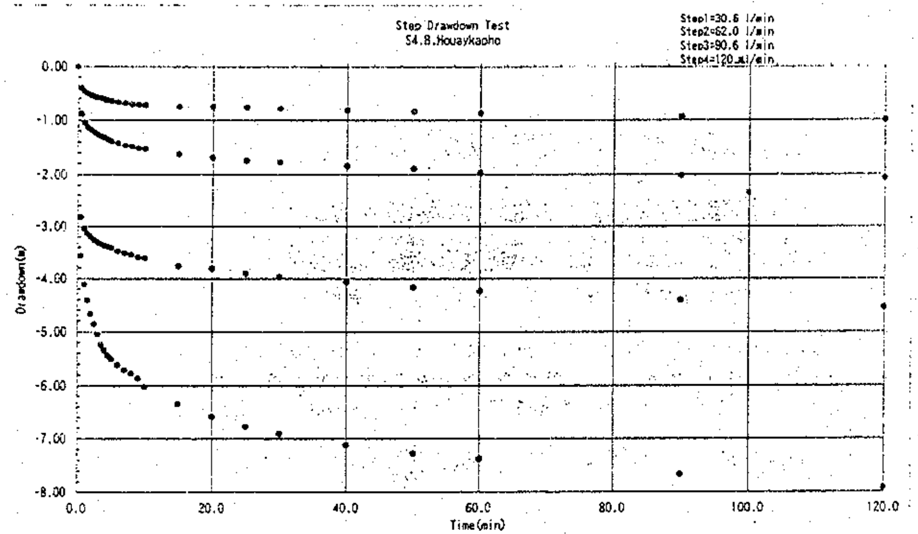
Figure 4.3.2	Step Drawdown Test T-S Curve

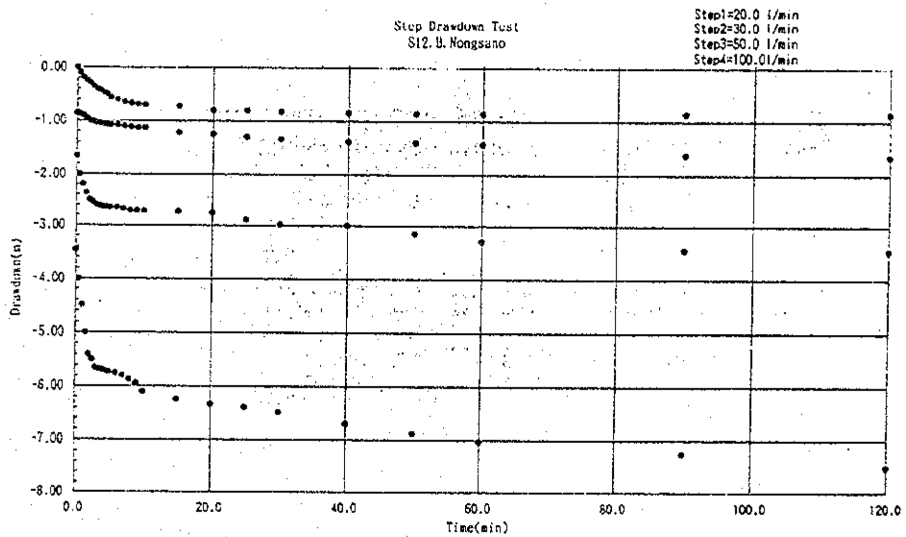
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.


Step Drawdown Test
C88.B.Waisivilai
Step1=20.0 l/min
Step2=30.0 l/min
Step3=50.0 l/min
Step4=100.0l/min
Drawdown(m)
Time(min)


Step Drawdown Test
C89.B.Nasenohan
Step1=1.4 l/min
Step2=5.6 l/min
Step3=21.0 l/min
Step4=30.6 l/min
Drawdown(m)
Time(min)


Step Drawdown Test
S4.B.Houaykapho
Step1=30.6 l/min
Step2=62.0 l/min
Step3=90.6 l/min
Drawdown(m)
Time(min)


Step Drawdown Test
S12.B.Nongsano
Step1=20.0 l/min
Step2=30.0 l/min
Step3=50.0 l/min
Step4=100.0l/min
Drawdown(m)
Time(min)

