ANNEXES FOR FEASIBILITY STUDY

ANNEX F-10
HYDROLOGICAL INVESTIGATION RESULTS

ANNEX F-10 HYDROLOGICAL INVESTIGATION RESULTS

(1) Max. & Min. of Water Level at Pakse (m)

Month / Year	Gage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	Max	1.47	1.03	0.79	1.08	1.32	5.77	8.96	12.66	13.25	7.82	4.91	2.44
	Min	1.04	0.78	0.68	0.64	0.73	1.19	4.59	7.09	7.52	5.02	2.45	1.45
1992	Max	1.56	1.13	1.06	0.98	1.05	4.68	7.78	8.76	7.87	5.87	3.87	1.91
	Min	1.10	0.82	0.61	0.61	0.77	1.04	2.78	6.35	5.77	2.92	1.69	1.14
1993	Max	1.38	0.80	0.74	0.76	2.43	3.67	9.66	9.08	9.03	5.73	3.28	1.80
	Min	0.81	0.66	0.55	0.45	0.66	1.55	3.86	6.15	5.92	3.15	1.85	1.23
1994	Max	1.22	0.98	0.76	1.09	1.92	7.58	10.48	11.41	11.60	8.06	3.90	2.06
	Min	0.89	0.64	0.63	0.71	0.69	1.91	6.59	9.45	8.35	3.63	1.95	1.55
1995	Max	1.68	1.02	0.89	0.96	1.89	4.60	9.08	11.00	12.39	7.43	4.88	2.58
	Min	1.02	0.86	0.65	0.47	0.53	1.50	3.88	9.00	7.52	4.54	2.58	1.53
1996	Max	1.54	1.06	1.01	1.20	2.22	4.36	9.10	10.50	13.01	12.45	5.46	3.48
	Min	1.02	0.94	0.74	0.74	0.93	1.76	3.28	8.33	7.00	4.92	3.54	1.80
1997	Max	1.40	1.03	0.80	1.01	1.74	2.94	7.18	7.38	9.36	5.10	2.60	1.93
	Min	1.02	0.78	0.59	0.58	0.90	1.75	3.12	4.82	5.06	2.47	1.78	0.98
1998	Max	1.80	1.27	0.97	1.36	2.02	4.54	11.04	12.36	11.09	7.36	3.56	2.18
	Min	1.24	0.88	0.80	0.86	1.08	1.60	4.78	8.76	6.32	3.64	2.02	1.39
1999	Max	1.06	1.00	0.60	1.05	4.75	6.18	10.04	9.99	10.25	8.84	6.17	2.96
	Min	0.78	0.57	0.45	0.50	0.74	4.46	4.82	7.56	7.92	4.28	3.00	1.72
2000	Max	1.73	1.22	1.26	1.40	6.72	8.68	11.76	10.42	13.34	8.38	4.91	2.48
	Min	1.08	0.95	0.86	0.81	1.41	4.31	7.09	8.47	8.52	4.63	2.56	1.68

(2) Monthly Temperature at Pakse (℃)

Month / Year	January		February		March		April		May		June	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1991	35.2	16.3	36.5	15.8	31.8	22.2	39.0	19.5	38.5	22.3	35.6	20.0
1992	33.6	12.1	34.5	16.9	37.8	20.1	38.9	23.5	38.6	22.8	33.5	23.1
1993	34.2	12.0	35.2	14.1	38.0	18.8	37.5	20.7	37.8	22.3	35.2	23.1
1994	35.2	13.0	36.8	19.1	37.1	18.2	38.0	23.7	39.1	22.8	32.7	23.2
1995	34.4	12.1	35.2	13.7	37.6	18.0	39.3	24.4	38.0	22.2	34.4	22.5
1996	35.2	12.5	36.6	15.0	38.7	16.3	39.3	20.4	33.2	22.6	33.8	23.4
1997	33.4	13.7	34.5	17.6	36.5	17.6	36.5	21.4	36.8	23.3	35.0	22.7
1998	35.5	18.5	37.0	18.4	38.8	24.8	41.3	23.8	38.5	23.7	35.8	23.4
1999	36.0	15.9	37.3	15.8	37.2	22.1	36.7	21.8	35.6	23.0	34.4	22.8
2000	36.0	14.5	37.7	14.1	37.4	18.8	38.0	22.9	35.0	21.9	34.0	23.5
Max.Min	36.0	12.0	37.7	13.7	38.8	16.3	41.3	19.5	39.1	21.9	35.8	20.0
Ave	34.9	14.1	36.1	16.1	37.1	19.7	38.5	22.2	37.1	22.7	34.4	22.8

Month / Year	July		August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1991	33.5	23.0	32.5	23.0	32.8	22.4	32.8	17.0	33.5	16.3	33.4	16.1
1992	33.7	21.8	32.7	22.1	33.0	22.0	32.0	19.6	33.1	16.1	30.1	14.8
1993	33.7	23.0	33.0	22.2	32.8	22.0	33.5	20.0	33.8	17.2	34.5	14.2
1994	32.2	23.1	33.4	22.4	32.4	24.8	33.0	16.0	34.7	17.7	34.4	16.4
1995	32.5	23.1	34.2	22.6	33.0	23.1	33.3	21.2	32.7	16.2	34.1	16.4
1996	33.4	23.0	33.0	22.3	32.5	23.0	33.4	21.2	33.0	18.7	32.2	15.3
1997	32.4	21.7	33.0	22.5	34.4	21.3	35.0	20.0	35.3	18.5	35.6	18.3
1998	34.9	26.0	34.4	22.5	32.7	23.4	34.2	20.0	34.6	19.5	34.0	17.7
1999	33.9	23.5	33.3	23.1	32.8	22.5	34.0	18.6	34.0	19.0	32.9	9.7
2000	34.6	23.1	34.7	23.0	34.2	21.3	33.8	20.4	34.7	16.2	34.5	16.0
Max.Min	34.9	21.7	34.7	22.1	34.4	21.3	35.0	16.0	35.3	16.1	35.6	9.7
Ave	33.5	23.1	33.4	22.6	33.1	22.6	33.5	19.4	33.9	17.5	33.6	15.5

(3) Monthly Precipitation at Pakse (mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1991	NT	NT	0.7	14.9	61.1	295.8	340.2	558.7	335.7	148.6	8.7	0.5	1764.9
1992	16.6	10.1	NT	21.0	66.5	189.8	257.4	644.8	294.2	64.8	1.0	3.1	1542.6
1993	NT	NT	33.4	46.9	147.5	147.5	18.0	335.5	380.4	91.3	6.7	2.7	1209.9
1994	0.0	0.0	13.4	22.0	253.7	359.6	516.1	538.4	769.3	151.3	23.6	9.4	2656.8
1995	0.0	0.1	33.0	17.5	158.5	320.6	646.3	160.1	210.0	92.8	35.0	0.6	1674.4
1996	0.0	0.2	22.7	212.4	349.9	211.3	328.5	308.8	583.4	69.7	100.0	0.0	2186.7
1997	5.1	78.9	9.4	89.1	199.3	475.8	699.9	655.7	272.6	108.4	10.2	0.0	2520.4
1998	0.0	87.8	0.4	37.3	278.1	150.2	181.3	468.0	409.7	50.8	62.0	7.9	1645.7
1999	0.0	0.0	62.3	137.9	402.5	486.4	592.3	374.9	189.7	111.2	89.2	0.1	2446.5
2000	0.3	7.0	11.9	121.1	533.5	286.9	725.7	507.8	232.5	165.8	5.1	0.8	2591.1
Max	16.6	87.8	62.3	212.4	533.5	486.4	725.7	655.7	769.3	165.8	100.0	9.4	2656.8
Min	0.0	0.0	0.4	14.9	61.1	147.5	18.0	160.1	189.7	50.8	1.0	0.0	1209.9
Ave	2.2	18.4	18.7	72.0	245.1	292.4	430.6	455.3	367.8	105.5	34.2	2.5	2023.9

(4) Number of Rainy Day at Pakse (day)

Month / Year	January		February		March		April		May		June	
	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<
1991	1	0	0	0	1	0	3	2	8	7	19	6
1992	2	2	1	1	0	0	3	2	9	9	21	3
1993	0	0	0	0	5	2	6	5	22	6	10	10
1994	0	0	0	0	5	2	3	2	14	5	19	5
1995	0	0	1	0	3	2	5	3	14	4	22	5
1996	0	0	1	0	2	2	7	6	21	5	15	9
1997	1	0	3	2	2	1	7	6	10	8	16	6
1998	0	0	5	1	1	0	4	3	15	5	11	4
1999	0	0	0	0	2	2	8	6	14	12	21	4
2000	3	0	2	0	2	1	13	6	22	5	16	11
Ave	0.7	0.2	1.3	0.4	2.3	1.2	5.9	4.1	14.9	6.6	17.0	6.3

Month / Year	July		August		September		October		November		December	
	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<
1991	18	8	22	6	17	7	14	7	2	1	1	0
1992	17	5	29	0	17	6	10	7	2	0	1	1
1993	16	9	21	7	19	4	7	6	3	1	2	0
1994	25	3	22	4	18	10	7	4	2	0	3	1
1995	23	6	16	6	13	8	9	4	3	2	2	0
1996	19	5	16	9	20	8	8	7	6	3	0	0
1997	23	5	21	8	16	3	7	5	1	0	1	0
1998	15	3	16	7	22	2	8	6	7	6	2	1
1999	22	8	17	6	17	7	11	8	6	5	2	0
2000	22	4	20	3	16	7	10	9	3	1	2	0
Ave	20.0	5.6	20.0	5.6	17.5	6.2	9.1	6.3	3.5	1.9	1.6	0.3

(5) Monthly Humidity at Pakse (%)

Month / Year	January		February		March		April		May		June	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1991	93	26	91	23	83	22	96	38	97	43	98	50
1992	95	25	86	30	87	27	87	22	92	35	95	55
1993	97	25	85	19	85	28	96	34	95	38	95	47
1994	90	25	86	27	89	22	92	32	96	32	97	58
1995	90	28	81	24	86	28	70	40	96	32	96	52
1996	90	26	83	21	89	14	96	23	97	55	97	52
1997	89	52	96	28	89	20	96	34	96	43	97	50
1998	90	26	96	30	82	21	94	28	98	34	96	51
1999	89	28	83	19	98	27	95	35	98	43	98	56
2000	96	25	95	24	85	28	95	31	97	51	88	64
Max.Min	97	25	96	19	98	14	96	22	98	32	98	47
Ave	91.9	28.6	88.2	24.5	87.3	23.7	91.7	31.7	96.2	40.6	95.7	53.5

Month / Year	July		August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1991	98	61	97	57	96	57	98	32	100	37	97	30
1992	97	53	97	61	97	58	95	49	93	34	91	34
1993	96	52	97	58	96	49	95	42	89	36	90	30
1994	96	60	98	52	98	58	95	38	94	34	94	23
1995	96	51	97	53	96	57	97	42	95	43	94	23
1996	97	50	98	58	97	55	95	45	98	47	95	31
1997	98	57	97	56	97	39	98	47	93	37	90	28
1998	98	54	97	53	99	57	97	33	97	38	91	29
1999	97	54	97	55	97	54	97	48	96	42	92	29
2000	99	50	97	56	98	43	97	51	96	36	95	35
Max.Min	99	50	98	52	99	39	98	32	100	34	97	23
Ave	97.2	54.2	97.2	55.9	97.1	52.7	96.4	42.7	95.1	38.4	92.9	29.2

(6) Monthly Max. Wind Velocity at Pakse (m/s)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	4	7	6	6	12	8	10	6	5	8	8	6
1992	7	12	8	10	8	20	12	10	6	10	8	8
1993	6	6	14	6	8	8	8	8	6	6	8	8
1994	4	8	10	7	6	8	15	8	6	12	8	8
1995	4	4	4	6	3	3	4	4	2	4	3	4
1996	4	6	4	5	4	2	3	3	15	3	3	3
1997												
1998												
1999												
2000												
Max	7	12	14	10	12	20	15	10	15	12	8	8
Min	4	4	4	5	3	2	3	3	2	3	3	3
Ave	4.8	7.2	7.7	6.7	6.8	8.2	8.7	6.5	6.7	7.2	6.3	6.2

(7) Temperature at Paksong (℃)

Month / Year	January		February		March		April		May		June	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1991	26.7	7.6	27.2	9	29.1	12.5	28.4	10.5	27.8	12.5	27	11
1992	26	4.5	26.7	9	28.5	11.5	29.5	14.8	28.8	13.8	26.6	16
1993	26	3.6	26.8	5.6	28.5	10.2	28	13.5	28.3	15	27.5	15
1994	27.1	4.3	28.4	8.5	28.4	9.9	27.8	14.4	28.5	15	24.5	12.3
1995	26	2.3	26.8	5.5	29.5	10.9	28.4	14.6	27.6	15.7	27	16.8
1996	25.6	3.8	27.9	6.9	29	6.6	28.8	12.5	26.7	12.6	27.9	14.7
1997	25.5	4	27.3	9	27.5	6.6	26.7	12.5	27	14.5	27.2	13.5
1998	27.2	7.7	29.4	10.4	29.5	13.5	29.5	14.2	29	15.6	26.9	16.3
1999	27	4.5	28.5	5	27.8	10.4	27.5	11.9	26.6	14.6	26.2	15
2000	27.5	8	27.7	6	28	11.6	28	13.6	27.4	13.3	26.5	15.5
Max;Min	27.5	2.3	29.4	5.0	29.5	6.6	29.5	10.5	29.0	12.5	27.9	11.0
Ave	26.5	5.0	27.7	7.5	28.6	10.4	28.3	13.3	27.8	14.3	26.7	14.6

Month / Year	July		August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1991	26	12	25.1	12	26.1	14.5	26.2	8.1	26.6	8	25.7	9.2
1992	25.4	14	26.5	16	26.2	15	25.7	12	26	5	27.7	6
1993	26.5	15	25	15.3	26.2	14.3	26.5	11.9	27.9	7.8	26.3	5.5
1994	26.1	15.8	25.4	15.3	26.6	14.4	27	8.9	26.8	9.8	26.5	7.3
1995	26	15.6	26.8	15.5	26.5	14.1	26	11.7	26.5	9.9	25.8	3.6
1996	26.5	14.8	25.9	15.5	26.3	14.9	26	13	27	10.5	26.8	5
1997	25.3	16	25	15.5	26.2	14.2	27	13.2	27.4	11.1	28	8.5
1998	27.5	15.5	27.5	14.8	26.5	15.5	28	9	27.5	8.5	26.9	9.1
1999	25.7	15.3	26	14.9	26	13.4	27	12.5	27.8	8.4	25.7	8
2000	27.4	15	26.9	14.5	26.7	13	26.5	11	27	5.8	26.1	4.6
Max;Min	27.5	12.0	27.5	12.0	26.7	13.0	28.0	8.1	27.9	5.0	28.0	3.6
Ave	26.2	14.9	26.0	14.9	26.3	14.3	26.6	11.1	27.1	8.5	26.6	6.7

(8) Temperature at Sekong (℃)

Month / Year	January		February		March		April		May		June	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1994	31	17.7	32.5	15.5	32.5	16.6	33.5	19.8	33.5	23.5	33.8	22.3
1995	36.5	8	37.5	10	40	17	40	21.6	39.8	21.8	36	23
1996	35.5	7.8	38	12	39	11	39.5	18.5	38	22.5	35	21.5
1997	35.2	9	35.7	12.5	38	13	38.5	16.5	36.5	21.5	38	22
1998	37	13	38	15.4	40.6	18	41.2	21	40.9	22.5	40	23
1999	36.5	11.2	39.2	10.1	40	16.5	38.9	20.5	35.5	22.9	35	21.9
2000	35.5	10.5	39	10.2	39.5	18	39	18	36.5	22	35	23.2
2001	37.5	13	38	11.5	38.6	17	39.5	21	38.7	22	36	22.5
Max;Min	37.5	7.8	39.2	10	40.6	11	41.2	16.5	40.9	21.5	40	21.5
Ave	35.6	11.3	37.2	12.2	38.5	15.9	38.8	19.6	37.4	22.3	36.1	22.4

Month / Year	July		August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1994	34	23.7	35	22	35.5	20.5	34	13.5	35.5	13.5	35.4	13
1995	34.2	22.5	35.5	22	25.5	22	35.5	17.5	33.5	12.5	35	8.5
1996	35.4	21.6	35.5	22	34.8	22.1	34.5	19	33.4	17.6	33.2	10
1997	33.4	23.3	32.6	23	34.9	21	35.9	20	36.3	15.9	36	13.4
1998	36.3	21.8	35.3	22	35	21	35.2	16	34.5	16	35.7	14
1999	34	22.5	34.6	21	34.7	19	34.5	14	33.5	14	33.5	5.5
2000	30.1	23.4	35.5	21	34.5	18.5	35.5	18.6	35	12	35.5	11.5
2001	34	22	35.5	22.5	35.8	21.5	39.5	18.5	35.6	12.5	35.5	10
Max;Min	36.3	21.6	35.5	21	35.8	18.5	39.5	13.5	36.3	12	36	5.5
Ave	33.9	22.6	34.9	21.9	33.8	20.7	35.6	17.1	34.7	14.3	35.0	10.7

(9) Monthly Precipitation at Paksong (mm)

Month / Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1991	21.40	0.30	69.5	294.0	264.0	551.1	958.6	1318.7	488.2	153.7	0.2	8.4	4106.4
1992	45.00	11.80	41.0	130.2	211.2	866.7	566.6	836.8	373.3	125.3	9.6	23.8	3184.5
1993	0.00	4.10	40.2	154.6	335.5	251.0	522.5	758.4	392.4	57.9	80.2	8.9	2601.6
1994	0.60	48.40	318.2	292.1	374.7	500.9	1213.8	594.9	606.2	181.8	53.7	67.2	4203.5
1995	1.70	34.70	145.5	183.1	291.3	289.9	690.8	464.8	268.5	179.6	20.1	54.9	2588.5
1996	3.80	74.40	89.8	165.0	367.5	314.2	809.2	673.3	1153.6	163.2	170.1	0.0	3905.9
1997	4.20	79.20	108.1	319.8	248.0	499.1	1084.8	889.6	316.6	130.6	58.4	34.8	3689.8
1998	0.40	71.50	167.8	166.6	347.0	186.4	229.3	378.2	258.2	206.9	58.6	59.5	2058.5
1999	50.40	0.30	159.6	265.7	410.5	389.0	1499.8	783.3	461.0	262.0	97.1	0.0	4328.0
2000	15.10	145.90	76.6	289.7	293.1	314.7	1182.8	983.7	427.4	259.8	19.8	11.7	3859.3
Max	50.40	145.90	318.2	319.8	410.5	866.7	1499.8	1318.7	1153.6	262.0	170.1	67.2	6386.6
Min	0.00	0.30	40.2	130.2	211.2	186.4	229.3	378.2	258.2	57.9	0.2	0.0	1491.8
Ave	14.3	47.1	121.6	226.1	314.3	416.3	875.8	768.2	474.5	172.1	56.8	26.9	3452.6

(10) Monthly Precipitation at Sekong (mm)

Month / Yea	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1989	2.00	3.90	37.4	137.4	161.3	137.8	388.9	409.3	261.7	154.6	9.0	4.4	**1707.7**
1990	6.70	9.60	18.2	152.0	240.7	296.1	291.2	334.0	391.4	361.5	37.5	7.3	**2146.2**
1991	6.80	13.60	36.0	59.0	167.6	138.5	288.1	320.9	133.3	271.6	29.8	11.3	**1476.5**
1992	4.50	5.00	13.3	132.0	138.7	133.6	173.9	268.6	280.1	126.0	14.4	9.2	**1299.3**
1993	1.80	0.00	0.0	102.0	144.0	314.0	191.0	364.0	384.0	37.8	15.8	0.0	**1554.4**
1994	0.00	0.00	55.2	56.7	187.0	133.0	145.0	187.0	294.0	27.6	1.8	10.5	**1097.8**
1995	0.00	0.50	11.4	85.6	340.3	235.0	364.7	159.7	130.3	110.3	9.7	10.1	**1457.6**
1996	0.00	0.20	29.4	123.0	167.2	176.9	200.3	130.1	501.3	170.4	100.1	0.4	**1599.3**
1997	1.00	23.70	19.5	147.0	117.2	217.4	395.2	304.6	242.5	92.6	0.0	18.0	**1578.7**
1998	0.00	34.60	3.2	32.9	203.4	100.6	261.6	208.6	317.7	92.3	76.2	10.7	**1341.8**
1999	0.00	0.00	68.9	105.1	205.4	83.3	505.0	284.6	133.3	134.7	52.5	0.6	**1573.4**
2000	1.40	35.80	18.8	72.1	246.1	147.0	478.5	308.1	217.9	131.1	6.3	0.3	**1663.4**
2001	0.00	31.00	212.5	16.6	220.1	237.0	209.0	314.7	176.8	57.0	10.3	9.1	**1494.1**
Maximum	6.80	35.80	212.5	152.0	340.3	314.0	505.0	409.3	501.3	361.5	100.1	18.0	**2956.6**
Minimum	0.00	0.00	0.0	16.6	117.2	83.3	145.0	130.1	130.3	27.6	0.0	0.0	**650.1**
Average	1.9	12.1	40.3	94.0	195.3	180.8	299.4	276.5	266.5	136.0	28.0	7.1	**1537.7**

