2.4.3 Unitgraph Derivation for Ungaged Areas

Since hydrograph records at a given point are seldom available, a means of transferring unitgraphs to ungaged areas is necessary. The factor "lag time" is used for this purpose. Lag time is an index to the time of concentration of runoff from a basin. It may be determined from recorded hydrographs and empirically correlated with basin characteristics.

Determination of a lag time for an ungaged watershed from basin measurements provides the key to unitgraph computation for that watershed if a representative dimensionless graph is known. Lag time is defined as the time from the center of excess rainfall to the time of occurrence of one-half the volume of the hydrograph used with the dimensionless graph procedure. Lag time is determined mainly by the topography and shape of the basin like overall slope. The following formula is commonly used to explain the topographic nature :

$$\frac{L.L_{ca}}{\sqrt{S}}$$

where ;

L = length of longest watercourse from point of interest to watershed divide, measured in kilometers.

ca = centroid of basin -- usually found by vertically suspending a car card board cut-out of basin shape successively from two or more points and finding inter-section of plumb lines from each point.

L_{ca} = length of water course from point of interest to inter-section of perpendicular from ca to stream alinement.

S = overall slope in feet per km of longest water source from point of interest divide.

After calculating the value of $\frac{L.Lca}{\sqrt{S}}$ based on relevant topographic map, the lag time can be estimated using the relationships between lag time and $\frac{L.Lca}{\sqrt{S}}$ obtained in the gaged basins. From the value of $\frac{L.Lca}{\sqrt{S}}$ and typical non-dimensional hydrograph, unit hydrograph for the ungaged basin can be obtained. For the Kedungwarak river, the log-time is estimated by the observed hydrograph. For Ketandan river, the log-time curve is derived from "Design Calculation Note 2 of the Tulungagung Drainage Project" (See Fig. 2.4.3).

Table 2.4.1 FLOOD RUNOFF ESTIMATED AT K.WARAK (1/8)

10 - 12 - 1982

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.06	.5	.06	.11	.11	.1
2	1.44	13.46	1.1	20.14	19.13	18.22
3	1.28	11.69	1.01	16.54	15.72	14.97
4	1.1	9.83	.9	12.9	12.25	11.67
5	.94	8.27	.8	10	9.5	9.05
6	.8	6.96	.7	7.72	7.33	6.98
7	.7	6.05	.63	6.23	5.92	5.64
8	.62	5.34	.56	5.13	4.88	4.64
9	.57	4.91	.52	4.49	4.26	4.06
10	.5	4.3	.47	3.64	3.46	3.29
11	.46	3.95	.43	3.18	3.03	2.88
12	.4	3.43	.38	2.54	2.42	2.3
13	.36	3.09	.35	2.15	2.04	1.94
14	.32	2.75	.31	1.78	1.69	1.61
15	.27	2.32	.27	1.35	1.28	1.22
16	.25	2.14	.25	1.19	1.13	1.08
17	.21	1.8	.21	.89	.85	.81
18	.18	1.54	.18	.69	.66	.63
19	.14	1.19	.14	.46	.44	.42
20	.12	1.02	.12	.36	.34	.32
21	.1	.85	.1	.26	.25	.24
22	.09	.76	.09	.22	.21	.2
23	.08	.67	.08	.18	.17	.16
0	0	0	0	11.7	11.1	10.6

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Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD.WARAK (2/8)

25 - 12 - 1982

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.2	1.71	.2	.83	.78	.75
2	1.4	13.01	1.08	19.21	18.25	17.38
3	2.18	23.2	1.44	41.64	39.56	37.67
4	2.72	32.11	1.66	63.41	60.24	57.37
5	2.88	35.04	1.73	71.06	67.51	64.29
6	2.66	31.05	1.64	60.69	57.65	54.91
7	2.28	24.73	1.48	45.24	42.98	40.93
8	1.82	18.11	1.28	30.11	28.61	27.25
9	1.56	14.85	1.16	23.06	21.91	20.87
10	1.4	13.01	1.08	19.21	18.25	17.38
11	1.29	11.8	1.01	16.76	15.92	15.16
12	1.21	10.95	.97	15.08	14.32	13.64
13	1.13	10.13	.92	13.48	12.8	12.19
14	1.06	9.43	.88	12.14	11.54	10.99
15	.99	8.75	.83	10.87	10.33	9.84
16	.92	8.08	.78	9.66	9.17	8.74
17	.86	7.51	.74	8.67	8.23	7.84
18	.81	7.05	.71	7.87	7.48	7.12
19	.79	6.87	.69	7.56	7.18	6.84
20	.73	6.32	.65	6.66	6.33	6.03
21	.68	5.88	.61	5.95	5.65	5.38
22	.63	5.43	.57	5.27	5	4.76
23	.59	5.08	.54	4.74	4.51	4.29
24	.55	4.73	.51	4.24	4.03	3.84
25	.52	4.47	.48	3.88	3.68	3.51
26	.49	4.21	.46	3.52	3.35	3.19
27	.46	3.95	.43	3.18	3.03	2.88
28	.44	3.78	.42	2.97	2.82	2.68
29	.42	3.6	.4	2.75	2.61	2.49
30	.4	3.43	.38	2.54	2.42	2.3
31	.38	3.26	.37	2.34	2.23	2.12
32	.36	3.09	.35	2.15	2.04	1.94
33	.34	2.92	.33	1.96	1.86	1.77
34	.33	2.83	.32	1.87	1.77	1.69
35	.32	2.75	.31	1.78	1.69	1.61
36	.31	2.66	.3	1.69	1.6	1.53
37	.3	2.57	.29	1.6	1.52	1.45
38	.29	2.49	.28	1.51	1.44	1.37
39	.29	2.49	.28	1.51	1.44	1.37
0	0	0	0	61.2	58.1	55.3

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Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD.WARAK (3/8)

16 - 1 - 1983

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	1.36	12.56	1.05	18.3	17.38	16.56
2	1.3	11.91	1.02	16.98	16.13	15.36
3	1.22	11.06	.97	15.28	14.52	13.83
4	1.17	10.54	.94	14.27	13.55	12.91
5	1.11	9.93	.91	13.09	12.44	11.84
6	1.06	9.43	.88	12.14	11.54	10.99
7	1.02	9.04	.85	11.41	10.84	10.32
8	.95	8.36	.8	10.17	9.66	9.2
9	.89	7.79	.76	9.16	8.7	8.28
10	.84	7.33	.73	8.34	7.93	7.55
11	.79	6.87	.69	7.56	7.18	6.84
12	.74	6.41	.66	6.81	6.47	6.16
13	.7	6.05	.63	6.23	5.92	5.64
14	.66	5.7	.6	5.67	5.39	5.13
15	.62	5.34	.56	5.13	4.88	4.64
16	.59	5.08	.54	4.74	4.51	4.29
17	.57	4.91	.52	4.49	4.26	4.06
18	.54	4.64	.5	4.12	3.91	3.72
19	.52	4.47	.48	3.88	3.68	3.51
20	.5	4.3	.47	3.64	3.46	3.29
21	.48	4.12	.45	3.41	3.24	3.08
22	.46	3.95	.43	3.18	3.03	2.88
23	.44	3.78	.42	2.97	2.82	2.68
24	.42	3.6	.4	2.75	2.61	2.49
25	.39	3.35	.37	2.44	2.32	2.21
26	.38	3.26	.37	2.34	2.23	2.12
27	.36	3.09	.35	2.15	2.04	1.94
28	.34	2.92	.33	1.96	1.86	1.77
29	.32	2.75	.31	1.78	1.69	1.61
30	.31	2.66	.3	1.69	1.6	1.53
31	.3	2.57	.29	1.6	1.52	1.45
32	.28	2.4	.28	1.43	1.36	1.29
33	.27	2.32	.27	1.35	1.28	1.22
34	.26	2.23	.26	1.27	1.2	1.15
35	.25	2.14	.25	1.19	1.13	1.08
36	.24	2.06	.24	1.11	1.06	1.01
37	.23	1.97	.23	1.04	.99	.94
38	.22	1.89	.22	.97	.92	.87
39	.21	1.8	.21	.89	.85	.81
40	.21	1.8	.21	.89	.85	.81
41	.2	1.71	.2	.83	.78	.75
0	0	0	0	24.8	23.6	22.5

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Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD. WARAK (4/8)

5 - 2 - 1983

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.2	1.71	.2	.83	.78	.75
2	.8	6.96	.7	7.72	7.33	6.98
3	.9	7.89	.77	9.32	8.86	8.43
4	1.6	15.33	1.18	24.08	22.88	21.79
5	1.76	17.33	1.26	28.4	26.98	25.69
6	1.82	18.11	1.28	30.11	28.61	27.25
7	1.65	15.94	1.2	25.39	24.12	22.97
8	1.52	14.38	1.14	22.07	20.96	19.96
9	1.41	13.12	1.08	19.44	18.47	17.59
10	1.31	12.01	1.03	17.19	16.33	15.56
11	1.28	11.69	1.01	16.54	15.72	14.97
12	1.23	11.16	.98	15.49	14.72	14.02
13	1.18	10.64	.95	14.47	13.75	13.09
14	1.16	10.44	.94	14.07	13.37	12.73
15	1.12	10.03	.91	13.28	12.62	12.02
16	1.08	9.63	.89	12.52	11.89	11.33
17	1.05	9.33	.87	11.96	11.36	10.82
18	1.02	9.04	.85	11.41	10.84	10.32
19	.98	8.65	.82	10.69	10.16	9.68
20	.95	8.36	.8	10.17	9.66	9.2
21	.91	7.98	.78	9.49	9.01	8.59
22	.87	7.61	.75	8.83	8.39	7.99
23	.84	7.33	.73	8.34	7.93	7.55
24	.81	7.05	.71	7.87	7.48	7.12
25	.88	7.7	.76	8.99	8.54	8.13
26	2.04	21.14	1.38	36.9	35.05	33.38
27	2.8	33.56	1.7	67.16	63.8	60.76
28	3.14	40.07	1.85	84.88	80.63	76.79
29	2.88	35.04	1.73	71.06	67.51	64.29
30	2.5	28.29	1.57	53.82	51.13	48.7
31	2.06	21.43	1.39	37.55	35.68	33.98
32	1.83	18.24	1.29	30.4	28.88	27.51
33	1.64	15.82	1.2	25.13	23.87	22.73
34	1.55	14.73	1.15	22.81	21.67	20.64
35	1.44	13.46	1.1	20.14	19.13	18.22
36	1.35	12.45	1.05	18.07	17.17	16.35
37	1.3	11.91	1.02	16.98	16.13	15.36
38	1.24	11.27	.99	15.7	14.91	14.2
39	1.18	10.64	.95	14.47	13.75	13.09
40	1.14	10.23	.93	13.67	12.99	12.37
41	1.09	9.73	.89	12.71	12.07	11.5
42	1.05	9.33	.87	11.96	11.36	10.82
43	1	8.84	.84	11.05	10.5	10
44	.95	8.36	.8	10.17	9.66	9.2
45	.9	7.89	.77	9.32	8.86	8.43
46	.86	7.51	.74	8.67	8.23	7.84
47	.82	7.14	.71	8.03	7.63	7.26
48	.78	6.78	.69	7.41	7.04	6.7

- to be continued -

!	49 !	.75 !	6.5 !	.66 !	6.96 !	6.61 !	6.3 !
!	50 !	.72 !	6.23 !	.64 !	6.52 !	6.19 !	5.9 !
!	51 !	.68 !	5.88 !	.61 !	5.95 !	5.65 !	5.38 !
!	52 !	.65 !	5.61 !	.59 !	5.54 !	5.26 !	5.01 !
!	53 !	.62 !	5.34 !	.56 !	5.13 !	4.88 !	4.64 !
!	54 !	.59 !	5.08 !	.54 !	4.74 !	4.51 !	4.29 !
!	55 !	.57 !	4.91 !	.52 !	4.49 !	4.26 !	4.06 !
!	56 !	.54 !	4.64 !	.5 !	4.12 !	3.91 !	3.72 !
!	57 !	.52 !	4.47 !	.48 !	3.88 !	3.68 !	3.51 !
!	58 !	.5 !	4.3 !	.47 !	3.64 !	3.46 !	3.29 !
!	59 !	.48 !	4.12 !	.45 !	3.41 !	3.24 !	3.08 !
!	60 !	.46 !	3.95 !	.43 !	3.18 !	3.03 !	2.88 !
!	61 !	.45 !	3.86 !	.43 !	3.07 !	2.92 !	2.78 !
!	62 !	.43 !	3.69 !	.41 !	2.86 !	2.72 !	2.59 !
!	63 !	.42 !	3.6 !	.4 !	2.75 !	2.61 !	2.49 !
!	64 !	.41 !	3.52 !	.39 !	2.65 !	2.52 !	2.4 !
!	65 !	.39 !	3.35 !	.37 !	2.44 !	2.32 !	2.21 !
!	66 !	.38 !	3.26 !	.37 !	2.34 !	2.23 !	2.12 !
!	67 !	.37 !	3.18 !	.36 !	2.24 !	2.13 !	2.03 !
!	68 !	.36 !	3.09 !	.35 !	2.15 !	2.04 !	1.94 !
!	69 !	.35 !	3 !	.34 !	2.05 !	1.95 !	1.86 !
!	70 !	.34 !	2.92 !	.33 !	1.96 !	1.86 !	1.77 !
!	71 !	.33 !	2.83 !	.32 !	1.87 !	1.77 !	1.69 !
!	72 !	.32 !	2.75 !	.31 !	1.78 !	1.69 !	1.61 !
!	73 !	.31 !	2.66 !	.3 !	1.69 !	1.6 !	1.53 !
!	74 !	.3 !	2.57 !	.29 !	1.6 !	1.52 !	1.45 !
!	75 !	.29 !	2.49 !	.28 !	1.51 !	1.44 !	1.37 !
!	76 !	.29 !	2.49 !	.28 !	1.51 !	1.44 !	1.37 !
!	77 !	.28 !	2.4 !	.28 !	1.43 !	1.36 !	1.29 !
!	78 !	.27 !	2.32 !	.27 !	1.35 !	1.28 !	1.22 !
!	79 !	.27 !	2.32 !	.27 !	1.35 !	1.28 !	1.22 !
!	80 !	.26 !	2.23 !	.26 !	1.27 !	1.2 !	1.15 !
!	0 !	0 !	0 !	0 !	120.9 !	114.8 !	109.3 !

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Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD.WARAK (5/8)

17 - 1 - 1984

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.21	1.8	.21	.89	.85	.81
2	1.16	10.44	.94	14.07	13.37	12.73
3	1.6	15.33	1.18	24.08	22.88	21.79
4	1.72	16.82	1.24	27.28	25.92	24.68
5	1.5	14.15	1.13	21.58	20.5	19.52
6	1.34	12.34	1.04	17.85	16.96	16.15
7	1.25	11.37	.99	15.91	15.11	14.39
8	1.19	10.75	.96	14.67	13.94	13.27
9	1.1	9.83	.9	12.9	12.25	11.67
10	1.05	9.33	.87	11.96	11.36	10.82
11	1	8.84	.84	11.05	10.5	10
12	.95	8.36	.8	10.17	9.66	9.2
13	.91	7.98	.78	9.49	9.01	8.59
14	.87	7.61	.75	8.83	8.39	7.99
15	.83	7.23	.72	8.19	7.78	7.41
16	.79	6.87	.69	7.56	7.18	6.84
17	.75	6.5	.66	6.96	6.61	6.3
18	.71	6.14	.63	6.37	6.06	5.77
19	.66	5.7	.6	5.67	5.39	5.13
20	.63	5.43	.57	5.27	5	4.76
21	.6	5.17	.55	4.87	4.63	4.41
22	.56	4.82	.52	4.36	4.14	3.95
23	.52	4.47	.48	3.88	3.68	3.51
24	.48	4.12	.45	3.41	3.24	3.08
25	.44	3.78	.42	2.97	2.82	2.68
26	.41	3.52	.39	2.65	2.52	2.4
27	.37	3.18	.36	2.24	2.13	2.03
28	.33	2.83	.32	1.87	1.77	1.69
29	.3	2.57	.29	1.6	1.52	1.45
30	.26	2.23	.26	1.27	1.2	1.15
31	.24	2.06	.24	1.11	1.06	1.01
32	.22	1.89	.22	.97	.92	.87
33	.2	1.71	.2	.83	.78	.75
34	.19	1.63	.19	.76	.72	.69
35	.18	1.54	.18	.69	.66	.63
36	.18	1.54	.18	.69	.66	.63
37	.18	1.54	.18	.69	.66	.63
0	0	0	0	31.3	29.7	28.3

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Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD.WARAK (6/8)

22 - 1 - 1984

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.16	1.37	.16	.57	.54	.52
2	1.6	15.33	1.18	24.08	22.88	21.79
3	2.1	22.01	1.41	38.89	36.94	35.18
4	2.21	23.65	1.45	42.7	40.56	38.63
5	1.9	19.18	1.32	32.49	30.87	29.4
6	1.64	15.82	1.2	25.13	23.87	22.73
7	1.4	13.01	1.08	19.21	18.25	17.38
8	1.28	11.67	1.01	16.54	15.72	14.97
9	1.17	10.54	.94	14.27	13.55	12.91
10	1.06	9.63	.89	12.52	11.89	11.33
11	1.02	9.04	.85	11.41	10.84	10.32
12	.96	8.46	.81	10.34	9.83	9.36
13	.91	7.98	.78	9.49	9.01	8.59
14	.86	7.51	.74	8.67	8.23	7.84
15	.82	7.14	.71	8.03	7.63	7.26
16	.78	6.78	.69	7.41	7.04	6.7
17	.73	6.32	.65	6.66	6.33	6.03
18	.67	5.79	.6	5.81	5.52	5.26
19	.62	5.34	.56	5.13	4.88	4.64
20	.58	4.99	.53	4.61	4.38	4.18
21	.53	4.56	.49	4	3.8	3.61
22	.5	4.3	.47	3.64	3.46	3.29
23	.46	3.95	.43	3.18	3.03	2.88
24	.43	3.69	.41	2.86	2.72	2.59
25	.4	3.43	.38	2.54	2.42	2.3
26	.38	3.26	.37	2.34	2.23	2.12
27	.36	3.09	.35	2.15	2.04	1.94
28	.34	2.92	.33	1.96	1.86	1.77
29	.33	2.83	.32	1.87	1.77	1.69
30	.31	2.66	.3	1.69	1.6	1.53
31	.29	2.49	.28	1.51	1.44	1.37
32	.27	2.32	.27	1.35	1.28	1.22
33	.26	2.23	.26	1.27	1.2	1.15
34	.24	2.06	.24	1.11	1.06	1.01
35	.23	1.97	.23	1.04	.99	.94
36	.21	1.8	.21	.89	.85	.81
37	.2	1.71	.2	.83	.78	.75
38	.19	1.63	.19	.76	.72	.69
39	.18	1.54	.18	.69	.66	.63
40	.17	1.45	.17	.63	.6	.57
41	.17	1.45	.17	.63	.6	.57
42	.17	1.45	.17	.63	.6	.57
43	.16	1.37	.16	.57	.54	.52
44	.16	1.37	.16	.57	.54	.52
0	0	0	0	38.9	37	35.2

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Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD.WARAK (7/8)

26 - 1 - 1984

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.17	1.45	.17	.63	.6	.57
2	.8	6.96	.7	7.72	7.33	6.98
3	1.5	14.15	1.13	21.58	20.5	19.52
4	2.03	21	1.38	36.57	34.74	33.09
5	1.95	19.87	1.34	34.03	32.33	30.79
6	1.75	17.2	1.25	28.12	26.71	25.44
7	1.6	15.33	1.18	24.08	22.88	21.79
8	1.48	13.91	1.12	21.09	20.04	19.08
9	1.36	12.56	1.05	18.3	17.38	16.56
10	1.27	11.59	1	16.33	15.51	14.78
11	1.17	10.54	.94	14.27	13.55	12.91
12	1.1	9.83	.9	12.9	12.25	11.67
13	1.04	9.23	.86	11.77	11.19	10.65
14	.96	8.46	.81	10.34	9.83	9.36
15	.9	7.89	.77	9.32	8.86	8.43
16	.84	7.33	.73	8.34	7.93	7.55
17	.78	6.78	.69	7.41	7.04	6.7
18	.72	6.23	.64	6.52	6.19	5.9
19	.66	5.7	.6	5.67	5.39	5.13
20	.6	5.17	.55	4.87	4.63	4.41
21	.56	4.82	.52	4.36	4.14	3.95
22	.52	4.47	.48	3.88	3.68	3.51
23	.49	4.21	.46	3.52	3.35	3.19
24	.45	3.86	.43	3.07	2.92	2.78
25	.44	3.78	.42	2.97	2.82	2.68
26	.4	3.43	.38	2.54	2.42	2.3
27	.37	3.18	.36	2.24	2.13	2.03
28	.34	2.92	.33	1.96	1.86	1.77
29	.32	2.75	.31	1.78	1.69	1.61
30	.3	2.57	.29	1.6	1.52	1.45
31	.27	2.32	.27	1.35	1.28	1.22
32	.25	2.14	.25	1.19	1.13	1.08
33	.24	2.06	.24	1.11	1.06	1.01
34	.22	1.89	.22	.97	.92	.87
35	.2	1.71	.2	.83	.78	.75
36	.2	1.71	.2	.83	.78	.75
37	.19	1.63	.19	.76	.72	.69
38	.18	1.54	.18	.69	.66	.63
39	.18	1.54	.18	.69	.66	.63
0	0	0	0	38.2	36.3	34.5

PR#0

Table 2.4.1 FLOOD RUNOFF ESTIMATED AT KD.WARAK (8/8)

6 - 2 - 1984

HOUR	GAUGE READ	FLOW AREA	HY. DEPTH	N= 0.095	N= 0.100	N= 0.105
1	.23	1.97	.23	1.04	.99	.94
2	.5	4.3	.47	3.64	3.46	3.29
3	2.13	22.45	1.42	39.91	37.91	36.11
4	2	20.57	1.37	35.61	33.83	32.21
5	1.76	17.33	1.26	28.4	26.98	25.69
6	1.5	14.15	1.13	21.58	20.5	19.52
7	1.3	11.91	1.02	16.98	16.13	15.36
8	1.14	10.23	.93	13.67	12.99	12.37
9	1.09	9.73	.89	12.71	12.07	11.5
10	1.04	9.23	.86	11.77	11.19	10.65
11	.97	8.55	.82	10.52	9.99	9.52
12	.9	7.89	.77	9.32	8.86	8.43
13	.83	7.24	.72	8.19	7.78	7.41
14	.78	6.78	.69	7.41	7.04	6.7
15	.73	6.32	.65	6.66	6.33	6.03
16	.69	5.96	.62	6.09	5.79	5.51
17	.65	5.61	.59	5.54	5.26	5.01
18	.62	5.34	.56	5.13	4.88	4.64
19	.58	4.99	.53	4.61	4.38	4.18
20	.56	4.82	.52	4.36	4.14	3.95
21	.53	4.56	.49	4	3.8	3.61
22	.5	4.3	.47	3.64	3.46	3.29
23	.48	4.12	.45	3.41	3.24	3.08
24	.46	3.95	.43	3.18	3.03	2.88
25	.44	3.78	.42	2.97	2.82	2.68
26	.43	3.69	.41	2.86	2.72	2.59
27	.41	3.52	.39	2.65	2.52	2.4
28	.39	3.35	.37	2.44	2.32	2.21
29	.38	3.26	.37	2.34	2.23	2.12
30	.37	3.18	.36	2.24	2.13	2.03
31	.35	3	.34	2.05	1.95	1.86
32	.34	2.92	.33	1.96	1.86	1.77
33	.33	2.83	.32	1.87	1.77	1.69
34	.31	2.66	.3	1.69	1.6	1.53
35	.3	2.57	.29	1.6	1.52	1.45
36	.29	2.49	.28	1.51	1.44	1.37
37	.28	2.4	.28	1.43	1.36	1.29
0	0	0	0	33.5	31.8	30.3

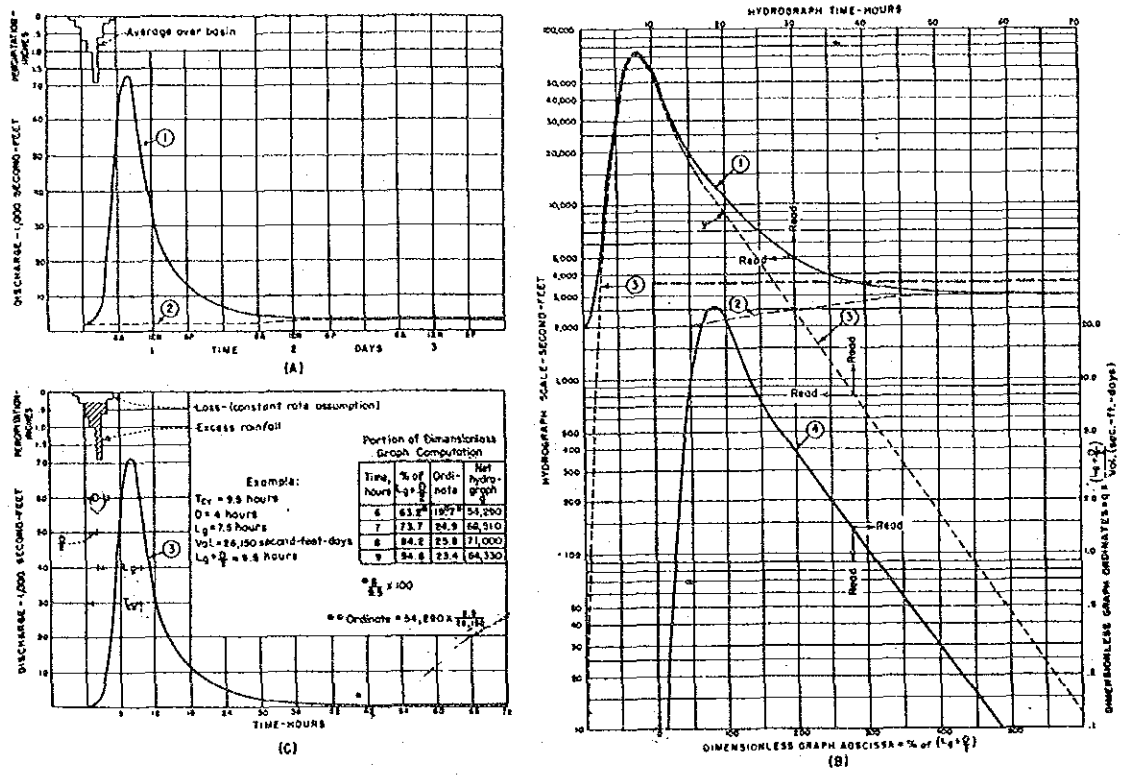


Fig. 2.4.1 Hydrograph analysis. 288–D–2457.