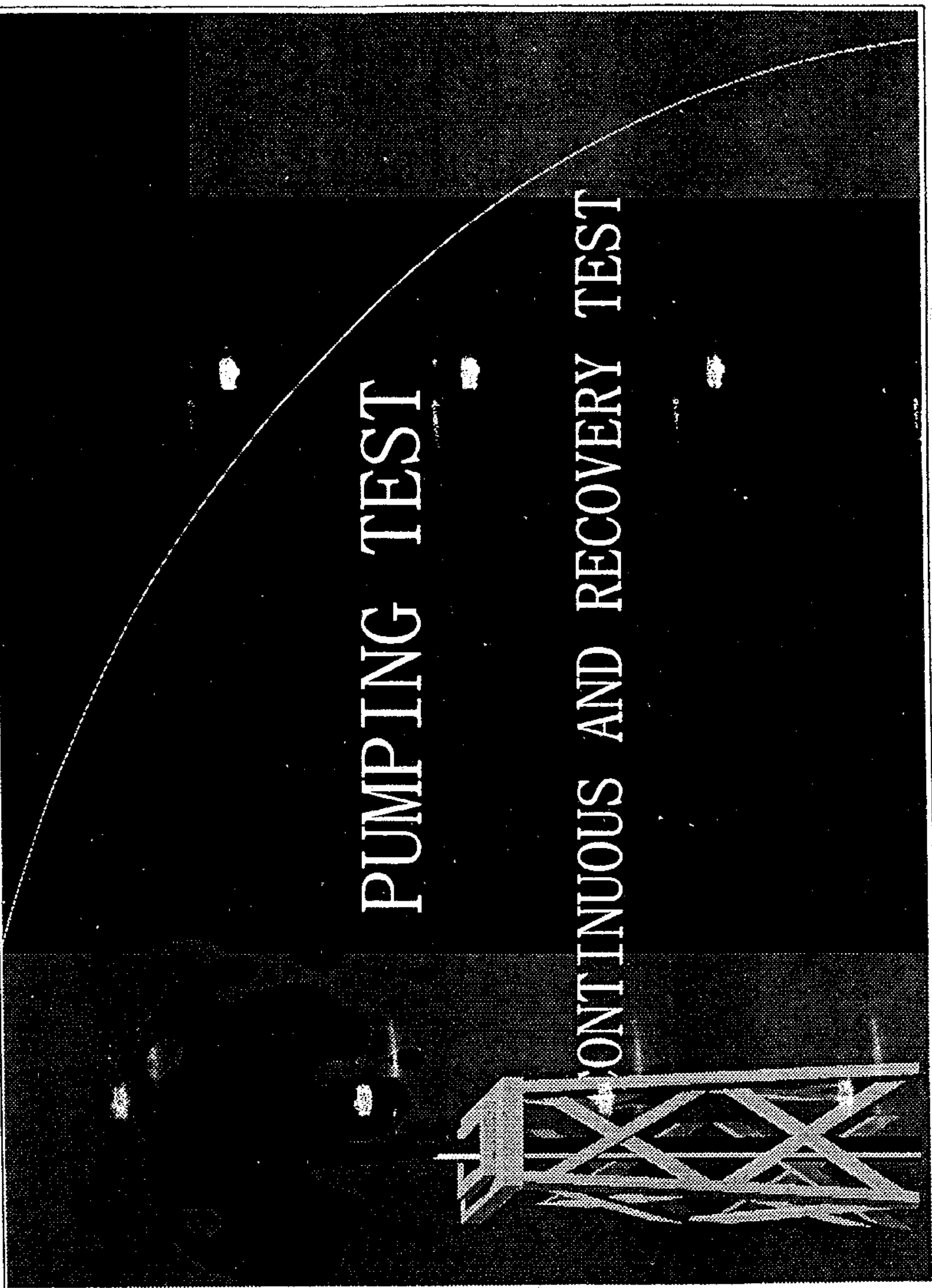
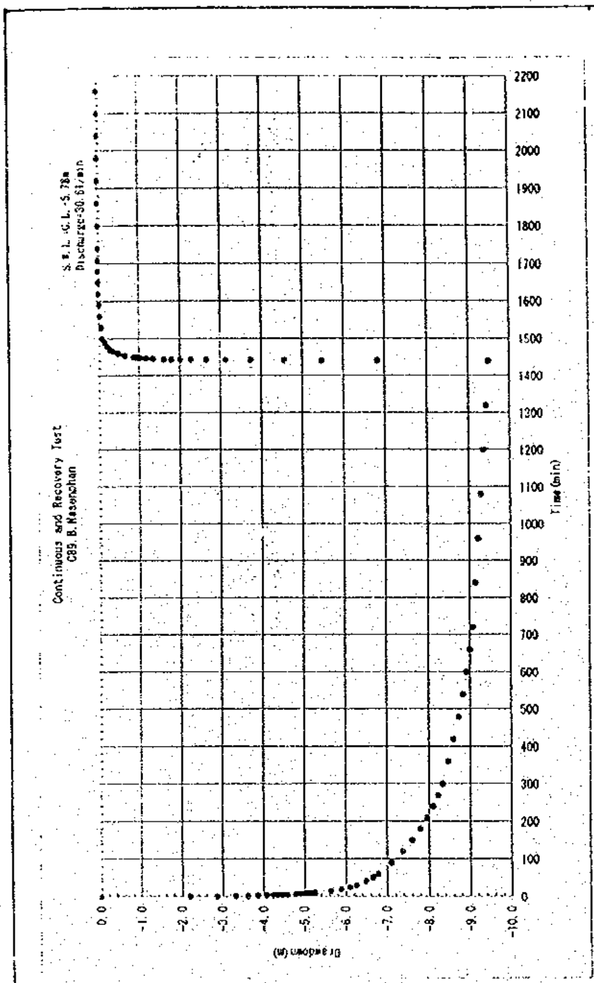
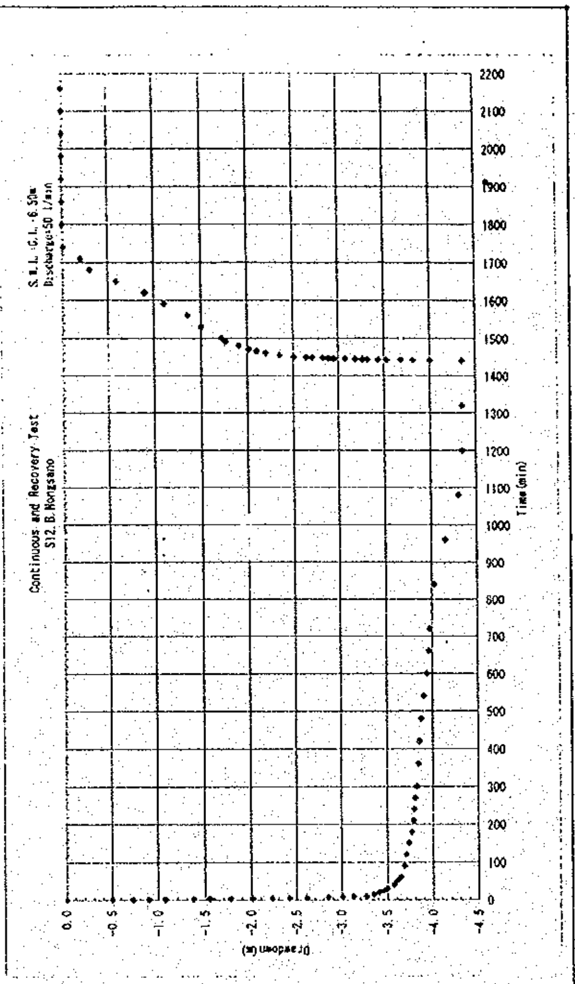
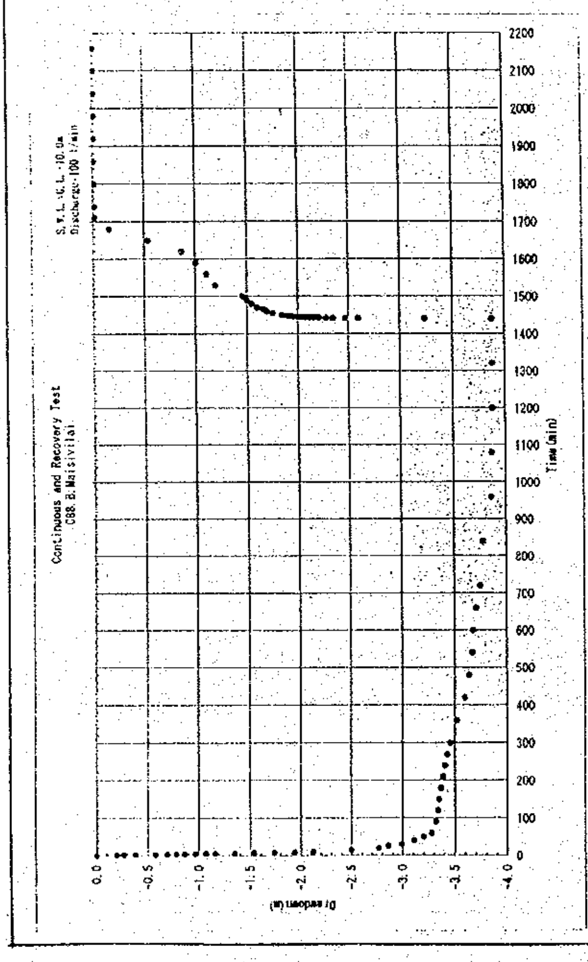
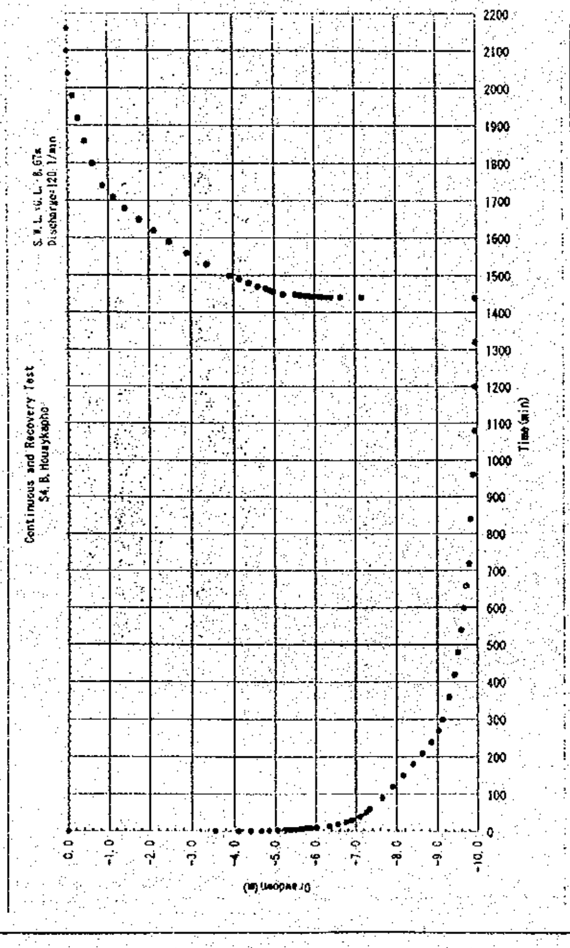