(11) Number of Rainy at Paksong (day)

Month / Year	January		February		March		April		May		June	
	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<
1991	0	1	1	0	12	0	10	2	13	7	14	13
1992	6	0	4	0	10	0	5	3	19	2	18	10
1993	0	0	2	0	8	0	11	2	15	6	12	5
1994	1	0	4	1	10	5	14	5	14	7	14	13
1995	1	0	2	1	6	2	14	3	15	4	16	7
1996	2	0	1	2	3	3	12	3	18	6	16	5
1997	1	0	9	0	6	2	14	6	12	4	7	10
1998	1	0	6	1	8	1	9	2	18	5	17	3
1999	7	0	2	0	13	1	10	5	21	6	18	8
2000	6	0	6	2	6	1	15	6	22	4	17	8
Max	7	1	9	2	13	5	15	6	22	7	18	13
Min	0	0	1	0	3	0	5	2	12	2	7	3
Ave	2.5	0.1	3.7	0.7	8.2	1.5	11.4	3.7	16.7	5.1	14.9	8.2

Month / Year	July		August		September		October		November		December	
	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<
1991	14	12	17	13	14	9	14	2	1	0	2	0
1992	17	8	15	12	18	6	13	2	4	0	4	0
1993	15	10	15	15	13	8	10	1	6	1	4	0
1994	19	19	18	16	16	9	13	2	2	2	4	1
1995	15	10	13	11	21	4	11	3	5	0	4	1
1996	16	11	14	11	14	13	14	1	6	4	0	0
1997	17	13	19	10	13	6	11	3	6	1	3	0
1998	21	2	16	8	13	7	11	4	8	1	4	1
1999	15	13	13	12	18	7	12	6	10	1	0	0
2000	18	10	13	12	17	7	17	3	6	0	3	0
Max	21	19	19	16	21	13	17	6	10	4	4	1
Min	14	2	13	8	13	4	10	1	1	0	0	0
Ave	16.7	10.8	15.3	12.0	15.7	7.6	12.6	2.7	5.4	1.0	2.8	0.3

(12) Number of Rainy at Sekong (day)

Month / Yea	January		February		March		April		May		June	
	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<
1991	7	0	4	0	5	0	9	0	15	0	22	0
1992	3	0	4	0	10	0	15	0	19	0	19	0
1993	5	0	0	0	0	0	7	0	12	0	29	1
1994	0	0	0	0	9	0	6	0	24	0	17	0
1995	0	0	2	0	4	0	12	1	14	4	18	5
1996	0	0	1	0	2	1	14	2	19	2	18	2
1997	1	0	5	0	4	0	12	3	18	1	19	3
1998	0	0	3	1	2	0	8	0	16	3	17	1
1999	0	0	0	0	2	1	8	2	18	3	20	0
2000	1	0	0	1	2	0	13	1	16	4	16	2
2001	0	0	4	0	4	3	3	0	10	4	22	2
Max	7	0	5	1	10	3	15	3	24	4	29	5
Min	0	0	0	0	0	0	3	0	10	0	16	0
Ave	1.5	0.0	2.1	0.2	4.0	0.5	9.7	0.8	16.5	1.9	19.7	1.5

Month / Yea	July		August		September		October		November		December	
	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<	mm 0<	mm 20<
1991	27	0	28	0	12	0	26	0	5	0	3	0
1992	20	0	22	1	25	0	13	0	4	0	6	0
1993	24	0	27	3	25	4	5	0	3	0	0	0
1994	18	0	15	4	22	5	11	0	2	0	7	0
1995	21	5	20	2	22	1	24	1	9	0	3	0
1996	20	3	20	1	18	7	14	2	16	1	1	0
1997	21	7	22	6	18	3	4	2	0	0	1	0
1998	13	5	15	3	14	7	13	2	10	1	2	0
1999	20	5	17	4	19	1	13	2	8	0	1	0
2000	19	7	14	4	13	3	12	2	2	0	1	0
2001	22	3	22	5	7	3	8	0	1	0	3	0
Max	27	7	28	6	25	7	26	2	16	1	7	0
Min	13	0	14	0	7	0	4	0	0	0	0	0
Ave	20.5	3.2	20.2	3.0	17.7	3.1	13.0	1.0	5.5	0.2	2.5	0.0

(13) Max. Water Level at Pakse Station (m)

Pakse			Pakse		
Year	Height	Altitudde	Year	Height	Altitudde
1902	9.65	96.297	1951	12.47	99.117
1903	12.35	98.997	1952	11.75	98.397
1904	12.65	99.297	1953	10.98	97.627
1905	12.65	99.297	1954	11.69	98.337
1906	11.65	98.297	1955	9.55	96.197
1907	13.35	99.997	1956	12.52	99.167
1908	11.70	98.347	1957	11.03	97.677
1909	11.75	98.397	1958	11.88	98.527
1910	11.35	97.997	1959	10.75	97.397
1911	11.00	97.647	1960	13.01	99.657
1912	11.30	97.947	1961	13.35	99.997
1913	11.25	97.897	1962	10.81	97.457
1914	13.22	99.867	1963	12.08	98.727
1915	#	#	1964	12.50	99.147
1916	9.20	95.847	1965	9.94	96.587
1917	10.44	97.087	1966	12.95	99.597
1918	12.34	98.987	1967	10.61	97.257
1919	11.65	98.297	1968	12.08	98.727
1920	11.65	98.297	1969	10.90	97.547
1921	10.30	96.947	1970	12.49	99.137
1922	11.26	97.907	1971	12.10	98.747
1923	13.35	99.997	1972	11.99	98.620
1924	13.33	99.977	1973	11.64	98.270
1925	#	#	1974	12.98	99.610
1926	11.47	98.117	1975	11.83	98.460
1927	11.43	98.077	1976	10.88	97.510
1928	9.86	96.507	1977	11.10	97.730
1929	13.61	100.257	1978	14.48	101.110
1930	#	#	1979	12.13	98.760
1931	9.84	96.487	1980	12.17	98.800
1932	10.27	96.917	1981	12.99	99.620
1933	11.75	98.397	1982	10.78	97.410
1934	12.00	98.647	1983	10.80	97.430
1935	10.32	96.967	1984	12.98	99.610
1936	11.28	97.927	1985	11.16	97.790
1937	13.07	99.717	1986	9.80	96.430
1938	11.20	97.847	1987	11.90	98.530
1939	13.35	99.997	1988	9.76	96.390
1940	12.40	99.047	1989	9.61	96.240
1941	11.85	98.497	1990	11.50	98.130
1942	12.53	99.177	1991	13.26	99.890
1943	12.53	99.177	1992	8.87	95.500
1944	10.96	97.607	1993	8.68	95.310
1945	11.20	97.847	1994	11.60	98.230
1946	12.30	98.947	1995	12.43	99.060
1947	11.60	98.247	1996	13.04	99.670
1948	13.30	99.947	1997	12.36	98.990
1949	12.00	98.647	1998	9.36	95.990
1950	11.95	98.597	1999	10.25	96.880
			2000	13.36	99.990

Remark : **Altitude (1902 to 1971) 86.507+0.14+H**
Altitude (1971 to 2000) 86.490+0.15+H

(14) Max. Water Level at Phaphin & Channoy Station (m)

B.Cannoy		
Year	Height	Altitude
1965	7.71	89.48
1966	9.20	90.97
1967	7.71	89.48
1968	8.65	90.42
1969	7.85	89.62
1970	8.89	90.66
1971	8.75	90.52
1972	9.84	91.61
1973	8.36	90.13
1974	9.27	91.04
1975	#	#
1976	#	#
1977	#	#
1978	10.40	92.17
1979	8.74	90.51
1980	8.66	90.43
1981	#	#
1982	#	#
1983	#	#
1984	#	#
1985	#	#
1986	#	#
1987	#	#
1988	#	#
1989	7.18	88.95
1990	8.20	89.97
1991	9.38	91.15
1992	6.06	87.83
1993	7.19	88.96
1994	#	#
1995	#	#
1996	9.00	90.77
1997	8.72	90.49
1998	7.02	88.79
1999	7.66	89.43
2000	9.40	91.17
2001	9.18	90.95

Altitude =H+81.63+0.14

Phaphin		
Year	Height	Altitude
1965	#	#
1966	#	#
1967	#	#
1968	#	#
1969	10.36	94.64
1970	11.70	95.98
1971	11.37	95.65
1972	#	#
1973	10.96	95.24
1974	12.05	96.33
1975	10.18	94.46
1976	#	#
1977	#	#
1978	14.08	98.36
1979	11.45	95.73
1980	11.94	96.22
1981	12.02	96.30
1982	#	#
1983	#	#
1984	#	#
1985	#	#
1986	#	#
1987	#	#
1988	#	#
1989	#	#
1990	#	#
1991	#	#
1992	#	#
1993	#	#
1994	#	#
1995	#	#
1996	#	#
1997	12.97	97.25
1998	8.89	93.17
1999	9.73	94.01
2000	12.70	96.98
2001	12.03	96.31

Altitude **=H+84.28**

(15) Max. Daily Rainfall for Route 14A (mm)

Station / Year	No.14 (Phonthong)		No.20 (Soukhouma)		No.17 (Champhasack)		No.18(Phathoumphone)	
	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall	Date
1965	#	#	#	#	#	#	91.6	24-Apr
1966	#	#	#	#	#	#	10.3	24-Jul
1967	#	#	#	#	#	#	83.8	24-Aug
1968	#	#	#	#	#	#	92.6	24-Jul
1969	#	#	#	#	#	#	30.4	26-Jun
1970	#	#	#	#	#	#	83.4	01-May
1971	#	#	#	#	#	#	54.2	11-Jul
1972	#	#	#	#	#	#	#	#
1973	#	#	#	#	#	#	#	#
1974	#	#	#	#	#	#	#	#
1975	#	#	#	#	#	#	#	#
1976	#	#	#	#	#	#	#	#
1977	#	#	#	#	#	#	#	#
1978	#	#	#	#	#	#	#	#
1979	#	#	86.0	22-Jun	201.4	04-Aug	148.2	21-Jun
1980	#	#	82.6	18-Jun	81.0	20-Jul	115.4	23-Jul
1981	#	#	151.9	05-Aug	120.0	05-Aug	127.6	06-Aug
1982	#	#	140.0	26-Jun	70.0	21-May	193.0	07-Sep
1983	144.5	26-Jun	150.0	01-Sep	141.4	26-Jun	70.6	16-Aug
1984	107.8	05-Sep	122.2	24-Apr	107.7	16-Oct	170.0	01-Sep
1985	#	#	173.8	16-Jul	102.9	22-Jun	#	#
1986	#	#	173.8	16-Jul	125.4	22-May	#	#
1987	#	#	247.4	22-Aug	#	#	#	#
1988	#	#	105.7	05-Oct	#	#	#	#
1989	#	#	94.0	01-Jun	136.7	03-Aug	#	#
1990	100.0	15-Jun	90.0	29-Jul	120.0	14-Jul	119.0	20-Jun
1991	138.0	01-Jul	131.5	04-Sep	188.6	23-Jul	199.0	04-Sep
1992	99.0	13-May	93.2	28-Aug	111.5	29-Aug	105.0	14-Aug
1993	93.7	06-Sep	60.0	03-Aug	265.5	11-Jul	122.5	20-Jul
1994	172.5	05-Sep	100.0	06-May	150.0	10-Sep	124.0	05-Sep
1995	97.3	28-Sep	101.4	01-Jul	103.5	31-Jul	131.0	01-Jul
1996	85.7	14-Sep	109.5	18-Aug	207.2	17-Sep	217.0	16-Sep
1997	92.8	26-Jun	132.0	25-Jun	209.0	28-Jul	218.7	28-Jul
1998	188.0	19-Sep	75.0	19-Aug	100.0	21-Aug	85.3	29-May
1999	103.1	26-Jun	98.0	02-Jul	166.0	26-Jul	171.0	23-Jul
2000	109.1	10-May	148.0	22-Aug	200.5	16-Jul	180.0	16-Jul
2001	125.0	17-Aug	91.1	17-Aug	113.4	06-Jun	113.8	07-Jul

(16) Max. Daily Rainfall for Route 16A (mm)

Statio / Year	No.5 (Paksong)		No.7 (Nikom 34)		No.4 (Km 42)	
	Rainfall	Date	Rainfall	Date	Rainfall	Date
1977	#	#	#	#	191.2	21-Aug
1978	#	#	#	#	270.0	10-Aug
1979	#	#	#	#	159.2	23-Sep
1980	#	#	#	#	198.6	26-Aug
1981	#	#	#	#	149.2	09-Aug
1982	#	#	#	#	183.8	07-Sep
1983	#	#	#	#	533.5	26-Jun
1984	#	#	95.6	06-Sep	237.7	17-Aug
1985	#	#	110.9	10-Aug	255.9	18-Jun
1986	#	#	102.2	13-Aug	167.4	12-Aug
1987	242.2	21-Aug	132.0	21-Aug	350.3	21-Aug
1988	86.6	31-Jul	#	#	108.3	01-Aug
1989	194.7	22-Jul	83.5	22-Aug	232.0	22-Jul
1990	202.4	29-Aug	78.1	29-Jul	307.5	29-Aug
1991	179.9	30-Apr	131.1	20-Jul	174.3	20-Jul
1992	169.5	27-Jun	82.9	21-Aug	151.7	26-Jul
1993	103.6	19-Aug	117.8	11-Jul	178.6	06-Aug
1994	126.1	11-Jul	82.3	03-Jul	126.8	11-Jul
1995	84.3	13-May	193.0	29-Aug	83.1	01-Jul
1996	259.3	18-Sep	127.8	18-Sep	275.0	18-Sep
1997	188.5	31-Jul	88.0	18-Aug	251.8	31-Jul
1998	57.2	19-Apr	78.1	18-Sep	91.5	19-Apr
1999	203.0	28-Jul	110.2	31-Jul	402.4	31-Jul
2000	263.1	22-Aug	220.1	11-Jul	294.2	22-Aug
2001	171.4	07-Jul	90.7	29-Aug	203.4	07-Jul

(17) Max. Daily Rainfall at Pakse (mm)

Station / Yea	No.1 (Pakse)	
	Rainfall	Date
1960	148.5	27-Jun
1961	108.7	29-Jun
1962	110.7	01-Aug
1963	84.9	11-Jul
1964	191.9	15-Sep
1965	112.2	17-Jun
1966	138.0	22-Jul
1967	156.6	28-Aug
1968	143.7	05-Sep
1969	82.0	02-Sep
1970	66.2	16-Aug
1971	95.0	18-Jun
1972	253.6	04-Jun
1973	83.6	29-May
1974	150.0	11-Jun
1975	77.8	08-Sep
1976	87.9	23-Sep
1977	150.0	11-Sep
1978	273.6	16-Aug
1979	175.0	08-Aug
1980	60.4	26-Apr

Station / Yea	No.1 (Pakse)	
	Rainfall	Date
1981	115.8	09-Aug
1982	108.4	06-Sep
1983	450.3	25-Jun
1984	131.6	31-Aug
1985	89.0	13-Jun
1986	105.8	07-Aug
1987	226.4	21-Aug
1988	115.7	01-Aug
1989	83.0	30-May
1990	92.4	15-Jun
1991	87.6	03-Sep
1992	81.2	27-Aug
1993	86.4	06-Aug
1994	178.1	05-Sep
1995	95.9	01-Jul
1996	93.9	04-Aug
1997	147.7	25-Jun
1998	101.5	03-Aug
1999	116.8	04-Jun
2000	168.6	31-Aug
2001	114.8	22-Jun

(18) Time Concentration at Each River for Route 14A

No	C.A Km2	L (Km)	H (m)	Tc	T	Tav	Note
1	9.6	7.00	500	1.07	2.32	1.7	
2	0.8	1.40	200	0.43	0.78	0.6	
3							
4	0.9	1.30	200	0.42	0.74	0.6	
5	1.6	1.80	500	0.42	0.75	0.6	
6	1.2	1.00	300	0.36	0.57	0.5	
7	1.1	1.40	300	0.41	0.71	0.6	
8	4.6	2.70	600	0.50	0.96	0.7	
9							
10							
11	4.59	3.30	700	0.55	1.08	0.8	
12	1.9	2.30	600	0.46	0.85	0.7	
13	3	2.40	600	0.47	0.88	0.7	
14	3.2	2.70	600	0.50	0.96	0.7	
15	3.4	2.50	600	0.48	0.91	0.7	
16	3.1	2.70	700	0.49	0.93	0.7	
17	0.8	0.80	200	0.35	0.54	0.4	
18	6.6	4.20	600	0.67	1.38	1.0	
19	6	4.50	500	0.74	1.55	1.1	
20	22.5	8.50	300	1.50	3.28	2.4	
21_1	20	10.00	900	1.24	2.70	2.0	
21_2	6.4	7.70	300	1.36	2.98	2.2	
22	11.5	14.70	900	1.79	3.92	2.9	
23	15	10.00	10	5.83	12.07	9.0	

(19) Time Concentration at Each River for Route 16A

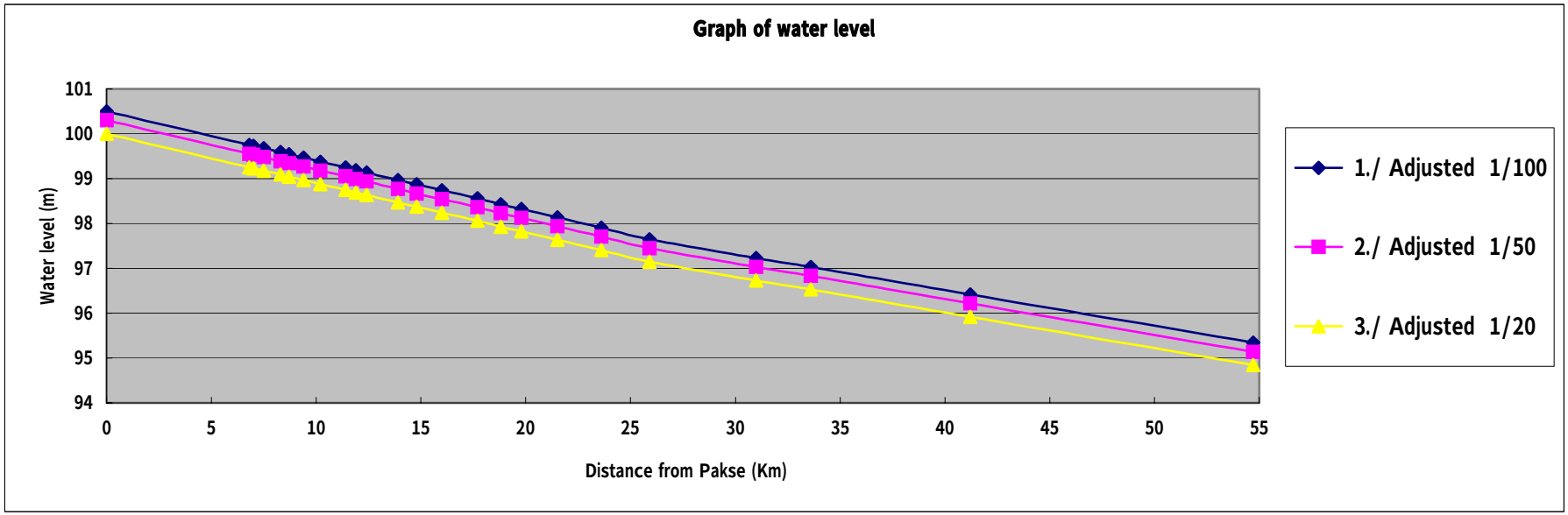
No	C.A Km^2	L (Km)	H (m)	Tc	T	Tav	Note
1	33.0	13.0	200	2.88	5.96	4.4	
2	56.0	21.0	310	4.01	8.25	6.1	
2A	75.0	27.0	440	4.59	9.42	7.0	
3	296.0	52.0	1100	6.63	13.38	10.0	
4	800.0						
5							
6	71.0	19.0	660	2.83	5.85	4.3	