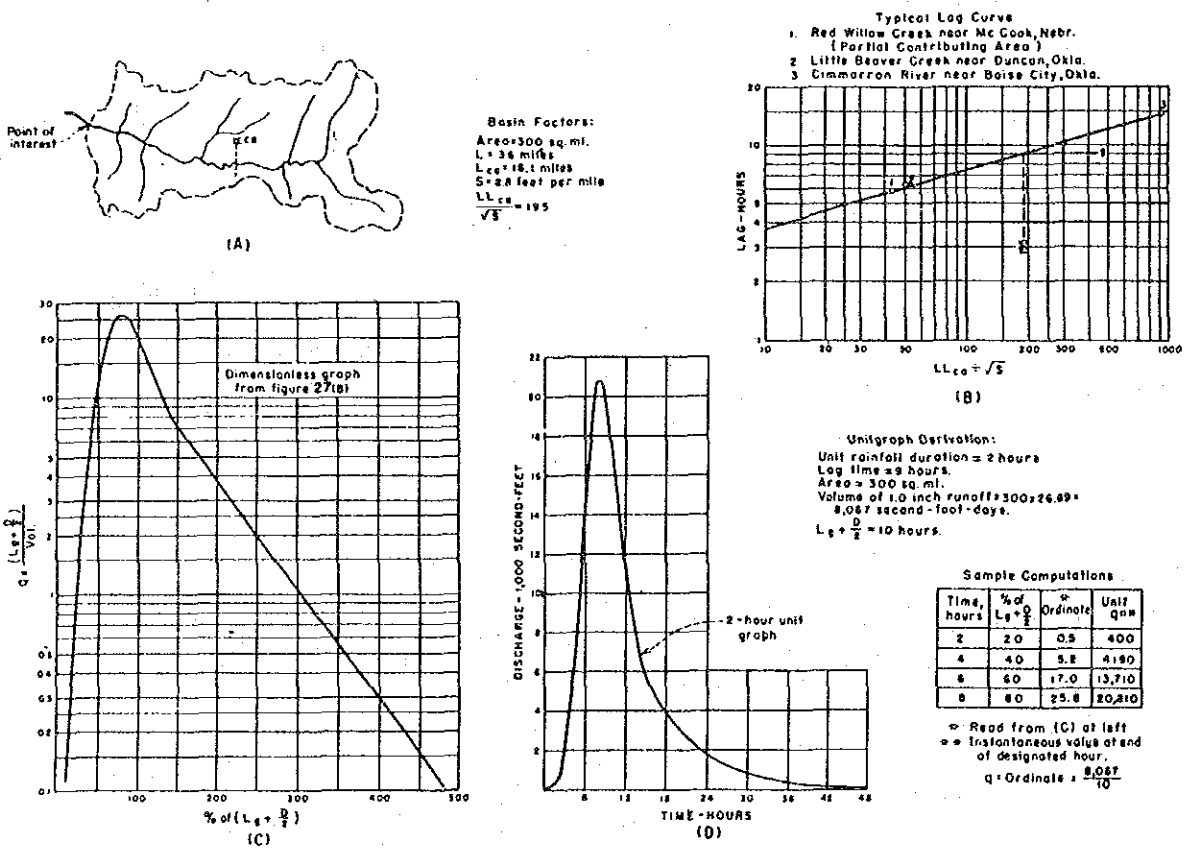
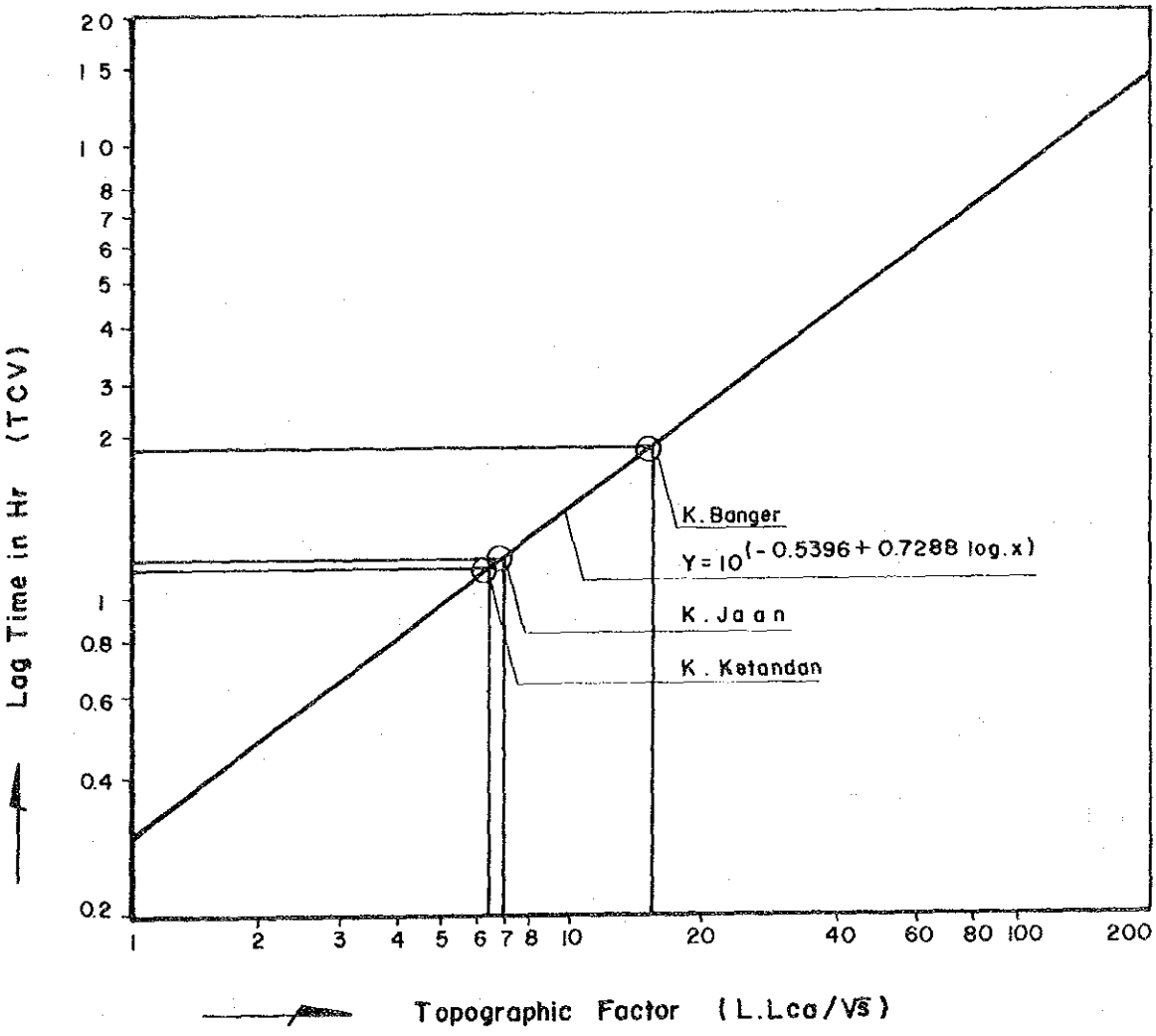


Fig. 2.4.2 Unitgraph derivation for ungaged area. 288–D–2458.



NOTE : Lag Time Curve is derived from " DESIGN CALCULATION ,, Note: 2. of the Tulungagung Drainage Project.

Fig. 2.4.3 **RELATION BETWEEN TOPOGRAPHIC FACTOR AND LAG. TIME**

2.5 Sediment Discharge Analysis

Sediment analysis aims at grasping the relationship between hydraulic parameter and sediment carrying capacity.

2.5.1 Sediment Data

Sediment load sampling in K. Widas is carried out on suspended load at Lengkong - Widas water level gauging station since 1973. Available suspended data are listed in Table 2.5.1.

2.5.2 Hydraulic Parameter

In the K. Brantas basin, the relationship between the suspended load and hydraulic parameters is proposed to be expressed by water depth and friction velocity through the Brantas Middle Reach River Improvement Project. The formula is as below.

$$q_s = A\ (\ hu^2\ )^B$$

Where, q_s : Suspended load (m^3/sec/m)

h : Water depth (m)

u : Friction velocity (m/sec)

In the above equation, constants of A and B are determined from the observed suspended load data and hydraulic parameter. Hydraulic parameter at Lengkong - Widas water level gauging stations as shown below are calculated by means of uniform flow calculation.

Water depth (m)	Area (m^2)	Wetted Perimeter (m)	Hydraulic Mean Radius (m)
0.5	10.5	28.0	0.53
1.0	23.0	31.0	0.74
1.5	38.0	33.0	1.15
2.0	53.5	36.0	1.49
3.0	84.0	46.0	2.10
4.0	114.0	43.0	2.65

2.5.3 Suspended Load Rating Formula

Table 2.5.2 shown suspended load observed and hydraulic parameter estimated from discharge data.

By the regression analysis on suspended load and hydraulic parameter of, hu^2, coefficients are estimated as follows.

$$q_s = 4.901 \times 10^{-3}\ (\ hu^2\ )^{0.733}$$

The above formula and suspended load data are illustrated in Fig. 2.5.1.

Table 2.5.1 SUSPENDED LOAD AT LENGKONG - WIDAS

Date	Depth (m)	Area (m^2)	Width (m)	Slope $x10^{-4}$	Dis. (m^3/sec)	Dis./ width (m^3/s/m)	Suspended Load (kg/m^3)
Jul. 12,73	0.29	5.92	22.0	8.4	2.2	0.10	0.185
Nov. 7	0.44	9.20	21.0	8.4	3.5	0.17	0.413
Jan. 23,74	0.80	41.80	12.0	15.0	33.9	0.65	0.279
Feb. 8	2.87	159.70	55.6	11.5	163.3	2.94	0.699
Feb. 20	1.65	84.3	51.0	11.5	56.4	1.11	0.348
Mar. 6	3.71	212.00	57.0	28.5	288.3	5.06	0.177
Mar. 21	1.90	89.10	47.0	4.9	67.3	1.43	0.344
Apr. 19	3.35	189.00	56.3	28.5	167.0	2.97	0.808
Dec. 13	4.31	246.00	57.0	11.5	155.0	2.72	2.211
Jan. 28,76	1.29	94.50	73.2	13.0	61.0	0.83	0.280
Feb. 11	2.45	181.00	73.5	4.8	133.9	1.82	1.043
Mar. 10	3.56	207.00	58.0	20.0	210.0	3.62	0.602
Mar. 30	3.07	178.00	58.0	11.0	164.0	2.83	0.351
May 2	0.27	3.80	14.0	1.8	1.6	0.11	0.089
Jun. 1	0.30	4.40	14.8	4.5	2.0	0.14	0.070
Jun. 18	0.83	2.80	12.0	7.0	0.9	0.08	0.088
Jun. 28	0.26	3.10	12.0	3.0	1.1	0.09	0.063
Jul. 15	0.22	2.70	12.0	3.0	1.0	0.08	0.167
Jul. 30	0.16	1.90	12.0	1.0	0.6	0.05	0.202

Table 2.5.2 SUSPENDED LOAD AND HYDRAULIC MEAN RADIUS

Date	q	h	R	u	$h.u_*^2 \times 10^{-3}$	$qs \times 10^{-3}$ (m^3/sec/m)
Jul. 12, 73	0.10	0.29	0.22	0.042	0.512	0.012
Nov. 7	0.17	44	0.34	0.053	1.236	0.044
Jan. 23, 74	0.65	80	0.61	0.095	7.22	0.113
Feb. 8	2.94	2.87	2.04	0.152	66.300	1.284
Feb. 20	1.11	1.65	1.22	0.173	49.400	0.241
Mar. 6	5.06	3.71	2.59	0.269	268.000	0.560
Mar. 21	1.43	1.90	1.40	0.082	12.800	0.307
Apr. 19	2.97	3.35	2.36	0.257	221.000	1.500
Dec. 13	2.72	4.31	2.98	0.183	144.000	3.759
Jan. 28, 76	0.83	1.29	1.00	0.113	16.5	0.145
Feb. 11	1.82	2.45	1.76	0.091	20.300	1.186
Mar. 10	3.62	3.56	2.50	0.221	174.000	1.362
Mar. 30	2.83	3.07	2.18	0.153	71.900	0.621
May 2	0.11	0.27	0.20	0.019	0.097	0.006
Jun. 1	0.14	0.30	0.22	0.031	0.288	0.006
Jun. 18	0.08	0.23	0.17	0.034	0.266	0.007
Jun. 28	0.09	0.26	0.19	0.024	0.150	0.004
Jul. 15	0.08	0.22	0.16	0.022	0.106	0.008
Jul. 30	0.05	0.16	0.13	0.013	0.027	0.006

Note : q : Discharge (m^3/sec/m)
h : Water depth (m)
R : Hydraulic mean radius (m)
u : Friction velocity (m/s)
qs : Suspended load discharge (m^3/sec/m)

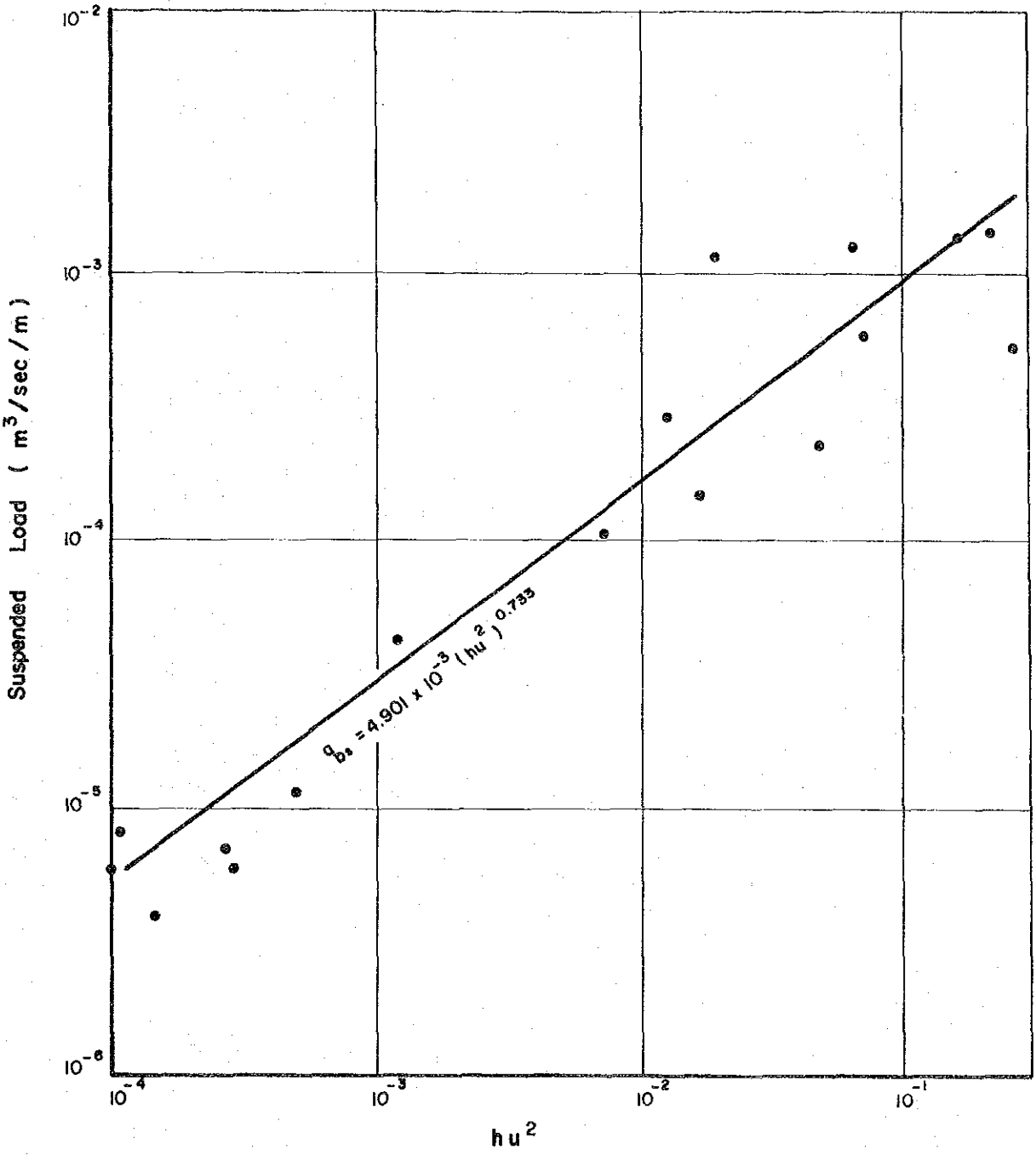


Fig. 2.5.1 RELATION BETWEEN SUSPENDED LOAD AND HYDRAULIC PARAMETER (hu^2)

ANNEX - 3

GEOLOGY AND CONSTRUCTION MATERIAL

ANNEX - 3

GEOLOGY AND CONSTRUCTION MATERIALS

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3. GEOLOGY AND CONSTRUCTION MATERIALS

3.1 General

3.1.1 Scope of investigation

The purpose of the survey is to understand engineering geology and stratigraphy of the study area. The field reconnaissance study was carried out for one month on July and one week on November 1985 in cooperation with counterpart.

The geologic data and information collected for the study consist of geologic map, general geologic report, drilling logs, engineering study report, drilling core samples and results of permeability test. Inventory of these information referred in the report are shown in the list of referrence.

The drilling work was carried out at the Ketandan dam site and other structure sites by the Brantas office and the local contractor in cooperation with JICA Team's expert. The drilling work consist of core drilling, standard penetration test and field permeability test.

3.1.2 Previous geological investigations

Geological investigation of the Kedungwarak site was carried out by 11 bore holes by the Brantas Multi Purpose Project Office in 1984.

Drilling programs of Widas river route and retarding basin were also undertaken by the Brantas Project in 1984. These programs included 41 core borings, the depths of which ranged 10 to 20 m. The core from all the drill holes was logged (Ref. 1 and 2). A summary of existing core boring are shown in Table 3.1.1.

The locations of existing core borings at the Kedungwarak site are shown on the geological map (Fig. 3.2.3).

Table 3.1.1 SUMMARY OF PREVIOUS INVESTIGATION

Location	Boring No.	Drilling Depth (m)	Remarks
Kedungwarak weir site	KW 84-1	60	Reference 1
	-2	50	"
	-3	60	"
	-4	30	"
	-5	35	"
	-6	30	"
	-7	40	"
	-8	60	"
	-9	40	"
	-10	50*	Reference 2
	-11	50*	"
T o t a l	11		

* Inclination 60°

3.2 Geology

3.2.1 Field reconnaissance

1. General geology

The Widas basin is divided into three topographic and geologic sub-regions (Fig. 3.2.1). The first sub-region is the Kendeng hill which consists of Quarternary and Tertiary sedimentary formation. The hill (average height 100 to 200 m) is located at the northern part and extends in the east-west direction. The second sub-region is the Widas-Nganjuk low flat alluvial plain which is located to the immediate south of the Kendeng hill, the east is bodered by the Brantas river and, the south-west is bounded by volcano Wilis. The last sub-region in the volcano Wilis (2863 m) which was composed of Tuff breccia and pyroclastic flow of pleistocene Epoch.

The general geologic condition in the project area is shown in Fig. 3.2.1, and the stratigraphy of the project area is shown in Table 3.2.1.

The sedimentary formations of Quarternary are divided into several formations. They are mainly composed of tuffaceous and calcareous sand-stone, tuff, tuff-breccia, claystone, conglomeratic sandstone which belong to the Notopuro Formation, Kabuh Formation and Puchangan Formation of Pleistocene in the Kendeng hill.

The sedimentary formations of Tertiary in the project area of Ken-deng hill is mainly composed of marl and limestone which belong to the Kalibeng Formation.

The volcano Wilis consists of Wilis tuff breccia, Wilis Pyroclastic flow and Talus deposit of Wilis Group Product.

2. Rock types characteristics

The geology clarified by surface geologic mapping and geologic log is summarized as follows.

(KENDENG HILL)

a. Kerek formation

The Kerek Formation is composed commonly of tuff sandstone, coloured in yelowish grey, showing well cemented and silicified tuff which is presumed to be Middle Miocene deposits and to be identified as the lowest deposits in the Kendeng zone. This formation is not observed in the project area which is unconformably overlain by the Kalibeng formation.

b. Kalibeng formation

The Kalibeng Formation in this area is divided into two types of sedimentary facies as follows;

Lower Kalibeng member : consists of ustratified marls with sporadic

intercalation of tuffaceous limestone (as stratified marls) and the sandy limestone with graded bedding sedimentary structure and conglomerate with piece of andesite. The age of the lower Kalibeng belongs to lower Pliocene. The marls always contain of globigerises and other smaller foraminifera fossil.

Upper Kalibeng member : consists of clastic limestone and limestone which is likely to be a coral limestone and sometimes it shows some change in facies as transitional marl, friable to hard.

The upper Kalibeng is conformable to the lower Kalibeng.

The marl facies of the Kalibeng Formation is distributed of Kedungwarak river basin and upper stream of Ketandan dam site. The strike of the stratified marl is variable between N 20° E and dip between 22° and 71°. The Kalibeng Formation underlies the Puchangan Formation.

c. Puchangan formation

The Puchangan Formation overlies the Kalibeng Formation and is composed of two facies, a marine clayey facies and a volcanic tuffaceous to sandy facies of Pleistocene.

Lower Puchangan (clay facies) consists of stiff and unstratified bluish grey colour claystone in locality as seen in the Ketandan river bed 1 km downstream from confluence of Tanggungan river. The claystone overlies the stratified claystone with intercalated tabular cross laminated sandstone at the same location. The bed of stratified claystone strikes N 47° E and dips 28° SE. The lower Puchangan Formation is not observed at Kedungwarak site.

Upper Puchangan (volcanic facies) consists of fine to coarse grained poorly to well cemented grey to brown sandstone and hard jointed compact grey tuff breccia, sometimes intercalation hard compact sandstone bears much fossils of mollusks or gastropods, and medium to coarse grained hard brown sandstone without mollusks or gastopods.

The volcanic facies of the Puchangan Formation is exposed both on the Ketandan riverbed and the Kedungwarak riverbed. In the Ketandan riverbed, the volcanic facies is conformable to the lower member (clay facies).

Tuff breccia-zone of volcanic facies widely crops out on the downstream riverbed of the Kedungwarak weir site, however in the Ketandan river bed, tuff breccia zone is scarce. The bed of volcanic sandstone trends east-south west and dip southeast.

The Puchangan Formation conformably underlies the Kabuh Formation.

d. Kabuh formation

The Kabuh Formation conformably overlies the Puchangan Formation and is composed of medium to coarse grained weakly cemented sandstone and conglomerate, contain molluses and vertebrate fossils of upper Pleistocene.

The Kabuh Formation have a mainly fluviatile facies, cross-bedding often occurs, and forms good aquifer. The Kabuh Formation is not exposed at the downstream of the Ketandan river.

The Jaan river and the Ngrembek river runs across the Kabuh Formation through after the Puchangan Formation.

The Kabuh Formation is overlain disconformably by the Notopuro Formation or by Holocene deposits.

e. Notopuro Formation

The Notopuro Formation unconformably overlies the Kabuh Formation and is only distributed in the western part of the Widas basin.

In the right bank of the Brantas river, this formation is called the Jombang Formation. This formation consists of tuff alternatively with medium to coarse sandstone and conglomerate with matrix of andesite and pumice with rare fossils.

The Notopuro Formation is overlain by Holocene volcanic or alluvial deposits.

f. Young volcanic product

The young volcanic product of Holocene is especially distributed in Mt. Pandan area, northwest corner of the basin. It consists of tuff breccia and andesite boulders.

(VOLCANO WILIS)

a. Wilis tuff breccia

The Wilis tuff breccia consists of grey to brown hard volcanic breccia, and well cemented tuff flows includes lahar. They are widely exposed at the right bank of the Kuncir river on the slope of north east of Wilis mountain.

b. Wilis pyroclastic flow

The Wilis pyroclastic flow consists of grey hard volcanic breccia and tuff flow. They are well cemented and covered with andesitic boulder at the lower part of northern slope of Mt. Wilis. They are mainly exposed at the left bank of the Kuncir river on the slope of north of Wilis mountain.

c. Talus deposit

The Talus deposit consists of mainly andesitic large boulder and volcanic sand, which is distributed along the river as seen in Kuncir village of the Kuncir river.

(WIDAS - NGANJUK ALLUVIAL PLAIN)

a. Alluvial deposits

The river alluvial deposits are distributed in the flood low plain of the Widas and the Brantas river. They consist of clay, silt, sand and gravel.

3.2.2 Drilling investigation

1. Equipment

The equipment listed below were used for the drilling works and the tests at the Ketandan dam site, Kedungwarak - Ketandan trans-basin tunnel, Borrow area and Bangle Headworks, from the beginning of August to the middle of November 1985.

- Drilling rig : The rotary drilling machine with a capacity of drilling to depth to the more than 50 meters with a drilling diameter not less than 56 mm diameter.

- Drilling pump : The reciprocating piston type with discharge capacity of 40-60 l/min and capable pressure of 10-20 kg/cm^2.

- Packer : Pneumatically expanding type

- Penetration test equipment : 63.5 kg driver hammer and free fall from 75 cm of height.

2. Core drilling

Diameter of the drill holes ranges from 56 to 76 mm. All core samples for every depth of drill hole were taken and kept in wooden cases which mark the depth of core recovery at every one meter interval and hole numbers.

During the drilling, the following matters were recorded;

- Hole No., date of operation, diameter of hole
- Ground water table in the hole
- Depth of drilling, progress of drilling and length of recovered core samples for each recovery core barrel, rock quantity designation, time for each progress of drilling, and
- Description of judgement on subsurface conditions.

3. Standard penetration test

The standard penetration tests were carried out in accordance with the Designation E-21 specified in Earth Mannual.

4. Field permeability test

Water pressure test

Water pressure tests were performed in the drill holes for the rock formation by applying the single packer method (descending stage method).

The first 5 m section is drilled and water pressure is tested and then next lower 5 m is drilled and water pressure is tested. Likewise, the drilling and water pressure test are conducted for every 5 m section to the bottom of the hole. A single packer is installed at each test section. Clean water is pumped into the test section under a constant pressure. After the injection rate becomes stable, the injected water quantity is measured for 10 minutes for each constant pressure. For each test section, the test pressure range is 0.5 kg/cm^2 to 7.0 kg/cm^2.

Calculation of permeability coefficient and Lugeon value

Permeability coefficient K is calculated as follows;

$$K = \frac{Q}{2\pi \times L \times H} \times \log \frac{L}{r} \quad (cm/sec)$$

where,

Q : Constant rate of flow into the hole, (cm^3/s)
L : Section length of the hole tested (cm)
H : Total water head, and (cm)
r : Radius of hole tested (cm)

Lugeon value is the amount of water leakage (l/min) from 1 m testing section under 10 kg/cm^2 pressure.

Lugeon value (Lu) is calculated as follows;

$$Lu = \frac{10 \times Q}{P \times \ell}$$

Where,

Q : Constant rate of injected water (ℓ/min)
ℓ : Section length of the hole tested (m)
P : Yielding pressure (kg/cm^2)

In case of bore hole diameter of 76 mm, 1 lugeon is approximately correspondent to 1.2 x 10^{-5} cm/sec. The test results are shown on Table 3.2.4 and Fig. 3.2.20.

5. Boring and rock test

Out of twenty five (25) numbers of bore holes, 12 were proposed in the Ketandan dam site, 3 were at the Kedungwarak-Ketandan trans-basin tunnel site, 2 were at the Borrow area, and 4 were at Bangle headworks and other 4 were at the other sited, respectively.

The location of these are shown in each site geological map. The list of borings is as shown in Table 3.2.2 and also, drill logs are attached hereto as ATTACHEMENT.

Rock samples from boring holes at the Ketandan dam site and Kedungwarak-Ketandan dam site were collected and tested by the local contractor. The detailed results of rock test are described in Chapter 3.3. (Construction materials)

3.2.3 Engineering geology

1. The Kedungwarak weir site

The site is located at the volcanic facies of the Puchangan Formation (see Fig. 3.2.3). These rocks are overlain by top soil and thin weathered layer and are exposed mostly on the riverbed and along the road of right bank of the Kedungwarak river. The gorge is very narrow width in an V-shaped valley. The right bank slope is around 30° up to top of the mountain. On the other hand, the left bank is rather steep slope angle of around 40° up to 190 m in elevation. General strike and dip at weir axis are N 34° W to 60° W and 21° S to 31° S showing monocline.

The volcanic facies of the Puchangan Formation are composed of tuff breccia zone and tuffaceous sandstone zone. Tuff breccia has enough strength for weir foundation, but weir located outside of tuff breccia. At the weir axis, tuffaceous sandstone distributed with high permeability values which is in the order of 3×10^{-3} to 5×10^{-2} cm/s (5 - 15 m in depth)

The permeability test results of jointed tuff breccia are slightly high permeability values of $K = 5 \times 10^{-3}$ cm/sec, however compact and hard tuff breccia are good condition of water tightnee. According to the core boring calcareous sandstone developed beneath of tuffaceous sandstone or tuff breccia, which are almost low to medium permeability value.

From these results, the recommended depth of curtain grout and blanket grout for adequate water tightness under the weir are from 15 to 30 m from the excavated surface.

The calcareous sandstone is presumed to be transition zone to marl facies of thw Kalibeng Formation.

According to the field reconnaissance marl facies are developed in the upper Kedungwarak river basin.

Boring core from drilling hole at the Kedungwarak site is classified by quality of rock as fairly hard to slightly weathered and partly weathered and solf and rich joints. Generally tuff breccia without joint is good, but tuffaceous sandstone is slightly good and calcareous sandstone is rather poor condition.

The top soil, talus deposit and hard weathered rocks are found in top portion of drilling log and covering stiff rock in 3 to 5 m thick. Based on these results the recommended excavation line weir foundation is shown in Fig. 3.2.6.

As the N-value (results of SPT) of sandstone are in the order 30, allowable height of concrete structure will be limited and foundation treatment is necessary for bearing strength like as blanket grout.

2. The Ketandan dam site

A dam height of about 40 m has been considered at this site. The

site is located about 700 m downstream from the Ketandan river and the Tanggungan river confluence and the riverbed is about 15 m wide (See Fig. 4.2.7).

Bedrock is exposed at the base of the right abutment in the riverbed where there is the hard brown compact bedded sandstone with intercalated limestone and grey calcareous sandstone which varies from fresh to moderately weathered and partly fractured. They are generally considered to be the Kalibeng Formation but some may be the Puchangan Formation. The precise age can not be determined.

Geologic profile is shown on Fig. 3.2.8 and Fig. 3.2.9. However, at the geologic facies of upstream side of the right bank ridge slope change to the marl which are overlain by the sandstone. Slopes on this bank vary locally between 30 and 40 degrees.

The right abutment would be the end of a sandstone ridge overlies marl.

Fresh sanstone is not exposed on the foot of the left ridge abutment which slopes generally between 40 degrees and 50 degrees.

The massive and solid sandstone form the steeper slopes and cliff at the right bank of dam abutment. Continuous land slide is well exposed at the left bank between B8 and B9.

Strike and dip in the dam site is N 43°E, 31°S. Riverbed of upper stream side belong to marl which is weaker than the sandstone. An earth fill dam would be the most likely structure for comparatively weak foundation (marl) at the site.

Water pressure tests were carried out in the bore holes along the dam axis, river bed and diversion tunnel route. Generally, the test results shows high permeability in calcareous sandstone ($K = 3 \times 10^{-3}$ cm/sec - 3×10^{-4} cm/sec) and low permeability in marl (K 3×10^{-4} cm/sec).