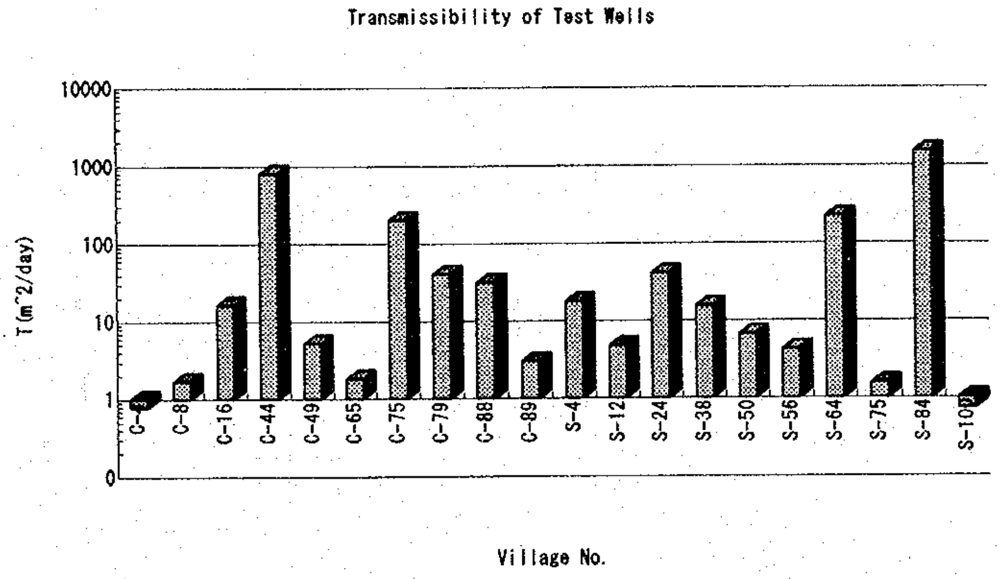
Figure 4.3.3	Continuous and Recovery Test T-S Curve
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.