(20) Analysis of Water Slope for Mekong River

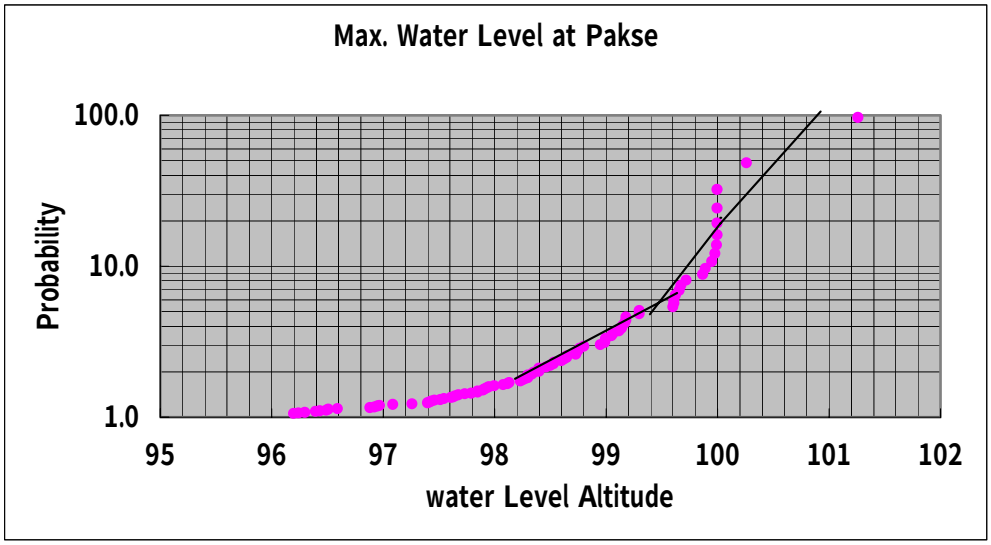
Pakse				Phaphin			Channoy	
Year	Height	Altitude	Slop	Height	Altitude	Slop	Height	Altitude
1972	11.99	98.62					9.84	91.61
1973	11.64	98.27	0.00011520913	10.96	95.24	0.00007223479491	8.36	90.13
1974	12.98	99.61	0.00012471483	12.05	96.33	0.00007478076379	9.27	91.04
1975	11.83	98.46		10.18	94.46			
1976	10.88	97.51						
1977	11.1	97.73						
1978	14.48	101.11	0.00010456274	14.08	98.36	0.00008751060820	10.40	92.17
1979	12.13	98.76	0.00011520913	11.45	95.73	0.00007379066478	8.74	90.51
1980	12.17	98.8	0.00009809886	11.94	96.22	0.00008185289958	8.66	90.43
1981	12.99	99.62	0.00012623574	12.02	96.30			
1982	10.78	97.41						
1983	10.8	97.43						
1984	12.98	99.61						
1985	11.16	97.79						
1986	9.8	96.43						
1987	11.9	98.53						
1988	9.76	96.39						
1989	9.61	96.24					7.18	88.95
1990	11.5	98.13					8.20	89.97
1991	13.26	99.89					9.38	91.15
1992	8.87	95.5					6.06	87.83
1993	8.68	95.31					7.19	88.96
1994	11.6	98.23						
1995	12.43	99.06						
1996	13.04	99.67					9.00	90.77
1997	12.36	98.99		12.97	97.25	0.00009557284300	8.72	90.49
1998	9.36	95.99	0.00010722433	8.89	93.17	0.00006190947666	7.02	88.79
1999	10.25	96.88	0.00010912548	9.73	94.01	0.00006473833098	7.66	89.43
2000	13.36	99.99	0.00011444867	12.70	96.98	0.00008213578501	9.40	91.17
			0.00011275877			7.71696E-05		
			0.011%			0.008%		

(21) Analysis of water level of Each River Mouth for Route 14A

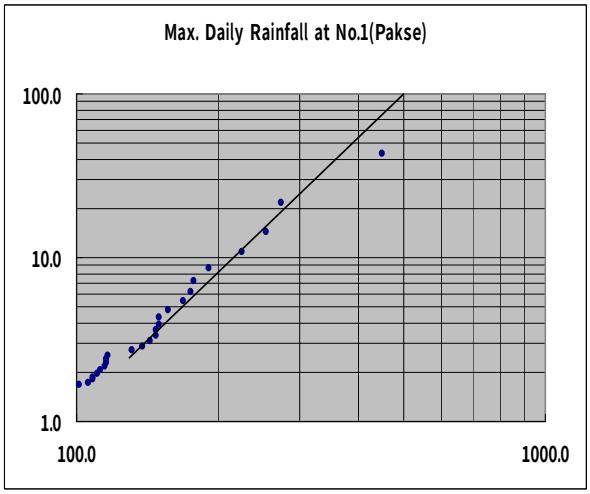
River mouth No.		1	2	3	4	5	6	7	8	9	10	11
River ame	Pakse	Huay Thok	No Name	Huay Maknao	No Name	Huay Namxam	NoName	Huay Gnang	Huay Nangname	Huay Kaunam	Huay Khao dam	Huay Thakhong
Distance from Pakse (Km)	0.00	6.80	7.00	7.50	8.30	8.70	9.40	10.20	11.40	11.90	12.40	13.90
Adjusted 1/100	100.50	99.75	99.73	99.68	99.59	99.54	99.47	99.38	99.25	99.19	99.14	98.97
Adjusted 1/150	100.30	99.55	99.53	99.48	99.39	99.34	99.27	99.18	99.05	98.99	98.94	98.77
Adjusted 1/20	100.00	99.25	99.23	99.18	99.09	99.04	98.97	98.88	98.75	98.69	98.64	98.47
River mouth No.	12	13	14	15	16	17	18	19	20	21	22	23
River ame	Tabxang	Khone lai	Khonken	Huay Hong	Huay He	Huay Dua	Huay Xai	Huay Phaphin	Huay Phabang	Huay Sahoua	Huay Thateng	Huay Manpha
Distance from Pakse (Km)	14.80	16.00	17.70	18.80	bb	21.50	23.60	25.90	31.00	33.60	41.20	54.70
Adjusted 1/100	98.87	98.74	98.56	98.43	98.32	98.14	97.91	97.65	97.23	97.03	96.42	95.34
Adjusted 1/150	98.67	98.54	98.36	98.23	98.12	97.94	97.71	97.45	97.03	96.83	96.22	95.14
Adjusted 1/20	98.37	98.24	98.06	97.93	97.82	97.64	97.41	97.15	96.73	96.53	95.92	94.84

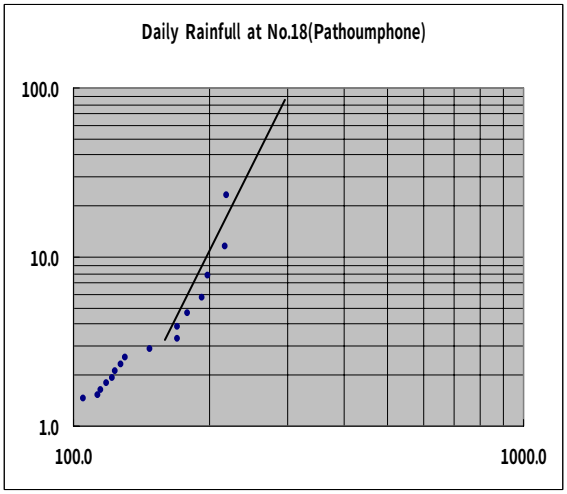


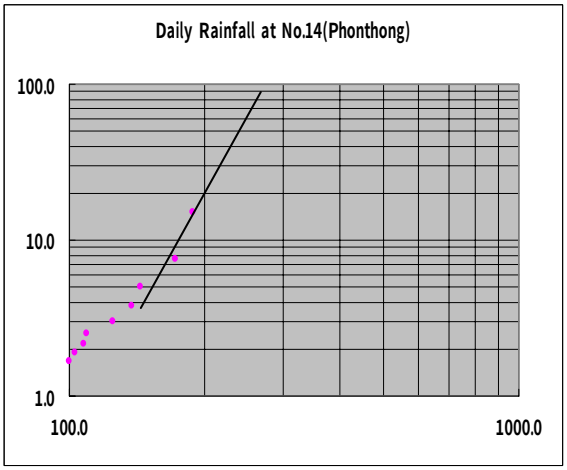
(22) Probability of Max. Water Level of Mekong at Pakse

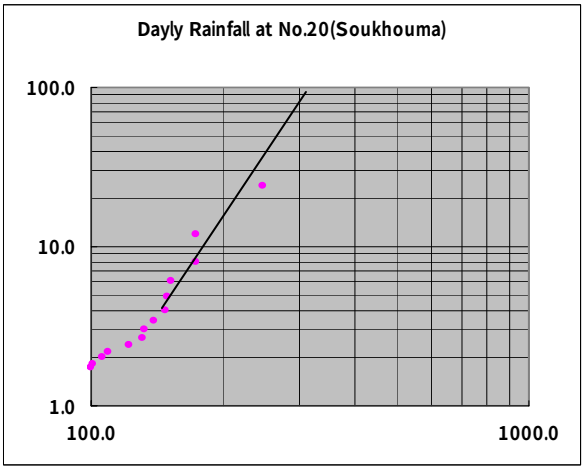


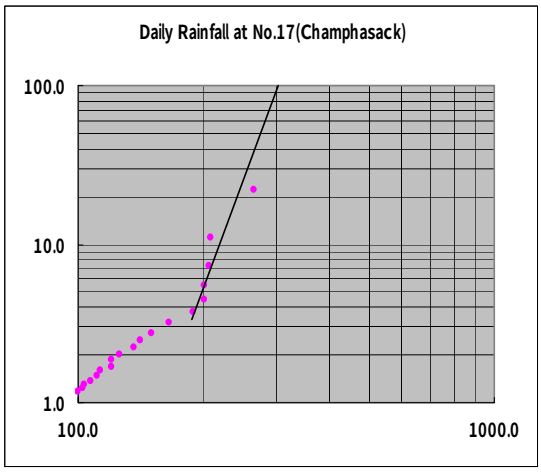
(23) Probability of Daily Rainfall for Route 14A



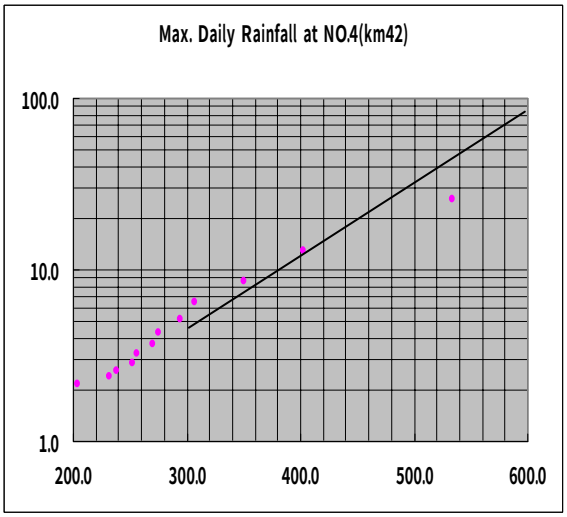


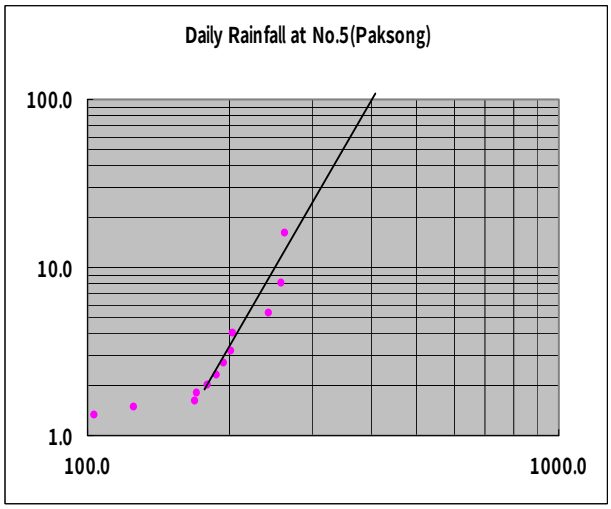


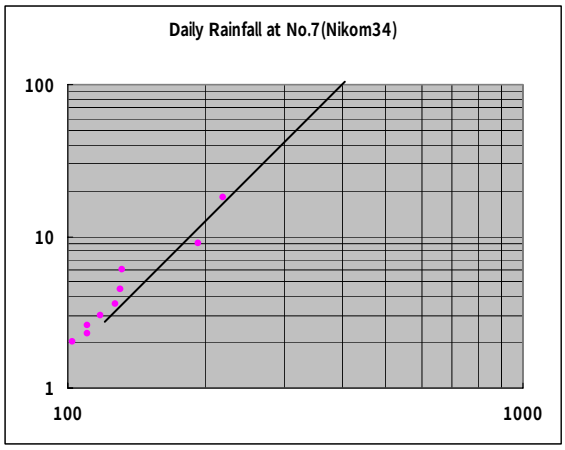




(24) Probability of Daily Rainfall for Route 16A







(25) Calculation of The Discharge at No4 &No.5 Bridge

The calculation of discharge adopts the calculation method for the design bridge of the Xe Nam Noy river (Unite Gragh Method) in Six Road Improvement Project by ADB in 1994.
Refer to ENCLOURE-B HYDROLOGICAL REPORT (SEPTEMBER 1994

Catchment area : 1,530 km^2 Q1/50=3,860 m^3/s from the report

No.4&No.5 Catchment area : 1,170 km^2

$Qp = 1.171 (A)^{0.7} = 1.171 (1170)^{0.7} = 164.55\ m^3/s$

$q_p = 0.14$ (cumec/km^2) after figure are same as the report.

Computation of Direct Runoff (peak) Total Discharge

Nam Noy R.	Duration corresponding U.G.Odinates(hr)	1-hr.U. G. Ordinates in Descending Oder	Critical Sequence on Rainfall Excess (cm)	Direct Runoff (cumec)
No4 & No.5	15	164.5	9.71	1,597.3
	16	159.4	3.17	505.3
	14	157.0	2.26	354.8
	17	153.5	1.16	178.1
	13	147.8	0.91	134.5
	18	146.8	0.90	132.1
	19	140.1	0.41	57.4
	12	135.9	0.16	21.7
	20	132.2	0.15	19.8
	21	123.9	0.15	18.6
	11	120.2	0.15	18
	22	116.4	0.15	17.5
	23	109.4	0.15	16.4
				3,071.5
	Base flow @	0.05 cumec/km^2	for 1170 km2 **Peak Discharge**	58.5 **3130 m^3/s**

(26) Calculation of The Discharge at No3 Bridge

The calculation of discharge adopts the calculation method for the design bridge of the Nam Noy river (Unite Gragh Method) in Six Road Improvement Project by ADB in 1994.
Refer to ENCLOURE-B HYDROLOGICAL REPORT (SEPTEMBER 1994

BridgeNo.3 River Catchment area : 296.0km^2

$Qp = 1.171 (A)^{0.7} = 1.171 (296)^{0.7} = 91.8\ m^3/s$

$q_p = 0.14$ (cumec/km^2) after figure are same as the report.

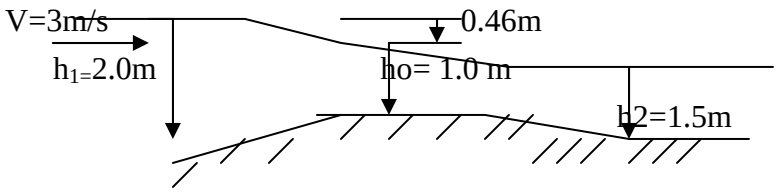
Computation of Direct Runoff (peak) Total Discharge

Nam Noy R.	Duration corresponding U.G.Odinates(hr)	1-hr.U. G. Ordinates in Descending Oder	Critical Sequence on Rainfall Excess (cm)	Direct Runoff (cumec)
No4 & No.5	15	91.8	9.71	891
	16	88.9	3.17	282
	14	87.6	2.26	198
	17	85.6	1.16	99
	13	82.5	0.91	75
	18	81.9	0.90	74
	19	78.1	0.41	32
	12	75.8	0.16	12
	20	73.7	0.15	11
	21	69.1	0.15	10
	11	67.0	0.15	10
	22	64.9	0.15	10
	23	61.0	0.15	10
				1,714
	Base flow @	0.05 cumec/km^2	For 296 **Peak Discharge**	15 **1,730 m^3/s**

(27) Calculation of The Side Outflow to Bridge No. 5

The discharge of bridge No.5 becomes over flowing during the high water level of Nam Noy river from about 100m upstream of the bridge No.4 and it is the right bank.
The over flowing discharge was more than 1.0 m of water depth of top land and about 50 m .of width.

Calculation discharge is as follows



Estimation V=3.0 m/s

$hg = V^2 / 2g = 0.46$ m

$h_1 = 2.0$ m $h_2 = 1.5$ m

ho = 1.0 m C= 0.6 (coefficient)

B=50 m

$Q = C B \{ 2/3 (h_1-h_2) + h2 \} \sqrt{2 g(h_1-h_2+ ho)}$

$= 0.6 \times 50 \{ 2/3 (2-1.5) + 1.5 \} \sqrt{2 \times 9.8(2.0-1.5+1.0)}$

$= 297$ **300 m^3/s**

ANNEX F-11
ECONOMIC ANALYSIS: RED MODEL

ANNEX F-11 ECONOMIC ANALYSIS: RED MODEL

1. Overview

This annex introduces the Roads Economic Decision Model (RED), developed by the World Bank to improve decision-making for low-volume rural road projects.The model performs an economic evaluation using the consumer surplus approach customized to the characteristics and needs of low-volume roads, for example high uncertainty in the reliability of model inputs, particularly the traffic and the condition of the unpaved roads and the importance for the analysis of generated and induced traffic.

RED computes benefits for normal, generated, induced, and diverted traffic, and takes into account changes in road length, condition, geometry, type, accidents, and days per year when the passage of vehicles is further disrupted by a highly deteriorated road condition (during the rainy season). The model can add to the analysis other benefits, such as non-motorized traffic, social services and environmental impacts, if computed separately. The model is presented on a series of Excel 97 workbooks that collect all user inputs, present the results on an efficient manner and perform sensitivity, switching values and risk analyses.

The RED model was funded by the Africa Road Management Initiative (RMI), a key component of the Sub-Saharan Africa Transport Policy Program (SSATP), which is a collaborative framework set up to improve transport policies and strengthen institutional capacity in the Africa region. The author of the model was Rodrigo Archondo-Callao (rarchondocallao@worldbank.org) of the World Bank Transportation, Water and Urban Development Department.

2. Introduction

The decision-making process for the development and maintenance of low-volume rural roads has suffered from the lack of an economic evaluation tool customized for this type of roads. The World Bank's Highway Design and Maintenance Standards Model (HDM-III) and the Highway Development and Management Model (HDM-4) provide for the economic analysis of road investments, but are not particularly customized for unpaved roads. They do not capture all the benefits associated with low-volume roads investments, and require inputs which are impractical to collect for networks with low traffic levels, such as surface layers material properties and refined traffic data.

RED is an economic evaluation model customized for low-volume unpaved roads, with traffic volumes between 25 and 300 vehicles per day, to fulfil the planning and programming needs of highways agencies in charge of low-volume roads, presenting the results in a practical and effective manner. The appraisal of very low volume roads with traffic less than around 25 vehicles per day is best treated with a multi-criteria analysis or cost effectiveness analysis.

3. The Model

RED performs the economic evaluation of improvements and maintenance projects adopting the consumer surplus approach, which measures the benefits to road users and consumers of reduced transport costs. This approach is preferred to a producer surplus approach, which measures the "value added" or generated benefits to productive users in the project zone of influence, e.g. agricultural producers, since the consumer surplus approach was judged to allow for a better judgment of the assumptions made and an improved assessment of the investment alternatives simulated. The HDM models also adopt the consumer surplus approach and can be used for the economic evaluation of low-volume roads, but the developer of RED considers them to be not particularly customized for this purpose and more demanding in terms of input requirements.

RED simplifies the evaluation process while addressing the following additional concerns:

- reduce the input requirements for low-volume roads;
- take into account the higher uncertainty related to the input requirements;
- clearly state the assumptions made, particularly on the road condition assessment and the economic development forecast (induced traffic).
- compute internally the generated traffic due to decrease in transport costs based on a defined price elasticity of demand;
- quantify the economic costs associated with the days per year when the passage of vehicles is further disrupted by a highly deteriorated road condition;
- use alternative parameters, if required, to road roughness to define the level of service of low-volume roads (vehicle speeds and passability);
- allow for the consideration in the analysis of road safety improvements;
- include in the analysis other benefits (or costs) such as those related to non-motorized traffic, social service delivery and environmental impacts;
- raise questions in non traditional ways, for example, instead of asking what is the economic return of an investment, one could ask for the maximum economically justified investment for a proposed change in level of service, with

additional investments being justified by other social impacts;
- present the results with sensitivity, switching values and stochastic risk analyses; and
- have the evaluation model on a spreadsheet, such as Excel, in order to capitalize on built-in features and tools such as goal seek, scenarios, solver, data analysis, and additional analytical add-ins.

A simplification in RED compared to the HDM models is that it considers a constant level of service, during the analysis period, for the with and without project cases, while the HDM models include road deterioration equations. The road deterioration equations of the HDM models, which vary over time the roughness of a given road as function of condition, traffic, environment, and maintenance characteristics, are not implemented on RED. Rather, RED uses the concept of average levels of service, which is considered reasonable for low volume unpaved roads for the following reasons.