The test results of B1, B2, B4, B5 and B11 locating at both side abutments show fairly high permeability ranging from 3×10^{-4} to 3×10^{-3} cm/sec. And also these bore holes have very deep ground water level from surface. Specially in B2, ground water level is exist at 45 m in depth, which means ground water of B2 is lower than river bed height. But it is not reconfirmed after drilling completed on 14 Nov. 1985 by the JICA expert, because of caving.

However, the test results of same calcareous sandstone at B3, B8 and B9 shows rather low permeability except shallow part (from surface until 15 m in depth) and ground water level is exist at ground level or higher than ground level.

Usually, permeability depends on porosity or fractured ratio of rocks. In this case high permeability of calcareous sandstone is due to large porosity and weakly cemented condition, because permeability value is not so much different in weathered fractures zone and fresh rock zone above the ground water level (See Fig. 3.2.10). However,permeability

of deep portion of sandstone at river bed is lower than abutment area because sandstone is saturated by ground water. The field permeability test results of B12 is rather low permeability for sandstone, because grain is very fine and fragments is well cemented.

These kind of rock is very difficult to get the high watertghtness by cement grouting methods. From these results, the recommended water-tight method is over all blanket method for upstream side of dam and abutment and river bed.

Boring core from drilling hole at the Ketandan dam site consists of calcareous sandstone and marl which are classified by quality of rock as CH, CM, CL and D classes. Quality classification of rock in dam foundation is shown on Table 3.2.3. The calcareous sandstone of CL and D classes are strongly to moderatly weathered friable and fractured partly altered into clay. These weathered sandstone reaches 25 m in thickness at left abutment, and its lower part may correspond to the land sliding clay seam, balance after this layer sandstones suddenly change to fresh and compact. Almost all of the fresh rocks belong to category CM to CH. These sandstones are fairly hard and stiff. Based on these results, the recommended excavation line of dam foundation same as surface of assumed fresh rock line is shown on Fig. 3.2.8.

Marl occurs in contact with the overlying calcareous sandstone at the dam axis (B3) and dips south-east. And also Marl is widely distributed and exposed in river bed of reservoir area.

Marl of these boring cores (B3, B6 and B7) are belongs to category CL-D classes. Specially D category is altered into clay which is probably indicates the presence of fractured weak zone between the B3 and B6. Some consolidated grout is may required if necessary.

Geology of reservoir area is classified into Kalibeng Formation of Pliocene. Most part of the reservoir area consist of marl. The weathered layer over these formation at the rims of the reservoir.

Marl is usuallu water tightness with low permeability and compact except sandy marl.

The intercalated hard limestone or compact sandstone are exposed in the reservoir area and deposits will thickness ranging from a few cm to 100 cm. In general, water tightness of reservoir area seems to good. However, marl is easily eroded by water, so sedimentation must be taken into account because existing river gravel consists of marl.

3. Kedungwarak-Ketandan trans-basin tunnel

The trans basin tunnel (1500 m in length with about 2 m in diameter) to connect the Kedungwarak river and the Ketandan river is located near Semanding village.

Topographic features of tunnel route shows gently sloped hill. General geology in the tunnel route is similar to that of the Ketandan reservoir area.

According to the field reconnaissance and boring cores, geology of tunnel route is composed of stiff and compact marl. The geology map of the area is shown in Fig. 3.2.12.

However, inlet and outlet of tunnel site slope is steep and marl is weathered. It is required to consider the construction plan of tunnel.

According to the boring results, rodes of tunnel site are generally stiff and partially fractured with slicken side. Water permeability test of the drilling holes in the marl shows the values in the order of 10^{-4} cm/sec. The RQD value shows from 50% to 75% fractured zone. The geotechnical condition of the stiff marl on the tunnel route is rather good for tunnel excavation.

4. Bangle headworks

The site of Bangle headworks is located at near Bangle village. Geologic condition of the site is composed of tuff and tuffaceous sandstone. The geological map of the area is shown in Fig. 3.2.13. The Ketandan river flows into alluvial plain of the dowstream of the sites.

Basement of the headworks site is composed of tuffaceous sandstone of the Puchangan Formation, having strikes N 77°W and dip 14°S. They are composed of fine to coarse grained tuffaceous sandstone intercalating tuff of silty clay with molluscas river terrace deposits developed at both banks consist of volcanic sandstone, boulder and sand.

According to the boring results of IB-6, rocks of weir site are tuffaceous fine to medium grained well bedded sandstone with some calcite rein. The R.Q.D Category of rocks shows very poor and rocks correspond to that of CM and CL classes in rock quality classification. Water permeability test of the IB1 and IB2 shows the fairly high values of permeability ranging from 2.3×10^{-3} cm/sec. Rock strength of weir site (IB-6) is not so high strength however enough strength for small weir foundation.

5. Main canal crossing point with Jaan river

The crossing point of Main canal to the Tretes area with the Jaan river is located at 3 km upstream of Jaan village. Topography of the site shown undulate plain and narrow meandering riverbed (see Fig. 3.2.15). The banks of the site with some 2 to 3 height formed of uncompacted medium to coarse grained sand with clay and the riverbed may be predominantly thick sandy sediment (see Fig. 3.2.16). Rock out crops were not seen at the site but hard weathered sandstone is exposed of 500 m upstream of side which may belong to the Kabuh Formation of Pleistocene.

The alluvial sandy formation of site would need the boring investigation for detailed engineering geological assesment.

6. Borrow area

The proposed borrow area for Ketandan dam site is located at 700 m downstream from dam axis on the left bank site of Ketandan river. The site is formed of mainly tuffacesous sandstone and tuff breccia zone

of the Puchangan Formation which is marked by a weathered and slightly weathere tuff breccia is exposed at the top of hill. (see Fig. 3.2.7). Test boring (MB1) was carried out to be confirmed the depth of excavation for earth materials. According to the boring data, geology of MB1 is composed of strongly to moderately brown fine grained sandstone of 15.2 m in thickness. And also the group of tuff brecciea boulder is cropping out about 2 km southeast from the dam site at foot of mount Alasmalang, which is examined by test pit as an alternative borrow area.

7. Lower Widas river site

New bridges and other river structures has been considered along the Widas river.

The regional map (Fig. 3.2.1) shows the lower Widas river site to be formed of alluvial deposits. These deposits overlie Wilis volcanic deposit in the southern part which is exposing on the slope of the volcano Wilis. And also these deposits overlie the Kabuh to the Puchangan Formation in the northern part which is outcropping in the Kendeng hill.

Diagramatic geologic profile are summarized by geological data included boring logs and deep well logs as shown Fig. 3.2.2.

According to these profile, the thickness of alluvial clay and sand in the lower reach of the Widas river is assumed to be some 10 to 50 m. In the middle reach of tributary to the Widas river the alluvium becomes thinner and grading southwest toward into talus deposits of Mt. Wilis.

8. Widas retarding basin

The Widas retarding basin is located at mainly both bank of the Widas river between from the Widas river and the Brantas river confluence to about 7 km upstream of the confluence and is about 12 km^2 broad (see Fig. 3.2.17).

The results of boring investigation on Fig. 4.2.18 show alluvial sand, clay, silt and some gravels. These beds overlie Pleistocene sedimentary rocks which is shown on Fig. 3.2.2, however these rocks are not seen at the site by the boring investigation. The permeability of the alluvium and the position of the water table in the retarding basin would be main features of assessment of water tightness which is determined by the permeability test.

According to the permeability test, permeable range in permeability coefficient order from 10^{-2} to 10^{-5} cm/sec and the water table from the surface in the range of 0 to 3 m in the April to May 1985 as shown on Fig. 3.2.17 and 3.2.18.

These boring logs can be divided into impermeable zone and permeable zone, however most upper part of the boring log is not tested.

These no test section of top soil can be estimated to be slightly pervious because top layer mainly formed of sandy clay, and ground water level of this area seems deeper in the dry season.

Therefore, this retarding basin can not be kept for the flood water for long term period, because of poor water tightness and moderate infiltration rate.

9. Seismicity

Earthquake data in Indonesia are available in "Earthquakes in Indonesia" Prepared by Meteorological and Geological Institute, Jakarta, which record 7,118 events during the period from 1948 to 1979.

Form the above record, the peak ground acceleration of the proposed site has been calculated as follows ;

Log NC = A - B x IJ (Frequency - Intensity Relation by the Kawasumi's method).

Where ; NC : Accumulated frequency
IJ : The earth intensity in Japanese Meteorological Agency scale at the project site
A, B : Constant

Relation of acceleration ($\bar{a}$) and IJ was calculated by the following formula (Kawasumi, 1951).

$$\bar{a} = 0.45 \times 10^{0.5IJ} \quad \text{(in gal)}$$

Kedungwarak site

Epicentral of influential earthquakes of the dam site is plotted and shown in Fig. 3.2.19.

Earthquake Intensity and Frequency

Intensity (IJ)	Frequency in 32 years	Frequency in 100 years	Cummulative Number for 100 years
0 (0.0 - 0.5)	12	37.50	100.01
1 (0.6 - 1.5)	11	34.38	62.51
2 (1.6 - 2.5)	8	25.00	28.13
3 (2.6 - 3.5)	1	3.13	3.13
4 (3.6 - 4.5)	0	0	0
5 (4.6 - 5.5)	0	0	0
6 (5.6 - 6.5)	0	0	0
7 (6.6 - 7.5)	0	0	0

Non lenear Regression Analysis by Least Square Method

Log (Y) = 2.164 - 0.486X

Coefficient of corelation

RR = 0.942

Expected Maximum Intensity for 100 years

= 4.45

Maximum Acceleration on return period of 100 years

= 76 gal
= 0.08 g

Table 3.2.1 STRATIGRAPHY OF THE PROJECT AREA

	Epoch	Kendeng Hill Zone Formation	Wilis Volcano Group Formation
QUATERNARY	Holocene	River Alluvium	River Alluvium
	Pleistocene	Young volcanic	Talus deposits
	upper	product	
		High Terrace	
	middle	Notopuro (Jombang)	Wilis pyroclastic
		Kabuh	Flow
	lower	Upper Puchangan (volcanic faices)	Wilis Tuff Breccia
		Lower Puchangan (clay faices)	
TERTIARY	Pliocene	Kalibeng (marl, limestone)	
	Miocene	Kerek	

Table 3.2.2 QUANTITY OF CORE BORINGS

Location	Boring No.	Drilling Depth in meter	Remarks
Ketandan damsite	B1	50	by Indra Karya
	B2	50	by Indra Karya
	B3	60	by Brantas
	B4	50	by Indra Karya
	B5	50	by Indra Karya
	B6	50	by Brantas
	B7	50	by Brantas
	B8	50	by Brantas
	B9	50	by Brantas
	B10	30	by Brantas
	B11	70	by Brantas
	B12	30	by Brantas
Sub-Total	12	590	
Kedungwarak-Ketandan tunnel	TB1	40	by Indra Karya
	TB2	60	by Indra Karya
	TB3	42	by Indra Karya
Sub-Total	3	142	
Bangle headworks	IB1	20	by Brantas
	IB2	20	by Brantas
	IB5	4	by Brantas
	IB6	4	by Brantas
Sub-Total	4	48	
Main Canal Crossing point with Jaan River	IB3	(20)*1	
	IB4	(20)*1	
Sub-Total	2		
Borrow area	MB1	20	
	MB2	( )*1	
Sub-Total	2		
Lower Reach Improvement area	RB1	( )*2	
	RB2	( )*2	
Sub-Total	2		
Total	25	800	

*1 : Not yet completed
*2 : No imformation

Table 3.2.3 QUALITY CLASSIFICATION ROCK IN DAM FOUNDATION

Rock Class	
A	Rock-forming minerals/1 are fresh and not weathered or altered. Joints and cracks are closed tightly, no weatherings on their planes. Clear sound is emitted when hammered.
B	Rock-forming minerals are weathered slightly or partially altered and the rock is hard. Joints and cracks are closed tightly. Clear sound is emitted when hammered.
C_H	Rock-forming minerals are weathred and the rock is fairly hard. Tightness of joints and crack is slightly reduced and each block is apt to be exfoliated along joints and cracks sometimes contain clay and other material which may be coloured by limonite. A slightly dull sound is estimated when hammered.
C_M	Rock forming minerals are weathered and the rock is slightly soft. Exfloitation of the rock occurs along joints and cracks by normal hammering. Joints and cracks sometimes contain clay and other materials. A somewhat dull sound is emitted when hammered.
C_L	Rock forming materials are weathered, and the rock is soft. Exfloitation of the rock occurs along joints and cracks by light hammering. Joints and cracks contain clay. A dull sound is emitted when hammered.
D	Rock forming minerals are weathered, and the rock is very soft. There is virtually no bond between rock blocks, and collapse occurs at the slightest hammering. Joints and cracks contain clay. A very dull sound is emitted when hammered.

/1 : Except quartz
Source : Ref. 5

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (1/17)

BOREHOLE NUMBER : B-1

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.00	5.00	4.00	5.6	0.5	3.00	1.40	9.26	42.7	1.5E-03	115.2
	2	1.00	5.00	4.00	5.6	1.0	3.00	1.40	14.22	49.1	1.1E-03	86.3
	3	1.00	5.00	4.00	5.6	1.5	3.00	1.40	19.14	56.3	1.0E-03	76.1
	4	1.00	5.00	4.00	5.6	1.0	3.00	1.40	14.22	48.7	1.1E-03	85.7
	5	1.00	5.00	4.00	5.6	0.5	3.00	1.40	9.25	43.8	1.6E-03	119.2
2	1	5.00	10.00	5.00	5.6	0.5	7.50	1.40	13.27	40.9	8.5E-04	61.7
	2	5.00	10.00	5.00	5.6	1.0	7.50	1.40	17.73	55.6	8.6E-04	62.7
	3	5.00	10.00	5.00	5.6	0.5	7.50	1.40	13.31	39.4	8.1E-04	59.2
3	1	10.00	15.00	5.00	5.6	0.5	12.50	1.40	17.55	42.3	6.6E-04	48.2
	2	10.00	15.00	5.00	5.6	1.0	12.50	1.40	21.29	58.7	7.6E-04	55.1
	3	10.00	15.00	5.00	5.6	0.5	12.50	1.40	17.60	41.4	6.5E-04	47.1
4	1	15.00	20.00	5.00	5.6	0.5	17.50	1.40	21.99	41.0	5.1E-04	37.3
	2	15.00	20.00	5.00	5.6	1.0	17.50	1.40	25.98	50.7	5.4E-04	39.0
	3	15.00	20.00	5.00	5.6	1.5	17.50	1.40	30.19	57.2	5.2E-04	37.9
	4	15.00	20.00	5.00	5.6	1.0	17.50	1.40	26.10	49.7	5.2E-04	38.1
	5	15.00	20.00	5.00	5.6	0.5	17.50	1.40	22.25	38.1	4.7E-04	34.3
5	1	20.00	25.00	5.00	5.6	0.5	22.50	1.40	26.63	38.7	4.0E-04	29.1
	2	20.00	25.00	5.00	5.6	1.0	22.50	1.40	29.17	55.9	5.3E-04	38.3
	3	20.00	25.00	5.00	5.6	0.5	22.50	1.40	26.90	36.3	3.7E-04	27.0
6	1	25.00	30.00	5.00	5.6	1.0	27.50	1.40	35.35	43.3	3.4E-04	24.5
	2	25.00	30.00	5.00	5.6	1.5	27.50	1.40	38.92	51.3	3.6E-04	25.4
	3	25.00	30.00	5.00	5.6	2.0	27.50	1.40	42.57	57.8	3.7E-04	27.2
	4	25.00	30.00	5.00	5.6	1.5	27.50	1.40	39.02	50.8	3.6E-04	26.0
	5	25.00	30.00	5.00	5.6	1.0	27.50	1.40	34.87	46.1	3.6E-04	26.5
7	1	30.00	35.00	5.00	5.6	1.0	28.20	1.40	36.12	39.1	3.0E-04	21.7
	2	30.00	35.00	5.00	5.6	2.0	28.20	1.40	45.44	42.8	2.6E-04	18.8
	3	30.00	35.00	5.00	5.6	3.0	28.20	1.40	51.71	58.9	3.1E-04	22.8
	4	30.00	35.00	5.00	5.6	2.0	28.20	1.40	45.28	43.6	2.6E-04	19.3
	5	30.00	35.00	5.00	5.6	1.0	28.20	1.40	35.87	40.5	3.1E-04	22.6
8	1	35.00	40.00	5.00	5.6	1.0	28.20	1.40	37.83	25.9	1.9E-04	13.7
	2	35.00	40.00	5.00	5.6	2.0	28.20	1.40	45.00	41.7	2.5E-04	18.5
	3	35.00	40.00	5.00	5.6	3.0	28.20	1.40	50.64	58.2	3.2E-04	23.0
	4	35.00	40.00	5.00	5.6	2.0	28.20	1.40	43.99	46.0	2.9E-04	20.9
	5	35.00	40.00	5.00	5.6	1.0	28.20	1.40	37.33	29.3	2.2E-04	15.7
9	1	40.00	45.00	5.00	5.6	0.5	28.20	1.40	29.14	42.5	4.0E-04	29.1
	2	40.00	45.00	5.00	5.6	1.0	28.20	1.40	31.85	50.6	4.4E-04	31.8
	3	40.00	45.00	5.00	5.6	2.0	28.20	1.40	42.50	48.4	3.1E-04	22.8
	4	40.00	45.00	5.00	5.6	2.5	28.20	1.40	44.36	58.2	3.6E-04	26.2
	5	40.00	45.00	5.00	5.6	2.0	28.20	1.40	42.52	48.4	3.1E-04	22.8
	6	40.00	45.00	5.00	5.6	1.0	28.20	1.40	31.19	52.7	4.6E-04	33.8

BOREHOLE NUMBER : B-1

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	7	40.00	45.00	5.00	5.6	0.5	28.20	1.40	28.78	43.8	4.2E-04	30.5
10	1	45.00	50.00	5.00	5.6	1.0	28.20	1.40	34.94	37.0	2.9E-04	21.2
	2	45.00	50.00	5.00	5.6	2.0	28.20	1.40	44.13	40.1	2.5E-04	18.2
	3	45.00	50.00	5.00	5.6	2.5	28.20	1.40	47.64	56.7	3.6E-04	26.0
	4	45.00	50.00	5.00	5.6	2.0	28.20	1.40	43.60	42.0	2.6E-04	19.3
	5	45.00	50.00	5.00	5.6	1.0	28.20	1.40	34.45	38.9	3.1E-04	22.6

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (2/17)

BOREHOLE NUMBER : B-2

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	3.50	5.00	1.50	5.6	0.5	4.25	1.30	10.07	42.6	3.0E-03	282.3
	2	3.50	5.00	1.50	5.6	1.0	4.25	1.30	14.68	57.4	2.8E-03	260.6
	3	3.50	5.00	1.50	5.6	0.5	4.25	1.30	9.97	47.0	3.3E-03	314.2
2	1	5.00	10.00	5.00	5.6	0.5	7.50	1.30	13.10	43.0	9.0E-04	65.6
	2	5.00	10.00	5.00	5.6	1.0	7.50	1.30	17.49	59.8	9.2E-04	67.2
	3	5.00	10.00	5.00	5.6	0.5	7.50	1.30	12.90	48.7	1.0E-03	75.5
3	1	10.00	15.00	5.00	5.6	0.5	12.50	1.30	17.70	38.1	5.9E-04	43.1
	2	10.00	15.00	5.00	5.6	1.0	12.50	1.30	21.52	54.9	7.0E-04	51.0
	3	10.00	15.00	5.00	5.6	0.5	12.50	1.30	17.36	43.6	6.9E-04	50.3
4	1	15.00	20.00	5.00	5.6	0.5	17.50	1.30	22.36	35.6	4.4E-04	31.8
	2	15.00	20.00	5.00	5.6	1.0	17.50	1.30	25.66	52.6	5.6E-04	41.0
	3	15.00	20.00	5.00	5.6	0.5	17.50	1.30	20.29	55.6	7.5E-04	54.8
5	1	20.00	25.00	5.00	5.6	0.5	22.50	1.30	27.68	27.3	2.7E-04	19.7
	2	20.00	25.00	5.00	5.6	1.0	22.50	1.30	28.45	59.5	5.7E-04	41.8
	3	20.00	25.00	5.00	5.6	0.5	22.50	1.30	25.05	49.8	5.5E-04	39.7
6	1	25.00	30.00	5.00	5.6	0.5	27.50	1.30	31.83	32.3	2.8E-04	20.3
	2	25.00	30.00	5.00	5.6	1.0	27.50	1.30	35.19	43.7	3.4E-04	24.8
	3	25.00	30.00	5.00	5.6	2.0	27.50	1.30	42.20	59.1	3.8E-04	28.0
	4	25.00	30.00	5.00	5.6	1.0	27.50	1.30	34.92	45.3	3.6E-04	25.9
	5	25.00	30.00	5.00	5.6	0.5	27.50	1.30	31.17	37.3	3.3E-04	23.9
7	1	30.00	35.00	5.00	5.6	0.0	32.50	1.30	30.40	38.7	3.5E-04	25.5
	2	30.00	35.00	5.00	5.6	0.5	32.50	1.30	31.59	56.3	4.9E-04	35.7
	3	30.00	35.00	5.00	5.6	0.0	32.50	1.30	28.95	46.2	4.4E-04	31.9
8	1	35.00	40.00	5.00	5.6	0.5	37.50	1.30	41.27	30.9	2.1E-04	15.0
	2	35.00	40.00	5.00	5.6	1.0	37.50	1.30	40.71	55.3	3.7E-04	27.2
	3	35.00	40.00	5.00	5.6	0.5	37.50	1.30	38.44	45.0	3.2E-04	23.4
9	1	40.00	45.00	5.00	5.6	0.5	40.00	1.30	43.72	29.2	1.8E-04	13.4
	2	40.00	45.00	5.00	5.6	1.0	40.00	1.30	46.56	39.6	2.3E-04	17.0
	3	40.00	45.00	5.00	5.6	2.0	40.00	1.30	50.78	58.9	3.2E-04	23.2
	4	40.00	45.00	5.00	5.6	1.0	40.00	1.30	44.77	46.4	2.9E-04	20.7
	5	40.00	45.00	5.00	5.6	0.5	40.00	1.30	42.60	35.0	2.3E-04	16.4
10	1	45.00	50.00	5.00	5.6	0.5	45.00	1.30	48.61	28.1	1.6E-04	11.6
	2	45.00	50.00	5.00	5.6	1.0	45.00	1.30	51.02	39.4	2.1E-04	15.4
	3	45.00	50.00	5.00	5.6	2.0	45.00	1.30	55.73	55.6	2.7E-04	19.9
	4	45.00	50.00	5.00	5.6	1.0	45.00	1.30	48.95	52.4	3.1E-04	22.3
	5	45.00	50.00	5.00	5.6	0.5	45.00	1.30	43.73	47.2	3.0E-04	21.6

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (3/17)

BOREHOLE NUMBER : B-3

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.20	5.00	3.80	5.6	1.0	0.00	1.75	11.47	55.5	1.7E-03	127.3
	2	1.20	5.00	3.80	5.6	2.0	0.00	1.75	21.01	90.0	1.5E-03	112.7
2	1	4.50	10.00	5.50	5.6	1.0	0.00	1.75	10.63	57.2	1.4E-03	97.8
	2	4.50	10.00	5.50	5.6	2.0	0.00	1.75	18.99	90.0	1.2E-03	86.2
3	1	10.00	15.00	5.00	5.6	1.0	0.00	1.75	11.28	24.8	6.0E-04	44.0
	2	10.00	15.00	5.00	5.6	2.0	0.00	1.75	20.27	44.2	6.0E-04	43.6
	3	10.00	15.00	5.00	5.6	3.0	0.00	1.75	29.38	55.9	5.2E-04	38.0
	4	10.00	15.00	5.00	5.6	4.0	0.00	1.75	37.25	77.1	5.7E-04	41.4
	5	10.00	15.00	5.00	5.6	2.0	0.00	1.75	20.25	44.5	6.0E-04	43.9
	6	10.00	15.00	5.00	5.6	1.0	0.00	1.75	11.31	24.0	5.8E-04	42.4
4	1	15.00	20.00	5.00	5.6	1.0	0.00	1.75	11.73	4.4	1.0E-04	7.4
	2	15.00	20.00	5.00	5.6	2.0	0.00	1.75	21.67	8.2	1.0E-04	7.5
	3	15.00	20.00	5.00	5.6	3.0	0.00	1.75	31.61	11.3	9.8E-05	7.2
	4	15.00	20.00	5.00	5.6	4.0	0.00	1.75	41.45	16.3	1.1E-04	7.9
	5	15.00	20.00	5.00	5.6	5.0	0.00	1.75	51.05	24.8	1.3E-04	9.7
	6	15.00	20.00	5.00	5.6	3.0	0.00	1.75	31.62	10.8	9.4E-05	6.9
	7	15.00	20.00	5.00	5.6	1.0	0.00	1.75	11.73	4.2	9.7E-05	7.1
5	1	20.00	25.00	5.00	5.6	1.0	0.00	1.75	11.75	0.8	1.8E-05	1.3
	2	20.00	25.00	5.00	5.6	2.0	0.00	1.75	21.75	1.2	1.6E-05	1.1
	3	20.00	25.00	5.00	5.6	3.0	0.00	1.75	31.72	4.2	3.7E-05	2.7
	4	20.00	25.00	5.00	5.6	5.0	0.00	1.75	51.67	7.2	3.8E-05	2.8
	5	20.00	25.00	5.00	5.6	3.0	0.00	1.75	31.73	3.8	3.3E-05	2.4
	6	20.00	25.00	5.00	5.6	1.0	0.00	1.75	11.75	0.6	1.5E-05	1.1
6	1	25.00	30.00	5.00	5.6	1.0	0.00	1.75	11.75	1.3	3.0E-05	2.2
	2	25.00	30.00	5.00	5.6	2.0	0.00	1.75	21.74	2.7	3.5E-05	2.5
	3	25.00	30.00	5.00	5.6	3.0	0.00	1.75	31.71	4.5	3.9E-05	2.9
	4	25.00	30.00	5.00	5.6	5.0	0.00	1.75	51.66	6.9	3.7E-05	2.7
	5	25.00	30.00	5.00	5.6	7.0	0.00	1.75	71.72	3.7	1.4E-05	1.0
	6	25.00	30.00	5.00	5.6	5.0	0.00	1.75	51.74	2.5	1.3E-05	1.0
	7	25.00	30.00	5.00	5.6	3.0	0.00	1.75	31.74	1.7	1.5E-05	1.1
	8	25.00	30.00	5.00	5.6	1.0	0.00	1.75	11.75	1.0	2.3E-05	1.7
7	1	30.00	35.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.8E-06	0.2
	2	30.00	35.00	5.00	5.6	2.0	0.00	1.75	21.75	0.5	5.7E-06	0.4
	3	30.00	35.00	5.00	5.6	3.0	0.00	1.75	31.75	1.0	8.8E-06	0.6
	4	30.00	35.00	5.00	5.6	5.0	0.00	1.75	51.74	1.9	1.0E-05	0.7
	5	30.00	35.00	5.00	5.6	7.0	0.00	1.75	71.75	0.9	3.6E-06	0.3
	6	30.00	35.00	5.00	5.6	5.0	0.00	1.75	51.75	0.6	3.0E-06	0.2
	7	30.00	35.00	5.00	5.6	3.0	0.00	1.75	31.75	0.2	2.0E-06	0.1
	8	30.00	35.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.8E-06	0.2
8	1	35.00	40.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0