Continuous and Recovery Test
C89. B. Nasenghan
S.W.L.:G.L.-5.78m
Discharge:30.6l/min
Time (min)
Drawdown (m)


Continuous and Recovery Test
S12. B. Nongsano
S.W.L.:G.L.-6.50m
Discharge:50 l/min
Time (min)
Drawdown (m)


Continuous and Recovery Test
C88. B. Maisivilai
S.W.L.:G.L.-10.0m
Discharge:100 l/min
Time (min)
Drawdown (m)


Continuous and Recovery Test
S4. B. Houaykapho
S.W.L.:G.L.-8.67m
Discharge:120 l/min
Time (min)
Drawdown (m)



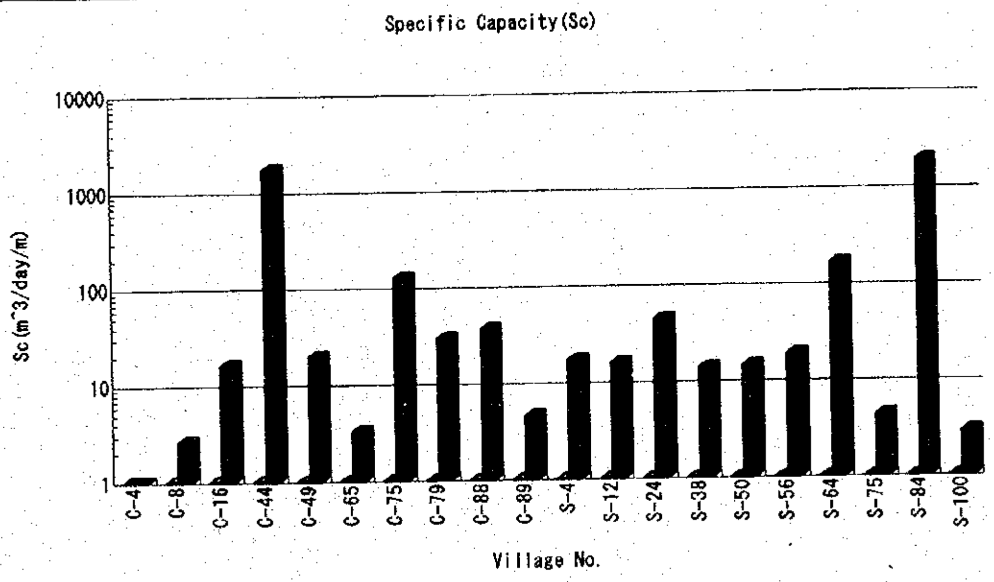
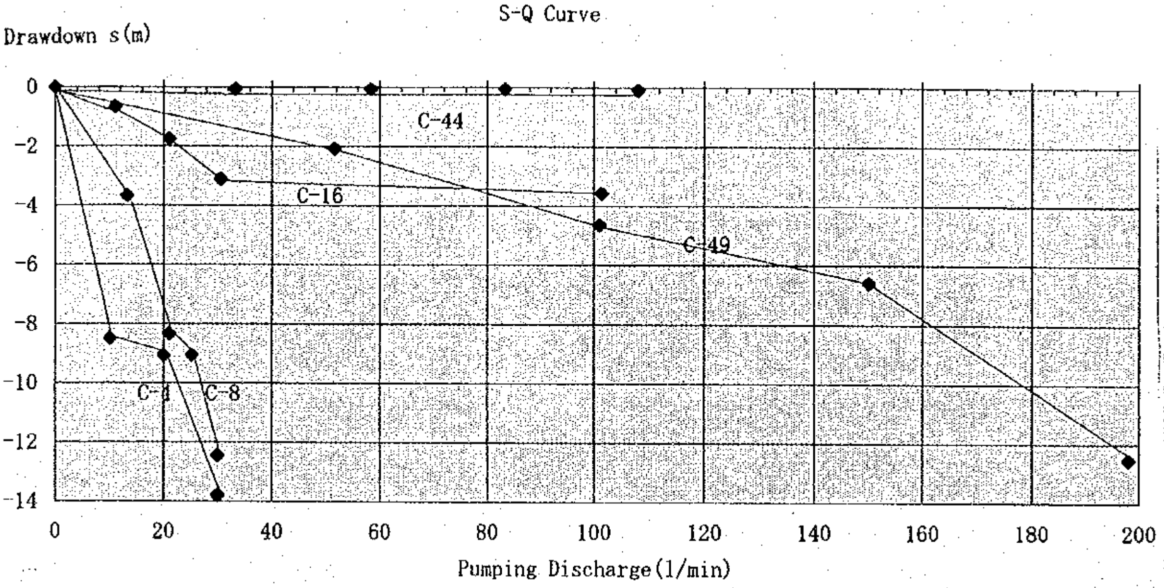