- difficulty in measuring or estimating the current roughness of unpaved roads;
- seasonal changes in road condition and passability;
- difficulty in determining the past and/or future grading frequencies;
- cyclical nature of the road condition under a defined maintenance policy; and
- convenience in defining levels of service for low-volume roads with parameters other than average annual roughness and gravel thickness.

4. The Software

The RED software is composed of a series of Excel 97 workbooks that contain a series of input worksheets, where all inputs are placed, output worksheets, where results are presented and support worksheets, where calculations are made. The main evaluation module workbook evaluates one road at a time and compares three project-options against a without project case, yielding the economic indicators needed to select the more desirable option and to quantify its economic benefits. There is also a network module workbook that evaluates a network of roads. The main project benefits are the reduction of vehicle operating costs and time costs, which are computed from relationships relating vehicle operating costs and speeds to road roughness customized for a particular country. The model also performs a basic risk analysis based on user defined triangular distributions for the main inputs.

Source: Adapted from the *RED Guide*.

ANNEX F-12
ECONOMIC ANALYSIS ROUTE 14A
KM 0.0-34.0/34.0-59.3

ANNEX F-12 ECONOMIC ANALYSIS ROUTE 14A KM 0.0-34/34.0-59.3

(1) Economic Analysis Route 14A Km 0.0-34.0 (in US$ thousand)

	Economic Costs		Benefits:Diverted Traffic		Generated Traffic		Ferry	Motorcycles	Total	Net
Year	Construction	Maintenance	VOC	Time	VOC	Time	Time	VOC/Time	Benefits	Benefits
2005	-2993	0	0	0	0	0	0	0	0	-2993
2006	-9845	0	0	0	0	0	0	0	0	-9845
2007	-8848	0	0	0	0	0	0	0	0	-8848
2008	0	-27	702	138	325	63	100	302	1630	1603
2009	0	-27	757	149	351	68	108	336	1768	1741
2010	0	-27	821	161	380	73	116	363	1915	1888
2011	0	-27	890	174	412	79	126	392	2073	2046
2012	0	-27	964	189	447	86	136	423	2245	2218
2013	0	-27	1046	204	485	93	146	457	2430	2403
2014	0	-27	1133	221	525	100	158	493	2632	2605
2015	0	-27	1229	239	570	109	171	533	2850	2823
2016	0	-27	1332	258	618	118	184	575	3086	3059
2017	0	-27	1445	279	670	127	199	621	3341	3314
2018	0	-1924	1566	302	726	137	215	671	3618	1695
2019	0	-27	1698	327	787	149	232	725	3919	3891
2020	0	-27	1842	354	854	161	251	783	4244	4217
2021	0	-27	1997	382	926	174	271	830	4580	4553
2022	0	-27	2166	414	1004	188	293	880	4944	4917
2023	0	-27	2349	448	1089	204	316	932	5337	5310
2024	0	-27	2547	484	1181	220	341	988	5762	5735
2025	0	-27	2762	524	1281	238	369	1048	6221	6194
2026	0	-27	2996	567	1389	258	398	1111	6717	6690
2027	8674	-27	3249	613	1506	279	430	1177	7254	15901
Results:	**EIRR**	**11.1%**	**NPV 12%**	**-1.41**	**FYB %**	**6.1**	**B/C**	**0.92**		

(2) Economic Analysis Route 14A Km 34.0-59.3 (in US$ thousand)

	Economic Costs		Benefits:Normal Traffic		Generated Traffic		Motorcycles	Total	Net
Year	Constructionj	Maintenance	VOC	Time	VOC	Time	VOC/Time	Benefits	Benefits
2005	-1382	0	0	0	0	0	0	0	-1382
2006	-4548	0	0	0	0	0	0	0	-4548
2007	-4087	0	0	0	0	0	0	0	-4087
2008	0	-14	265	57	95	18	196	630	616
2009	0	-14	286	61	103	19	217	686	672
2010	0	-14	310	66	112	21	235	743	729
2011	0	-14	336	71	122	22	253	805	791
2012	0	-14	365	77	132	24	274	871	857
2013	0	-14	396	83	143	26	295	944	930
2014	0	-14	429	90	155	28	319	1022	1008
2015	0	-14	466	97	169	30	345	1107	1093
2016	0	-14	505	105	183	33	372	1199	1185
2017	0	-14	548	114	199	36	402	1299	1285
2018	0	-1432	595	123	216	39	434	1407	-25
2019	0	-14	646	133	234	42	469	1524	1510
2020	0	-14	701	144	254	45	506	1651	1637
2021	0	-14	760	156	276	49	537	1778	1764
2022	0	-14	825	169	300	53	569	1916	1901
2023	0	-14	896	183	325	57	603	2064	2050
2024	0	-14	972	197	353	62	639	2224	2210
2025	0	-14	1055	214	384	67	678	2397	2383
2026	0	-14	1145	231	416	73	718	2583	2569
2027	4007	-14	1243	250	452	79	761	2784	6777
Results:	**EIRR**	**9.2%**	**NPV 12%**	**-1.91**	**FYB %**	**5.0**	**B/C**	**0.77**	

ANNEX F-13
BRIDGE LIST ON ROUTE 18A

ANNEX F-13 BRIDGE LIST ON ROUTE 18A

No.	Bridge Name	Km Post	Section	Proposed Bridge				Quantity					
				Proposed type	Br. Length (m)	Effective Width(m)	Bridge Type	Permanent one-lane Bridge	Baily Bridge	Submersible Bridge	Permanent one-lane Bridge	Baily Bridge	Submersible Bridge
1	Huay Lek	11.6	1	B	15	5.0	P	75	0	0			
2	Huay Sang Khuab	17.8	1	B	15	5.0	P	75	0	0	225	0	250
3	Huay Din Poun	18.2	1	B	15	5.0	P	75	0	0			
4	Hong Hin River	25.7	1	B	50	5.0	S	0	0	250			
5	Xe Kham Pho River	30.6	1	B	90	5.0	S	0	0	450			
6	Huay Ka Yom Bai River	31.0	2	B	30	5.0	B	0	150	0			
7	Huay Lathai River	32.3	2	B	30	5.0	B	0	150	0			
8	Huay I Tone River	34.8	2	B	30	5.0	B	0	150	0			
9	Huay Ta Peung Nang River	38.4	2	B	30	5.0	B	0	150	0			
10	Huay Chan To River	39.7	2	B	25	5.0	S	0	0	125			
11	Huay Tapeungnang	41.0	2	B	50	5.0	S	0	0	250			
12	Huay Kasoi	43.0	2	B	40	5	B	0	200	0			
13	Huay Dakdam	43.5	2	B	25	5	B	0	125	0	0	1725	1725
14	Huay Chantor	45.9	2	B	25	5	B	0	125	0			
15	Unknown River	46.4	2	B	30	5	B	0	150	0			
16	Unknown River	54.0	2	B	20	5	B	0	100	0			
17	Unknown River	55.2	2	B	40	5	S	0	0	200			
18	Unknown River	56.9	2	B	25	5	B	0	125	0			
19	Huay Ka Lorn River	58.3	2	B	40	5	B	0	200	0			
20	Huay Loun	62.9	2	B	30	5	S	0	0	150			
21	Huay Anom	68.1	2	B	20	5	B	0	100	0			
22	Xe Piane River	69.3	2	B	110	5	S	0	0	550			
23	Huay Pin	71.4	3	B	35	5	B	0	175	0			
24	Hong Khen	75.2	3	B	10	5	P	50	0	0			
25	Huay Kan Chan	81.0	3	B	30	5	B	0	150	0			
26	Huay Deua	82.5	3	B	70	5	B	0	350	0			
27	Huay Ouk	91.3	3	B	85	5	B	0	425	0			
28	Huay Lang	96.0	3	B	24	5	-	0	0	0			
29	Huay Khang	97.1	3	B	15	5	P	75	0	0	460	1825	0
30	Huay Oth	99.2	3	B	50	5	B	0	250	0			
31	Huay Phay	100.8	3	B	12	5	P	60	0	0			
31	Huay Wave Noy	104.4	3	B	25	5	P	125	0	0			
32	Huay Beb Nhai	105.1	3	B	35	5	B	0	175	0			
33	Huay Bok	107.1	3	B	60	5	B	0	300	0			
34	Huay Phak Nam	112.1	3	B	15	5	P	75	0	0			
35	Huay Phokton	112.5	3	B	15	5	P	75	0	0			

ANNEX F-14
CONSTRUCTION SCHEDULE OF SUPERSTRUCTURE & SUBSTRUCTURE

ANNEX F-14 CONSTRUCTION SCHEDULE OF SUPERSTRUCTURE AND SUBSTRUCTURE

(1) Construction Schedule of Typical Superstructure

Work Item	Duration (days)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
		1 0 20	1 0 20	1 0 20	1 0 20	1 0 20	1 0 20
Prepararion	30.0						
Girder Fablication	43.0						
Fabrication of Erection Girder	12.0						
Girder Erection	5.3						
Dismantle of Erection Girder	5.3						
Fabri. & Transport of PC Pane	30.0						
Setting of PC Panel	4.0						
Cross Beam Work	13.3						
Slab Work	18.6						
Pavement & Fitting Work	26.6						
Clean-up Work	30.0						

(2) Construction Schedule of Typical Substructure

Work Item	Duration (days)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8
		1 0 20	1 0 20	1 0 20	1 0 20	1 0 20	1 0 20	1 0 20	1 0 20
Prepararion	90								
Pile Driving Work: A1	7.5								
Pile Driving Work: A2	4.8								
Excarvation :A1	5.4								
Excarvation :A2	3.1								
Footing & Wall Work:A1	76.5								
Footing & Wall Work:A2	59.1								
Filling Work :A1	6.0								
Filling Work :A2	3.3								
Gabion Protection Work	7.4								
Clean-up Work	30								
	222.1								

ANNEX F-15
PROVINCIAL DECREE FOR THE PRESERVATION OF THE HISTORICAL SITES

ANNEX F-15 PROVINCIAL DECREE FOR THE PRESERVATION OF THE HISTORICAL SITES

PROVINCIAL DECREE

Provincial Decree on the Regulations for the Preservation

of the Historical Site of Vat Phou and the Areas Related

to Vat Phou, No. 38/88

ມະຕິຕົກລົງຂອງແຂວງ

ມະຕິຕົກລົງຂອງແຂວງກ່ຽວກັບການຄຸ້ມຄອງ ແລະ ປົກປັກຮັກສາ

ສະຖານທີ່ທ່ອງທ່ຽວວັດພູພ້ອມດ້ວຍພື້ນທີ່ ເລກທີ 38/88

LAO PEOPLE'S DEMOCRATIC REPUBLIC

PEACE INDEPENDENCE DEMOCRACY UNITY AND PROSPERITY

Champasak Province — No. 38/PG

Provincial Executive Board Committee

DECREE of the Provincial Executive Board Committee concerning the Rules on Preservation and Restoration of Vat Phou Monuments and Associated Sites

- Based on the decision of the IV Resolution Meeting of the Central Party Revolutionary Committee concerning the preservation and investigation of various archaeological sites which are considered as the most valuable National Cultural Heritage.

- In pursuance of an order of the Ministerial Council No. 154/PM dated 8/5/1981 concerning prevention and interdiction of unauthorised excavation of valuable artefacts.

- Based on the agreement of the Ministerial Council No. 48/MC dated 24/3/1982 concerning the preservation of the National Cultural Heritage of Lao PDR and also in pursuance of the signed contract on the cooperation between the Government of Lao PDR and UNESCO and UNDP No.86/00/1/13 dated 7/8/1987 concerning the preservation of Vat Phou Champasak Monument Project.

Vat Phou Champasak is an architecturally rich and well-known ancient monument. Vat Phou consisted of palaces, halls and temples that contained sculptures, sandstone carvings and other valuable objects that the ancient people used in the construction of this monument. All these valuable things indicated the ancient people's intelligence and ability. These charming and fascinating handmade sculptures and artefacts gradually became a symbol of the National Culture.

In the old regime, imperialism and the reactionary party had turned this monument area into their own source of income by excavating the valuable artefacts and selling them to other countries. Their

excavation destroyed this historical archaeology. Since the country was established as Lao People's Democratic Republic, the remaining artefacts were stolen by some bad people without consideration for the loss of national heritage. Throughout the past, the Government of the Lao PDR considered this monument area to be the most valuable cultural heritage resource of our nation which we could use to show the world about our ancestors' civilisation and intelligence. All government levels have decided to guide people to protect and maintain this monument in a reasonable condition.

For the convenience of restoration and maintenance of the monument, and with the aim of turning this heritage site into a tourist centre of Champasak province, as well as maintaining this monument for future generations so that they can visit and learn of their ancestors' culture, the Provincial Executive Board Committee has agreed to set up the rules for management and preservation as follows:

GROUP 1: PRESERVATION AREA

The preservation area is a large area based on the ancient construction plan of the Vat Phou Monument which covers the rice fields, forests, ponds and various hills, all of which are major components of the natural beauty of the Vat Phou heritage site.

At present, the archaeological remains of Vat Phou in the preservation area are the exterior and interior city walls. Inside this area there are various small and big hills which are believed to be the site of the ancient city.

This preservation area has many valuable artefacts and sculptures which are related to the Vat Phou Monument. Therefore, the government declared this area as a preservation area and Article 1 sets out the preservation area as follows:

Article 1: The preservation area starts from Phou Nak (Nak Mountain) and goes to the Mekong River bank. This covers the following villages: Nongsa, Nongho, Ban Phon, Phon Du, Phon Sao Ae, Thong Than, Nong Vian, Houay Sa Houa, Wat Luang Keo, North Phanom and South Phanon.

The boundary of this preservation area is set out as follows:

The West: From the top to the bottom of Phou Nak (Vat Phou Monument is situated on the slope of Phou Nak).

The East: From the right bank of the Mekong River, end of Vat Sisoumang boundary, to South Phanom village and ending at the ditch of the south exterior city wall.

The North: Along Kok Brook which flows down from Nak Mountain to the bamboo forest at Mr Sing Choum's rice field, where the course of Kok Brook flows by to the north, then along a straight line across the rice field to Phay canal, along Phay canal to the front of the airport and then across the rice field to the junction of Phay canal and Ta Beng canal and along the Nong Vian ditch to Mr Bone and Mr Khamtan's rice field and Mr Luane's rice field (each side of the ditch) and to Mr Khammy's rice field in the triangle along Sanaine ditch to Mr Teum's rice field and then directly to Mr May's rice field, continuing to Kha Lake to Sa Houa Brook and then crossing to Mr Phan and Mr Da's rice fields and then to the Samsa tree (the one on the north) after that crossing Sahoua Brook to Mr Peu's rice field and then crossing Toum Hill and the brush to Vat Sang Oa Temple, crossing Champasak Road to Mr Gnom's house and ending at the boundary of Vat Sisoumang.

The South: From the top of Nak Mountain down to Sane Brook and down to the bottom of Nak Mountain then along a straight line down to Nang Sida's hall, along the south of Nang Sida's hall then straight across to Khane canal and Sane Brook, across Mrs Keola and Mrs Nang's rice field down to Sane Brook and then to Sao Ae Road, then across the road to Done Ta Lat, then along the road turning back to I-Kam canal to the straight road and across the rice field, then directly to the exterior city wall (locally called "Middle Wall"). Near this wall is Mr Kai's rice field that connects to Mr Keoleuam's rice field along the Middle Wall to the Mekong River in the South Phanon village.

Article 2: Restrictions on the use of the preservation area.

Paragraph 1: No unauthorised excavation of gold, silver and artefacts for personal ownership and no selling of artefacts which have been found previously.

Paragraph 2: No excavation or destruction to various hills in the village and the forest such as: Sao Ae Hill, Soung Hill, Dead Elephant Hill, etc.

No destruction of the city wall and the ancient roads such as: Khou kang (Kang path), Khat path, Sanaine path, Nongvian path, and the path from Thao Tau Hall through Nang Sida Hall to Vat Phou Nonetoum, etc.

Paragraph 3: No construction of houses, rice mills, storage houses or other kinds of construction on the hills mentioned above. The constructions which existed previously are to be maintained in the same condition and they are not permitted to be expanded or be removed.

In special cases, if the preservation area is part of the expansion plan of an agricultural or irrigation project, then the head of those projects should ask for the permission to use the preservation area from the provincial government or related parties.

Paragraph 4: No moving or stealing sculptured stones or non-sculptured stones. If a stone contains ancient carving, then it is not allowed to be destroyed, used to sharpen knifes or to be drawn on in any way that will change the image or the style of the stone.

Paragraph 5: Any rice field work, travelling, and other activities which do not contradict the restrictions mentioned in the 4 paragraphs above are allowed to be conducted as usual.

Article 3: Restrictions on the use of the forest

Paragraph 1: The forest on the slope of Nak Mountain is "the preservation forest"

Paragraph 2: No cutting down of trees to build houses. Only the cutting of small trees to clear the land and to maintain the forest in a good condition is permitted. If any organisations, soldiers or the villagers need the wood for building houses then they should send their requests through each government level for approval from the related parties.

Paragraph 3: No chopping or peeling off of the bark of a tree which will cause it to die when there is a natural disaster.

Paragraph 4: No burning of the trees in the preservation area, as it will cause fire in this area.

GROUP 2: PRESERVATION AREA.

The preservation area is the area where there are the remains of ancient constructions such as temples, halls, and palaces. In addition to these constructions, there are many ancient construction materials lying on the ground which were brought in from somewhere else or which were made at the construction site but had not been used in the construction, or if these materials had been fitted into the temples, as the centuries passed, these construction materials may have fallen down and been buried under the ground. To turn this area into a historical tourist attraction for both locals and foreigners, the preservation area is set out in the following articles:

Article 4: The preservation area covers 3 places as follow:

- Vat Phou Temple area
- Nang Sida Palace area
- Thao Tao Palace area

(1). **Vat Phou Temple area:** Vat Phou has its boundary as follows:

- The West: from the cliff at the back of the temple
- The East: from the foot of the east ditch of the big pond
- The North: Along a line from the cliff along a small brook and then along Nang Sida Palace down to the big pond to the boundary of the east.

(2). **Nang Sida Palace:** This area has a size of 150 x 102 square meters which covers Nang Sida Palace and the pond which makes the right angle on the northwest. Apart from that, there is Sao Sae road 12 meters - 110 meters which started from the east of this land area.

(3). **Thao Tao Palace:** Thao Tao Palace is surrounded by a stone wall enclosing an area of 30 x 25 square meters. The boundary of the Thao Tao Palace preservation area is 20 meters beyond the stone wall to the south and the boundary is 50 meters beyond the stone wall of the other three sides. Therefore, the preservation area of Thao Tao Palace is 150 x 95 square meters.

Article 5: Restrictions on the use of the preservation area

Paragraph 1: No destruction of the stone temples, palaces and ancient artefacts.

Paragraph 2: No removal or stealing of the sculpture, stone construction material and other valuable artefacts.

Paragraph 3: No excavation for gold and other artefacts.

Paragraph 4: No growing rice or cutting down trees.

Paragraph 5: No building houses and other kinds of construction in this area.

Paragraph 6: No buffaloes, cows, carts, cars and other vehicles allowed in this area.

Paragraph 7: For the Vat Phou area, no kind of animal or vehicle is allowed, especially along the Lotus Pole Road (from the platform to the steps of Chao Hall). Visitors' cars are allowed to drive along the upper road of Nong Nokkhao, the lower ditch of the brick pond and the road near the steps of Chao Hall only.

Article 6: Additional restriction

In a circle extending 100 meters beyond these three preservation areas mentioned above, no building of houses, rice mills, and other kinds of constructions are permitted. The existing houses, rice mills, etc. can be kept, but no expansion or removal is permitted (except in Nongsa village). For the celebration of the Vat Phou Festival, the department of information and culture at the district level should consult and ask for approval from the department of information and culture of the province. The provincial staff will then come to the site to monitor and enforce the restrictions of the preservation area in accordance with Article 6 and then they will allow the celebration of Vat Phou festival until the last day of the festival.

GROUP 3: PENALTY FOR PERSONS WHO ARE IN BREACH OF THE RESTRICTIONS.

Article 7: It is agreed to judge the person in breach of these restrictions as follows:

- To educate;
- To fine; and
- To jail (long term penalty).

(1). **Education case:** The person who is in breach of the following articles will be educated by the local government:

- Article 3, paragraph 3
- Article 5, paragraphs 4, 5, and 6

(2). **Fine case:** The person who is in breach of the following articles will be fined by the related organisation and local government:

- Article 2, paragraphs 1, 2, and 3.
- Article 3, paragraph 2
- Article 5, paragraph 2
- Article 6

In these two cases mentioned above, if this person still acts in breach of these articles then the local government organisation will present his case to the tribunal for judging.