BOREHOLE NUMBER : B-3

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	2	35.00	40.00	5.00	5.6	3.0	0.00	1.75	31.75	0.6	5.5E-06	0.4
	3	35.00	40.00	5.00	5.6	5.0	0.00	1.75	51.75	1.3	7.0E-06	0.5
	4	35.00	40.00	5.00	5.6	7.0	0.00	1.75	71.75	1.2	4.5E-06	0.3
	5	35.00	40.00	5.00	5.6	5.0	0.00	1.75	51.75	0.7	3.7E-06	0.3
	6	35.00	40.00	5.00	5.6	3.0	0.00	1.75	31.75	0.4	3.1E-06	0.2
	7	35.00	40.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
9	1	40.00	45.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
	2	40.00	45.00	5.00	5.6	3.0	0.00	1.75	31.75	0.6	4.8E-06	0.3
	3	40.00	45.00	5.00	5.6	5.0	0.00	1.75	51.75	1.2	6.4E-06	0.5
	4	40.00	45.00	5.00	5.6	7.0	0.00	1.75	71.75	1.0	3.8E-06	0.3
	5	40.00	45.00	5.00	5.6	5.0	0.00	1.75	51.75	0.7	3.8E-06	0.3
	6	40.00	45.00	5.00	5.6	3.0	0.00	1.75	31.75	0.3	2.9E-06	0.2
	7	40.00	45.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
10	1	45.00	50.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
	2	45.00	50.00	5.00	5.6	3.0	0.00	1.75	31.75	0.7	6.2E-06	0.4
	3	45.00	50.00	5.00	5.6	5.0	0.00	1.75	51.75	1.2	6.4E-06	0.5
	4	45.00	50.00	5.00	5.6	7.0	0.00	1.75	71.75	0.9	3.4E-06	0.2
	5	45.00	50.00	5.00	5.6	5.0	0.00	1.75	51.75	0.7	3.7E-06	0.3
	6	45.00	50.00	5.00	5.6	3.0	0.00	1.75	31.75	0.5	3.9E-06	0.3
	7	45.00	50.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
11	1	50.00	55.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
	2	50.00	55.00	5.00	5.6	3.0	0.00	1.75	31.75	0.8	6.5E-06	0.5
	3	50.00	55.00	5.00	5.6	5.0	0.00	1.75	51.74	1.4	7.5E-06	0.5
	4	50.00	55.00	5.00	5.6	7.0	0.00	1.75	71.75	0.9	3.4E-06	0.2
	5	50.00	55.00	5.00	5.6	5.0	0.00	1.75	51.75	0.6	3.2E-06	0.2
	6	50.00	55.00	5.00	5.6	3.0	0.00	1.75	31.75	0.4	3.5E-06	0.3
	7	50.00	55.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
12	1	55.00	60.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
	2	55.00	60.00	5.00	5.6	3.0	0.00	1.75	31.75	0.6	5.2E-06	0.4
	3	55.00	60.00	5.00	5.6	5.0	0.00	1.75	51.74	1.5	7.9E-06	0.6
	4	55.00	60.00	5.00	5.6	7.0	0.00	1.75	71.75	0.8	3.1E-06	0.2
	5	55.00	60.00	5.00	5.6	5.0	0.00	1.75	51.75	0.7	3.5E-06	0.3
	6	55.00	60.00	5.00	5.6	3.0	0.00	1.75	31.75	0.5	4.4E-06	0.3
	7	55.00	60.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (4/17)

BOREHOLE NUMBER : B-4

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	3.00	5.00	2.00	9.6	1.0	4.00	1.20	14.84	39.6	1.3E-03	133.5
	2	3.00	5.00	2.00	9.6	1.5	4.00	1.20	19.55	53.6	1.4E-03	137.1
	3	3.00	5.00	2.00	9.6	1.0	4.00	1.20	14.78	43.1	1.4E-03	145.8
2	1	6.00	10.00	4.00	9.6	0.5	8.00	1.20	12.97	52.1	1.2E-03	100.5
	2	6.00	10.00	4.00	9.6	1.0	8.00	1.20	17.69	57.6	9.5E-04	81.4
	3	6.00	10.00	4.00	9.6	0.5	8.00	1.20	12.94	52.7	1.2E-03	101.9
3	1	13.00	15.00	2.00	5.6	1.0	14.00	1.20	24.92	16.8	3.8E-04	33.7
	2	13.00	15.00	2.00	5.6	2.0	14.00	1.20	34.26	30.9	5.1E-04	45.1
	3	13.00	15.00	2.00	5.6	3.0	14.00	1.20	43.52	41.3	5.4E-04	47.4
	4	13.00	15.00	2.00	5.6	5.0	14.00	1.20	62.89	48.5	4.4E-04	38.5
	5	13.00	15.00	2.00	5.6	3.0	14.00	1.20	44.57	25.3	3.2E-04	28.4
4	1	15.00	20.00	5.00	5.6	1.0	17.50	1.20	26.46	44.4	4.6E-04	33.6
	2	15.00	20.00	5.00	5.6	1.5	17.50	1.20	30.56	51.8	4.6E-04	33.8
	3	15.00	20.00	5.00	5.6	1.0	17.50	1.20	26.41	44.9	4.7E-04	34.0
5	1	20.00	25.00	5.00	5.6	0.5	22.50	1.20	26.71	36.3	3.7E-04	27.2
	2	20.00	25.00	5.00	5.6	1.0	22.50	1.20	28.52	58.5	5.6E-04	41.0
	3	20.00	25.00	5.00	5.6	0.5	22.50	1.20	25.21	48.0	5.2E-04	38.1
6	1	25.00	30.00	5.00	5.6	1.0	27.50	1.20	34.35	48.0	3.8E-04	27.9
	2	25.00	30.00	5.00	5.6	1.5	27.50	1.20	37.66	56.5	4.1E-04	30.0
	3	25.00	30.00	5.00	5.6	1.0	27.50	1.20	33.61	51.9	4.2E-04	30.9
7	1	30.00	35.00	5.00	5.6	1.5	32.50	1.20	44.81	41.4	2.5E-04	18.5
	2	30.00	35.00	5.00	5.6	2.0	32.50	1.20	46.00	53.2	3.5E-04	25.3
	3	30.00	35.00	5.00	5.6	1.5	32.50	1.20	42.51	52.2	3.4E-04	24.6
8	1	35.00	40.00	5.00	5.6	1.5	21.00	1.20	32.91	40.2	3.4E-04	24.4
	2	35.00	40.00	5.00	5.6	2.0	21.00	1.20	33.23	58.2	4.8E-04	35.0
	3	35.00	40.00	5.00	5.6	1.5	21.00	1.20	29.67	53.3	4.9E-04	35.9
9	1	40.00	45.00	5.00	5.6	1.5	21.00	1.20	32.40	39.8	3.4E-04	24.6
	2	40.00	45.00	5.00	5.6	2.0	21.00	1.20	31.72	58.8	5.1E-04	37.1
	3	40.00	45.00	5.00	5.6	1.5	21.00	1.20	29.90	49.1	4.5E-04	32.8
10	1	45.00	50.00	5.00	5.6	1.0	21.35	1.20	25.34	46.0	5.0E-04	36.3
	2	45.00	50.00	5.00	5.6	1.5	21.35	1.20	25.97	58.3	6.2E-04	44.9
	3	45.00	50.00	5.00	5.6	1.0	21.35	1.20	23.01	52.9	6.3E-04	46.0

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (5/17)

BOREHOLE NUMBER : B-5

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.00	5.00	4.00	7.4	1.0	3.00	1.50	14.42	32.2	6.9E-04	55.8
	2	1.00	5.00	4.00	7.4	1.5	3.00	1.50	19.40	36.9	5.9E-04	47.6
	3	1.00	5.00	4.00	7.4	1.0	3.00	1.50	14.42	32.7	7.0E-04	56.7
2	1	5.00	10.00	5.00	7.4	0.5	7.50	1.50	13.28	43.6	8.5E-04	65.7
	2	5.00	10.00	5.00	7.4	1.0	7.50	1.50	18.01	51.2	7.4E-04	56.9
	3	5.00	10.00	5.00	7.4	0.5	7.50	1.50	13.26	44.3	8.7E-04	66.8
3	1	10.00	15.00	5.00	7.4	0.5	12.50	1.50	18.16	33.4	4.8E-04	36.8
	2	10.00	15.00	5.00	7.4	1.0	12.50	1.50	22.50	44.5	5.1E-04	39.5
	3	10.00	15.00	5.00	7.4	1.5	12.50	1.50	27.30	47.3	4.5E-04	34.7
	4	10.00	15.00	5.00	7.4	2.0	12.50	1.50	32.08	50.4	4.1E-04	31.4
	5	10.00	15.00	5.00	7.4	1.5	12.50	1.50	27.25	48.0	4.6E-04	35.2
	6	10.00	15.00	5.00	7.4	1.0	12.50	1.50	22.42	45.7	5.3E-04	40.8
	7	10.00	15.00	5.00	7.4	0.5	12.50	1.50	18.14	33.8	4.9E-04	37.3
4	1	15.00	20.00	5.00	7.4	1.0	17.50	1.50	26.46	47.3	4.7E-04	35.8
	2	15.00	20.00	5.00	7.4	1.5	17.50	1.50	30.59	54.8	4.7E-04	35.8
	3	15.00	20.00	5.00	7.4	1.0	17.50	1.50	26.37	48.1	4.8E-04	36.5
5	1	21.00	25.00	4.00	5.6	1.0	23.00	1.50	34.04	16.9	1.6E-04	12.4
	2	21.00	25.00	4.00	5.6	2.0	23.00	1.50	43.37	26.6	2.0E-04	15.4
	3	21.00	25.00	4.00	5.6	3.0	23.00	1.50	52.05	39.2	2.5E-04	19.8
	4	21.00	25.00	4.00	5.6	4.0	23.00	1.50	60.54	49.9	2.7E-04	20.6
	5	21.00	25.00	4.00	5.6	3.0	23.00	1.50	51.96	39.9	2.5E-04	19.2
	6	21.00	25.00	4.00	5.6	2.0	23.00	1.50	43.31	27.4	2.1E-04	15.8
	7	21.00	25.00	4.00	5.6	1.0	23.00	1.50	33.94	18.8	1.8E-04	13.9
6	1	25.00	30.00	5.00	5.6	1.0	27.50	1.50	38.50	16.3	1.2E-04	8.5
	2	25.00	30.00	5.00	5.6	2.0	27.50	1.50	47.53	27.9	1.6E-04	11.7
	3	25.00	30.00	5.00	5.6	3.0	27.50	1.50	53.92	51.8	2.6E-04	19.2
	4	25.00	30.00	5.00	5.6	4.0	27.50	1.50	64.55	48.5	2.1E-04	15.0
	5	25.00	30.00	5.00	5.6	3.0	27.50	1.50	55.95	40.2	2.0E-04	14.4
	6	25.00	30.00	5.00	5.6	2.0	27.50	1.50	47.42	28.9	1.7E-04	12.2
	7	25.00	30.00	5.00	5.6	1.0	27.50	1.50	38.35	18.6	1.3E-04	9.7
7	1	30.00	35.00	5.00	5.6	0.5	29.00	1.50	30.91	45.0	4.0E-04	29.1
	2	30.00	35.00	5.00	5.6	1.0	29.00	1.50	34.25	52.4	4.2E-04	30.6
	3	30.00	35.00	5.00	5.6	0.5	29.00	1.50	30.35	47.6	4.3E-04	31.4
8	1	35.00	40.00	5.00	5.6	0.5	29.00	1.50	30.87	41.8	3.7E-04	27.1
	2	35.00	40.00	5.00	5.6	1.0	29.00	1.50	32.05	56.5	4.8E-04	35.2
	3	35.00	40.00	5.00	5.6	0.5	29.00	1.50	29.64	47.0	4.4E-04	31.7
9	1	40.00	45.00	5.00	5.6	0.5	30.80	1.50	32.71	38.9	3.3E-04	23.8
	2	40.00	45.00	5.00	5.6	1.0	30.80	1.50	31.90	58.6	5.1E-04	36.7
	3	40.00	45.00	5.00	5.6	0.5	30.80	1.50	33.46	35.6	2.9E-04	21.3
10	1	45.00	50.00	5.00	5.6	0.5	30.80	1.50	35.39	23.7	1.8E-04	13.4

BOREHOLE NUMBER : B-5

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	2	45.00	50.00	5.00	5.6	1.0	30.80	1.50	37.78	36.4	2.7E-04	19.3
	3	45.00	50.00	5.00	5.6	1.5	30.80	1.50	40.73	43.9	3.0E-04	21.6
	4	45.00	50.00	5.00	5.6	2.0	30.80	1.50	40.68	58.4	3.9E-04	28.7
	5	45.00	50.00	5.00	5.6	1.5	30.80	1.50	40.56	44.5	3.0E-04	21.9
	6	45.00	50.00	5.00	5.6	1.0	30.80	1.50	37.35	38.1	2.8E-04	20.4
	7	45.00	50.00	5.00	5.6	0.5	30.80	1.50	35.31	24.2	1.9E-04	13.7

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (6/17)

BOREHOLE NUMBER : B-6

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.40	5.00	3.60	5.6	1.0	0.00	1.75	11.41	55.3	1.7E-03	134.4
	2	1.40	5.00	3.60	5.6	2.0	0.00	1.75	20.99	84.9	1.4E-03	112.4
2	1	5.00	10.00	5.00	5.6	1.0	0.00	1.75	10.58	55.7	1.4E-03	105.3
	2	5.00	10.00	5.00	5.6	2.0	0.00	1.75	19.02	84.9	1.2E-03	89.3
3	1	10.00	15.00	5.00	5.6	1.0	0.00	1.75	11.75	2.6	6.0E-05	4.4
	2	10.00	15.00	5.00	5.6	2.0	0.00	1.75	21.74	4.3	5.4E-05	3.9
	3	10.00	15.00	5.00	5.6	3.0	0.00	1.75	31.73	5.5	4.8E-05	3.5
	4	10.00	15.00	5.00	5.6	5.0	0.00	1.75	51.60	14.0	7.4E-05	5.4
	5	10.00	15.00	5.00	5.6	3.0	0.00	1.75	31.71	7.3	6.3E-05	4.6
	6	10.00	15.00	5.00	5.6	1.0	0.00	1.75	11.75	2.5	5.9E-05	4.3
4	1	15.00	20.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.6E-06	0.2
	2	15.00	20.00	5.00	5.6	2.0	0.00	1.75	21.75	0.9	1.2E-05	0.8
	3	15.00	20.00	5.00	5.6	3.0	0.00	1.75	31.75	1.9	1.6E-05	1.2
	4	15.00	20.00	5.00	5.6	4.0	0.00	1.75	41.73	3.8	2.5E-05	1.8
	5	15.00	20.00	5.00	5.6	5.0	0.00	1.75	51.57	12.6	6.7E-05	4.9
	6	15.00	20.00	5.00	5.6	3.0	0.00	1.75	31.73	4.4	3.8E-05	2.7
	7	15.00	20.00	5.00	5.6	1.0	0.00	1.75	11.75	0.6	1.4E-05	1.0
5	1	20.00	25.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.7E-06	0.2
	2	20.00	25.00	5.00	5.6	2.0	0.00	1.75	21.75	1.0	1.2E-05	0.9
	3	20.00	25.00	5.00	5.6	3.0	0.00	1.75	31.74	2.0	1.7E-05	1.2
	4	20.00	25.00	5.00	5.6	4.0	0.00	1.75	41.73	3.7	2.5E-05	1.8
	5	20.00	25.00	5.00	5.6	5.0	0.00	1.75	51.54	11.8	6.3E-05	4.6
	6	20.00	25.00	5.00	5.6	3.0	0.00	1.75	31.72	4.5	3.9E-05	2.8
	7	20.00	25.00	5.00	5.6	1.0	0.00	1.75	11.75	0.5	1.2E-05	0.9
6	1	30.00	35.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.7E-06	0.2
	2	30.00	35.00	5.00	5.6	2.0	0.00	1.75	21.75	0.4	5.6E-06	0.4
	3	30.00	35.00	5.00	5.6	3.0	0.00	1.75	31.75	1.0	8.5E-06	0.6
	4	30.00	35.00	5.00	5.6	5.0	0.00	1.75	51.75	1.5	7.1E-06	0.5
	5	30.00	35.00	5.00	5.6	7.0	0.00	1.75	71.75	1.1	4.3E-06	0.3
	6	30.00	35.00	5.00	5.6	3.0	0.00	1.75	31.75	1.0	8.2E-06	0.6
	7	30.00	35.00	5.00	5.6	1.0	0.00	1.75	11.75	0.4	1.0E-05	0.7
7	1	35.00	40.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
	2	35.00	40.00	5.00	5.6	2.0	0.00	1.75	21.75	0.2	1.9E-06	0.1
	3	35.00	40.00	5.00	5.6	3.0	0.00	1.75	31.75	0.3	2.9E-06	0.2
	4	35.00	40.00	5.00	5.6	5.0	0.00	1.75	51.75	0.5	2.4E-06	0.2
	5	35.00	40.00	5.00	5.6	7.0	0.00	1.75	71.75	0.7	2.9E-06	0.2
	6	35.00	40.00	5.00	5.6	3.0	0.00	1.75	31.75	0.3	2.3E-06	0.2
	7	35.00	40.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
8	1	40.00	45.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
	2	40.00	45.00	5.00	5.6	2.0	0.00	1.75	21.75	0.1	1.3E-06	0.1

BOREHOLE NUMBER : B-6

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	3	40.00	45.00	5.00	5.6	3.0	0.00	1.75	31.75	0.3	2.3E-06	0.2
	4	40.00	45.00	5.00	5.6	5.0	0.00	1.75	51.75	0.5	2.4E-06	0.2
	5	40.00	45.00	5.00	5.6	7.0	0.00	1.75	71.75	0.7	2.5E-06	0.2
	6	40.00	45.00	5.00	5.6	3.0	0.00	1.75	31.75	0.2	2.0E-06	0.1
	7	40.00	45.00	5.00	5.6	1.0	0.00	1.75	11.75	0.0	0.0E+00	0.0
9	1	45.00	50.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.7E-06	0.2
	2	45.00	50.00	5.00	5.6	2.0	0.00	1.75	21.75	0.2	2.8E-06	0.2
	3	45.00	50.00	5.00	5.6	3.0	0.00	1.75	31.75	0.3	2.3E-06	0.2
	4	45.00	50.00	5.00	5.6	5.0	0.00	1.75	51.72	2.9	1.5E-05	1.1
	5	45.00	50.00	5.00	5.6	7.0	0.00	1.75	71.71	3.4	1.3E-05	1.0
	6	45.00	50.00	5.00	5.6	3.0	0.00	1.75	31.75	0.4	3.8E-06	0.3
	7	45.00	50.00	5.00	5.6	1.0	0.00	1.75	11.75	0.1	2.4E-06	0.2

Table 3.2.4 TEST RESULTS OF PERMEABILITY LUGEON VALUE (7/17)

BOREHOLE NUMBER : B-7

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	5.00	10.00	5.00	5.6	1.0	5.70	0.40	16.09	4.2	7.1E-05	5.2
2	1	10.00	15.00	5.00	5.6	1.0	5.70	0.40	16.10	0.3	4.4E-06	0.3
	2	10.00	15.00	5.00	5.6	2.0	5.70	0.40	26.09	2.6	2.7E-05	2.0
	3	10.00	15.00	5.00	5.6	3.0	5.70	0.40	35.86	17.1	1.3E-04	9.6
	4	10.00	15.00	5.00	5.6	5.0	5.70	0.40	55.53	27.4	1.4E-04	9.9
	5	10.00	15.00	5.00	5.6	3.0	5.70	0.40	35.87	17.3	1.3E-04	9.7
	6	10.00	15.00	5.00	5.6	2.0	5.70	0.40	26.09	2.6	2.7E-05	2.0
	7	10.00	15.00	5.00	5.6	1.0	5.70	0.40	16.10	1.6	2.7E-05	2.0
3	1	15.00	20.00	5.00	5.6	1.0	5.70	0.40	16.10	1.8	3.1E-05	2.2
	2	15.00	20.00	5.00	5.6	2.0	5.70	0.40	26.09	2.7	2.8E-05	2.0
	3	15.00	20.00	5.00	5.6	3.0	5.70	0.40	36.08	4.1	3.1E-05	2.2
	4	15.00	20.00	5.00	5.6	5.0	5.70	0.40	55.97	10.7	5.3E-05	3.8
	5	15.00	20.00	5.00	5.6	3.0	5.70	0.40	36.08	4.0	3.1E-05	2.2
	6	15.00	20.00	5.00	5.6	2.0	5.70	0.40	26.10	2.1	2.2E-05	1.6
	7	15.00	20.00	5.00	5.6	1.0	5.70	0.40	16.10	1.9	3.3E-05	2.4
4	1	20.00	25.00	5.00	5.6	1.0	5.70	0.40	16.10	1.1	1.9E-05	1.4
	2	20.00	25.00	5.00	5.6	2.0	5.70	0.40	26.09	2.3	2.5E-05	1.8
	3	20.00	25.00	5.00	5.6	3.0	5.70	0.40	36.08	3.9	3.0E-05	2.2
	4	20.00	25.00	5.00	5.6	5.0	5.70	0.40	55.75	15.2	7.5E-05	5.4
	5	20.00	25.00	5.00	5.6	3.0	5.70	0.40	36.08	4.0	3.1E-05	2.2
	6	20.00	25.00	5.00	5.6	2.0	5.70	0.40	26.09	2.2	2.4E-05	1.7
	7	20.00	25.00	5.00	5.6	1.0	5.70	0.40	16.10	1.2	2.0E-05	1.4
5	1	25.00	30.00	5.00	5.6	1.0	5.70	0.40	16.10	0.7	1.2E-05	0.8
	2	25.00	30.00	5.00	5.6	2.0	5.70	0.40	26.09	2.0	2.1E-05	1.5
	3	25.00	30.00	5.00	5.6	3.0	5.70	0.40	36.09	2.8	2.1E-05	1.6
	4	25.00	30.00	5.00	5.6	5.0	5.70	0.40	55.87	12.0	5.9E-05	4.3
	5	25.00	30.00	5.00	5.6	3.0	5.70	0.40	36.08	2.8	2.2E-05	1.6
	6	25.00	30.00	5.00	5.6	2.0	5.70	0.40	26.09	2.2	2.3E-05	1.7
	7	25.00	30.00	5.00	5.6	1.0	5.70	0.40	16.10	0.9	1.5E-05	1.1
6	1	30.00	35.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
	2	30.00	35.00	5.00	5.6	2.0	5.70	0.40	26.10	0.3	3.4E-06	0.2
	3	30.00	35.00	5.00	5.6	3.0	5.70	0.40	36.09	2.3	1.7E-05	1.3
	4	30.00	35.00	5.00	5.6	5.0	5.70	0.40	55.98	7.2	3.5E-05	2.6
	5	30.00	35.00	5.00	5.6	3.0	5.70	0.40	36.09	1.9	1.5E-05	1.1
	6	30.00	35.00	5.00	5.6	2.0	5.70	0.40	26.10	0.3	3.5E-06	0.3
	7	30.00	35.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
7	1	35.00	40.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
	2	35.00	40.00	5.00	5.6	2.0	5.70	0.40	26.10	0.1	1.5E-06	0.1
	3	35.00	40.00	5.00	5.6	3.0	5.70	0.40	36.09	1.6	1.2E-05	0.9
	4	35.00	40.00	5.00	5.6	5.0	5.70	0.40	56.00	6.2	3.0E-05	2.2

BOREHOLE NUMBER : B-7

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	5	35.00	40.00	5.00	5.6	3.0	5.70	0.40	36.09	1.4	1.1E-05	0.8
	6	35.00	40.00	5.00	5.6	2.0	5.70	0.40	26.10	0.2	1.8E-06	0.1
	7	35.00	40.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
8	1	40.00	45.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
	2	40.00	45.00	5.00	5.6	2.0	5.70	0.40	26.10	0.2	2.1E-06	0.2
	3	40.00	45.00	5.00	5.6	3.0	5.70	0.40	36.09	1.9	1.4E-05	1.0
	4	40.00	45.00	5.00	5.6	5.0	5.70	0.40	55.92	7.6	3.8E-05	2.7
	5	40.00	45.00	5.00	5.6	3.0	5.70	0.40	36.09	2.1	1.6E-05	1.1
	6	40.00	45.00	5.00	5.6	2.0	5.70	0.40	26.10	0.2	2.0E-06	0.1
	7	40.00	45.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
9	1	45.00	50.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0
	2	45.00	50.00	5.00	5.6	2.0	5.70	0.40	26.10	0.2	1.8E-06	0.1
	3	45.00	50.00	5.00	5.6	3.0	5.70	0.40	36.09	1.6	1.2E-05	0.9
	4	45.00	50.00	5.00	5.6	5.0	5.70	0.40	56.00	5.3	2.6E-05	1.9
	5	45.00	50.00	5.00	5.6	3.0	5.70	0.40	36.09	1.6	1.2E-05	0.9
	6	45.00	50.00	5.00	5.6	2.0	5.70	0.40	26.10	0.2	2.0E-06	0.1
	7	45.00	50.00	5.00	5.6	1.0	5.70	0.40	16.10	0.0	0.0E+00	0.0

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (8/17)

BOREHOLE NUMBER : B-8

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	5.00	10.00	5.00	5.6	1.0	0.00	0.40	10.39	4.0	1.1E-04	7.7
	2	5.00	10.00	5.00	5.6	2.0	0.00	0.40	20.39	6.3	8.4E-05	6.1
	3	5.00	10.00	5.00	5.6	2.5	0.00	0.40	26.96	33.9	3.7E-04	27.2
	4	5.00	10.00	5.00	5.6	2.0	0.00	0.40	20.38	7.5	1.0E-04	7.4
	5	5.00	10.00	5.00	5.6	1.0	0.00	0.40	10.39	4.7	1.3E-04	9.1
2	1	10.00	15.00	5.00	5.6	1.0	+1.00	0.40	9.39	2.8	8.2E-05	6.0
	2	10.00	15.00	5.00	5.6	2.0	+1.00	0.40	19.38	5.1	7.3E-05	5.3
	3	10.00	15.00	5.00	5.6	3.0	+1.00	0.40	29.37	6.3	5.9E-05	4.3
	4	10.00	15.00	5.00	5.6	5.0	+1.00	0.40	49.35	8.0	4.4E-05	3.2
	5	10.00	15.00	5.00	5.6	3.0	+1.00	0.40	29.37	6.7	6.3E-05	4.6
	6	10.00	15.00	5.00	5.6	2.0	+1.00	0.40	19.38	5.5	7.8E-05	5.7
	7	10.00	15.00	5.00	5.6	1.0	+1.00	0.40	9.39	2.9	8.6E-05	6.3
3	1	15.00	20.00	5.00	5.6	1.0	+1.00	0.40	9.40	0.0	0.0E+00	0.0
	2	15.00	20.00	5.00	5.6	2.0	+1.00	0.40	19.40	0.0	5.7E-07	0.0
	3	15.00	20.00	5.00	5.6	3.0	+1.00	0.40	29.40	0.1	1.1E-06	0.1
	4	15.00	20.00	5.00	5.6	5.0	+1.00	0.40	49.39	2.9	1.6E-05	1.2
	5	15.00	20.00	5.00	5.6	3.0	+1.00	0.40	29.40	0.1	1.2E-06	0.1
	6	15.00	20.00	5.00	5.6	2.0	+1.00	0.40	19.40	0.0	4.3E-07	0.0
	7	15.00	20.00	5.00	5.6	1.0	+1.00	0.40	9.40	0.0	2.9E-07	0.0
4	1	25.00	30.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.0	0.0E+00	0.0
	2	25.00	30.00	5.00	5.6	2.0	+1.50	0.40	18.90	0.7	1.0E-05	0.7
	3	25.00	30.00	5.00	5.6	3.0	+1.50	0.40	28.88	2.9	2.8E-05	2.0
	4	25.00	30.00	5.00	5.6	5.0	+1.50	0.40	48.84	11.8	6.7E-05	4.9
	5	25.00	30.00	5.00	5.6	3.0	+1.50	0.40	28.86	3.0	2.8E-05	2.1
	6	25.00	30.00	5.00	5.6	2.0	+1.50	0.40	18.90	0.7	1.0E-05	0.8
	7	25.00	30.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.0	0.0E+00	0.0
5	1	30.00	35.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.0	0.0E+00	0.0
	2	30.00	35.00	5.00	5.6	2.0	+1.50	0.40	18.90	1.0	1.4E-05	1.0
	3	30.00	35.00	5.00	5.6	3.0	+1.50	0.40	28.86	3.9	3.8E-05	2.7
	4	30.00	35.00	5.00	5.6	5.0	+1.50	0.40	48.79	15.1	8.6E-05	6.2
	5	30.00	35.00	5.00	5.6	3.0	+1.50	0.40	28.86	4.0	3.9E-05	2.8
	6	30.00	35.00	5.00	5.6	2.0	+1.50	0.40	18.90	1.1	1.7E-05	1.2
	7	30.00	35.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.0	0.0E+00	0.0
6	1	35.00	40.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.3	7.7E-06	0.6
	2	35.00	40.00	5.00	5.6	2.0	+1.50	0.40	18.89	1.6	2.4E-05	1.7
	3	35.00	40.00	5.00	5.6	4.0	+1.50	0.40	38.83	5.1	3.6E-05	2.6
	4	35.00	40.00	5.00	5.6	7.0	+1.50	0.40	68.26	15.5	6.2E-05	4.5
	5	35.00	40.00	5.00	5.6	4.0	+1.50	0.40	38.82	5.4	3.8E-05	2.8
	6	35.00	40.00	5.00	5.6	2.0	+1.50	0.40	18.89	1.7	2.4E-05	1.8
	7	35.00	40.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.3	8.7E-06	0.6

BOREHOLE NUMBER : B-8

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
7	1	40.00	45.00	5.00	5.6	1.0	+1.50	0.40	8.88	2.8	8.6E-05	6.3
	2	40.00	45.00	5.00	5.6	2.0	+1.50	0.40	18.89	1.9	2.8E-05	2.0
	3	40.00	45.00	5.00	5.6	4.0	+1.50	0.40	38.79	5.9	4.2E-05	3.1
	4	40.00	45.00	5.00	5.6	7.0	+1.50	0.40	67.90	18.2	7.4E-05	5.3
	5	40.00	45.00	5.00	5.6	4.0	+1.50	0.40	38.78	6.4	4.5E-05	3.3
	6	40.00	45.00	5.00	5.6	2.0	+1.50	0.40	18.89	2.2	3.1E-05	2.3
	7	40.00	45.00	5.00	5.6	1.0	+1.50	0.40	8.87	3.1	9.6E-05	7.0
8	1	45.00	50.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.4	1.2E-05	0.8
	2	45.00	50.00	5.00	5.6	2.0	+1.50	0.40	18.89	2.1	3.0E-05	2.2
	3	45.00	50.00	5.00	5.6	4.0	+1.50	0.40	38.75	6.7	4.8E-05	3.5
	4	45.00	50.00	5.00	5.6	7.0	+1.50	0.40	67.47	19.0	7.7E-05	5.6
	5	45.00	50.00	5.00	5.6	4.0	+1.50	0.40	38.74	7.0	4.9E-05	3.6
	6	45.00	50.00	5.00	5.6	2.0	+1.50	0.40	18.88	2.3	3.3E-05	2.4
	7	45.00	50.00	5.00	5.6	1.0	+1.50	0.40	8.90	0.4	1.2E-05	0.9