Figure 4.3.4	Specific Capacities of Test Wells
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.



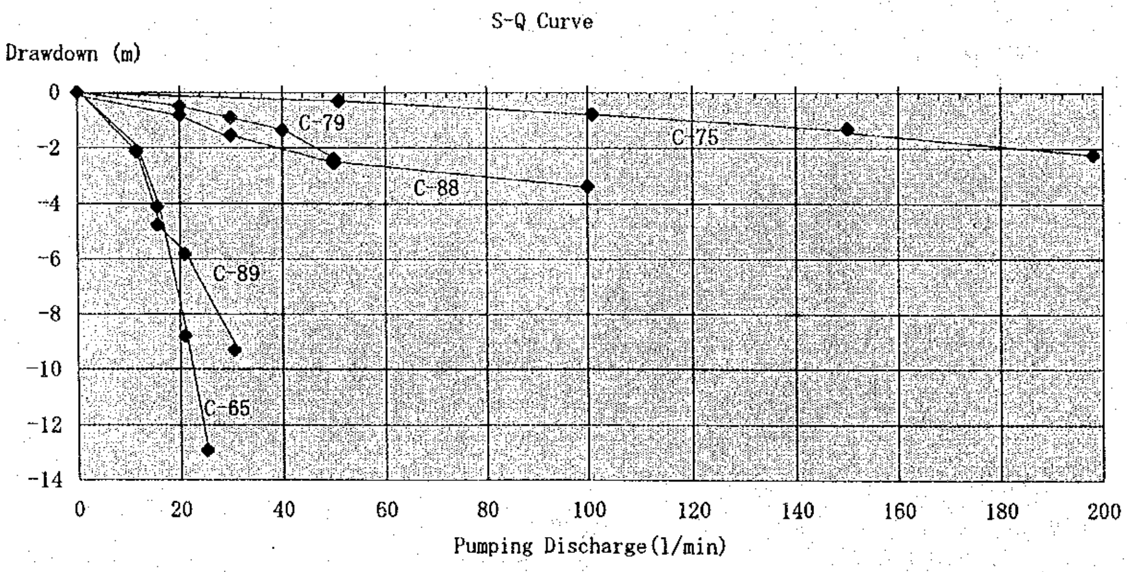
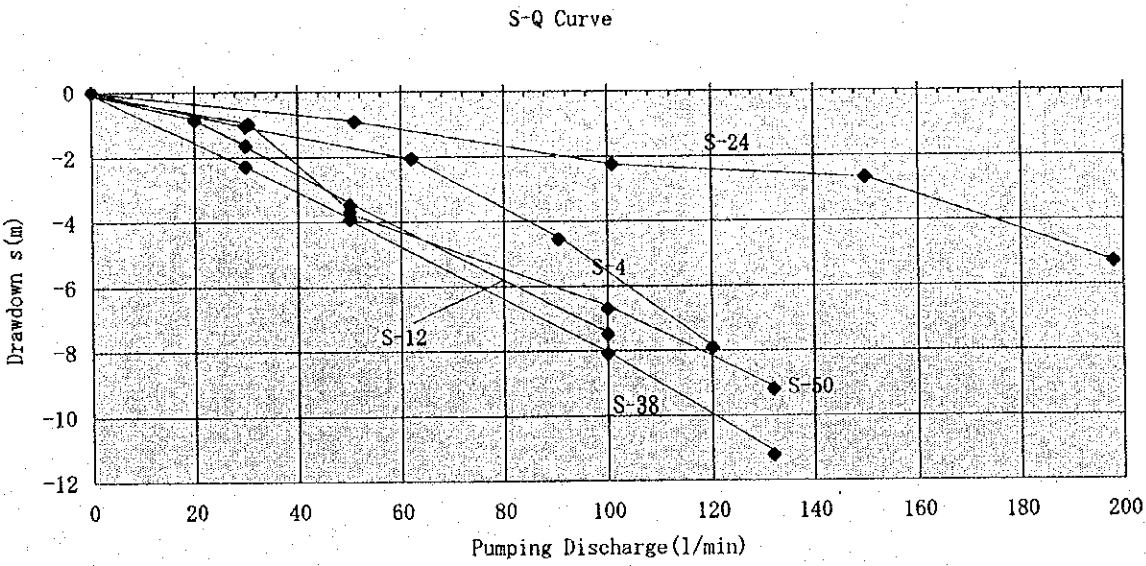


Figure 4.3.5 (1/2)	S-Q Curve
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.