(3). **Long term punishment case (jailed):** If the person who acts in breach of the following articles is considered to deserve a heavy penalty, then the local government will give the authority to the local tribunal to judge or to jail:

- Article 5, paragraphs 1, 2, and 3
- Article 3, paragraph 4
- Article 2, paragraph 4

Article 8: It is agreed to give authority to the related organisation and the local judge, the judge is to consider the penalty according to the suitable criminal law either to fine or to jail, as the judge considers suitable.

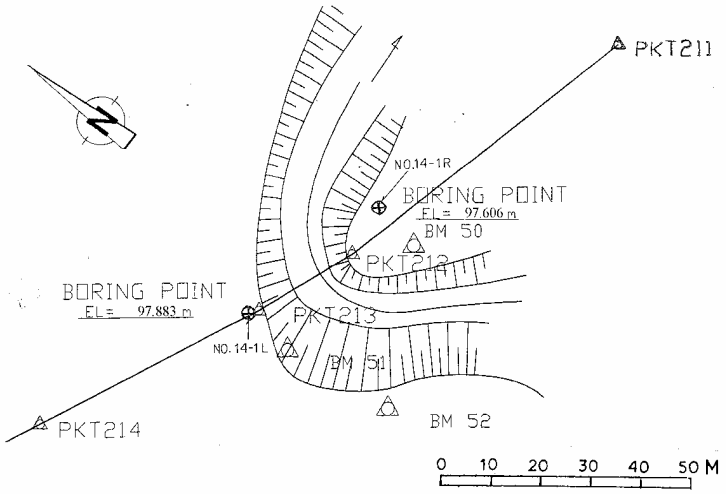
Article 9: This agreement is valid from the date of signature until it is cancelled by the new agreement of the related organisations. All the local government levels are to implement this decree.

Pakse, 11/10/1988

Provincial Executive Board Committee

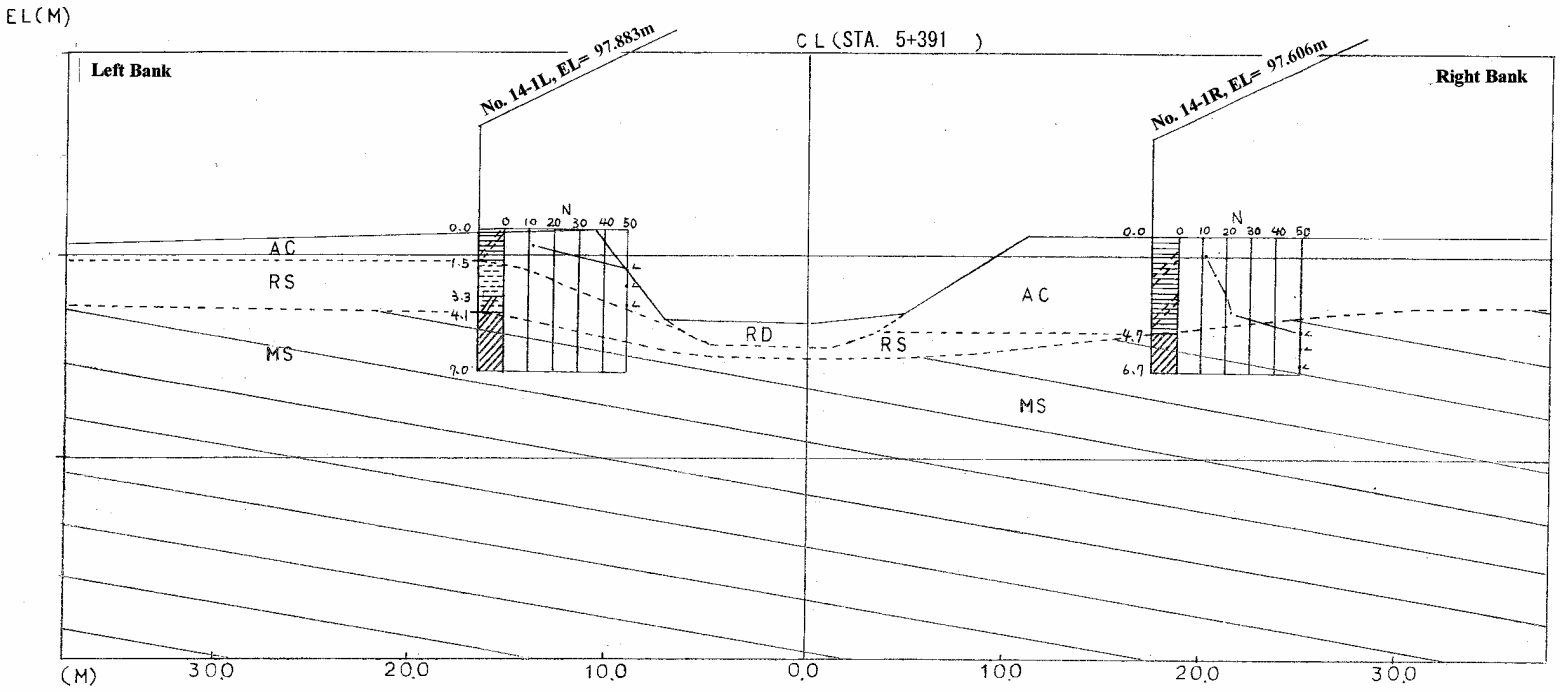
Signature and Seal

ANNEX F-16
GEOLOGICAL CROSS SECTION FOR THE RIVER



Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	← N Value>50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.

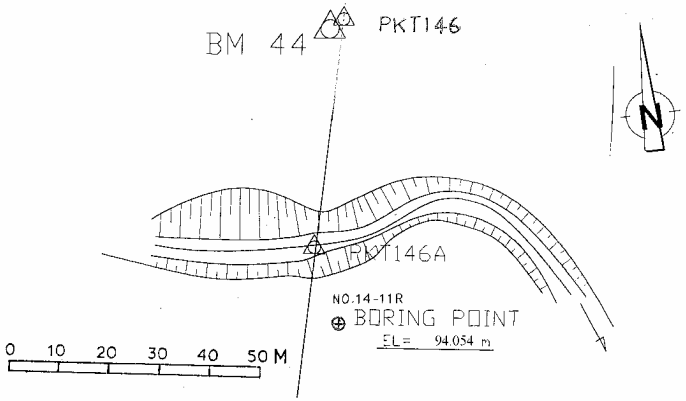


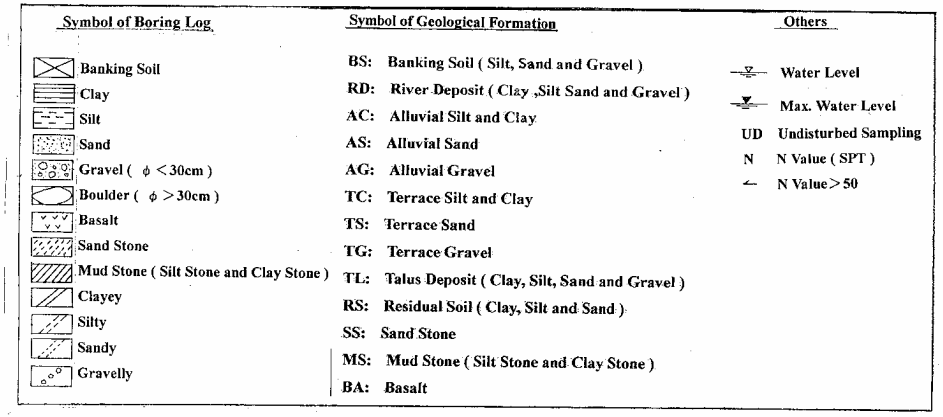
(1) Geological Cross Section for the Thok River (No. 14-1)

Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

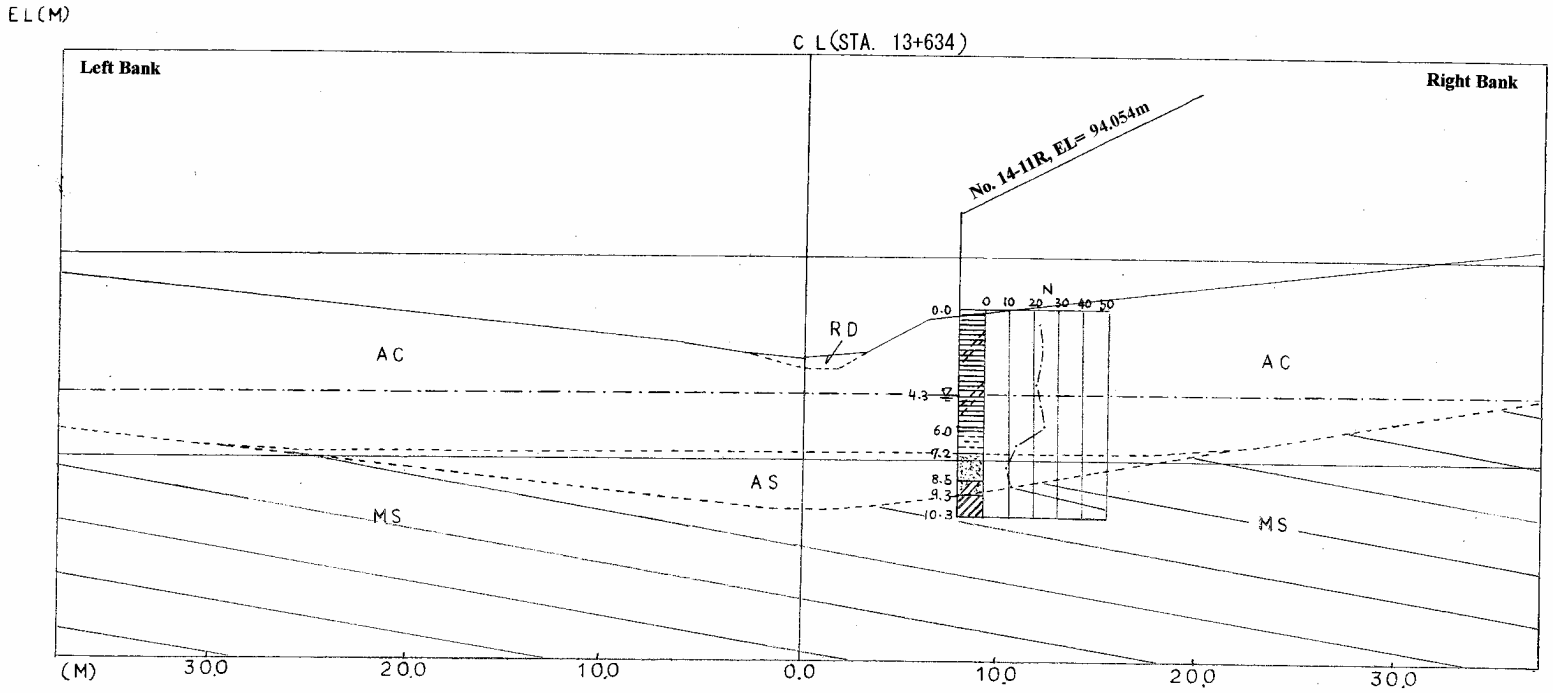
Note: The diagonal lines in rocks show the estimated dips of geological formations.

(2) Geological Cross Section for the Imet River (No. 14-8)

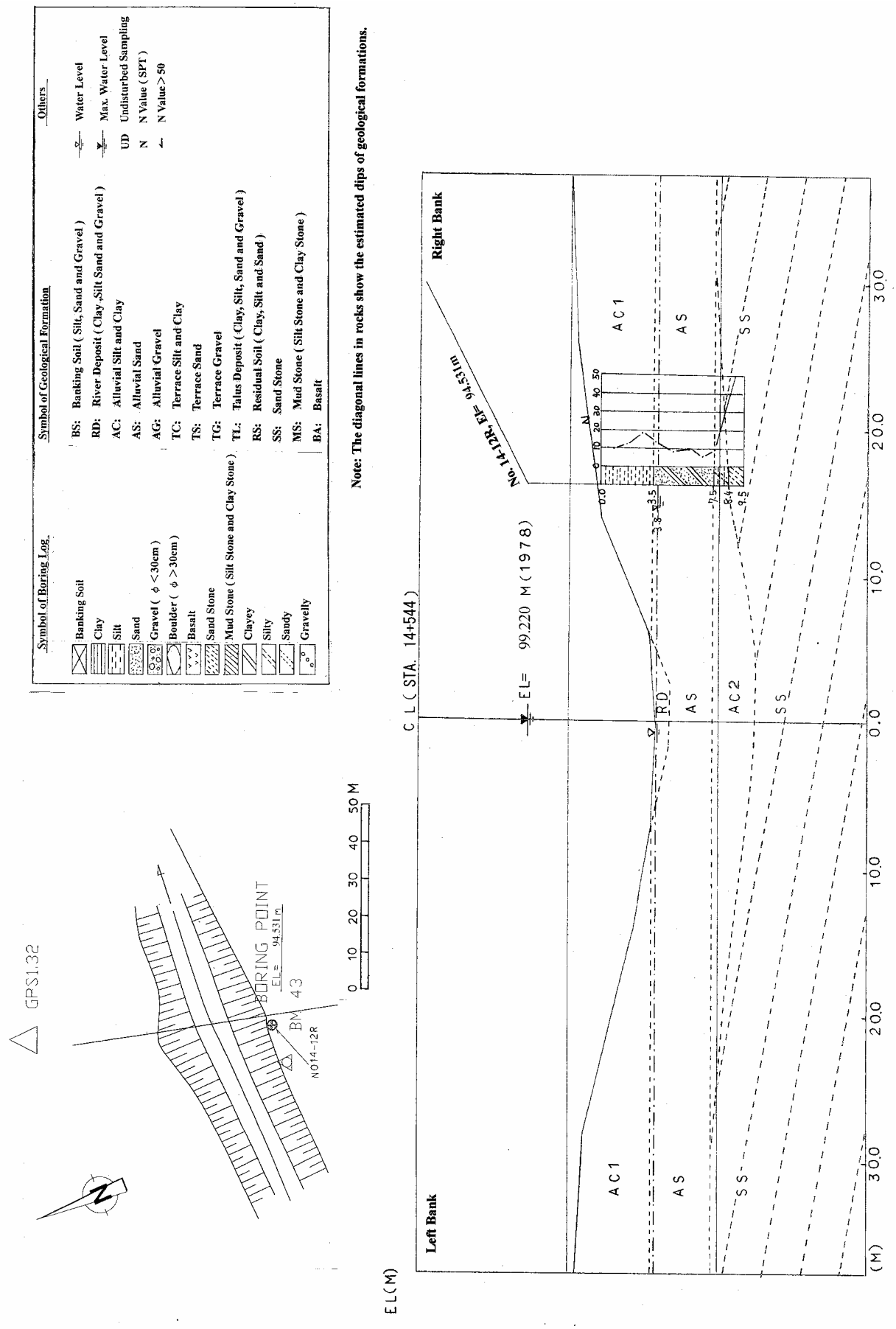




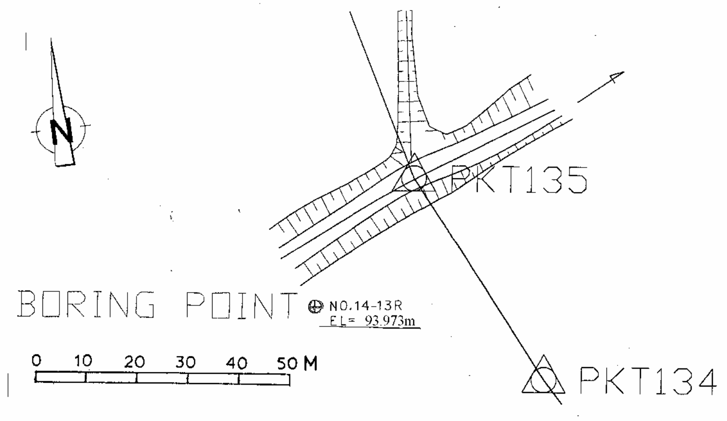
Note: The diagonal lines in rocks show the estimated dips of geological formations.



(3) Geological Cross Section for the Thakhong River (No. 14-11)

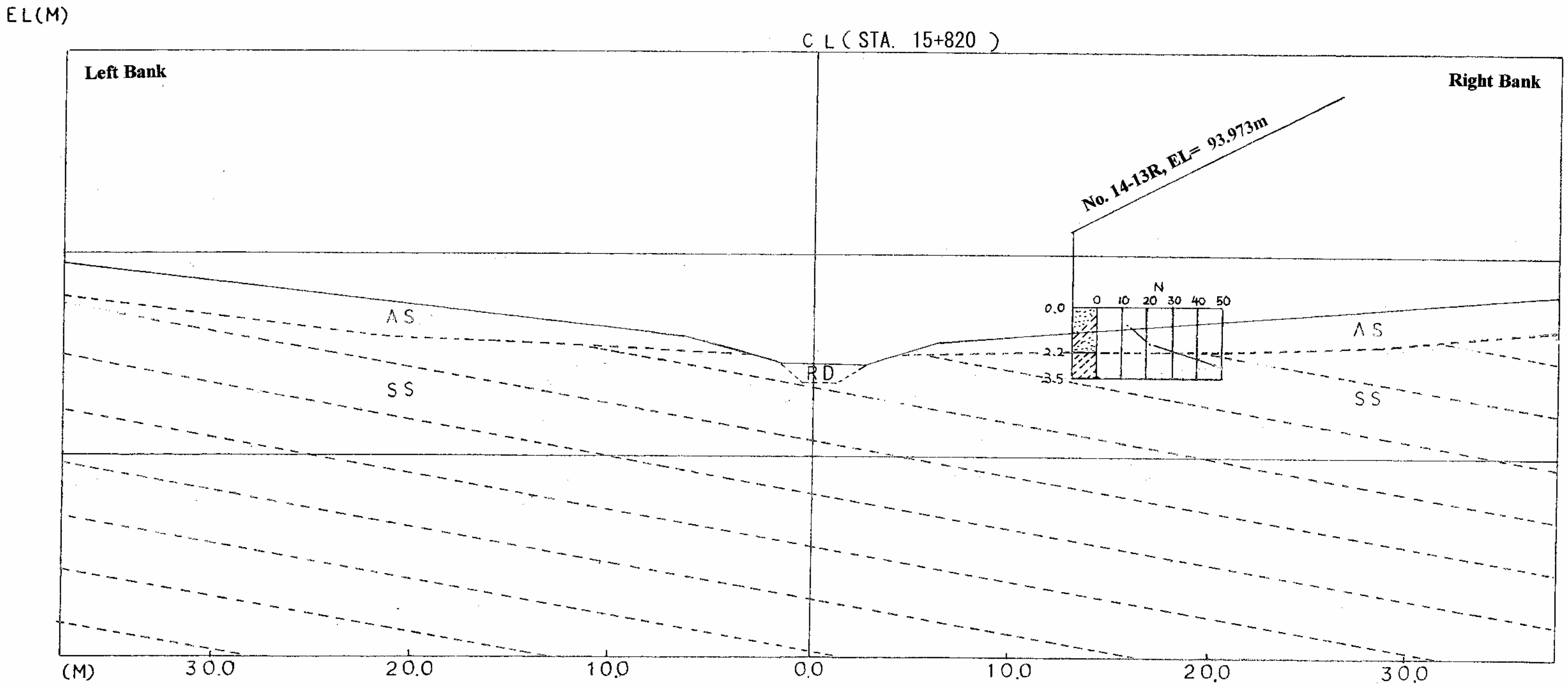


(4) Geological Cross Section for the Thapxang River (No. 14-12)

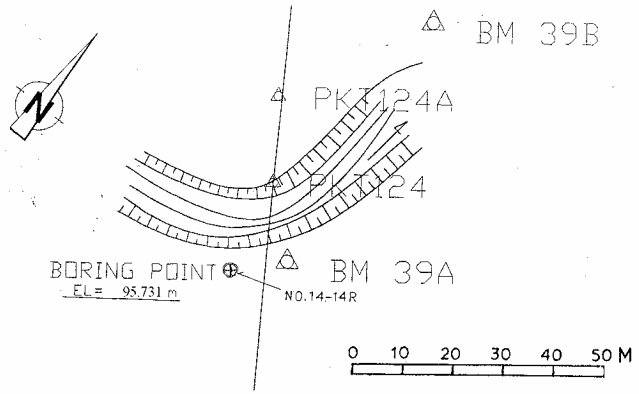


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.