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (9/17)

BOREHOLE NUMBER : B-9

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.00	5.00	4.00	5.6	1.0	0.60	1.65	12.01	56.4	1.5E-03	117.4
2	1	5.00	10.00	5.00	5.6	0.5	1.05	1.65	6.05	66.0	3.0E-03	218.2
3	1	10.00	15.00	5.00	5.6	1.0	1.05	1.65	12.61	10.6	2.3E-04	16.8
	2	10.00	15.00	5.00	5.6	2.0	1.05	1.65	22.24	24.7	3.1E-04	22.2
	3	10.00	15.00	5.00	5.6	3.0	1.05	1.65	29.89	60.9	5.6E-04	40.8
	4	10.00	15.00	5.00	5.6	2.0	1.05	1.65	22.31	22.8	2.8E-04	20.4
	5	10.00	15.00	5.00	5.6	1.0	1.05	1.65	12.65	8.1	1.8E-04	12.8
4	1	15.00	20.00	5.00	5.6	1.0	1.05	1.65	12.65	6.7	1.5E-04	10.6
	2	15.00	20.00	5.00	5.6	2.0	1.05	1.65	22.52	12.7	1.6E-04	11.3
	3	15.00	20.00	5.00	5.6	3.0	1.05	1.65	32.37	17.0	1.4E-04	10.5
	4	15.00	20.00	5.00	5.6	5.0	1.05	1.65	52.00	24.8	1.3E-04	9.5
	5	15.00	20.00	5.00	5.6	3.0	1.05	1.65	32.55	11.0	9.3E-05	6.8
	6	15.00	20.00	5.00	5.6	2.0	1.05	1.65	22.69	2.7	3.3E-05	2.4
	7	15.00	20.00	5.00	5.6	1.0	1.05	1.65	12.70	0.7	1.5E-05	1.1
5	1	20.00	25.00	5.00	5.6	1.0	1.05	1.65	12.66	5.3	1.1E-04	8.3
	2	20.00	25.00	5.00	5.6	3.0	1.05	1.65	32.50	11.4	9.6E-05	7.0
	3	20.00	25.00	5.00	5.6	5.0	1.05	1.65	51.66	26.2	1.4E-04	10.1
	4	20.00	25.00	5.00	5.6	7.0	1.05	1.65	70.92	34.3	1.3E-04	9.7
	5	20.00	25.00	5.00	5.6	5.0	1.05	1.65	51.89	23.1	1.2E-04	8.9
	6	20.00	25.00	5.00	5.6	3.0	1.05	1.65	32.62	7.1	6.0E-05	4.7
	7	20.00	25.00	5.00	5.6	1.0	1.05	1.65	12.69	2.2	4.9E-05	3.5
6	1	25.00	30.00	5.00	5.6	1.0	1.05	1.65	12.64	5.4	1.2E-04	8.5
	2	25.00	30.00	5.00	5.6	3.0	1.05	1.65	32.44	11.8	1.0E-04	7.3
	3	25.00	30.00	5.00	5.6	5.0	1.05	1.65	51.73	22.6	1.2E-04	8.7
	4	25.00	30.00	5.00	5.6	7.0	1.05	1.65	70.22	36.1	1.4E-04	10.3
	5	25.00	30.00	5.00	5.6	5.0	1.05	1.65	51.87	21.0	1.1E-04	8.1
	6	25.00	30.00	5.00	5.6	3.0	1.05	1.65	32.53	9.6	8.1E-05	5.9
	7	25.00	30.00	5.00	5.6	1.0	1.05	1.65	12.70	1.6	3.5E-05	2.6
7	1	30.00	35.00	5.00	5.6	1.0	0.50	1.65	12.11	4.1	9.4E-05	6.8
	2	30.00	35.00	5.00	5.6	3.0	0.50	1.65	31.96	9.1	7.9E-05	5.7
	3	30.00	35.00	5.00	5.6	5.0	0.50	1.65	51.41	18.1	9.7E-05	7.0
	4	30.00	35.00	5.00	5.6	7.0	0.50	1.65	70.27	28.8	1.1E-04	8.2
	5	30.00	35.00	5.00	5.6	5.0	0.50	1.65	51.54	16.3	8.7E-05	6.3
	6	30.00	35.00	5.00	5.6	3.0	0.50	1.65	31.94	9.7	8.3E-05	6.1
	7	30.00	35.00	5.00	5.6	1.0	0.50	1.65	12.14	2.4	5.3E-05	3.9
8	1	35.00	40.00	5.00	5.6	1.0	0.50	1.65	12.12	3.5	7.9E-05	5.7
	2	35.00	40.00	5.00	5.6	3.0	0.50	1.65	32.01	7.2	6.2E-05	4.5
	3	35.00	40.00	5.00	5.6	5.0	0.50	1.65	51.40	16.8	9.0E-05	6.5
	4	35.00	40.00	5.00	5.6	7.0	0.50	1.65	69.74	30.2	1.2E-04	8.6
	5	35.00	40.00	5.00	5.6	5.0	0.50	1.65	51.63	14.0	7.5E-05	5.4

BOREHOLE NUMBER : B-9

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	6	35.00	40.00	5.00	5.6	3.0	0.50	1.65	32.08	5.2	4.5E-05	3.2
	7	35.00	40.00	5.00	5.6	1.0	0.50	1.65	12.14	1.6	3.7E-05	2.7
9	1	40.00	45.00	5.00	5.6	1.0	0.65	1.65	12.25	4.1	9.2E-05	6.7
	2	40.00	45.00	5.00	5.6	3.0	0.65	1.65	32.16	6.8	5.8E-05	4.2
	3	40.00	45.00	5.00	5.6	5.0	0.65	1.65	51.54	15.8	8.4E-05	6.1
	4	40.00	45.00	5.00	5.6	7.0	0.65	1.65	69.90	28.2	1.1E-04	8.1
	5	40.00	45.00	5.00	5.6	5.0	0.65	1.65	51.69	14.2	7.6E-05	5.5
	6	40.00	45.00	5.00	5.6	3.0	0.65	1.65	32.22	5.2	4.4E-05	3.2
	7	40.00	45.00	5.00	5.6	1.0	0.65	1.65	12.28	2.8	6.3E-05	4.6
10	1	45.00	50.00	5.00	5.6	1.0	0.65	1.65	12.28	2.3	5.2E-05	3.7
	2	45.00	50.00	5.00	5.6	3.0	0.65	1.65	32.21	5.1	4.4E-05	3.2
	3	45.00	50.00	5.00	5.6	5.0	0.65	1.65	51.87	11.2	5.9E-05	4.3
	4	45.00	50.00	5.00	5.6	7.0	0.65	1.65	70.20	24.3	9.7E-05	7.1
	5	45.00	50.00	5.00	5.6	5.0	0.65	1.65	51.90	10.9	5.9E-05	4.2
	6	45.00	50.00	5.00	5.6	3.0	0.65	1.65	32.27	3.2	2.7E-05	2.0
	7	45.00	50.00	5.00	5.6	1.0	0.65	1.65	12.30	1.2	2.7E-05	2.0

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (10/17)

BOREHOLE NUMBER : B-10

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	3.00	5.00	2.00	5.6	0.0	4.00	1.75	5.39	39.7	4.2E-03	368.0
2	1	5.00	10.00	5.00	5.6	0.0	7.50	1.75	8.65	39.8	1.3E-03	92.0
3	1	10.00	15.00	5.00	5.6	1.0	12.50	1.75	24.25	1.9	2.2E-05	1.6
	2	10.00	15.00	5.00	5.6	2.0	12.50	1.75	34.23	4.6	3.7E-05	2.7
	3	10.00	15.00	5.00	5.6	3.0	12.50	1.75	44.22	6.2	3.9E-05	2.8
	4	10.00	15.00	5.00	5.6	5.0	12.50	1.75	63.99	18.5	7.9E-05	5.8
	5	10.00	15.00	5.00	5.6	3.0	12.50	1.75	44.22	6.3	3.9E-05	2.9
	6	10.00	15.00	5.00	5.6	2.0	12.50	1.75	34.24	4.4	3.6E-05	2.6
	7	10.00	15.00	5.00	5.6	1.0	12.50	1.75	24.25	1.8	2.1E-05	1.5
4	1	15.00	20.00	5.00	5.6	1.0	12.50	1.75	24.25	1.3	1.5E-05	1.1
	2	15.00	20.00	5.00	5.6	2.0	12.50	1.75	34.24	2.5	2.0E-05	1.5
	3	15.00	20.00	5.00	5.6	3.0	12.50	1.75	44.23	4.2	2.6E-05	1.9
	4	15.00	20.00	5.00	5.6	5.0	12.50	1.75	64.08	12.1	5.2E-05	3.8
	5	15.00	20.00	5.00	5.6	3.0	12.50	1.75	44.23	4.4	2.8E-05	2.0
	6	15.00	20.00	5.00	5.6	2.0	12.50	1.75	34.24	2.6	2.1E-05	1.5
	7	15.00	20.00	5.00	5.6	1.0	12.50	1.75	24.25	1.3	1.4E-05	1.0
5	1	20.00	25.00	5.00	5.6	1.0	7.80	1.75	19.55	0.0	4.9E-07	0.0
	2	20.00	25.00	5.00	5.6	2.0	7.80	1.75	29.55	1.2	1.1E-05	0.8
	3	20.00	25.00	5.00	5.6	3.0	7.80	1.75	39.53	3.3	2.3E-05	1.7
	4	20.00	25.00	5.00	5.6	5.0	7.80	1.75	59.48	6.6	3.1E-05	2.2
	5	20.00	25.00	5.00	5.6	3.0	7.80	1.75	39.53	3.4	2.3E-05	1.7
	6	20.00	25.00	5.00	5.6	2.0	7.80	1.75	29.55	1.2	1.1E-05	0.8
	7	20.00	25.00	5.00	5.6	1.0	7.80	1.75	19.55	0.0	5.8E-07	0.0
6	1	25.00	30.00	5.00	5.6	1.0	7.80	1.75	19.55	0.0	2.0E-07	0.0
	2	25.00	30.00	5.00	5.6	2.0	7.80	1.75	29.55	0.9	8.1E-06	0.6
	3	25.00	30.00	5.00	5.6	3.0	7.80	1.75	39.53	3.2	2.2E-05	1.6
	4	25.00	30.00	5.00	5.6	5.0	7.80	1.75	59.48	6.2	2.9E-05	2.1
	5	25.00	30.00	5.00	5.6	3.0	7.80	1.75	39.53	3.1	2.1E-05	1.5
	6	25.00	30.00	5.00	5.6	2.0	7.80	1.75	29.55	0.9	8.7E-06	0.6
	7	25.00	30.00	5.00	5.6	1.0	7.80	1.75	19.55	0.0	3.1E-07	0.0

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (11/17)

BOREHOLE NUMBER : B-11

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.20	6.00	4.80	5.6	1.0	3.60	1.75	14.71	84.1	1.6E-03	119.1
	2	1.20	6.00	4.80	5.6	2.0	3.60	1.75	24.51	96.4	1.1E-03	82.0
2	1	6.00	11.20	5.20	5.6	1.0	8.60	1.75	20.07	25.0	3.3E-04	24.0
	2	6.00	11.20	5.20	5.6	2.0	8.60	1.75	29.07	53.0	4.9E-04	35.1
	3	6.00	11.20	5.20	5.6	3.0	8.60	1.75	37.73	75.9	5.4E-04	38.7
	4	6.00	11.20	5.20	5.6	2.0	8.60	1.75	28.98	55.0	5.1E-04	36.5
	5	6.00	11.20	5.20	5.6	1.0	8.60	1.75	20.04	26.1	3.5E-04	25.0
3	1	10.00	15.00	5.00	5.6	1.0	12.50	1.75	23.85	23.1	2.7E-04	19.4
	2	10.00	15.00	5.00	5.6	2.0	12.50	1.75	32.40	49.5	4.2E-04	30.6
	3	10.00	15.00	5.00	5.6	3.0	12.50	1.75	39.70	77.5	5.4E-04	39.0
	4	10.00	15.00	5.00	5.6	2.0	12.50	1.75	32.40	49.5	4.2E-04	30.6
	5	10.00	15.00	5.00	5.6	1.0	12.50	1.75	23.81	24.0	2.8E-04	20.2
4	1	15.00	20.00	5.00	5.6	1.0	17.50	1.75	22.50	77.1	9.4E-04	68.5
	2	15.00	20.00	5.00	5.6	2.0	17.50	1.75	29.72	91.6	8.5E-04	61.6
	3	15.00	20.00	5.00	5.6	3.0	17.50	1.75	37.64	101.1	7.4E-04	53.7
	4	15.00	20.00	5.00	5.6	2.0	17.50	1.75	29.95	90.5	8.3E-04	60.4
	5	15.00	20.00	5.00	5.6	1.0	17.50	1.75	22.57	76.7	9.3E-04	68.0
5	1	20.00	25.00	5.00	5.6	1.0	21.00	1.75	23.89	76.5	8.8E-04	64.0
	2	20.00	25.00	5.00	5.6	2.0	21.00	1.75	29.80	92.5	8.5E-04	62.1
	3	20.00	25.00	5.00	5.6	3.0	21.00	1.75	36.81	102.6	7.7E-04	55.7
	4	20.00	25.00	5.00	5.6	2.0	21.00	1.75	30.21	91.0	8.3E-04	60.2
	5	20.00	25.00	5.00	5.6	1.0	21.00	1.75	24.12	75.5	8.6E-04	62.6
6	1	25.00	30.00	5.00	5.6	1.0	21.00	1.75	32.65	7.2	6.0E-05	4.4
	2	25.00	30.00	5.00	5.6	2.0	21.00	1.75	42.43	13.1	8.5E-05	6.2
	3	25.00	30.00	5.00	5.6	3.0	21.00	1.75	50.81	32.0	1.7E-04	12.6
	4	25.00	30.00	5.00	5.6	5.0	21.00	1.75	65.29	62.9	2.6E-04	19.2
	5	25.00	30.00	5.00	5.6	3.0	21.00	1.75	49.05	44.2	2.5E-04	18.0
	6	25.00	30.00	5.00	5.6	1.0	21.00	1.75	31.75	23.0	2.0E-04	14.5
7	1	30.00	35.00	5.00	5.6	1.0	21.00	1.75	32.65	6.7	5.7E-05	4.1
	2	30.00	35.00	5.00	5.6	2.0	21.00	1.75	42.27	14.5	9.4E-05	6.9
	3	30.00	35.00	5.00	5.6	3.0	21.00	1.75	50.16	33.8	1.9E-04	13.5
	4	30.00	35.00	5.00	5.6	5.0	21.00	1.75	63.59	63.5	2.7E-04	20.0
	5	30.00	35.00	5.00	5.6	3.0	21.00	1.75	48.65	42.5	2.4E-04	17.5
	6	30.00	35.00	5.00	5.6	1.0	21.00	1.75	31.58	22.7	2.0E-04	14.4
8	1	35.00	40.00	5.00	5.6	1.0	21.00	1.75	32.61	7.3	6.1E-05	4.4
	2	35.00	40.00	5.00	5.6	2.0	21.00	1.75	42.40	11.5	7.5E-05	5.4
	3	35.00	40.00	5.00	5.6	3.0	21.00	1.75	50.27	30.6	1.7E-04	12.2
	4	35.00	40.00	5.00	5.6	5.0	21.00	1.75	62.57	62.0	2.7E-04	19.8
	5	35.00	40.00	5.00	5.6	3.0	21.00	1.75	48.08	42.0	2.4E-04	17.5
	6	35.00	40.00	5.00	5.6	1.0	21.00	1.75	31.47	22.0	1.9E-04	14.0

BOREHOLE NUMBER : B-11

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
9	1	40.00	45.00	5.00	5.6	1.0	21.00	1.75	32.61	6.9	5.8E-05	4.2
	2	40.00	45.00	5.00	5.6	2.0	21.00	1.75	42.21	13.4	8.7E-05	6.3
	3	40.00	45.00	5.00	5.6	3.0	21.00	1.75	49.73	31.6	1.7E-04	12.7
	4	40.00	45.00	5.00	5.6	5.0	21.00	1.75	61.19	61.8	2.8E-04	20.2
	5	40.00	45.00	5.00	5.6	3.0	21.00	1.75	46.94	43.8	2.6E-04	18.7
	6	40.00	45.00	5.00	5.6	1.0	21.00	1.75	31.18	22.7	2.0E-04	14.6
10	1	45.00	50.00	5.00	5.6	1.0	21.00	1.75	32.58	7.1	6.0E-05	4.4
	2	45.00	50.00	5.00	5.6	2.0	21.00	1.75	42.25	12.2	7.9E-05	5.8
	3	45.00	50.00	5.00	5.6	3.0	21.00	1.75	47.83	38.0	2.2E-04	15.9
	4	45.00	50.00	5.00	5.6	4.0	21.00	1.75	46.06	70.0	4.2E-04	30.4
	5	45.00	50.00	5.00	5.6	3.0	21.00	1.75	42.71	54.3	3.5E-04	25.4
	6	45.00	50.00	5.00	5.6	2.0	21.00	1.75	40.30	26.8	1.9E-04	13.5
	7	45.00	50.00	5.00	5.6	1.0	21.00	1.75	32.22	12.5	1.1E-04	7.7
11	1	50.00	55.00	5.00	5.6	1.0	21.00	1.75	32.51	7.9	6.7E-05	4.9
	2	50.00	55.00	5.00	5.6	2.0	21.00	1.75	42.06	13.5	8.8E-05	6.4
	3	50.00	55.00	5.00	5.6	3.0	21.00	1.75	46.85	39.5	2.3E-04	16.9
	4	50.00	55.00	5.00	5.6	4.0	21.00	1.75	43.41	71.5	4.5E-04	32.9
	5	50.00	55.00	5.00	5.6	3.0	21.00	1.75	41.22	55.2	3.7E-04	26.8
	6	50.00	55.00	5.00	5.6	2.0	21.00	1.75	39.94	27.2	1.9E-04	13.6
	7	50.00	55.00	5.00	5.6	1.0	21.00	1.75	32.09	13.2	1.1E-04	8.2
12	1	55.00	60.00	5.00	5.6	1.0	21.00	1.75	32.54	7.1	6.0E-05	4.4
	2	55.00	60.00	5.00	5.6	2.0	21.00	1.75	42.13	12.2	7.9E-05	5.8
	3	55.00	60.00	5.00	5.6	3.0	21.00	1.75	46.74	38.0	2.2E-04	16.3
	4	55.00	60.00	5.00	5.6	4.0	21.00	1.75	42.35	70.0	4.5E-04	33.1
	5	55.00	60.00	5.00	5.6	3.0	21.00	1.75	40.47	54.3	3.7E-04	26.8
	6	55.00	60.00	5.00	5.6	2.0	21.00	1.75	39.75	26.8	1.9E-04	13.5
	7	55.00	60.00	5.00	5.6	1.0	21.00	1.75	32.10	12.5	1.1E-04	7.8

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (12/17)

BOREHOLE NUMBER : B-12

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	2.00	5.00	3.00	5.6	1.0	3.50	1.55	15.04	8.7	2.4E-04	19.2
	2	2.00	5.00	3.00	5.6	2.0	3.50	1.55	25.02	14.3	2.4E-04	19.1
	3	2.00	5.00	3.00	5.6	3.0	3.50	1.55	35.00	19.0	2.2E-04	18.0
	4	2.00	5.00	3.00	5.6	5.0	3.50	1.55	54.95	25.3	1.9E-04	15.3
	5	2.00	5.00	3.00	5.6	3.0	3.50	1.55	35.01	16.5	1.9E-04	15.7
	6	2.00	5.00	3.00	5.6	2.0	3.50	1.55	25.03	10.3	1.7E-04	13.7
	7	2.00	5.00	3.00	5.6	1.0	3.50	1.55	15.04	6.4	1.7E-04	14.1
2	1	5.00	10.00	5.00	5.6	1.0	7.50	1.55	19.04	4.1	6.0E-05	4.3
	2	5.00	10.00	5.00	5.6	2.0	7.50	1.55	29.02	9.4	8.9E-05	6.5
	3	5.00	10.00	5.00	5.6	3.0	7.50	1.55	38.96	15.4	1.1E-04	7.9
	4	5.00	10.00	5.00	5.6	5.0	7.50	1.55	58.91	19.2	8.9E-05	6.5
	5	5.00	10.00	5.00	5.6	3.0	7.50	1.55	39.00	11.5	8.1E-05	5.9
	6	5.00	10.00	5.00	5.6	2.0	7.50	1.55	29.03	6.4	6.1E-05	4.4
	7	5.00	10.00	5.00	5.6	1.0	7.50	1.55	19.05	1.3	1.8E-05	1.3
3	1	10.00	15.00	5.00	5.6	1.0	12.50	1.55	24.04	4.2	4.8E-05	3.5
	2	10.00	15.00	5.00	5.6	2.0	12.50	1.55	34.01	7.4	6.0E-05	4.4
	3	10.00	15.00	5.00	5.6	3.0	12.50	1.55	43.92	13.4	8.4E-05	6.1
	4	10.00	15.00	5.00	5.6	5.0	12.50	1.55	63.63	23.5	1.0E-04	7.4
	5	10.00	15.00	5.00	5.6	7.0	12.50	1.55	83.95	11.7	3.8E-05	2.8
	6	10.00	15.00	5.00	5.6	5.0	12.50	1.55	63.95	11.7	5.0E-05	3.6
	7	10.00	15.00	5.00	5.6	3.0	12.50	1.55	44.03	5.1	3.2E-05	2.3
	8	10.00	15.00	5.00	5.6	1.0	12.50	1.55	24.05	1.7	2.0E-05	1.4
4	1	15.00	20.00	5.00	5.6	1.0	14.30	1.55	25.77	8.6	9.2E-05	6.7
	2	15.00	20.00	5.00	5.6	3.0	14.30	1.55	45.69	11.7	7.1E-05	5.1
	3	15.00	20.00	5.00	5.6	5.0	14.30	1.55	65.32	21.5	9.1E-05	6.6
	4	15.00	20.00	5.00	5.6	7.0	14.30	1.55	84.63	32.7	1.1E-04	7.7
	5	15.00	20.00	5.00	5.6	5.0	14.30	1.55	65.47	18.4	7.7E-05	5.6
	6	15.00	20.00	5.00	5.6	3.0	14.30	1.55	45.72	10.8	6.5E-05	4.7
	7	15.00	20.00	5.00	5.6	1.0	14.30	1.55	25.80	6.8	7.3E-05	5.3
5	1	20.00	25.00	5.00	5.6	1.0	14.30	1.55	25.84	2.7	2.8E-05	2.1
	2	20.00	25.00	5.00	5.6	3.0	14.30	1.55	45.74	8.6	5.2E-05	3.8
	3	20.00	25.00	5.00	5.6	7.0	14.30	1.55	85.58	13.4	4.3E-05	3.1
	4	20.00	25.00	5.00	5.6	5.0	14.30	1.55	65.45	16.2	6.8E-05	5.0
	5	20.00	25.00	5.00	5.6	3.0	14.30	1.55	45.60	5.8	3.5E-05	2.5
	6	20.00	25.00	5.00	5.6	1.0	14.30	1.55	25.84	2.5	2.6E-05	1.9
6	1	25.00	30.00	5.00	5.6	1.0	14.30	1.55	25.83	3.2	3.4E-05	2.5
	2	25.00	30.00	5.00	5.6	3.0	14.30	1.55	45.70	9.0	5.4E-05	3.9
	3	25.00	30.00	5.00	5.6	5.0	14.30	1.55	65.47	14.2	6.0E-05	4.3
	4	25.00	30.00	5.00	5.6	7.0	14.30	1.55	85.07	20.3	6.6E-05	4.8
	5	25.00	30.00	5.00	5.6	5.0	14.30	1.55	65.41	15.2	6.4E-05	4.6

BOREHOLE NUMBER : B-12

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	6	25.00	30.00	5.00	5.6	3.0	14.30	1.55	45.74	7.6	4.6E-05	3.3
	7	25.00	30.00	5.00	5.6	1.0	14.30	1.55	25.83	3.0	3.2E-05	2.4

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (T3/T7)

BOREHOLE NUMBER : TB-1

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.00	5.00	4.00	5.6	0.5	3.00	1.30	9.30	4.6	1.6E-04	12.4
	2	1.00	5.00	4.00	5.6	1.0	3.00	1.30	14.26	21.6	5.0E-04	37.9
	3	1.00	5.00	4.00	5.6	1.5	3.00	1.30	19.15	44.9	7.7E-04	58.6
	4	1.00	5.00	4.00	5.6	1.0	3.00	1.30	14.25	26.0	6.0E-04	45.6
	5	1.00	5.00	4.00	5.6	0.5	3.00	1.30	9.29	10.7	3.8E-04	28.8
2	1	5.00	10.00	5.00	5.6	1.0	7.50	1.30	18.80	0.6	8.8E-06	0.6
	2	5.00	10.00	5.00	5.6	2.0	7.50	1.30	28.80	1.5	1.4E-05	1.0
	3	5.00	10.00	5.00	5.6	3.0	7.50	1.30	38.79	4.6	3.3E-05	2.4
	4	5.00	10.00	5.00	5.6	5.0	7.50	1.30	58.78	8.0	3.7E-05	2.7
	5	5.00	10.00	5.00	5.6	3.0	7.50	1.30	38.79	4.7	3.3E-05	2.4
	6	5.00	10.00	5.00	5.6	2.0	7.50	1.30	28.80	1.8	1.7E-05	1.3
	7	5.00	10.00	5.00	5.6	1.0	7.50	1.30	18.80	0.7	1.0E-05	0.7
3	1	10.00	15.00	5.00	5.6	0.5	4.45	1.30	10.75	0.7	1.9E-05	1.3
	2	10.00	15.00	5.00	5.6	1.0	4.45	1.30	15.75	1.5	2.3E-05	1.7
	3	10.00	15.00	5.00	5.6	1.5	4.45	1.30	20.74	3.9	5.2E-05	3.8
	4	10.00	15.00	5.00	5.6	2.0	4.45	1.30	25.30	24.3	2.6E-04	19.2
	5	10.00	15.00	5.00	5.6	2.5	4.45	1.30	29.31	43.6	4.1E-04	29.7
	6	10.00	15.00	5.00	5.6	2.0	4.45	1.30	25.12	26.9	3.2E-04	23.0
	7	10.00	15.00	5.00	5.6	1.5	4.45	1.30	20.33	23.7	3.2E-04	23.3
	8	10.00	15.00	5.00	5.6	1.0	4.45	1.30	15.54	16.8	3.0E-04	21.6
	9	10.00	15.00	5.00	5.6	0.5	4.45	1.30	10.66	11.0	2.8E-04	20.6
4	1	15.00	20.00	5.00	5.6	1.0	9.25	1.30	20.55	0.9	1.2E-05	0.9
	2	15.00	20.00	5.00	5.6	2.0	9.25	1.30	30.55	1.7	1.5E-05	1.1
	3	15.00	20.00	5.00	5.6	3.0	9.25	1.30	40.54	3.4	2.3E-05	1.7
	4	15.00	20.00	5.00	5.6	5.0	9.25	1.30	60.47	8.3	3.8E-05	2.7
	5	15.00	20.00	5.00	5.6	3.0	9.25	1.30	40.53	3.7	2.5E-05	1.8
	6	15.00	20.00	5.00	5.6	2.0	9.25	1.30	30.54	2.4	2.2E-05	1.6
	7	15.00	20.00	5.00	5.6	1.0	9.25	1.30	20.55	1.3	1.8E-05	1.3
5	1	20.00	25.00	5.00	5.6	1.0	9.10	1.30	20.40	0.5	7.0E-06	0.5
	2	20.00	25.00	5.00	5.6	2.0	9.10	1.30	30.40	1.0	8.7E-06	0.6
	3	20.00	25.00	5.00	5.6	3.0	9.10	1.30	40.40	1.4	9.6E-06	0.7
	4	20.00	25.00	5.00	5.6	5.0	9.10	1.30	60.38	3.7	1.7E-05	1.2
	5	20.00	25.00	5.00	5.6	3.0	9.10	1.30	40.40	1.5	10.0E-06	0.7
	6	20.00	25.00	5.00	5.6	2.0	9.10	1.30	30.40	1.2	1.1E-05	0.8
	7	20.00	25.00	5.00	5.6	1.0	9.10	1.30	20.40	0.5	6.9E-06	0.5
6	1	25.00	30.00	5.00	5.6	1.0	11.75	1.30	23.05	0.8	9.4E-06	0.7
	2	25.00	30.00	5.00	5.6	2.0	11.75	1.30	33.04	2.2	1.8E-05	1.3
	3	25.00	30.00	5.00	5.6	3.0	11.75	1.30	43.01	4.7	3.0E-05	2.2
	4	25.00	30.00	5.00	5.6	5.0	11.75	1.30	62.72	13.2	5.8E-05	4.2
	5	25.00	30.00	5.00	5.6	3.0	11.75	1.30	43.00	5.2	3.3E-05	2.4