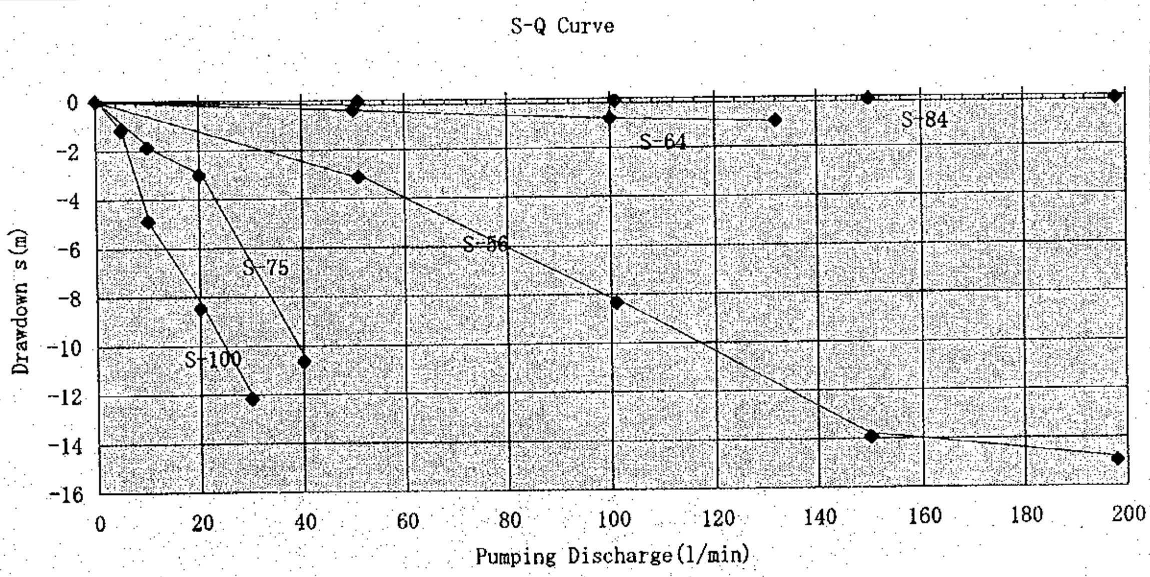
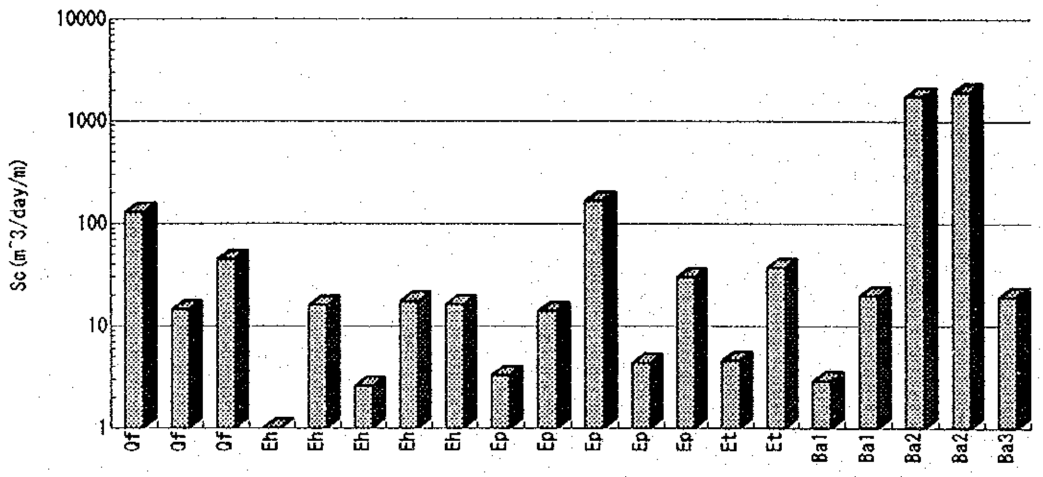


Figure 4.3.5 (2/2)	S-Q Curve
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO.,LTD. CONSTRUCTION PROJECT CONSULTANTS,INC.

Geo. Type-Specific Capacity (Sc)



Qf	Flood Plain
Eh	Erosinal hill
Ep	Erosional plain
Et	Erosional Terrace
Ba1	Basalt slope 1
Ba2	Basalt slope 2
Ba3	Basalt slope 3

QsJsh	Q Sand. Jura. SandyShale.
QsJs	Q Sand. Jura. Sandstone.
Js	Jura. Sandstone.
JCs	Jura-Creta. Sandstone.
Jsg	Jura. Sandstone. Conglo.
Jsh	Jura. Sandy Shale.
Tt	Triassic Asidic Tuff.
Psl	Paleozoic Slate.
Balm	N-Q Basalt, Loam.
Ba	N-Q Basalt Lava.
BaJs	N-Q Basalt, Jura. Sandstone.