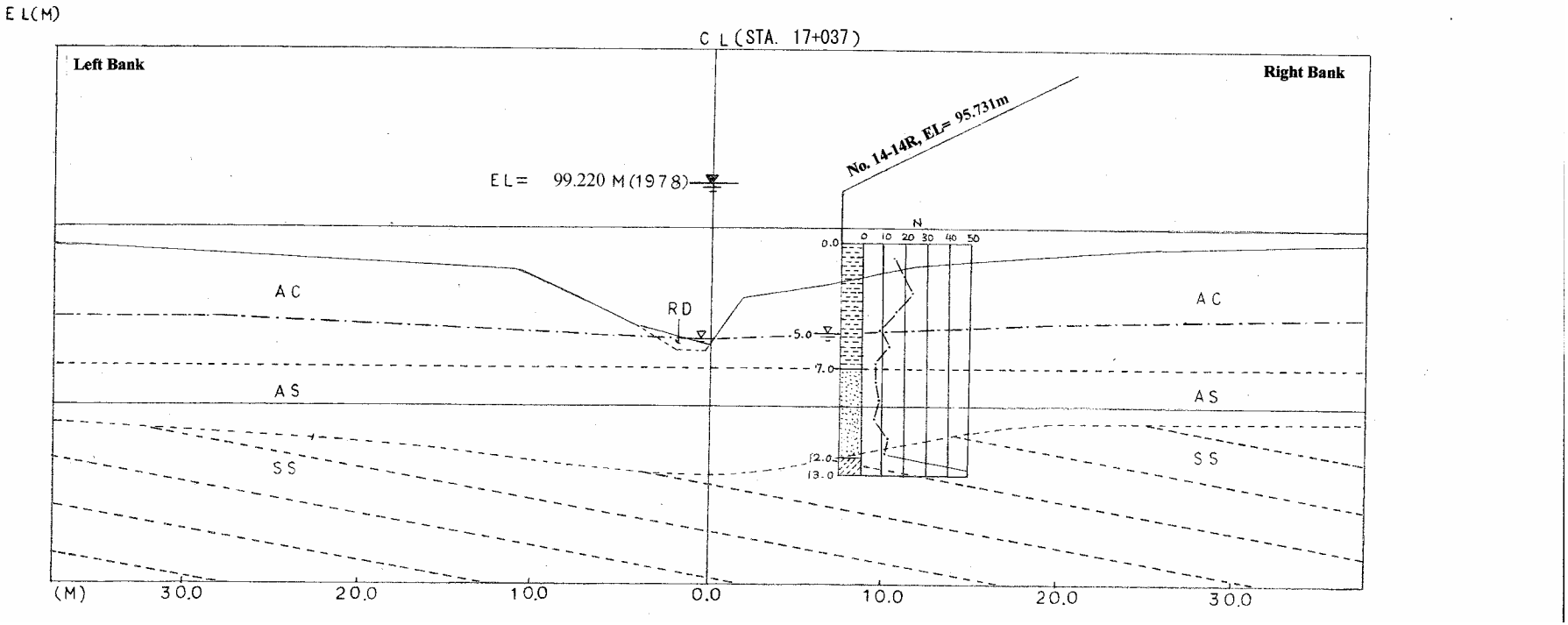


(5) Geological Cross Section for the Khone liao River (No. 14-13)

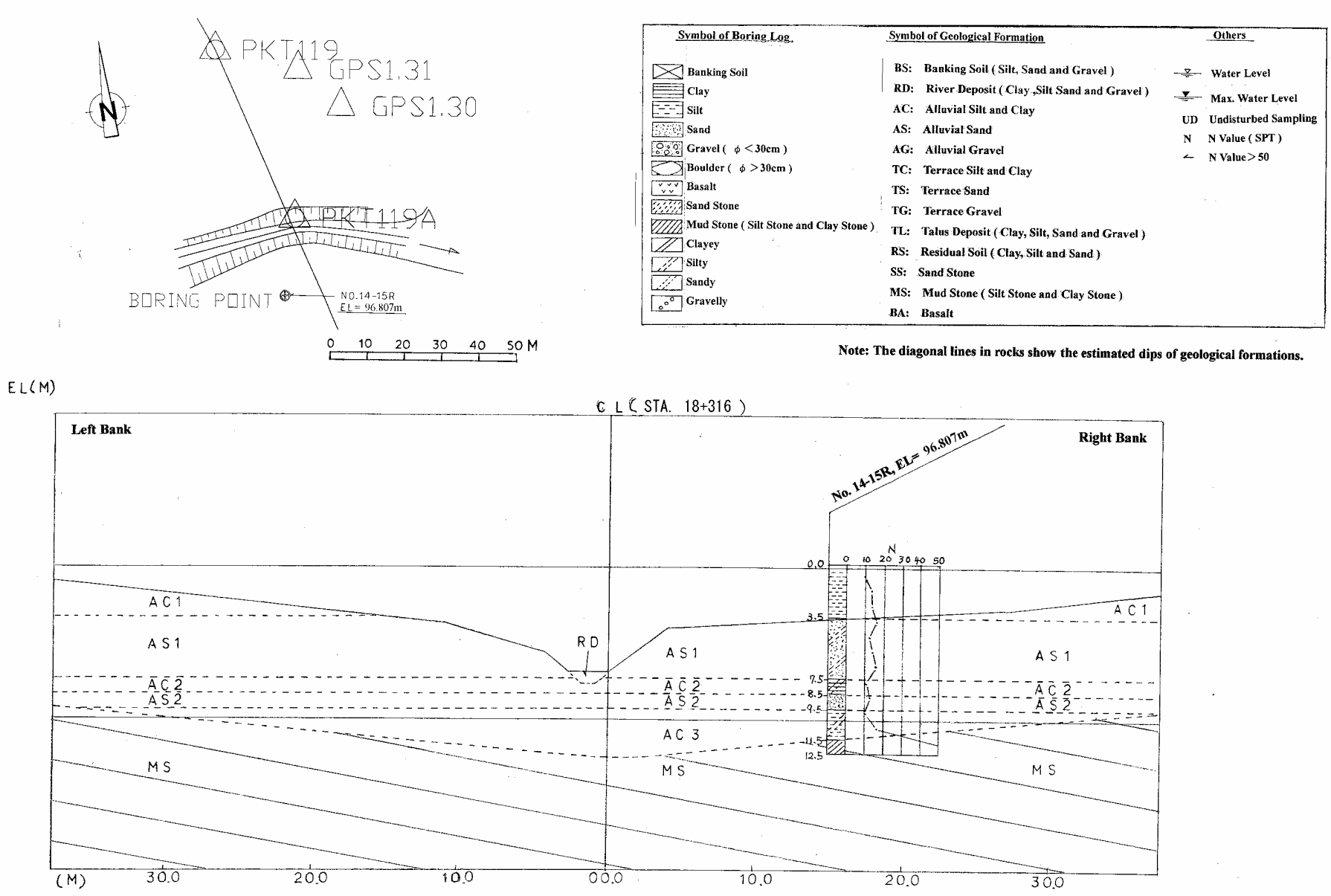


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

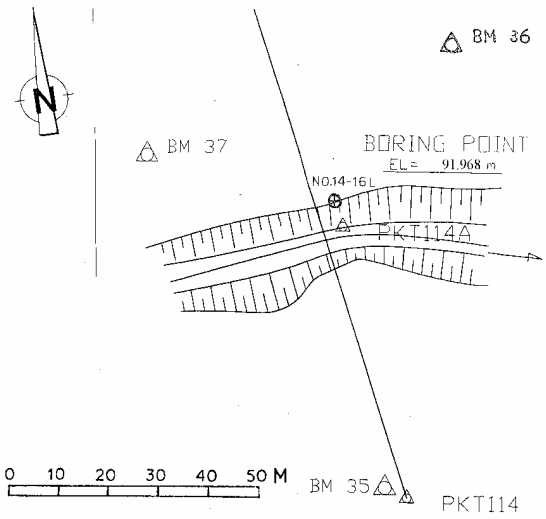
Note: The diagonal lines in rocks show the estimated dips of geological formations.



(6) Geological Cross Section for the Khonken River (No. 14-14)

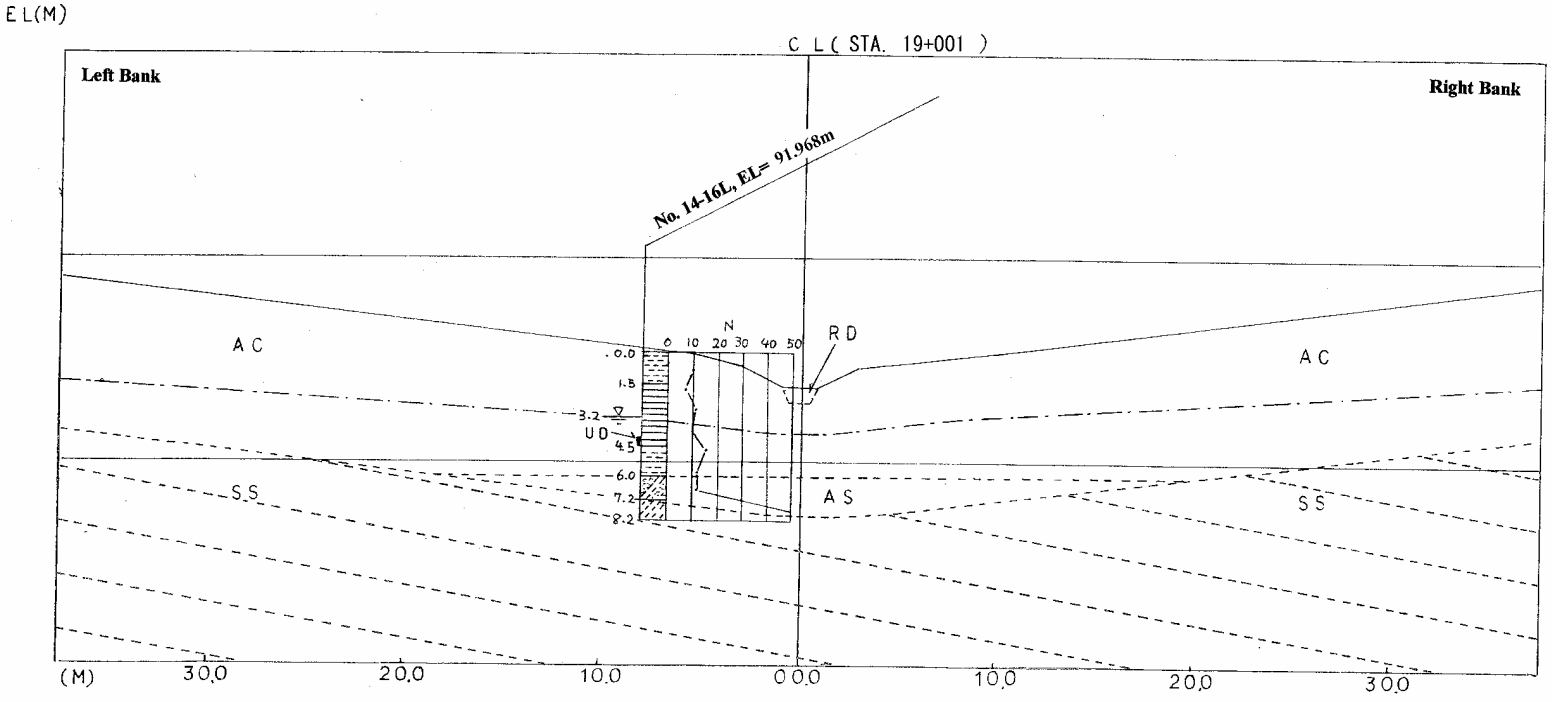


(7) Geological Cross Section for the Hong River (No. 14-15)

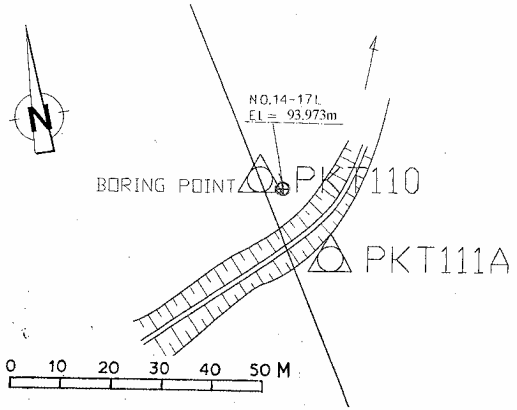


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.

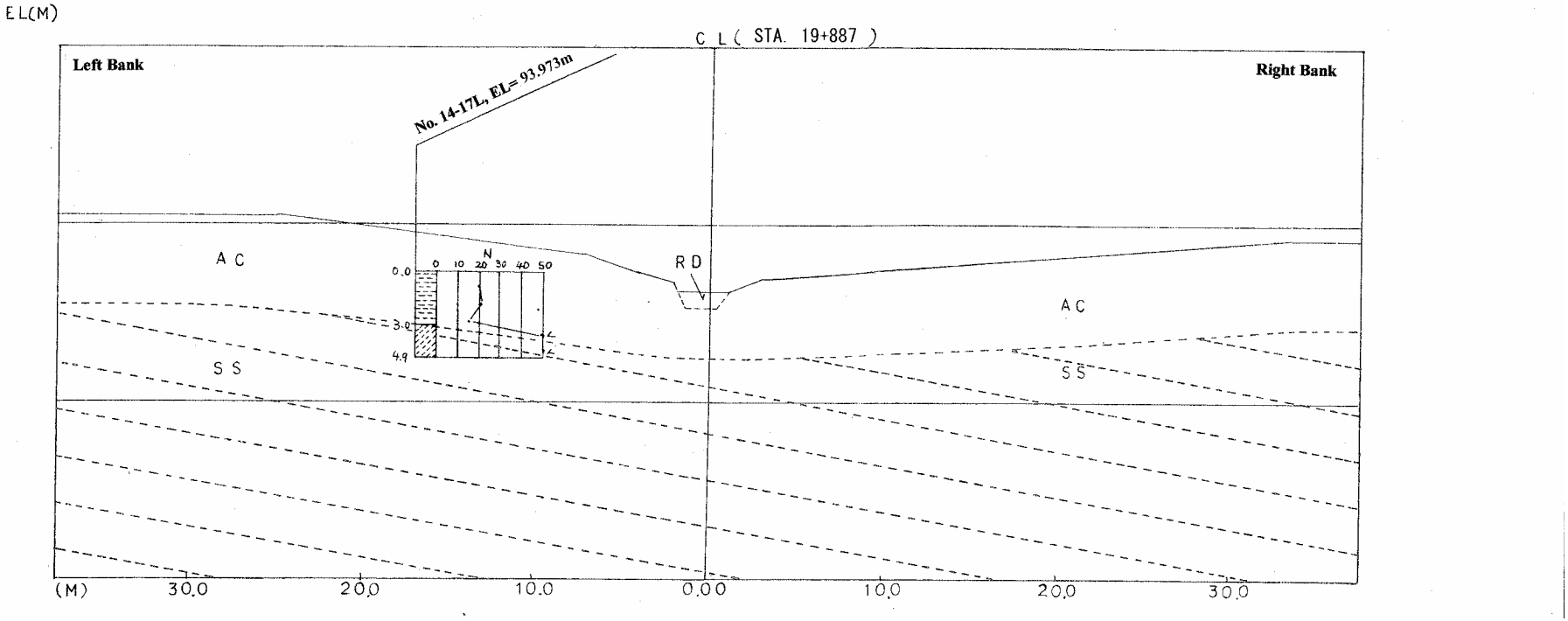


(8) Geological Cross Section for the He River (No. 14-16)

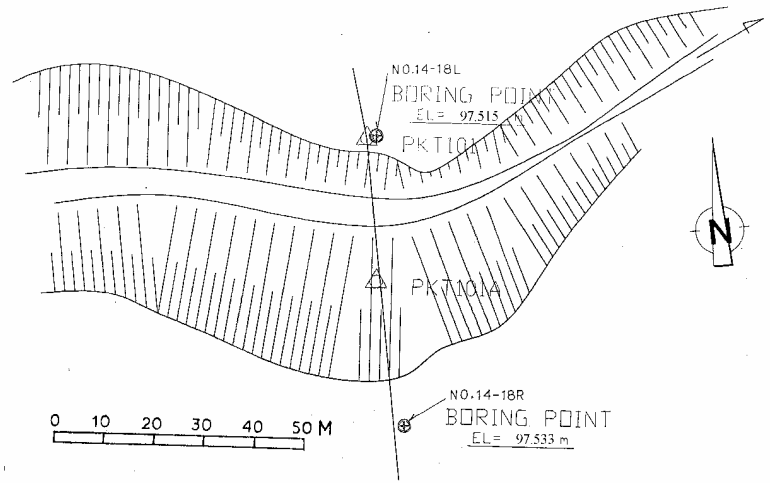


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.

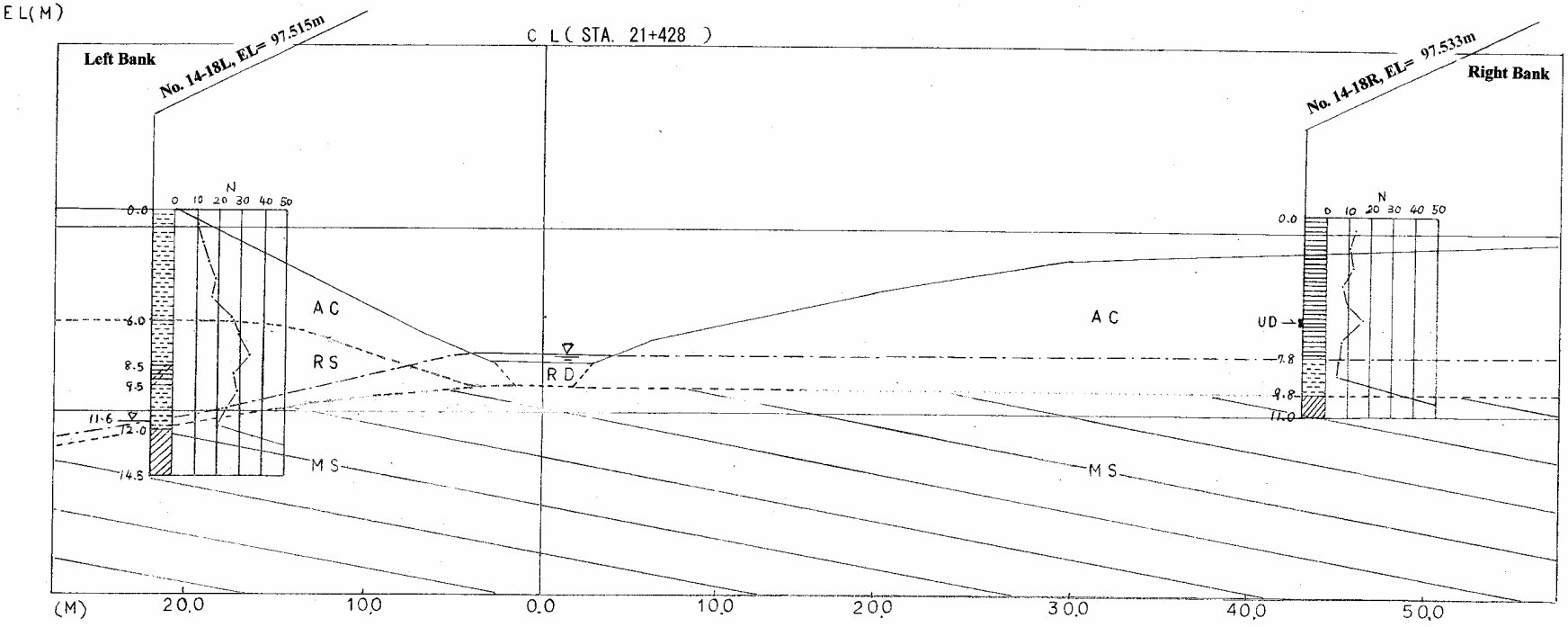


(9) Geological Cross Section for the Dua River (No. 14-17)

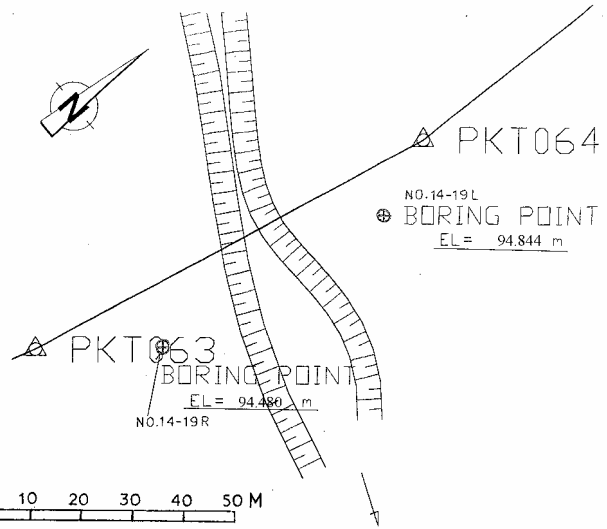


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.