BOREHOLE NUMBER : TB-1

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	6	25.00	30.00	5.00	5.6	2.0	11.75	1.30	33.03	2.8	2.4E-05	1.7
	7	25.00	30.00	5.00	5.6	1.0	11.75	1.30	23.04	1.7	2.0E-05	1.5
7	1	30.00	35.00	5.00	5.6	1.0	11.80	1.30	23.10	0.4	5.3E-06	0.4
	2	30.00	35.00	5.00	5.6	2.0	11.80	1.30	33.09	1.6	1.3E-05	0.9
	3	30.00	35.00	5.00	5.6	3.0	11.80	1.30	43.06	4.1	2.6E-05	1.9
	4	30.00	35.00	5.00	5.6	5.0	11.80	1.30	62.16	20.3	9.0E-05	6.5
	5	30.00	35.00	5.00	5.6	3.0	11.80	1.30	43.04	4.9	3.2E-05	2.3
	6	30.00	35.00	5.00	5.6	2.0	11.80	1.30	33.09	2.4	2.0E-05	1.4
	7	30.00	35.00	5.00	5.6	1.0	11.80	1.30	23.10	1.0	1.2E-05	0.8
8	1	35.00	40.00	5.00	5.6	1.0	12.25	1.30	23.55	0.6	6.7E-06	0.5
	2	35.00	40.00	5.00	5.6	2.0	12.25	1.30	33.55	1.3	1.1E-05	0.8
	3	35.00	40.00	5.00	5.6	3.0	12.25	1.30	43.52	3.3	2.1E-05	1.5
	4	35.00	40.00	5.00	5.6	5.0	12.25	1.30	63.19	11.7	5.1E-05	3.7
	5	35.00	40.00	5.00	5.6	3.0	12.25	1.30	43.51	3.7	2.3E-05	1.7
	6	35.00	40.00	5.00	5.6	2.0	12.25	1.30	33.54	1.9	1.6E-05	1.1
	7	35.00	40.00	5.00	5.6	1.0	12.25	1.30	23.55	1.0	1.2E-05	0.9

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (14/17)

BOREHOLE NUMBER : TB-2

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	2.00	5.00	3.00	5.6	0.5	3.50	1.50	9.99	7.6	3.1E-04	25.2
	2	2.00	5.00	3.00	5.6	1.0	3.50	1.50	14.96	15.8	4.4E-04	35.2
	3	2.00	5.00	3.00	5.6	1.5	3.50	1.50	19.83	33.9	7.1E-04	56.9
	4	2.00	5.00	3.00	5.6	2.0	3.50	1.50	24.60	51.2	8.6E-04	69.3
	5	2.00	5.00	3.00	5.6	1.5	3.50	1.50	19.73	42.2	8.9E-04	71.2
	6	2.00	5.00	3.00	5.6	1.0	3.50	1.50	14.84	32.6	9.1E-04	73.1
	7	2.00	5.00	3.00	5.6	0.5	3.50	1.50	9.97	13.0	5.4E-04	43.3
2	1	5.00	10.00	5.00	5.6	0.5	7.50	1.50	13.93	13.1	2.6E-04	18.8
	2	5.00	10.00	5.00	5.6	1.0	7.50	1.50	18.89	17.0	2.5E-04	18.0
	3	5.00	10.00	5.00	5.6	1.5	7.50	1.50	23.57	33.8	3.9E-04	28.7
	4	5.00	10.00	5.00	5.6	2.0	7.50	1.50	28.05	50.2	4.9E-04	35.8
	5	5.00	10.00	5.00	5.6	1.5	7.50	1.50	23.43	38.9	4.6E-04	33.2
	6	5.00	10.00	5.00	5.6	1.0	7.50	1.50	18.80	22.7	3.4E-04	24.4
	7	5.00	10.00	5.00	5.6	1.5	7.50	1.50	23.96	10.8	1.2E-04	9.0
3	1	10.00	15.00	5.00	5.6	0.5	5.50	1.50	12.00	0.1	1.5E-06	0.1
	2	10.00	15.00	5.00	5.6	1.0	5.50	1.50	17.00	0.8	1.2E-05	0.9
	3	10.00	15.00	5.00	5.6	2.0	5.50	1.50	27.00	1.5	1.6E-05	1.1
	4	10.00	15.00	5.00	5.6	3.0	5.50	1.50	37.00	2.0	1.5E-05	1.1
	5	10.00	15.00	5.00	5.6	2.0	5.50	1.50	27.00	1.6	1.7E-05	1.2
	6	10.00	15.00	5.00	5.6	1.0	5.50	1.50	17.00	1.0	1.6E-05	1.2
	7	10.00	15.00	5.00	5.6	0.5	5.50	1.50	12.00	0.2	5.6E-06	0.4
4	1	15.00	20.00	5.00	5.6	1.0	8.00	1.50	19.50	1.6	2.2E-05	1.6
	2	15.00	20.00	5.00	5.6	2.0	8.00	1.50	29.46	6.1	5.7E-05	4.1
	3	15.00	20.00	5.00	5.6	3.0	8.00	1.50	39.28	14.0	9.8E-05	7.1
	4	15.00	20.00	5.00	5.6	4.0	8.00	1.50	49.08	19.2	1.1E-04	7.8
	5	15.00	20.00	5.00	5.6	3.0	8.00	1.50	39.23	15.3	1.1E-04	7.8
	6	15.00	20.00	5.00	5.6	2.0	8.00	1.50	29.44	7.5	7.1E-05	5.1
	7	15.00	20.00	5.00	5.6	1.0	8.00	1.50	19.48	4.3	6.1E-05	4.4
5	1	20.00	25.00	5.00	5.6	1.0	10.00	1.50	21.50	0.5	6.7E-06	0.5
	2	20.00	25.00	5.00	5.6	2.0	10.00	1.50	31.50	1.7	1.5E-05	1.1
	3	20.00	25.00	5.00	5.6	3.0	10.00	1.50	41.49	2.7	1.8E-05	1.3
	4	20.00	25.00	5.00	5.6	4.0	10.00	1.50	51.48	3.7	2.0E-05	1.4
	5	20.00	25.00	5.00	5.6	5.0	10.00	1.50	61.45	5.9	2.6E-05	1.9
	6	20.00	25.00	5.00	5.6	4.0	10.00	1.50	51.47	4.3	2.3E-05	1.7
	7	20.00	25.00	5.00	5.6	3.0	10.00	1.50	41.49	1.9	1.2E-05	0.9
	8	20.00	25.00	5.00	5.6	2.0	10.00	1.50	31.50	1.1	9.7E-06	0.7
	9	20.00	25.00	5.00	5.6	1.0	10.00	1.50	21.50	0.1	1.4E-06	0.1
6	1	25.00	30.00	5.00	5.6	1.0	9.10	1.50	20.60	0.1	1.3E-06	0.1
	2	25.00	30.00	5.00	5.6	2.0	9.10	1.50	30.50	0.4	3.8E-06	0.3
	3	25.00	30.00	5.00	5.6	3.0	9.10	1.50	40.59	3.4	2.3E-05	1.7

BOREHOLE NUMBER : TB-2

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	4	25.00	30.00	5.00	5.6	4.0	9.10	1.50	50.55	5.2	2.8E-05	2.1
	5	25.00	30.00	5.00	5.6	5.0	9.10	1.50	60.53	6.1	2.8E-05	2.0
	6	25.00	30.00	5.00	5.6	4.0	9.10	1.50	50.54	5.4	3.0E-05	2.2
	7	25.00	30.00	5.00	5.6	3.0	9.10	1.50	40.58	3.4	2.3E-05	1.7
	8	25.00	30.00	5.00	5.6	2.0	9.10	1.50	30.59	1.7	1.5E-05	1.1
	9	25.00	30.00	5.00	5.6	1.0	9.10	1.50	20.59	1.7	2.3E-05	1.7
7	1	30.00	35.00	5.00	5.6	1.0	9.15	1.50	20.65	0.5	6.5E-06	0.5
	2	30.00	35.00	5.00	5.6	2.0	9.15	1.50	30.65	0.9	7.9E-06	0.6
	3	30.00	35.00	5.00	5.6	3.0	9.15	1.50	40.61	4.1	2.8E-05	2.0
	4	30.00	35.00	5.00	5.6	4.0	9.15	1.50	50.56	6.4	3.5E-05	2.5
	5	30.00	35.00	5.00	5.6	5.0	9.15	1.50	60.48	8.6	3.9E-05	2.8
	6	30.00	35.00	5.00	5.6	4.0	9.15	1.50	50.54	7.1	3.9E-05	2.8
	7	30.00	35.00	5.00	5.6	3.0	9.15	1.50	40.59	5.3	3.6E-05	2.6
	8	30.00	35.00	5.00	5.6	2.0	9.15	1.50	30.64	2.4	2.1E-05	1.5
	9	30.00	35.00	5.00	5.6	1.0	9.15	1.50	20.65	1.3	1.7E-05	1.3
8	1	35.00	40.00	5.00	5.6	1.0	9.30	1.50	20.31	13.6	1.8E-04	13.4
	2	35.00	40.00	5.00	5.6	2.0	9.30	1.50	27.55	35.6	3.5E-04	25.4
	3	35.00	40.00	5.00	5.6	3.0	9.30	1.50	35.30	45.6	3.6E-04	25.8
	4	35.00	40.00	5.00	5.6	5.0	9.30	1.50	49.97	63.9	3.5E-04	25.6
	5	35.00	40.00	5.00	5.6	3.0	9.30	1.50	36.35	41.0	3.1E-04	22.6
	6	35.00	40.00	5.00	5.6	2.0	9.30	1.50	27.95	32.8	3.2E-04	23.5
	7	35.00	40.00	5.00	5.6	1.0	9.30	1.50	19.44	22.5	3.3E-04	23.5
9	1	40.00	45.00	5.00	5.6	1.0	9.30	1.50	19.83	17.9	2.5E-04	18.1
	2	40.00	45.00	5.00	5.6	2.0	9.30	1.50	29.10	23.7	2.2E-04	16.3
	3	40.00	45.00	5.00	5.6	3.0	9.30	1.50	37.49	33.1	2.4E-04	17.6
	4	40.00	45.00	5.00	5.6	5.0	9.30	1.50	53.40	49.4	2.5E-04	18.5
	5	40.00	45.00	5.00	5.6	3.0	9.30	1.50	37.97	30.6	2.2E-04	16.1
	6	40.00	45.00	5.00	5.6	2.0	9.30	1.50	29.22	22.9	2.2E-04	15.7
	7	40.00	45.00	5.00	5.6	1.0	9.30	1.50	20.00	16.3	2.2E-04	16.3
10	1	45.00	50.00	5.00	5.6	1.0	9.30	1.50	17.02	33.3	5.4E-04	39.2
	2	45.00	50.00	5.00	5.6	2.0	9.30	1.50	24.53	42.9	4.8E-04	35.0
	3	45.00	50.00	5.00	5.6	3.0	9.30	1.50	32.66	48.9	4.1E-04	29.9
	4	45.00	50.00	5.00	5.6	5.0	9.30	1.50	51.16	53.2	2.9E-04	20.8
	5	45.00	50.00	5.00	5.6	3.0	9.30	1.50	32.56	49.2	4.2E-04	30.2
	6	45.00	50.00	5.00	5.6	2.0	9.30	1.50	24.45	43.2	4.9E-04	35.3
	7	45.00	50.00	5.00	5.6	1.0	9.30	1.50	17.99	29.2	4.5E-04	32.6
11	1	50.00	55.00	5.00	5.6	1.0	9.30	1.50	17.02	31.6	5.1E-04	37.1
	2	50.00	55.00	5.00	5.6	2.0	9.30	1.50	23.54	43.8	5.1E-04	37.2
	3	50.00	55.00	5.00	5.6	3.0	9.30	1.50	31.41	49.8	4.4E-04	31.7
	4	50.00	55.00	5.00	5.6	5.0	9.30	1.50	42.48	69.5	4.5E-04	32.8

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (15/17)

BOREHOLE NUMBER : TB-2

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	5	50.00	55.00	5.00	5.6	3.0	9.30	1.50	31.09	50.6	4.5E-04	32.6
	6	50.00	55.00	5.00	5.6	2.0	9.30	1.50	23.17	44.9	5.3E-04	38.7
	7	50.00	55.00	5.00	5.6	1.0	9.30	1.50	16.72	32.8	5.4E-04	39.3
12	1	55.00	60.00	5.00	5.6	1.0	9.30	1.50	17.75	27.1	4.2E-04	30.5
	2	55.00	60.00	5.00	5.6	2.0	9.30	1.50	25.81	34.6	3.7E-04	26.8
	3	55.00	60.00	5.00	5.6	3.0	9.30	1.50	32.66	44.2	3.7E-04	27.1
	4	55.00	60.00	5.00	5.6	5.0	9.30	1.50	44.39	62.8	3.9E-04	28.3
	5	55.00	60.00	5.00	5.6	3.0	9.30	1.50	32.20	45.5	3.9E-04	28.2
	6	55.00	60.00	5.00	5.6	2.0	9.30	1.50	24.27	39.6	4.5E-04	32.6
	7	55.00	60.00	5.00	5.6	1.0	9.30	1.50	16.31	32.9	5.5E-04	40.3

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (16/17)

BOREHOLE NUMBER : TB-3

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.00	5.00	4.00	5.6	0.0	3.00	1.55	4.53	18.0	1.3E-03	99.4
	2	1.00	5.00	4.00	5.6	0.5	3.00	1.55	9.51	24.2	8.4E-04	63.7
	3	1.00	5.00	4.00	5.6	1.0	3.00	1.55	14.34	52.1	1.2E-03	90.8
	4	1.00	5.00	4.00	5.6	0.5	3.00	1.55	9.47	31.9	1.1E-03	84.2
	5	1.00	5.00	4.00	5.6	0.0	3.00	1.55	4.50	24.9	1.8E-03	138.2
2	1	5.00	10.00	5.00	5.6	1.0	3.00	1.55	14.55	2.4	4.6E-05	3.4
	2	5.00	10.00	5.00	5.6	2.0	3.00	1.55	24.54	3.8	4.2E-05	3.1
	3	5.00	10.00	5.00	5.6	3.0	3.00	1.55	34.52	8.2	6.5E-05	4.8
	4	5.00	10.00	5.00	5.6	4.0	3.00	1.55	44.45	16.2	1.0E-04	7.3
	5	5.00	10.00	5.00	5.6	5.0	3.00	1.55	54.25	28.1	1.4E-04	10.4
	6	5.00	10.00	5.00	5.6	4.0	3.00	1.55	44.32	24.9	1.5E-04	11.2
	7	5.00	10.00	5.00	5.6	3.0	3.00	1.55	34.46	15.6	1.2E-04	9.0
	8	5.00	10.00	5.00	5.6	2.0	3.00	1.55	24.52	9.2	1.0E-04	7.5
	9	5.00	10.00	5.00	5.6	1.0	3.00	1.55	14.54	5.0	9.5E-05	6.9
3	1	10.00	15.00	5.00	5.6	1.0	3.70	1.55	15.25	2.2	3.9E-05	2.9
	2	10.00	15.00	5.00	5.6	2.0	3.70	1.55	25.24	3.7	4.0E-05	2.9
	3	10.00	15.00	5.00	5.6	3.0	3.70	1.55	35.21	6.8	5.3E-05	3.9
	4	10.00	15.00	5.00	5.6	4.0	3.70	1.55	45.12	13.3	8.1E-05	5.9
	5	10.00	15.00	5.00	5.6	5.0	3.70	1.55	54.73	26.3	1.3E-04	9.6
	6	10.00	15.00	5.00	5.6	4.0	3.70	1.55	44.91	21.2	1.3E-04	9.5
	7	10.00	15.00	5.00	5.6	3.0	3.70	1.55	35.19	8.8	6.9E-05	5.0
	8	10.00	15.00	5.00	5.6	2.0	3.70	1.55	25.22	6.1	6.7E-05	4.8
	9	10.00	15.00	5.00	5.6	1.0	3.70	1.55	15.24	3.9	7.0E-05	5.1
4	1	15.00	20.00	5.00	5.6	1.0	4.00	1.55	15.55	0.1	1.4E-06	0.1
	2	15.00	20.00	5.00	5.6	2.0	4.00	1.55	25.54	2.1	2.3E-05	1.6
	3	15.00	20.00	5.00	5.6	3.0	4.00	1.55	35.50	5.5	5.1E-05	3.7
	4	15.00	20.00	5.00	5.6	4.0	4.00	1.55	45.47	8.2	5.0E-05	3.6
	5	15.00	20.00	5.00	5.6	5.0	4.00	1.55	55.38	12.1	6.0E-05	4.4
	6	15.00	20.00	5.00	5.6	4.0	4.00	1.55	45.44	9.8	5.9E-05	4.3
	7	15.00	20.00	5.00	5.6	3.0	4.00	1.55	35.50	6.7	5.2E-05	3.8
	8	15.00	20.00	5.00	5.6	2.0	4.00	1.55	25.54	2.9	3.1E-05	2.2
	9	15.00	20.00	5.00	5.6	1.0	4.00	1.55	15.55	0.8	1.4E-05	1.0
5	1	20.00	25.00	5.00	5.6	1.0	3.90	1.55	15.45	0.6	1.1E-05	0.8
	2	20.00	25.00	5.00	5.6	2.0	3.90	1.55	25.44	2.5	2.7E-05	2.0
	3	20.00	25.00	5.00	5.6	3.0	3.90	1.55	35.40	5.6	4.3E-05	3.1
	4	20.00	25.00	5.00	5.6	4.0	3.90	1.55	45.32	9.1	5.5E-05	4.0
	5	20.00	25.00	5.00	5.6	5.0	3.90	1.55	55.18	13.3	6.6E-05	4.8
	6	20.00	25.00	5.00	5.6	4.0	3.90	1.55	45.28	10.6	6.4E-05	4.7
	7	20.00	25.00	5.00	5.6	3.0	3.90	1.55	35.27	7.4	5.3E-05	4.2
	8	20.00	25.00	5.00	5.6	2.0	3.90	1.55	25.42	4.1	4.4E-05	3.2

BOREHOLE NUMBER : TB-3

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
	9	20.00	25.00	5.00	5.6	1.0	3.90	1.55	15.45	1.3	2.4E-05	1.7
6	1	25.00	30.00	5.00	5.6	1.0	4.25	1.55	15.80	0.4	7.5E-06	0.5
	2	25.00	30.00	5.00	5.6	2.0	4.25	1.55	25.79	2.2	2.3E-05	1.7
	3	25.00	30.00	5.00	5.6	3.0	4.25	1.55	35.73	6.1	4.7E-05	3.4
	4	25.00	30.00	5.00	5.6	4.0	4.25	1.55	45.68	7.9	4.8E-05	3.5
	5	25.00	30.00	5.00	5.6	5.0	4.25	1.55	55.57	11.1	5.5E-05	4.0
	6	25.00	30.00	5.00	5.6	4.0	4.25	1.55	45.67	8.1	4.9E-05	3.6
	7	25.00	30.00	5.00	5.6	3.0	4.25	1.55	35.73	6.2	4.8E-05	3.5
	8	25.00	30.00	5.00	5.6	2.0	4.25	1.55	25.79	2.7	2.9E-05	2.1
	9	25.00	30.00	5.00	5.6	1.0	4.25	1.55	15.80	0.9	1.5E-05	1.1
7	1	30.00	35.00	5.00	5.6	1.0	4.25	1.55	15.80	0.5	8.1E-06	0.6
	2	30.00	35.00	5.00	5.6	2.0	4.25	1.55	25.79	1.9	2.0E-05	1.4
	3	30.00	35.00	5.00	5.6	3.0	4.25	1.55	35.73	5.5	4.2E-05	3.1
	4	30.00	35.00	5.00	5.6	4.0	4.25	1.55	45.67	7.6	4.6E-05	3.3
	5	30.00	35.00	5.00	5.6	5.0	4.25	1.55	55.45	12.4	6.2E-05	4.5
	6	30.00	35.00	5.00	5.6	4.0	4.25	1.55	45.66	7.8	4.7E-05	3.4
	7	30.00	35.00	5.00	5.6	3.0	4.25	1.55	35.72	5.8	4.5E-05	3.3
	8	30.00	35.00	5.00	5.6	2.0	4.25	1.55	25.79	2.1	2.3E-05	1.7
	9	30.00	35.00	5.00	5.6	1.0	4.25	1.55	15.80	0.7	1.1E-05	0.8
8	1	35.00	40.00	5.00	5.6	1.0	3.50	1.55	15.05	0.7	1.2E-05	0.9
	2	35.00	40.00	5.00	5.6	2.0	3.50	1.55	25.04	1.9	2.1E-05	1.5
	3	35.00	40.00	5.00	5.6	3.0	3.50	1.55	34.98	5.2	4.1E-05	3.0
	4	35.00	40.00	5.00	5.6	4.0	3.50	1.55	44.85	8.8	5.4E-05	3.9
	5	35.00	40.00	5.00	5.6	5.0	3.50	1.55	54.54	13.8	7.0E-05	5.1
	6	35.00	40.00	5.00	5.6	4.0	3.50	1.55	44.79	9.9	6.1E-05	4.4
	7	35.00	40.00	5.00	5.6	3.0	3.50	1.55	34.95	6.2	4.9E-05	3.6
	8	35.00	40.00	5.00	5.6	2.0	3.50	1.55	25.03	2.5	2.7E-05	2.0
	9	35.00	40.00	5.00	5.6	1.0	3.50	1.55	15.05	0.9	1.7E-05	1.3

Table 3.2.4 TEST RESULTS OF PERMEABILITY AND LUGEON VALUE (17/17)

BOREHOLE NUMBER : IB-1

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.50	5.00	3.50	5.6	1.0	0.00	1.50	11.50	5.1	1.6E-04	12.7
	2	1.50	5.00	3.50	5.6	2.0	0.00	1.50	21.45	20.5	3.5E-04	27.3
	3	1.50	5.00	3.50	5.6	1.0	0.00	1.50	11.06	62.1	2.1E-03	160.4
2	1	5.00	10.00	5.00	5.6	1.0	0.00	1.50	11.50	1.6	3.8E-05	2.8
	2	5.00	10.00	5.00	5.6	2.0	0.00	1.50	21.50	2.8	3.6E-05	2.6
	3	5.00	10.00	5.00	5.6	3.0	0.00	1.50	31.49	4.9	4.3E-05	3.1
	4	5.00	10.00	5.00	5.6	5.0	0.00	1.50	50.12	60.3	3.3E-04	24.1
	5	5.00	10.00	5.00	5.6	3.0	0.00	1.50	31.49	5.1	4.4E-05	3.2
	6	5.00	10.00	5.00	5.6	2.0	0.00	1.50	21.49	3.7	4.8E-05	3.5
	7	5.00	10.00	5.00	5.6	1.0	0.00	1.50	11.50	1.9	4.5E-05	3.3
3	1	10.00	15.00	5.00	5.6	1.0	0.00	1.50	11.49	2.7	6.3E-05	4.6
	2	10.00	15.00	5.00	5.6	2.0	0.00	1.50	21.49	4.2	5.4E-05	3.9
	3	10.00	15.00	5.00	5.6	3.0	0.00	1.50	31.47	6.5	5.6E-05	4.1
	4	10.00	15.00	5.00	5.6	4.0	0.00	1.50	37.56	72.1	5.3E-04	38.4
	5	10.00	15.00	5.00	5.6	3.0	0.00	1.50	31.15	21.4	1.9E-04	13.7
	6	10.00	15.00	5.00	5.6	2.0	0.00	1.50	21.31	15.8	2.0E-04	14.8
	7	10.00	15.00	5.00	5.6	1.0	0.00	1.50	11.47	8.2	1.5E-04	10.8
4	1	15.00	20.00	5.00	5.6	1.0	0.00	1.50	11.41	8.7	2.1E-04	15.2
	2	15.00	20.00	5.00	5.6	2.0	0.00	1.50	21.19	16.4	2.1E-04	15.5
	3	15.00	20.00	5.00	5.6	3.0	0.00	1.50	30.80	24.9	2.2E-04	16.2
	4	15.00	20.00	5.00	5.6	4.0	0.00	1.50	35.84	70.6	5.4E-04	39.4
	5	15.00	20.00	5.00	5.6	3.0	0.00	1.50	29.40	43.0	4.0E-04	29.3
	6	15.00	20.00	5.00	5.6	2.0	0.00	1.50	20.89	23.2	3.1E-04	22.2
	7	15.00	20.00	5.00	5.6	1.0	0.00	1.50	11.33	12.2	3.0E-04	21.5

BOREHOLE NUMBER : IB-2

TEST STAGE No.	TEST STEP No.	DEPTH FROM (m)	DEPTH TO (m)	LENGTH TESTED (m)	HOLE DIA. (cm)	PUMPING PRESSURE (Kg/cm2)	STATIC HEAD (m)	GAUGE HEIGHT (m)	TOTAL HEAD (m)	INJECTED FLOW RATE (l/min)	COEFFICIENT OF PERMEABILITY (cm/sec)	LUGEON UNIT (-)
1	1	1.50	5.00	3.50	5.6	1.0	3.25	0.50	12.97	82.7	2.3E-03	182.1
2	1	5.00	10.00	5.00	5.6	1.0	5.00	0.50	12.78	84.8	1.8E-03	132.7
3	1	10.00	15.00	5.00	5.6	1.0	5.50	0.50	15.96	7.4	1.3E-04	9.3
	2	10.00	15.00	5.00	5.6	2.0	5.50	0.50	25.85	14.1	1.5E-04	10.9
	3	10.00	15.00	5.00	5.6	3.0	5.50	0.50	35.55	24.4	1.9E-04	13.7
	4	10.00	15.00	5.00	5.6	5.0	5.50	0.50	52.42	68.8	3.6E-04	26.3
	5	10.00	15.00	5.00	5.6	3.0	5.50	0.50	34.83	39.3	3.1E-04	22.6
	6	10.00	15.00	5.00	5.6	2.0	5.50	0.50	25.59	23.3	2.5E-04	18.2
	7	10.00	15.00	5.00	5.6	1.0	5.50	0.50	15.91	10.7	1.8E-04	13.4
4	1	15.00	20.00	5.00	5.6	1.0	5.50	0.50	15.91	8.7	1.5E-04	10.9
	2	15.00	20.00	5.00	5.6	2.0	5.50	0.50	25.69	16.4	1.8E-04	12.8
	3	15.00	20.00	5.00	5.6	3.0	5.50	0.50	35.50	24.9	1.9E-04	14.1
	4	15.00	20.00	5.00	5.6	5.0	5.50	0.50	50.34	70.6	3.9E-04	28.0
	5	15.00	20.00	5.00	5.6	3.0	5.50	0.50	33.90	43.0	3.5E-04	25.4
	6	15.00	20.00	5.00	5.6	2.0	5.50	0.50	25.59	23.2	2.5E-04	18.2
	7	15.00	20.00	5.00	5.6	1.0	5.50	0.50	15.83	12.2	2.1E-04	15.4