Aquifer-Specific Capacity (Sc)

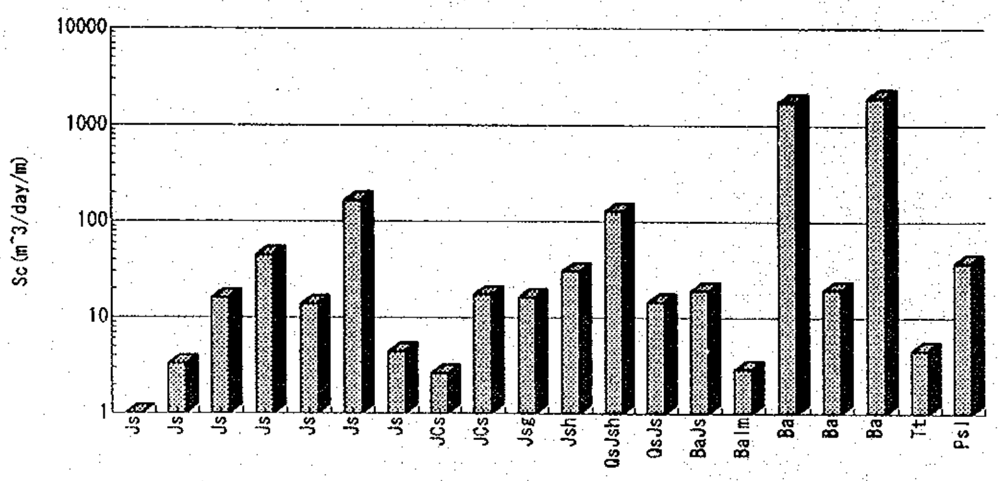


Figure 4.3.6	Specific Capacities of Aquifers
THE STUDY ON GROUNDWATER DEVELOPMENT FOR CHAMPASAK AND SARAVAN PROVINCES, LAO PEOPLE'S DEMOCRATIC REPUBLIC	
JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	KOKUSAI KOGYO CO., LTD. CONSTRUCTION PROJECT CONSULTANTS, INC.

SUPPORTING REPORT

CHAPTER 5 DATABASE

CONTENTS

LIST OF TABLES

5. DATABASE

On the occasion of establishing database system, careful consideration should be given to:

1) why a computerized database system is necessary
2) how the database system is maintained and operated

In the case that numbers of wells exceed several hundreds in a well inventory, sorting capacity of personnel is not enough in comparison with computers. In general, computers exceed personnel regarding data processing and data storage capacity in many fields, e.g. hydrology, meteorology, economy. Therefore, the computerized database system is indispensable for data processing and data storage. A computerized database is effective and helpful for handling much data. A well-organized database system is indispensable for carrying out this study and will also be effective for utilizing the data in future studies.

The database system should be accurate as far as possible and be updated at any time. Continuous efforts to correct and update various data are indispensable for good maintenance of the database system. A database manager should be appointed and necessary fund should be secured for maintenance of the database system. Otherwise, the database will be soon outdated.

Expected users of the database will be:

1) Staff of the Water Supply Section of the NIHE
2) Provincial and district water engineers
3) Groundwater hydrologists of Ministries and foreign corporation agencies
3) Planning and design engineers of Ministries and foreign corporation agencies

All of them are considered to have some knowledge on computers and software applications, e.g. Lotus 1-2-3, EXCEL.

5.1. Database Structure

The database system should handle and process the following information;

1) Meteorological data
2) Hydrological data
3) Well inventory

4) Village inventory

5.1.1 Hardware Requirement

The database system runs on IBM PC/AT 4860DX2 with the following configuration

1) A memory size of 12 megabytes(MB)
2) One 3.5" floppy disk drive
3) A hard disk of 340 megabytes(MB)
4) A co-processor
5) With DOS 6.0
6) With Windows 3.1
7) With a printer

5.1.2 Software Requirement

The system should be designed to be user-friendly and be developed specially to hide the complexity of its database's internal structures and procedures. Therefore, the most famous spreadsheet software with database function is utilized, Lotus 1-2-3 or EXCEL.

5.1.3 Subsystems

(1) Meteorology subsystem
The meteorology subsystem stores the monthly climatological data (temperature, humidity, evaporation, wind, and precipitation) and the daily rainfall data as follows:

a) Temperature
- Mean temperature
- Mean maximum temperature
- Mean minimum temperature
- Extreme high temperature
- Extreme low temperature

b) Relative humidity
- Mean relative humidity
- Extreme high relative humidity
- Extreme low relative humidity

c) Dew point
d) Evaporation
e) Wind
  - Direction
  - Mean speed
  - Extreme high speed
f) Monthly precipitation
  - Total
  - Rainy days
  - 24 hours' maximum
g) Annual precipitation
h) Daily precipitation

The directories and files of the meteorological subsystem and the file description are shown in Table 5.1. The data file structures and coding instruction of the climatology subsystem are presented in Tables 5.2 to 5.5.

(2) Hydrology subsystem

The hydrology subsystem contains the monthly and daily gauge heights and river discharge at the existing hydrological gauging stations. At the same time, the hydrology subsystem includes data of gauge heights and river discharge that will be observed in this study.

a) Gauge height
b) Discharge

The directories and files of the hydrological subsystem and the file description are shown in Table 5.6. The data file structures and coding instruction of the hydrology subsystem are presented in Tables 5.7 to 5.9.

(3) Well inventory subsystem

Well inventory subsystem should store data of both public and private wells. Abandoned and inactive wells are also included in the well inventory subsystem. The well inventory subsystem contains data of groundwater leveling which will be observed in this study.

a) Well inventory
b) Groundwater leveling

The directories and files of the well inventory subsystem and the file description are shown in Table 5.10. The data file structures and coding instruction of the well inventory subsystem are presented in Tables 5.11 and 5.12.

(4) Water quality subsystem

The water quality subsystem should store data of both groundwater and river water. The water quality subsystem contains water quality data which were sampled and analyzed in the Study.

a) Sampled well(village)
b) Sampled and reported dates
c) Non-biological chemistry
d) Biological chemistry

The directories and files of the water quality subsystem and the file description are shown in Table 5.13. The data file structures and coding instruction of the water quality subsystem are presented in Table 5.14.