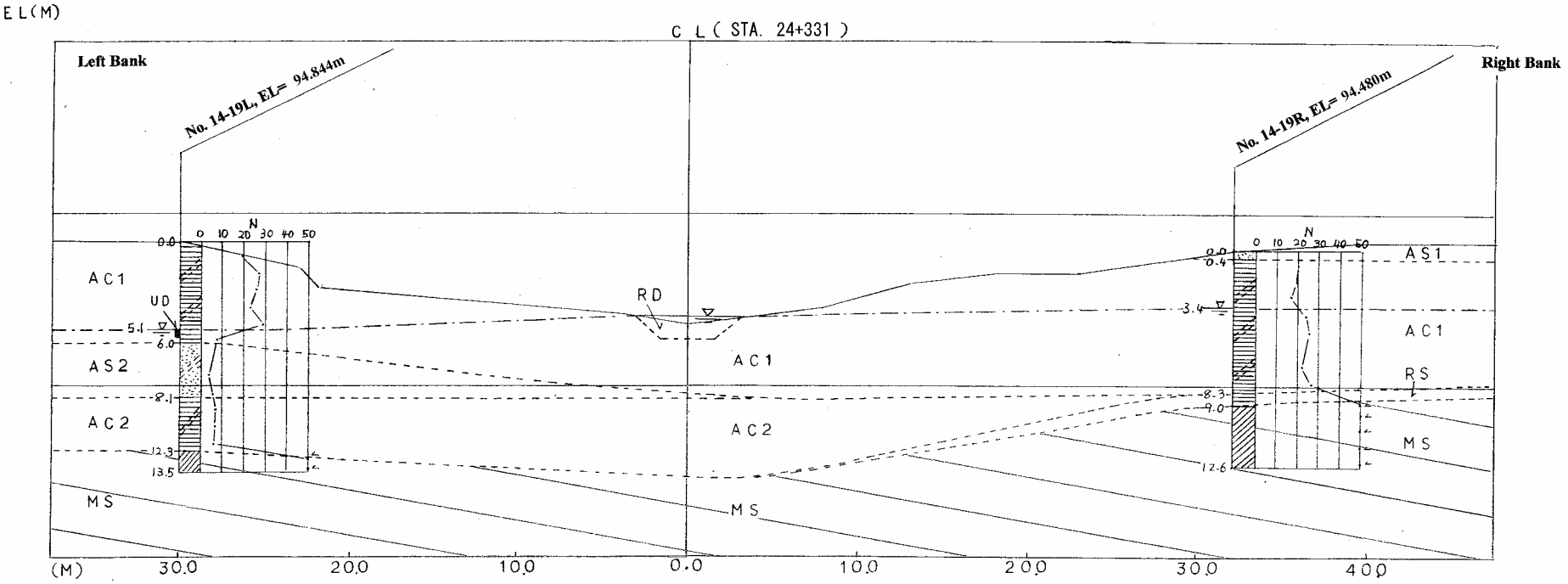


(10) Geological Cross Section for the Sai River (No. 14-18)

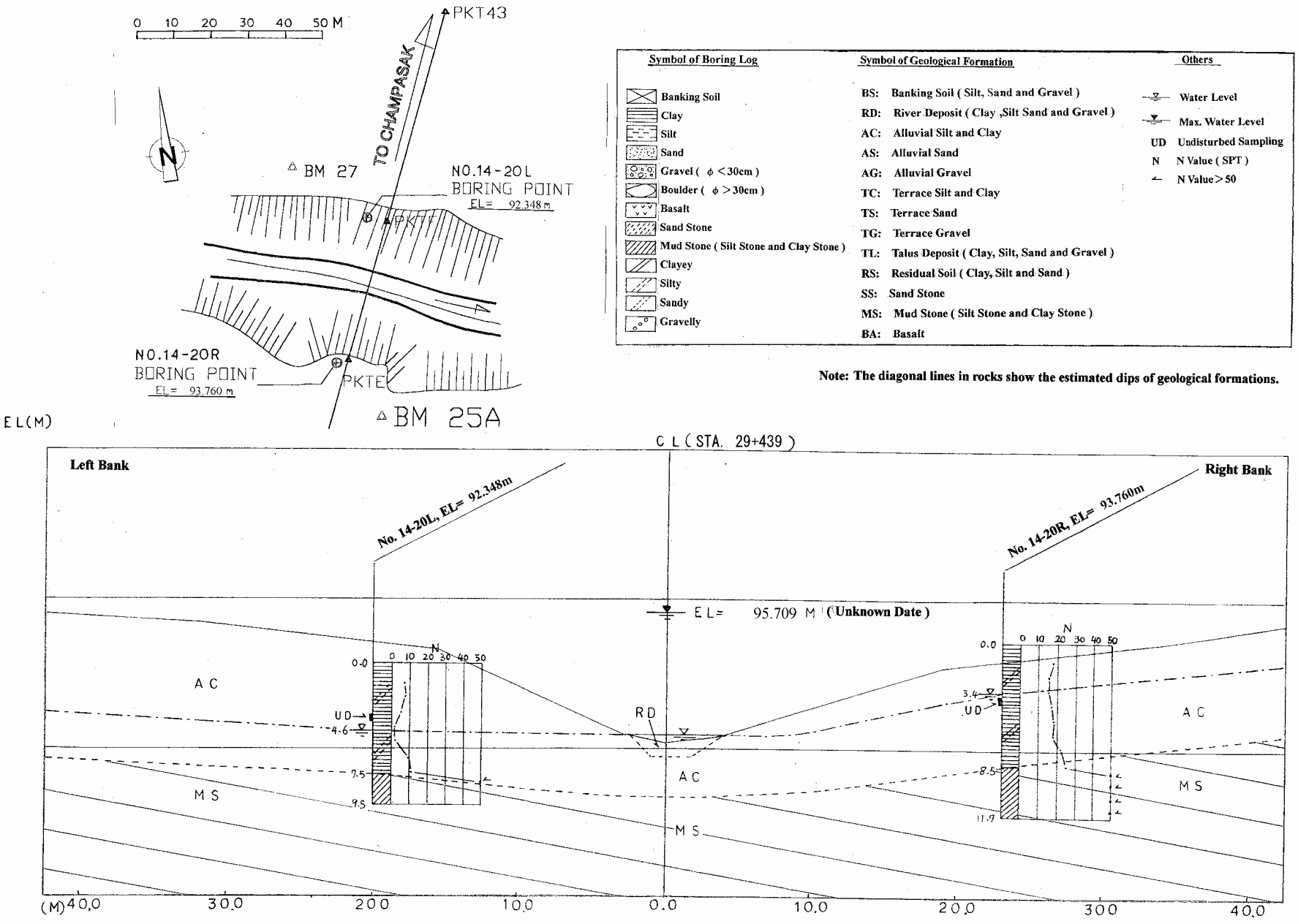


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value>50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

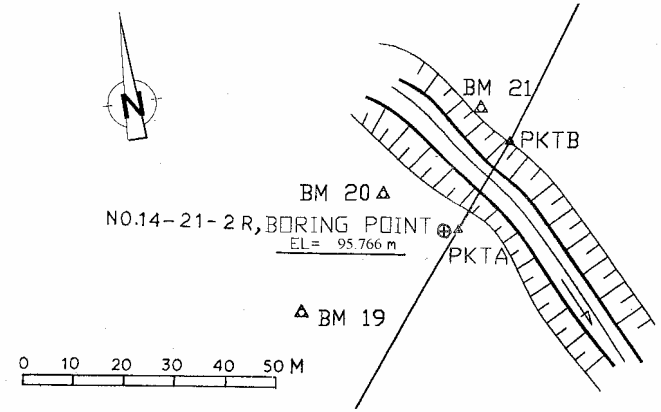
Note: The diagonal lines in rocks show the estimated dips of geological formations.



(11) Geological Cross Section for the Phapin River (No. 14-19)

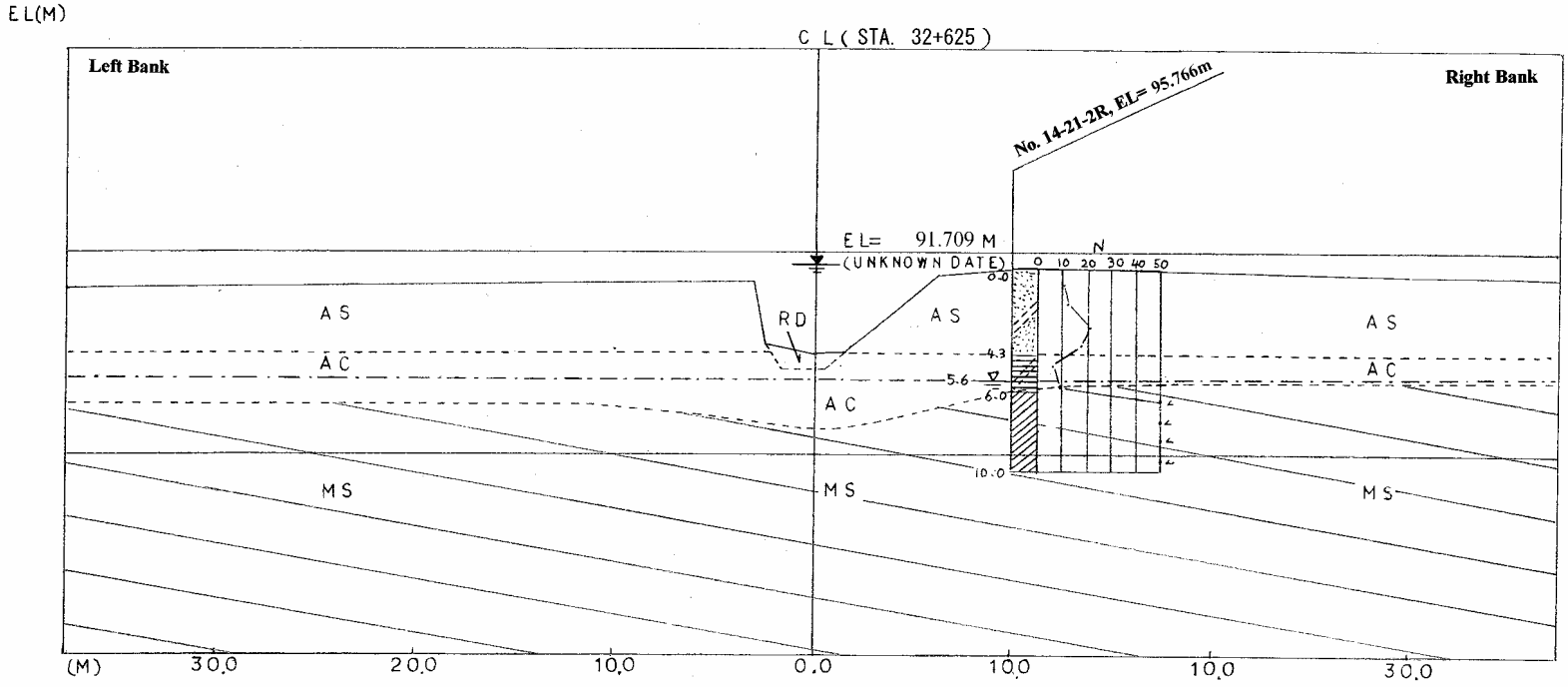


(12) Geological Cross Section for the Phabang River (No. 14-20)

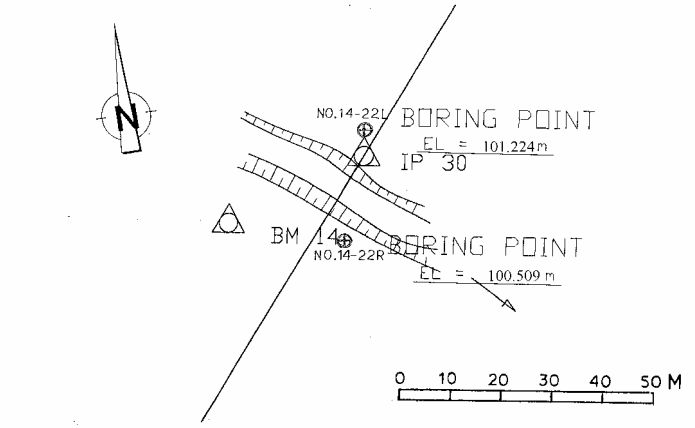


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ < 30cm)	AG: Alluvial Gravel	← N Value > 50
Boulder (ϕ > 30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.



(13) Geological Cross Section for the Kok River (No. 14-21-2)



Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
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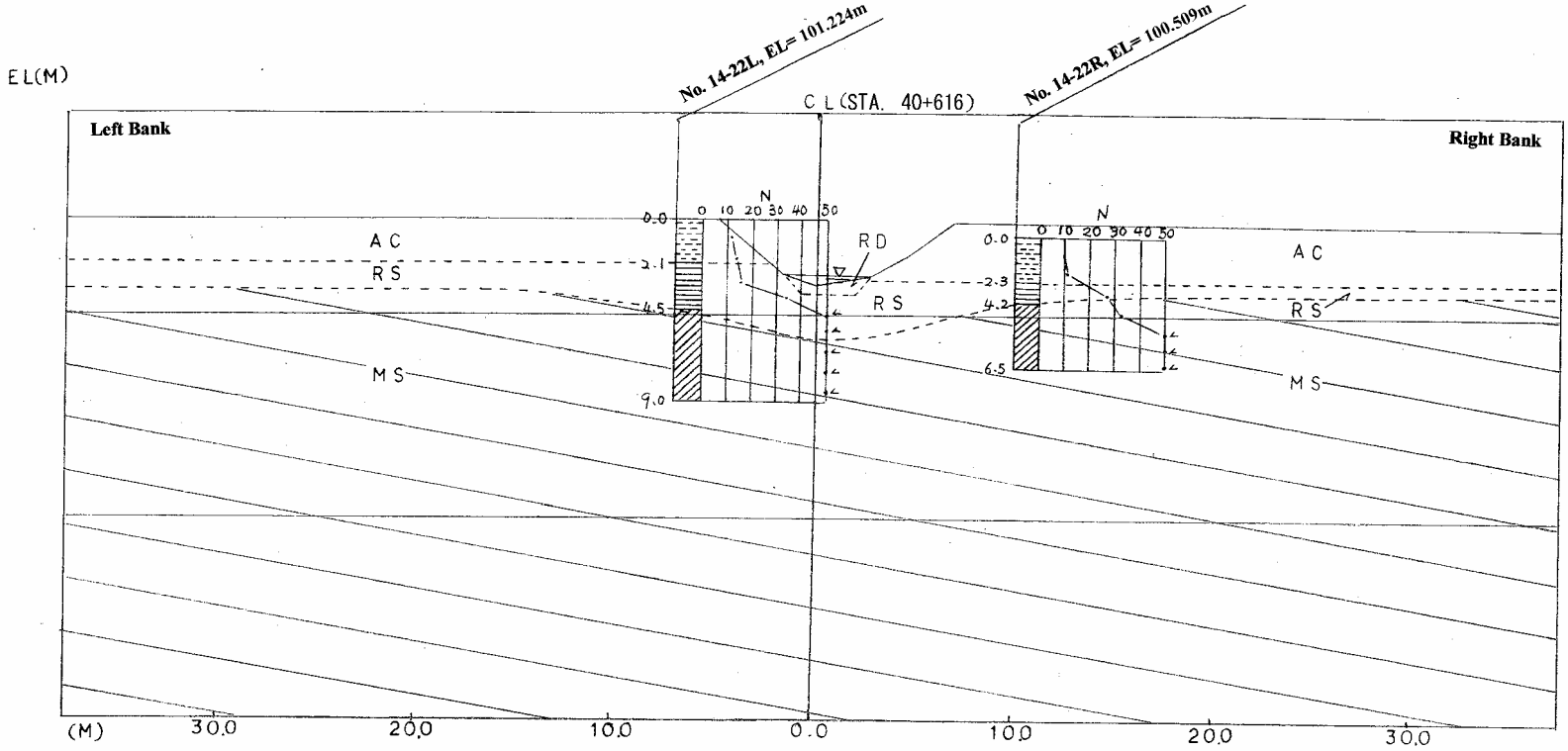
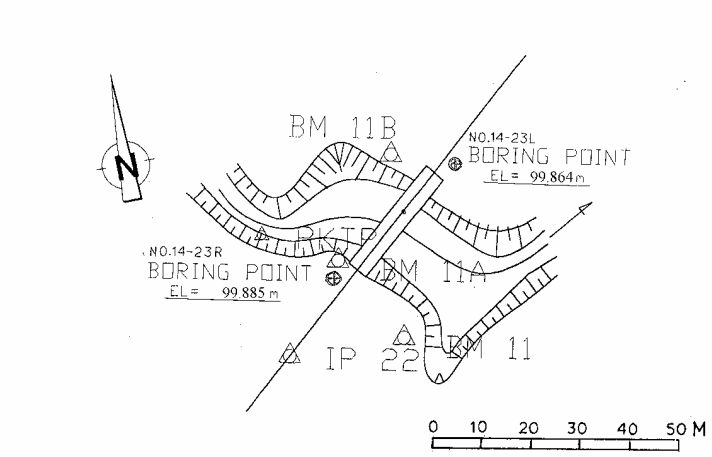
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.

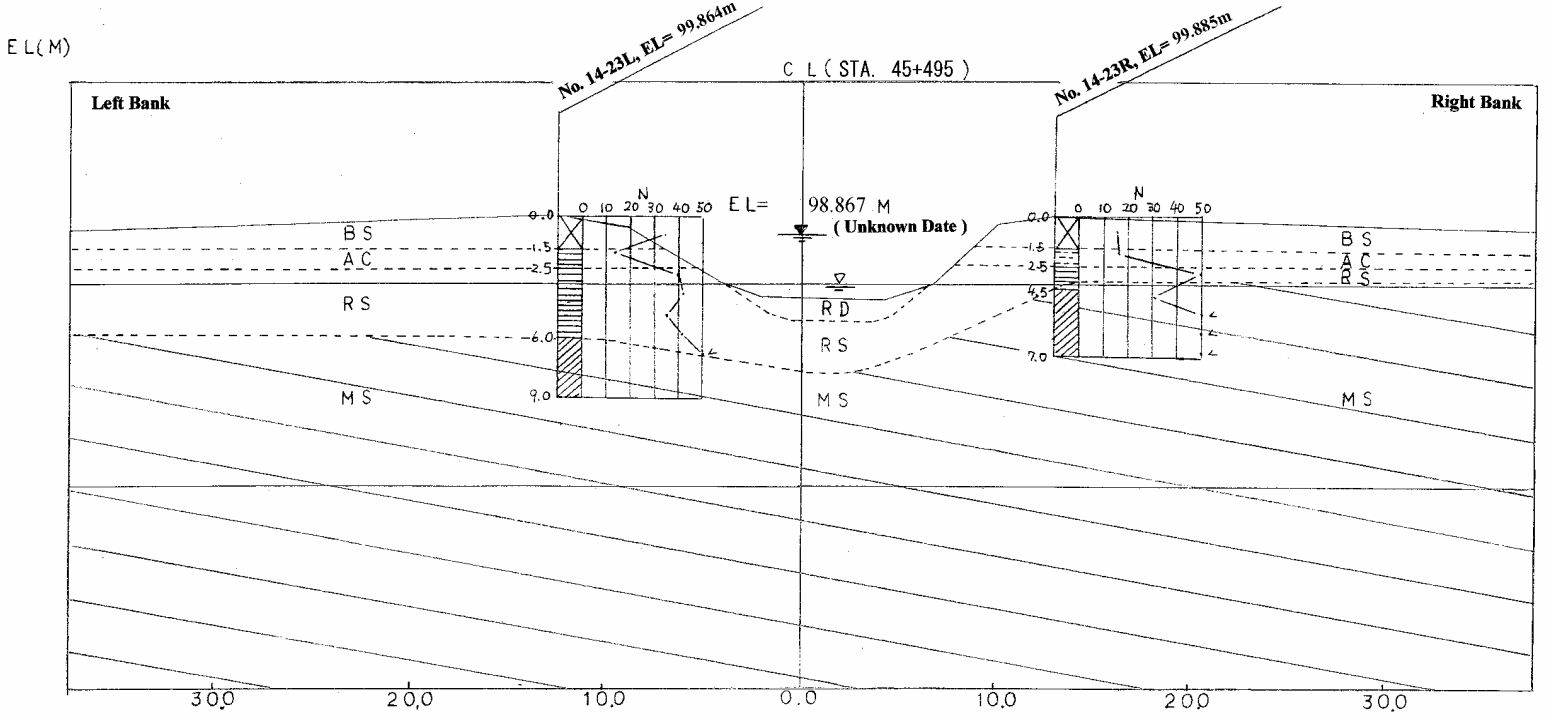


(14) Geological Cross Section for the Thateng River (No. 14-22)