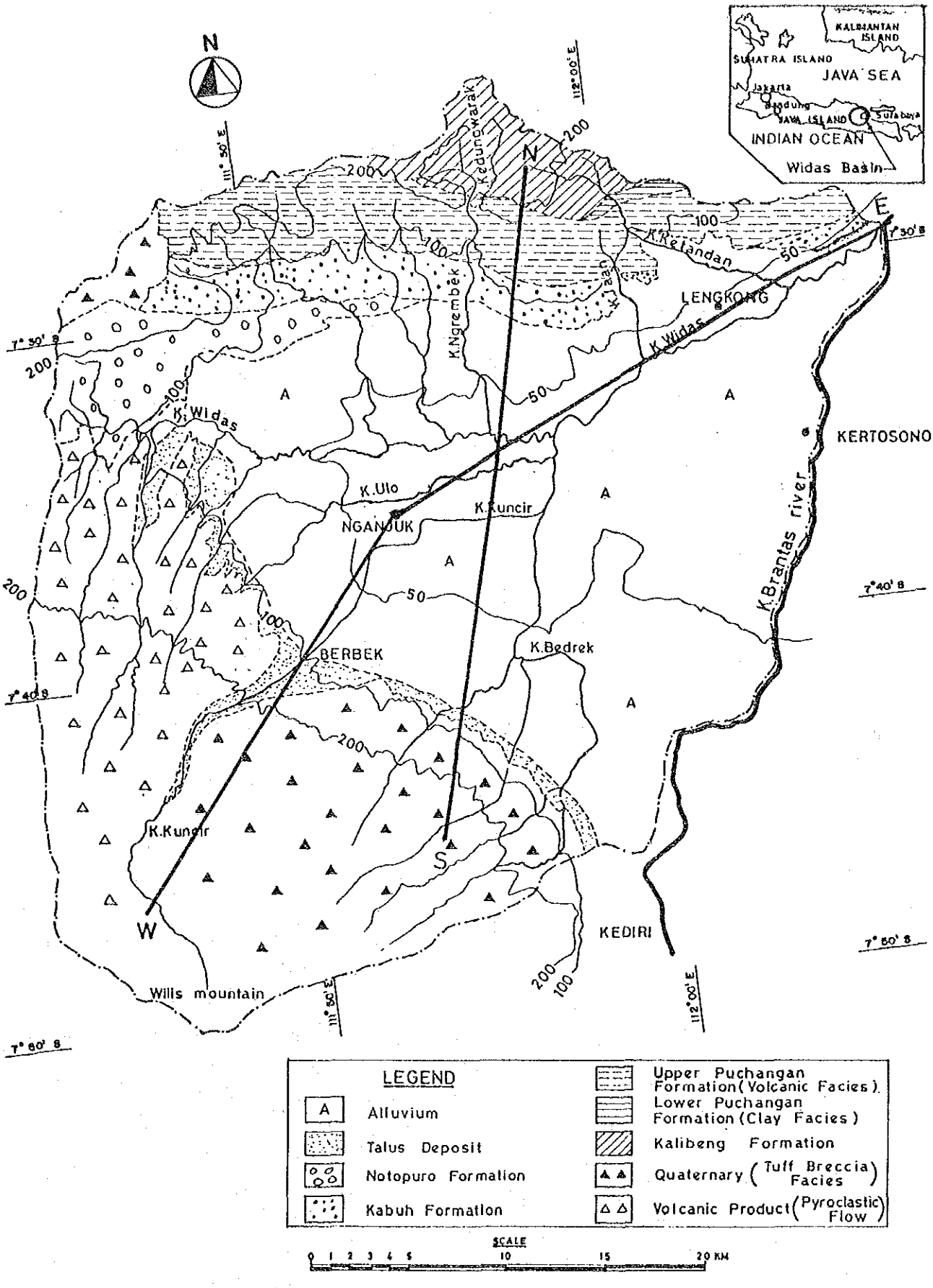
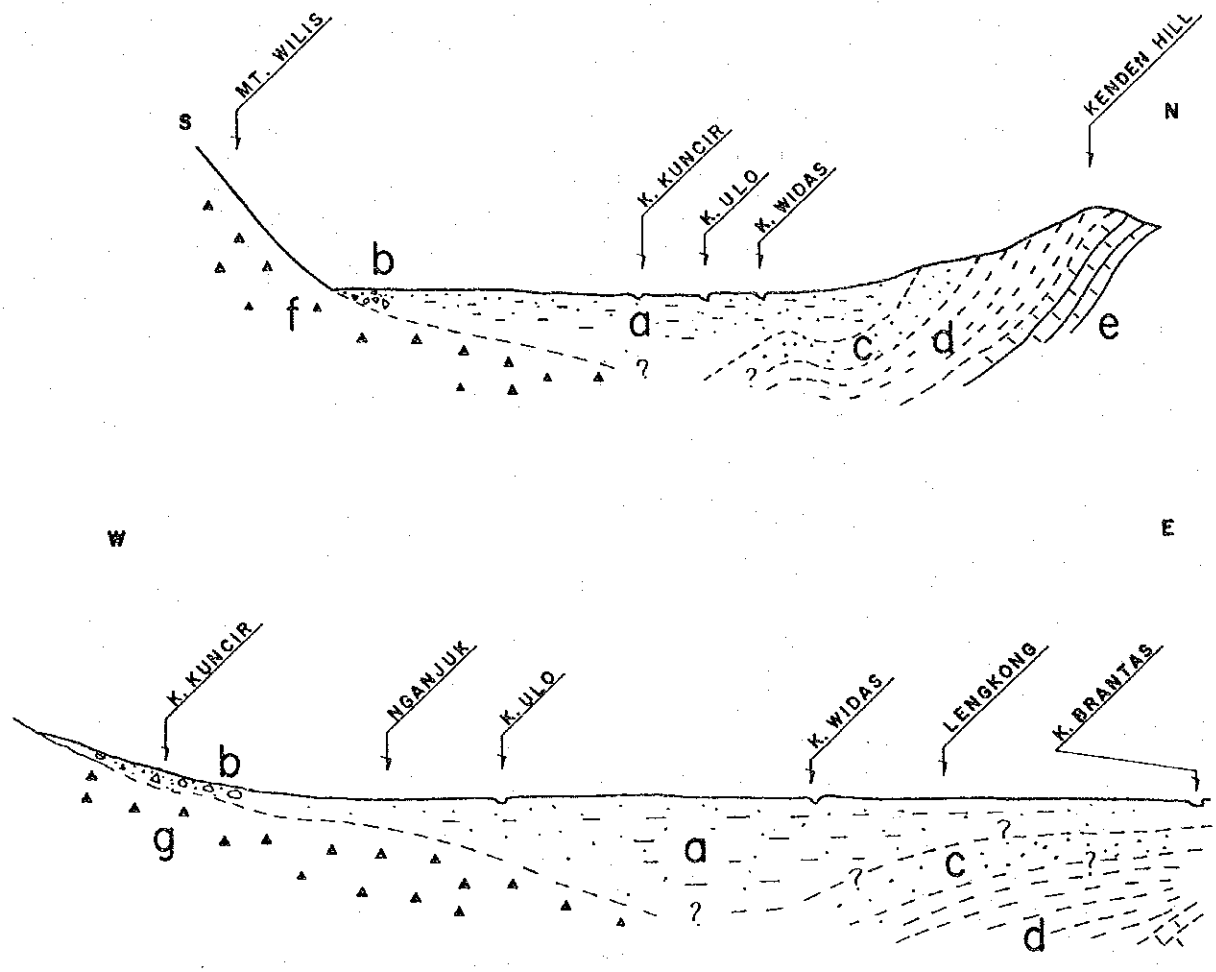


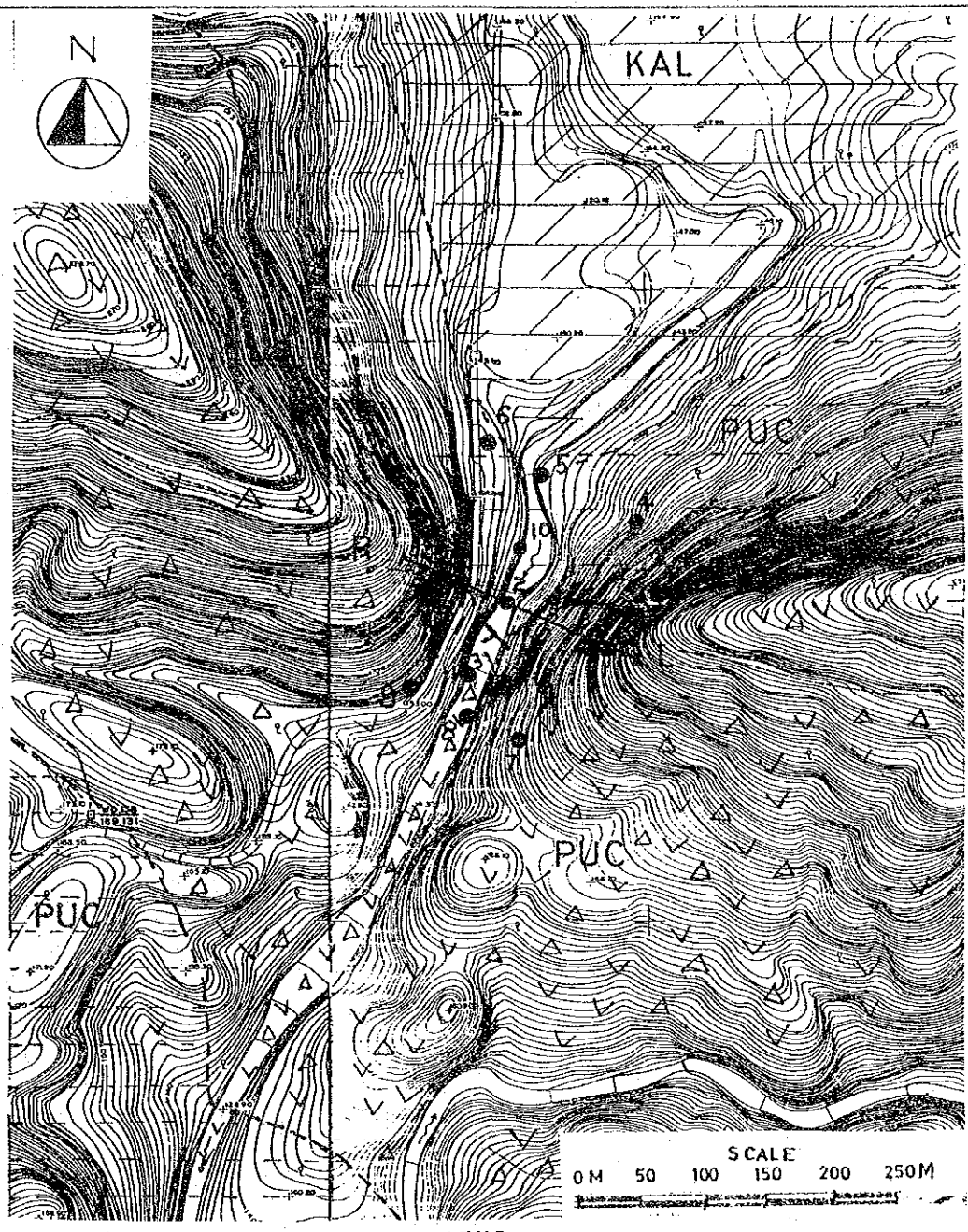
Fig.3.2.1 REGIONAL GEOLOGIC MAP



LEGEND

a : ALLUVIUM	e : KALI BENG FORMATION
b : TALUS DEPOSIT	f : Mt. WILIS TUFF BRECCIA
c : KABUH FORMATION	g : Mt. WILIS PYROCLASTIC FLOW
d : PUCHANGAN FORMATION	

Fig.3.2.2 DIAGRAMMATIC GEOLOGIC PROFILE OF WIDAS - NGANJUK BASIN



LEGEND

SYMBOL	FORMATION	FACIES	EPOCH
ALV	ALLUVIUM	(RIVER DEPOSIT)	HOLOCENE
KAB	KABUH	(SANDSTONE CONGLOMERATE)	PLEISTOCENE
PUC	UPPER PUCHANGAN	(TUFF BRECCIA) (SANDSTONE) (TUFF, SILTY CLAY)	PLEISTOCENE
PUC	LOWER PUCHANGAN	(CLAYSTONE INTERCALATED SANDSTONE) (CLAYSTONE)	
KAL	KALIBENG	(MARL)	PLIOCENE

- TALUS
- 10 DIP AND STIKE
- GEOLOGIC BOUNDARY
- GEOLOGIC PROFILE SECTION
- EXISTING BORING POINT
- CALCAREOUS
- FOSSIL

Fig. 3.2.3 GEOLOGIC MAP OF KEDUNGWARAK WEIR SITE

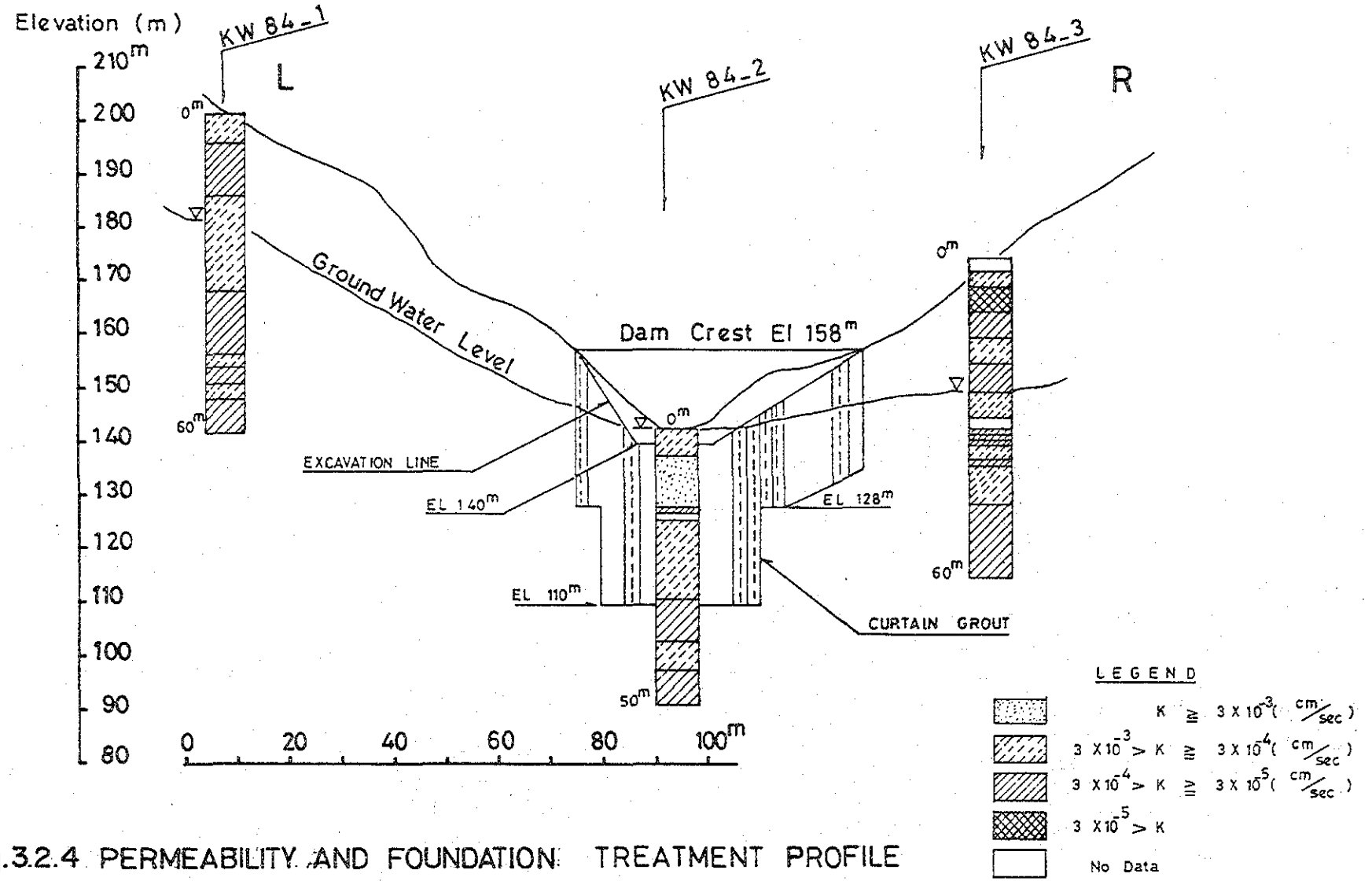


Fig.3.2.4 PERMEABILITY AND FOUNDATION TREATMENT PROFILE OF KEDUNGWARAK WEIR SITE

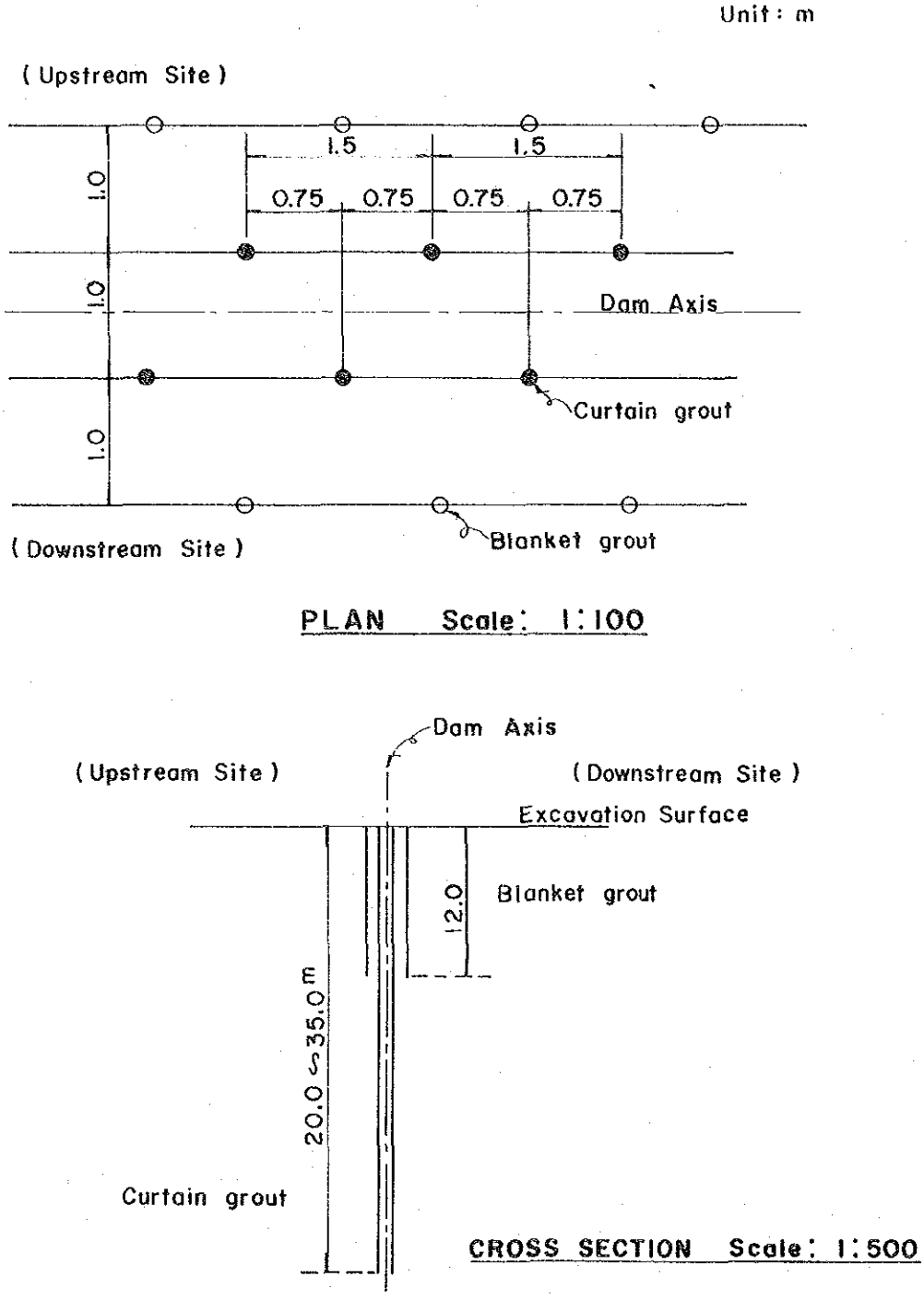


Fig. 3.2.5 TYPICAL PATTERN OF GROUT FOR KEDUNGWARAK WEIR SITE

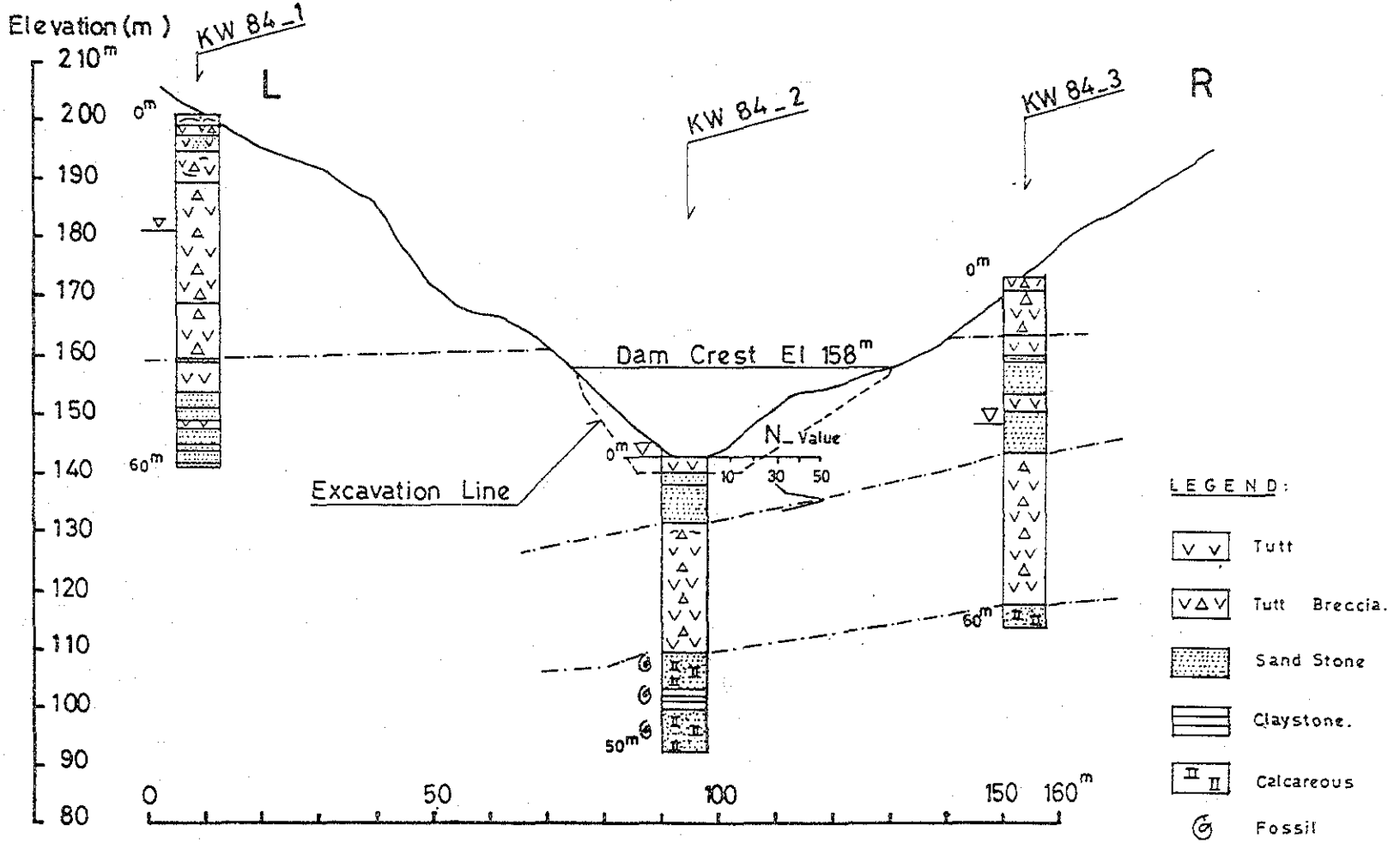


Fig. 3.2.6 GEOLOGIC PROFILE OF KEDUNGWARAK WEIR SITE

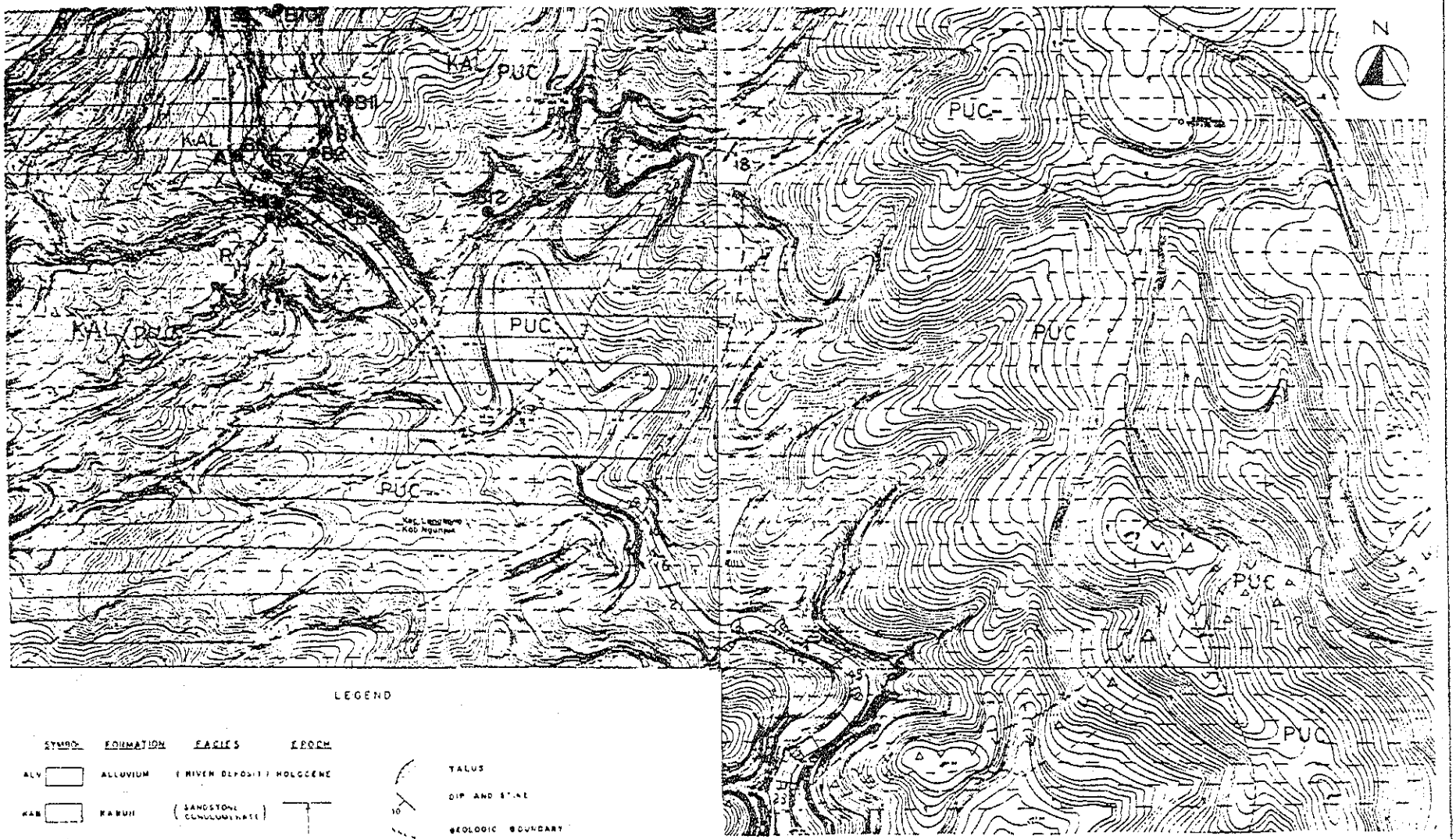


Fig. 3.2.7 GEOLOGIC MAP OF KETANDAN DAM SITE

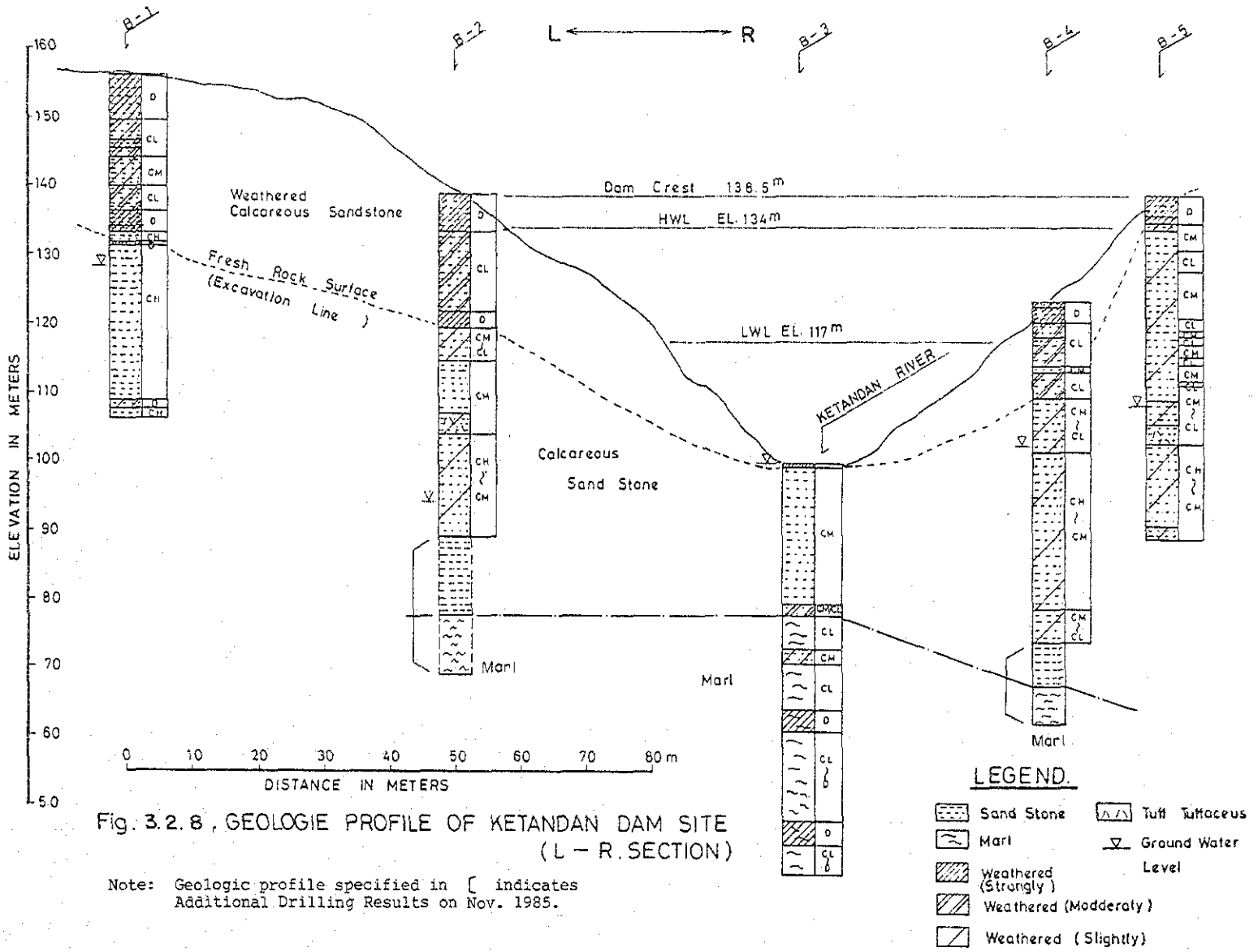


Fig. 3.2.8, GEOLOGIE PROFILE OF KETANDAN DAM SITE (L – R. SECTION)

Note: Geologic profile specified in [indicates Additional Drilling Results on Nov. 1985.