(5) Village inventory subsystem

The village inventory subsystem should store data of both water supply and sanitary condition. The village inventory data were based on the village survey for 200 villages in Champasak and Salavan Provinces that was carried out in the Study.

a) Village name and location
b) Topography and geology
c) Transportation
d) Population
e) Sanitary condition
f) Health condition
g) Main agricultural products
h) Main water sources

The directories and files of the village inventory subsystem and the file description are shown in Table 5.15. The data file structures and coding instruction of the village inventory subsystem are presented in Table 5.16.

5.2 Operation Manual

5.2.1 Introduction

This operation manual describes " Groundwater database " and operation and maintenance of the groundwater database.

On the occasion of establishing database system, careful consideration should be given to:

1) why a computerized database system is necessary
2) how the database system is maintained and operated

(1) Necessity of the computerized database system
In the case that numbers of wells exceed several hundreds in a well inventory, sorting capacity of personnel is not enough in comparison with computers. In general, computers exceed personnel regarding data processing and data storage capacity in many fields, e.g. hydrology, meteorology, economy. Therefore, the computerized database system is indispensable for data processing and data storage. A computerized database is effective and helpful for handling much data. A well-organized database system is indispensable for carrying out this study and will also be effective for utilizing the data in future studies.

(2) Operation and maintenance of the database system
The following operation will be required:

1) Sorting out of the present wells and new wells
2) Judgment of whether new wells are permissible or not

The database system should be accurate as far as possible and be updated at any time. Continuous efforts to correct and update various data are indispensable for good maintenance of the database system. A database manager should be appointed and necessary fund should be secured for maintenance of the database system. Otherwise, the database will be soon outdated.

Expected users of the database will be:

1) Staff of the Water Supply Section of the NIHE
2) Provincial and district water engineers
3) Groundwater hydrologists of Ministries and foreign corporation agencies

3) Planning and design engineers of Ministries and foreign corporation agencies

All of them are considered to have some knowledge on computers and software applications, e.g. Lotus 1-2-3, EXCEL.

5.2.2. Database System

The database system should handle and process the following information;

1) Meteorological data
2) Hydrological data
3) Well inventory
4) Village inventory

(1) Hardware requirement

The database system runs on IBM PC/AT 4860DX2 with the following configuration:

1) A memory size of 12 megabytes(MB)
2) One 3.5" floppy disk drive
3) A hard disk of 340 megabytes(MB)
4) A co-processor
5) With DOS 6.0
6) With Windows 3.1
7) With a printer

(2) Software requirement

The system should be designed to be user-friendly and be developed specially to hide the complexity of its database's internal structures and procedures. Therefore, the most famous spreadsheet software with database function is utilized, Lotus 1-2-3 or EXCEL.

(3) Subsystems

1) Meteorology subsystem

The meteorology subsystem stores the monthly climatological data (temperature, humidity, evaporation, wind, and precipitation) and the daily rainfall data as follows:

a) Temperature
- Mean temperature

- Mean maximum temperature
- Mean minimum temperature
- Extreme high temperature
- Extreme low temperature

b) Relative humidity
- Mean relative humidity
- Extreme high relative humidity
- Extreme low relative humidity

c) Dew point

d) Evaporation

e) Wind
- Direction
- Mean speed
- Extreme high speed

f) Monthly precipitation
- Total
- Rainy days
- 24 hours' maximum

g) Annual precipitation

h) Daily precipitation

The directories and files of the meteorological subsystem and the data description are shown in Table 5.1. The data file structures and coding instruction for the climatology subsystem are presented in Tables 5.2 to 5.5.

2) Hydrology subsystem

The hydrology subsystem contains the monthly and daily gauge heights and river discharge at the existing hydrological gauging stations. At the same time, the hydrology subsystem includes data of gauge heights and river discharge that will be observed in this study.

a) Gauge height

b) Discharge

The directories and files of the hydrological subsystem and the data description are shown in Table 5.6. The data file structures and coding instruction for the hydrology subsystem are presented in Tables 5.7 to 5.9.

3) Well inventory subsystem

Well inventory subsystem should store data of both public and private wells. Abandoned and inactive wells are also included in the well inventory subsystem. The well inventory subsystem contains data of groundwater leveling which will be observed in this study.

a) Well inventory
b) Groundwater leveling

The directories and files of the well inventory subsystem and the data description are shown in Table 5.10. The data file structures and coding instruction for the well inventory subsystem are presented in Tables 5.11 and 5.12.

4) Water quality subsystem

The water quality subsystem should store data of both groundwater and river water. The water quality subsystem contains water quality data that were sampled and analyzed in the Study.

a) Sampled well(village)
b) Sampled and reported dates
c) Non-biological chemistry
d) Biological chemistry

The directories and files of the water quality subsystem and the data description are shown in Table 5.13. The data file structures and coding instruction for the water quality subsystem are presented in Table 5.14.

5) Village inventory subsystem

The village inventory subsystem should store data of both water supply and sanitary condition. The village inventory data were based on the village survey for 200 villages in Champasak and Salavan Provinces that was carried out in the Phase I of the Study.

a) Village name and location
b) Topography and geology
c) Transportation
d) Population
e) Sanitary condition
f) Health condition
g) Main agricultural products