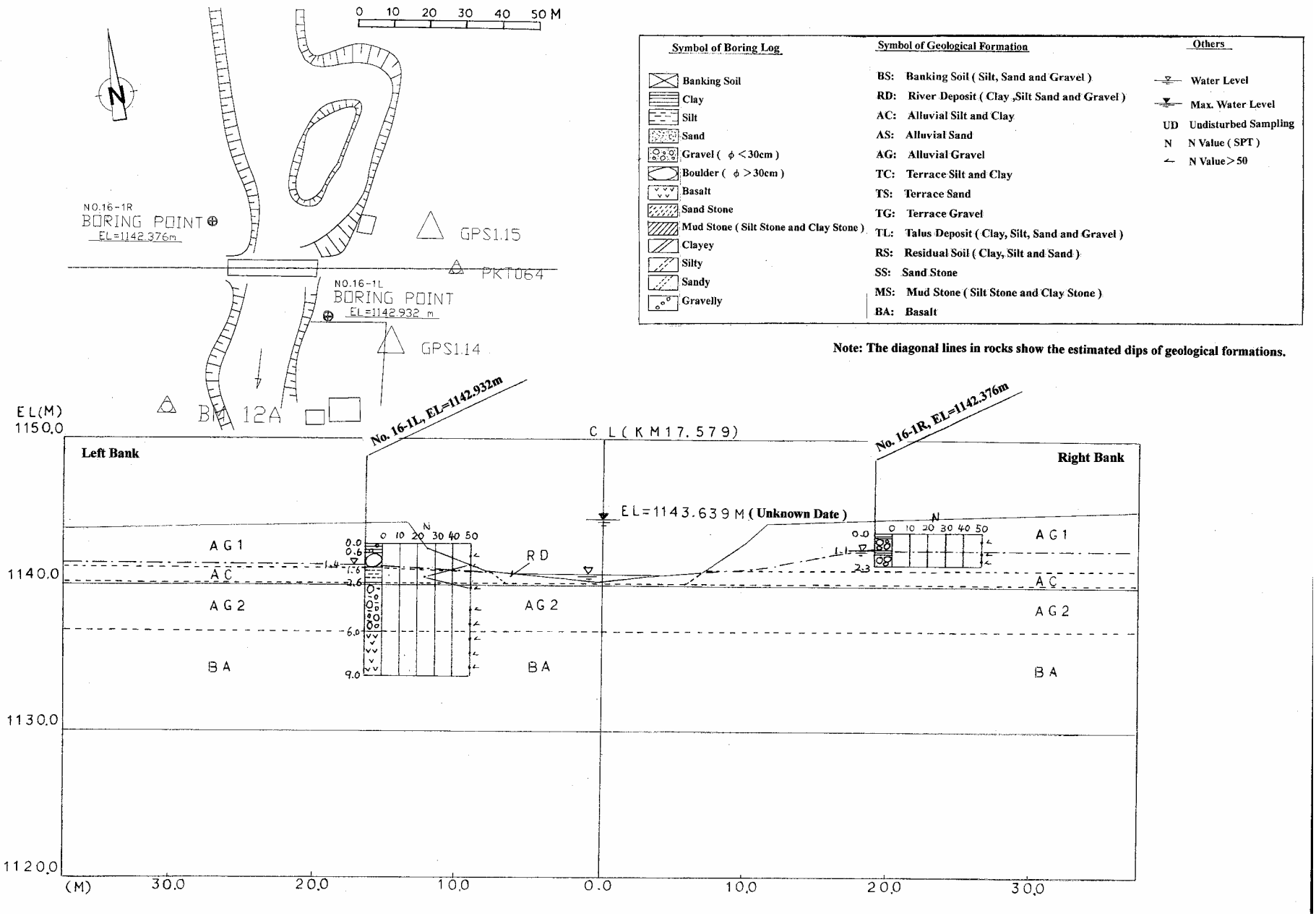


Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
Silty	SS: Sand Stone	
Sandy	MS: Mud Stone (Silt Stone and Clay Stone)	
Gravelly	BA: Basalt	

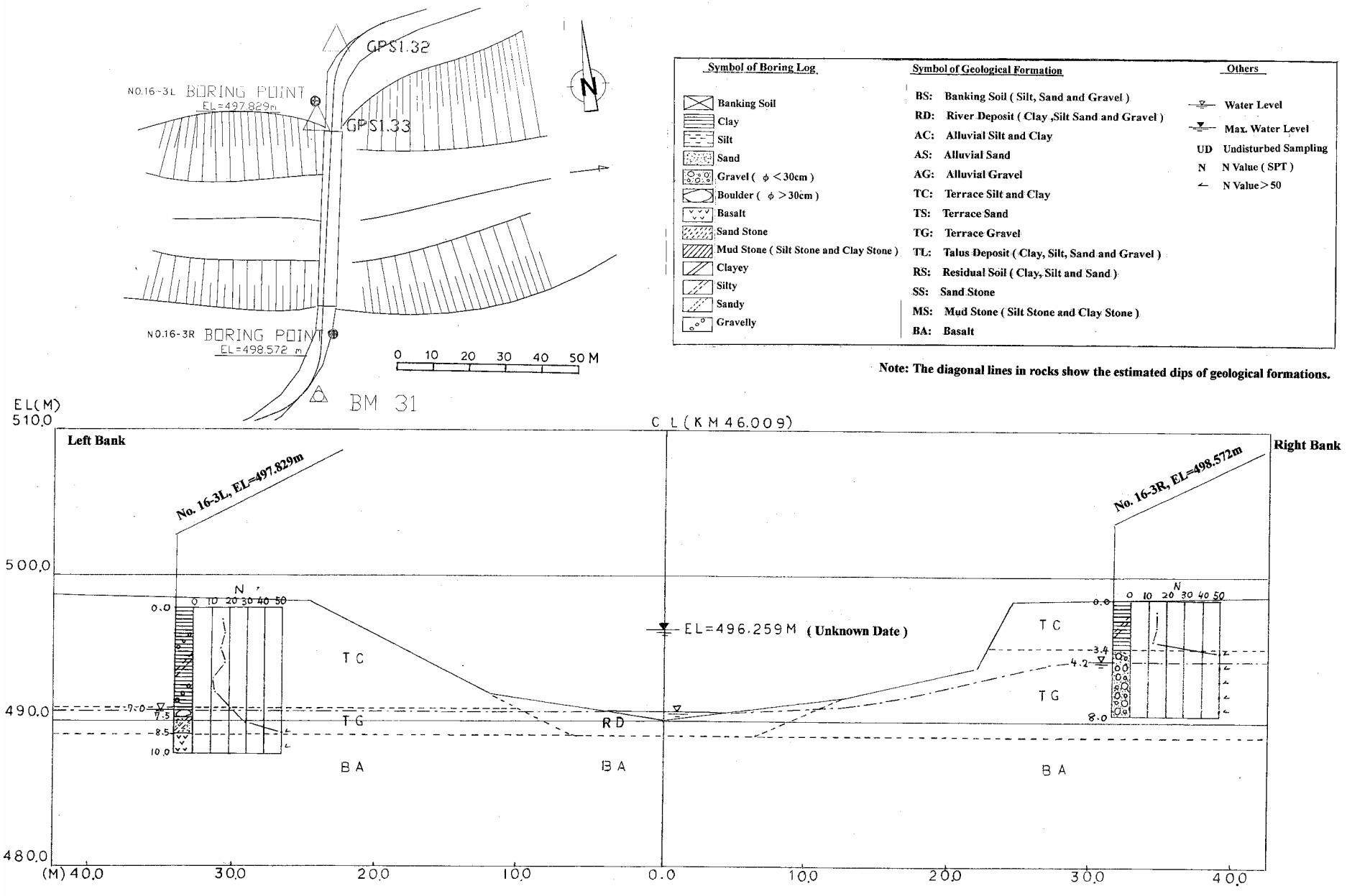
Note: The diagonal lines in rocks show the estimated dips of geological formations.



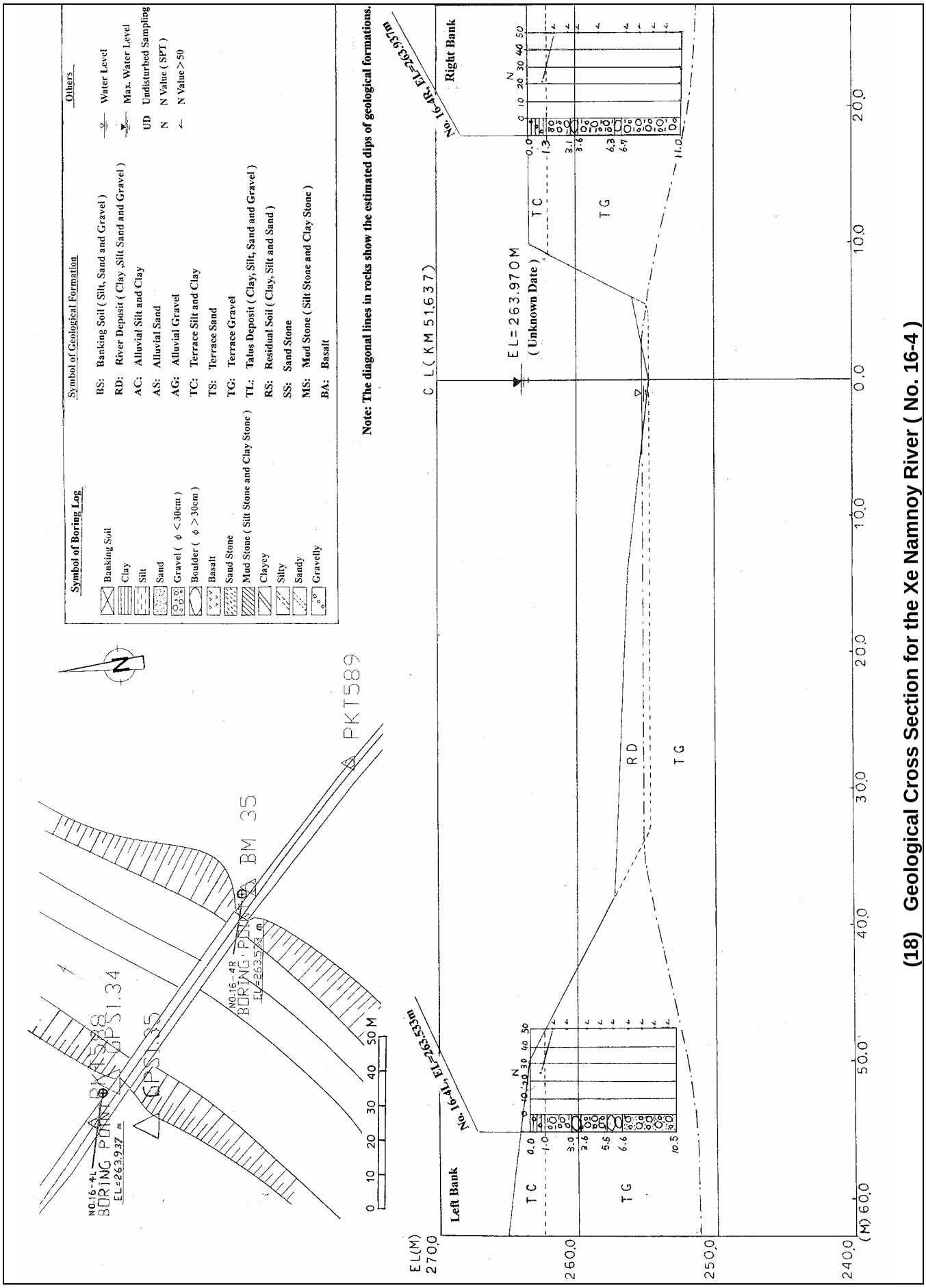
(15) Geological Cross Section for the Manpa River (No. 14-23)



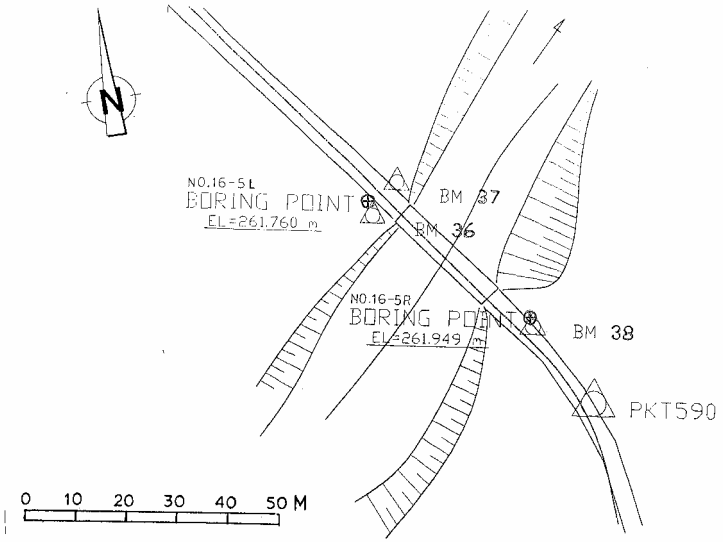
(16) Geological Cross Section for the Makchan-Gnai River (No. 16-1)



(17) Geological Cross Section for the Xe Katam River (No. 16-3)



(18) Geological Cross Section for the Xe Namnoy River (No. 16-4)



Symbol of Boring Log	Symbol of Geological Formation	Others
Banking Soil	BS: Banking Soil (Silt, Sand and Gravel)	Water Level
Clay	RD: River Deposit (Clay ,Silt Sand and Gravel)	Max. Water Level
Silt	AC: Alluvial Silt and Clay	UD Undisturbed Sampling
Sand	AS: Alluvial Sand	N N Value (SPT)
Gravel (ϕ <30cm)	AG: Alluvial Gravel	N Value > 50
Boulder (ϕ >30cm)	TC: Terrace Silt and Clay	
Basalt	TS: Terrace Sand	
Sand Stone	TG: Terrace Gravel	
Mud Stone (Silt Stone and Clay Stone)	TL: Talus Deposit (Clay, Silt, Sand and Gravel)	
Clayey	RS: Residual Soil (Clay, Silt and Sand)	
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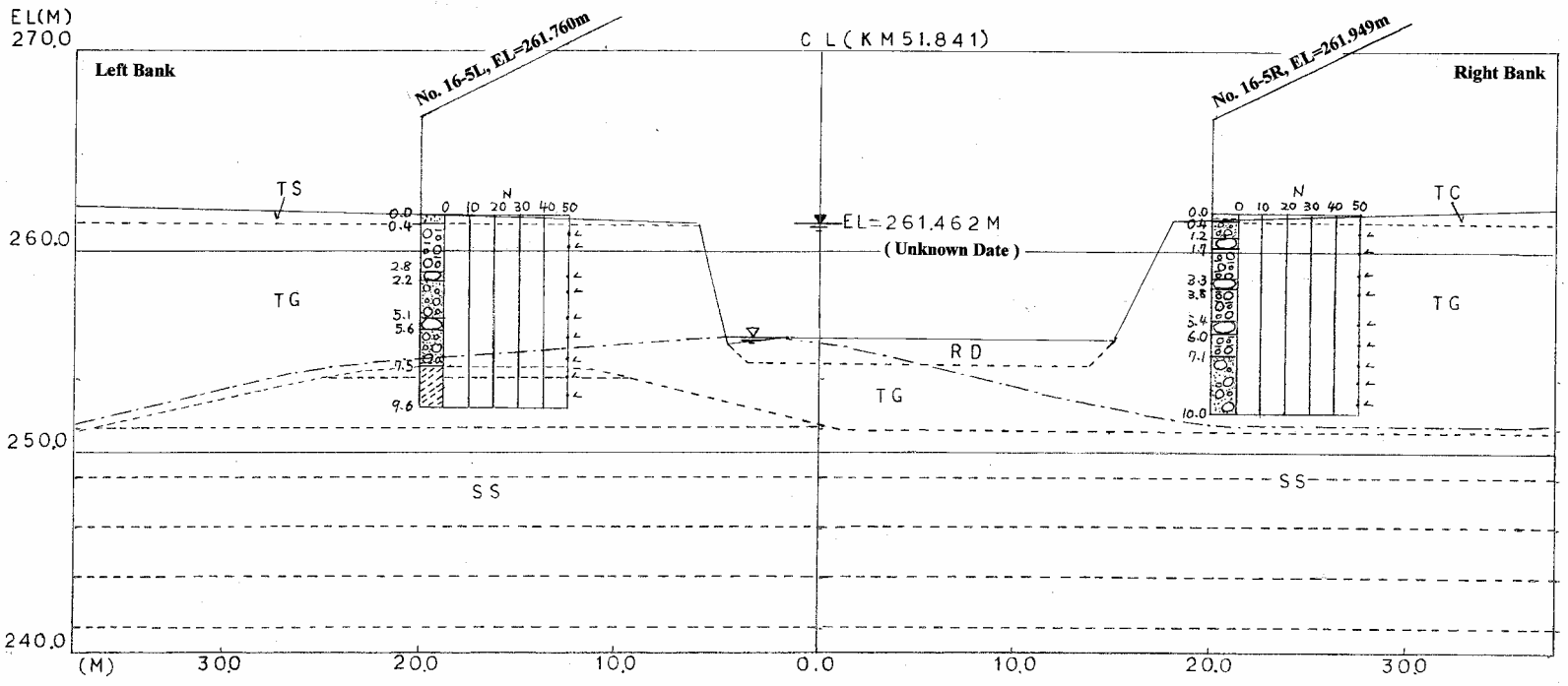
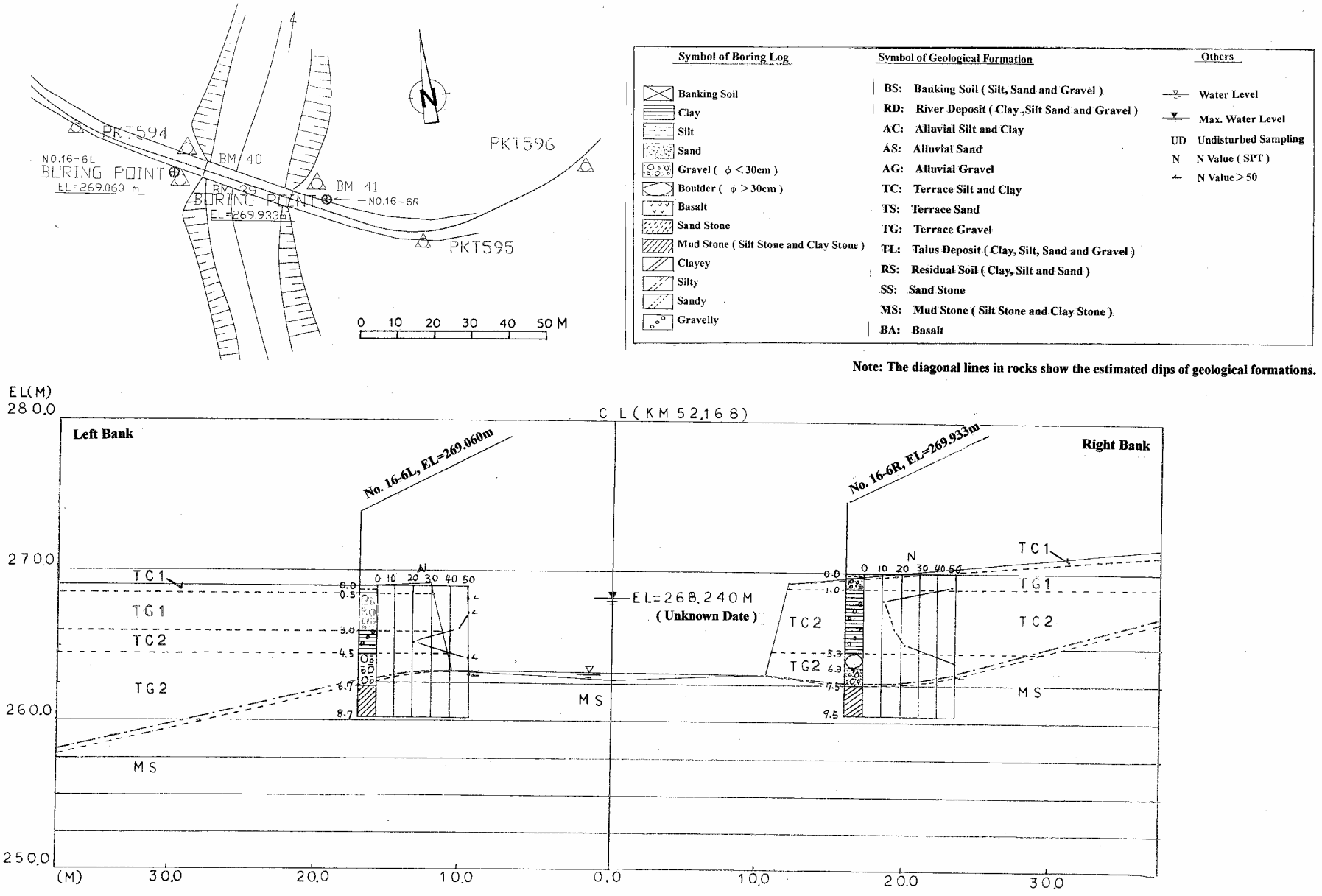
Gravelly	BA: Basalt	

Note: The diagonal lines in rocks show the estimated dips of geological formations.



(19) Geological Cross Section for the Xe Namnoy (Old Channel) River (No. 16-5)



(20) Geological Cross Section for the Katak Tok (Ho) River (No. 16-6)

ANNEX F-17
BIBLIOGRAPHY & LIST OF PEOPLE MET

ANNEX F-17 BIBLIOGRAPHY AND LIST OF PEOPLE MET

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