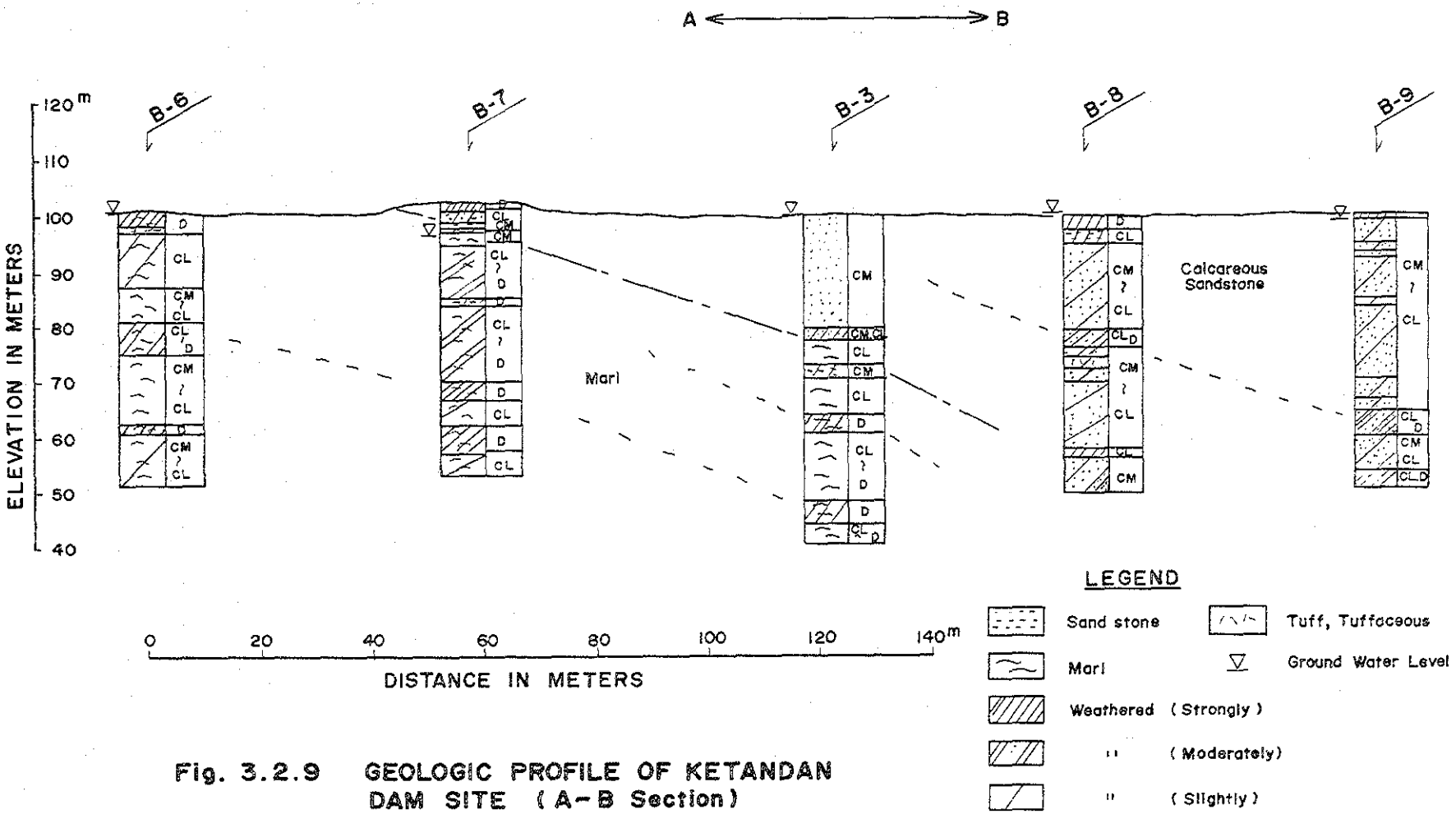


Fig. 3.2.9 GEOLOGIC PROFILE OF KETANDAN DAM SITE (A-B Section)

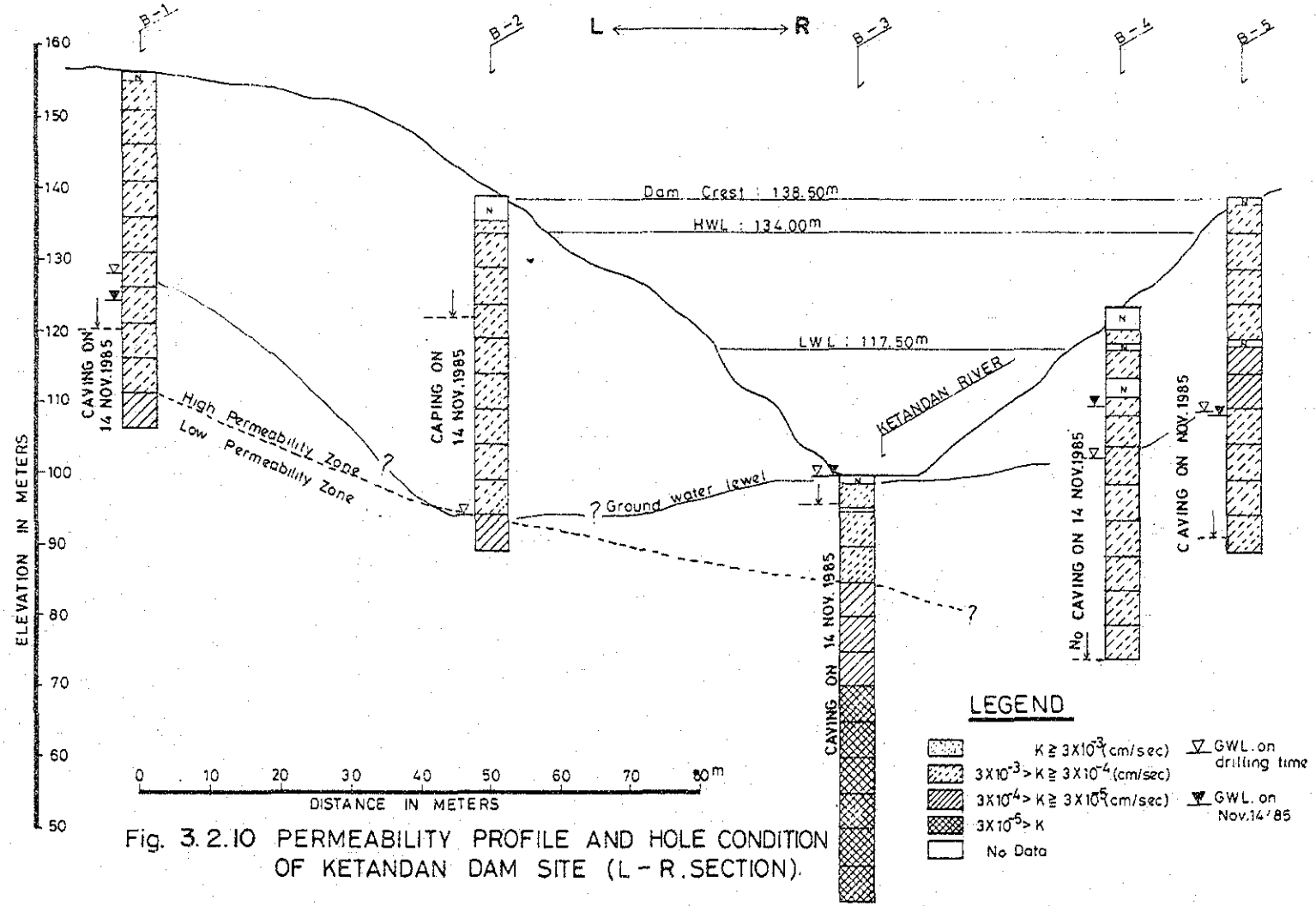


Fig. 3.2.10 PERMEABILITY PROFILE AND HOLE CONDITION OF KETANDAN DAM SITE (L - R. SECTION).

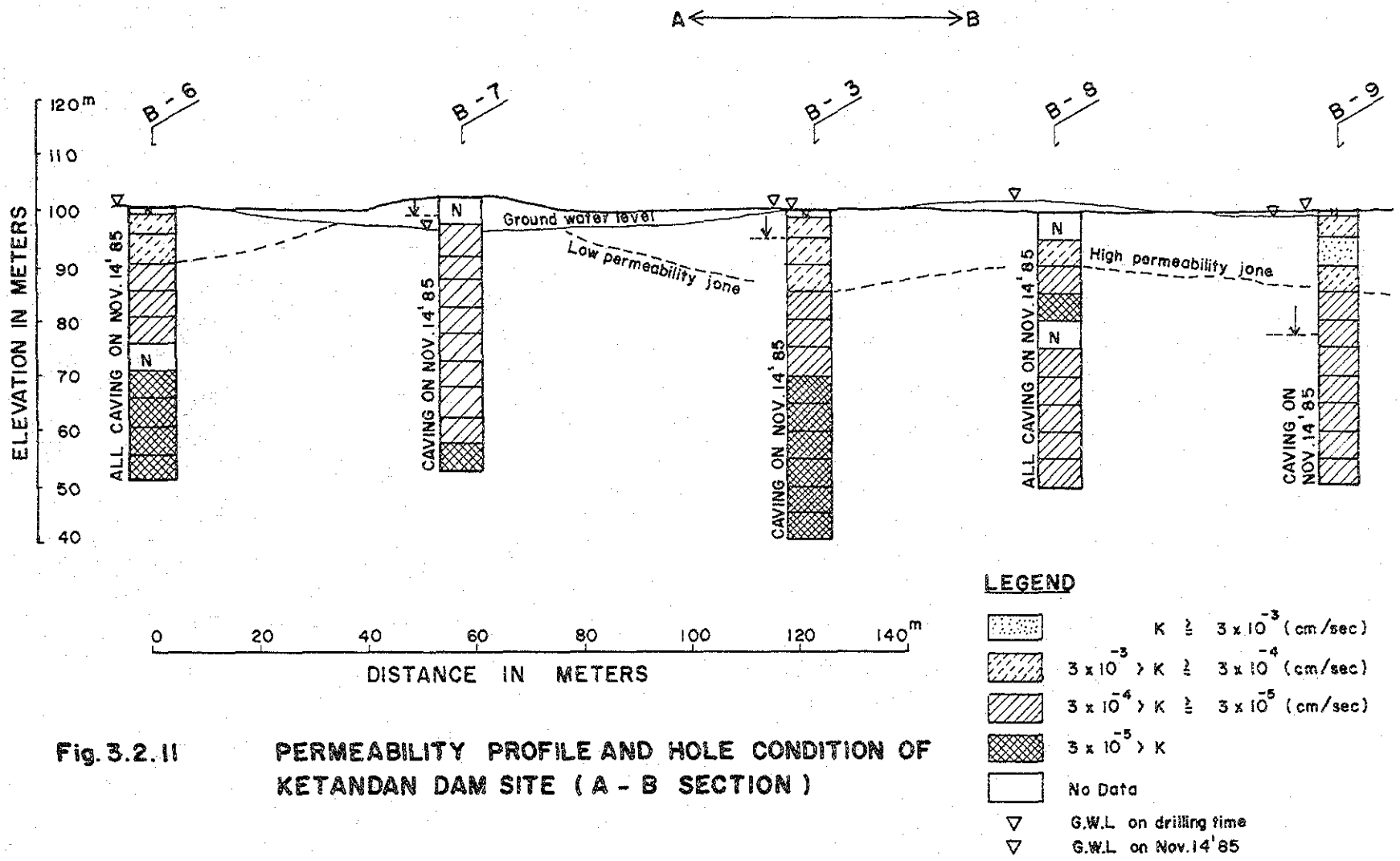


Fig. 3.2.11 PERMEABILITY PROFILE AND HOLE CONDITION OF KETANDAN DAM SITE (A - B SECTION)

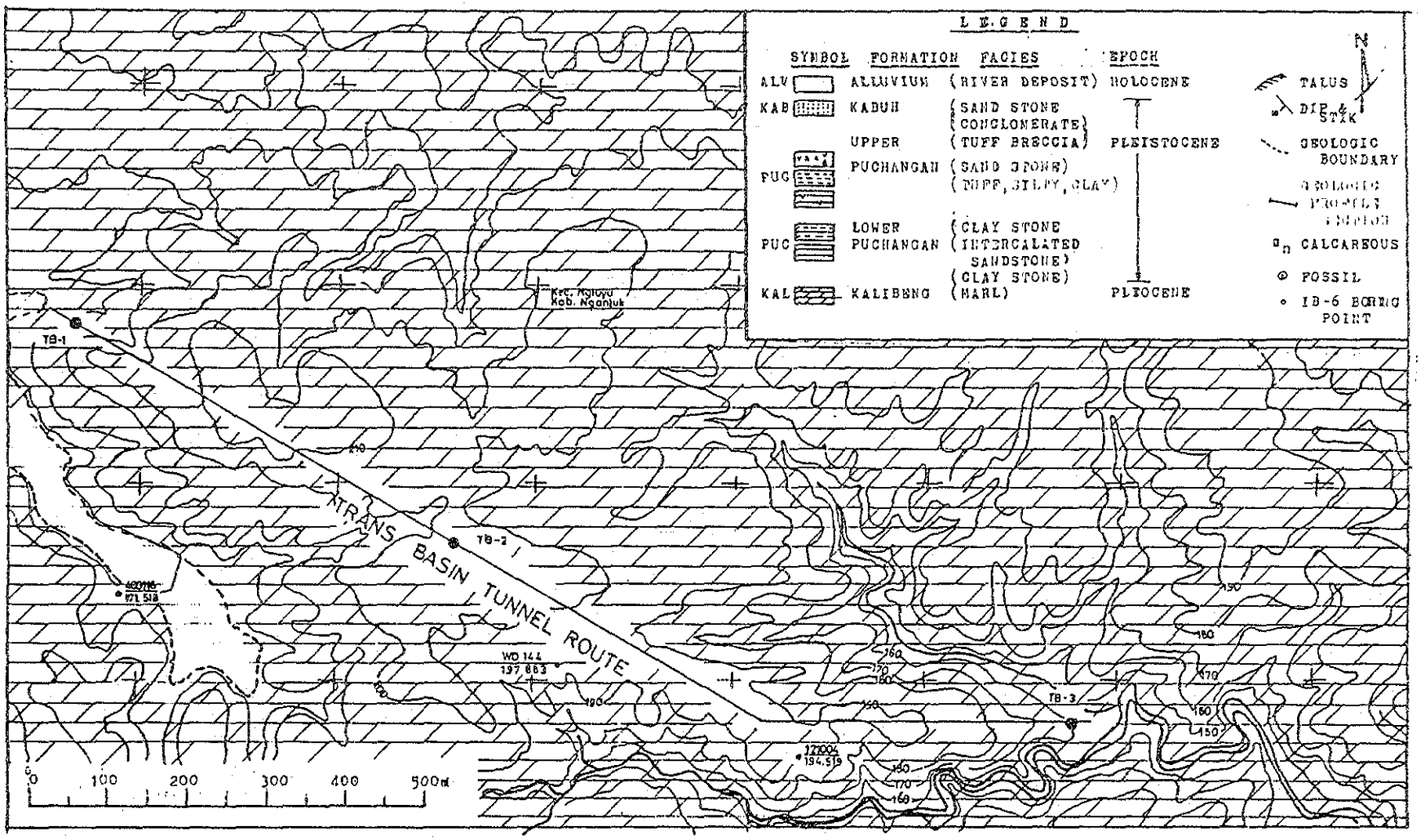
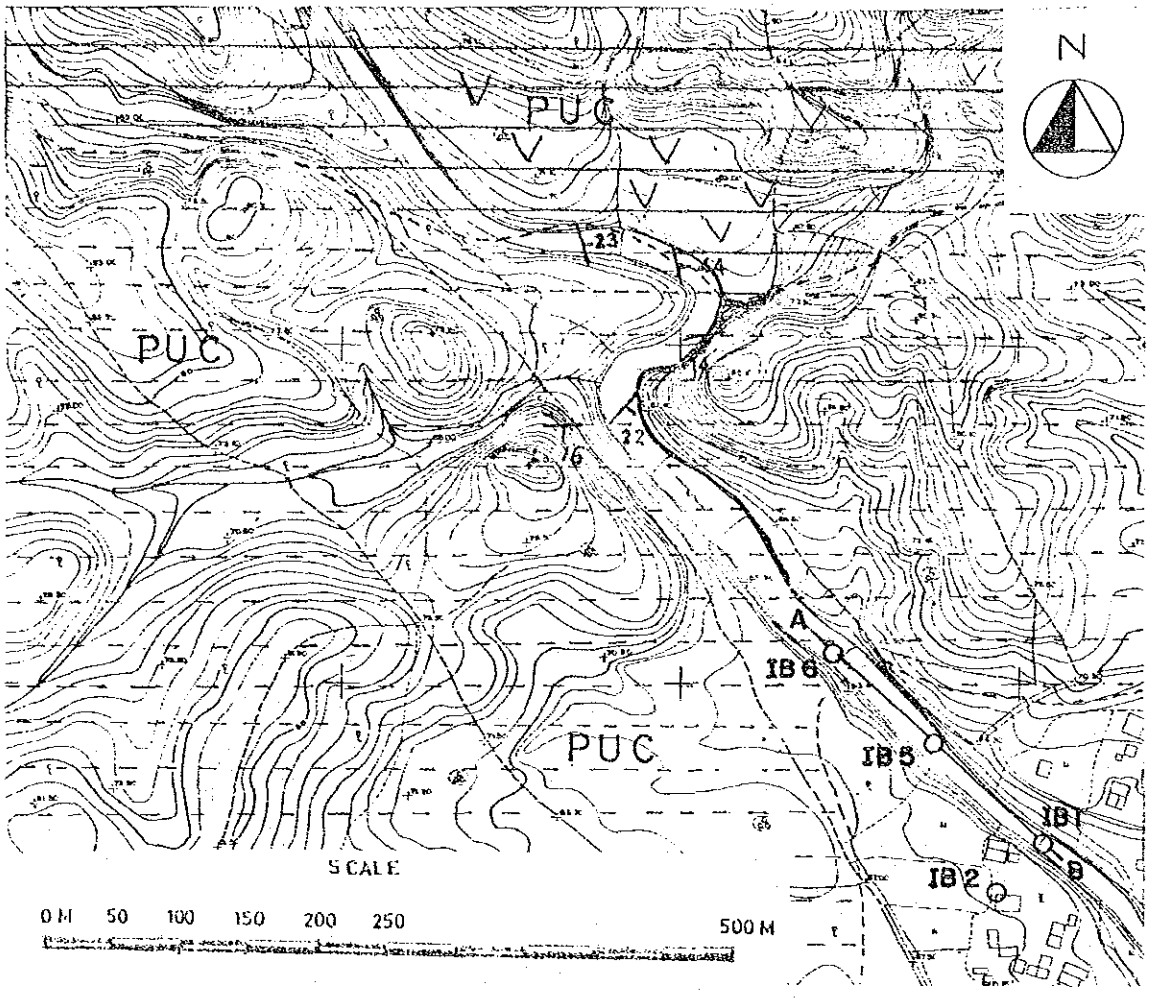


Fig. 3.2.12 GEOLOGIC MAP OF KEDUNGWARAK — KETANDAN TRANS BASIN TUNNEL



LEGEND

SYMBOL	FORMATION	FACIES	EPOCH
ALV	ALLUVIUM	(RIVER DEPOSIT)	HOLOCENE
KAB	KABUH	(SANDSTONE CONGLOMERATE)	
PUC	UPPER PUCHANGAN	(TUFF BRECCIA)	PLEISTOCENE
		(SANDSTONE)	
		(TUFF, SILTY CLAY)	
PUC	LOWER PUCHANGAN	(CLAYSTONE INTERCALATED SANDSTONE)	
		(CLAYSTONE)	
KAL	KALIBENG	(MARL)	PLIOCENE

TALUS

10 DIP AND STIKE

GEOLOGIC BOUNDARY

GEOLOGIC PROFILE SECTION

CALCAREOUS

FOSSIL

IB6 BORING POINT

Fig. 3.2.13 GEOLOGIC MAP OF BANGLE HEAD WORKS

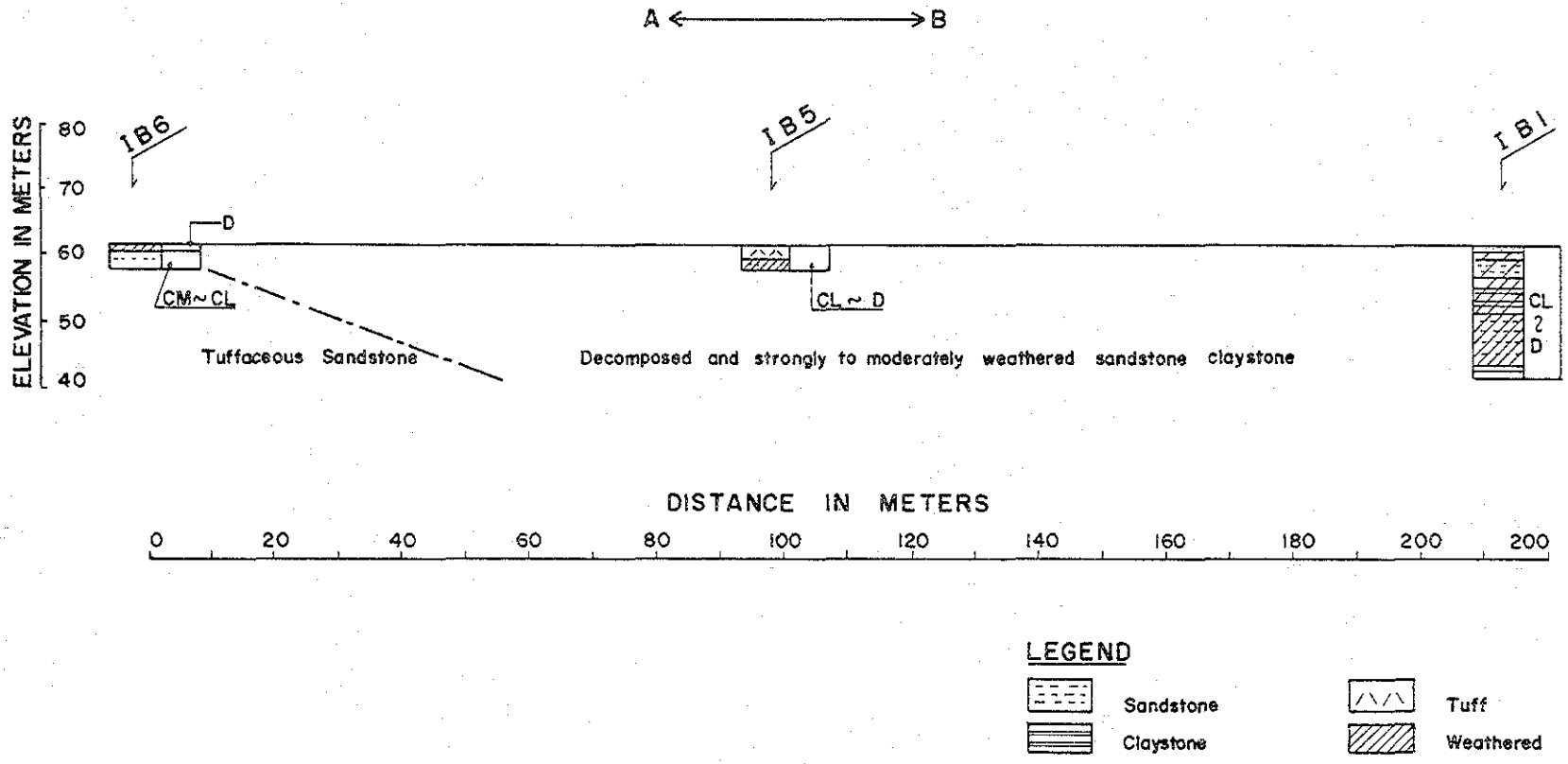
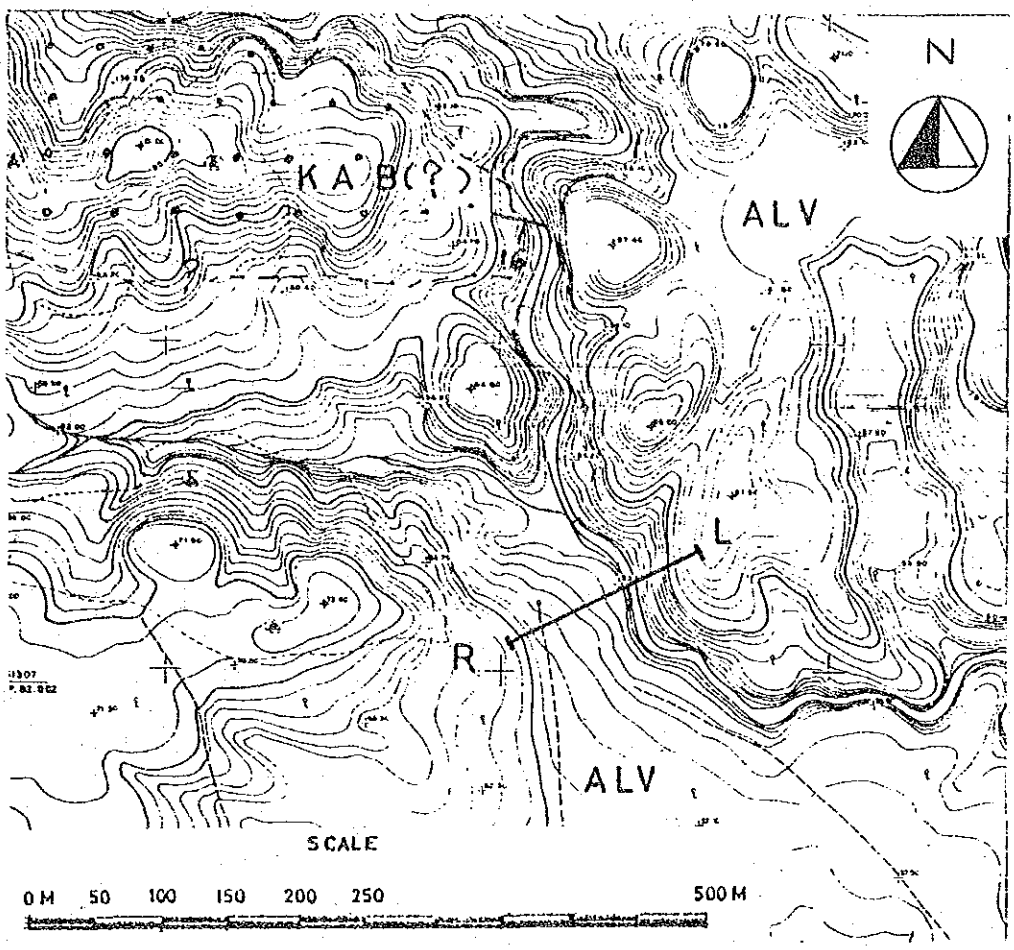


Fig.3.2.14 GEOLOGIC PROFILE OF BANGLE HEAD WORKS



LEGEND

SYMBOL	FORMATION	FACIES	EPOCH
ALV	ALLUVIUM	(RIVER DEPOSIT)	HOLOCENE
KAB	KABUH	(SANDSTONE CONGLOMERATE)	
PUC	UPPER PUCHANGAN	(TUFF BRECCIA)	PLEISTOCENE
		(SANDSTONE)	
		(TUFF, SILTY CLAY)	
PUC	LOWER PUCHANGAN	(CLAYSTONE INTERCALATED SANDSTONE)	
		(CLAYSTONE)	
KAL	KALIBENG	(MARL)	PLIOCENE

TALUS

DIP AND STIKE (10)

GEOLOGIC BOUNDARY

GEOLOGIC PROFILE SECTION

CALCAREOUS

FOSSIL

Fig. 3.2.15 GEOLOGIC MAP OF MAIN CANAL CROSSING - POINT WITH JAAN RIVER

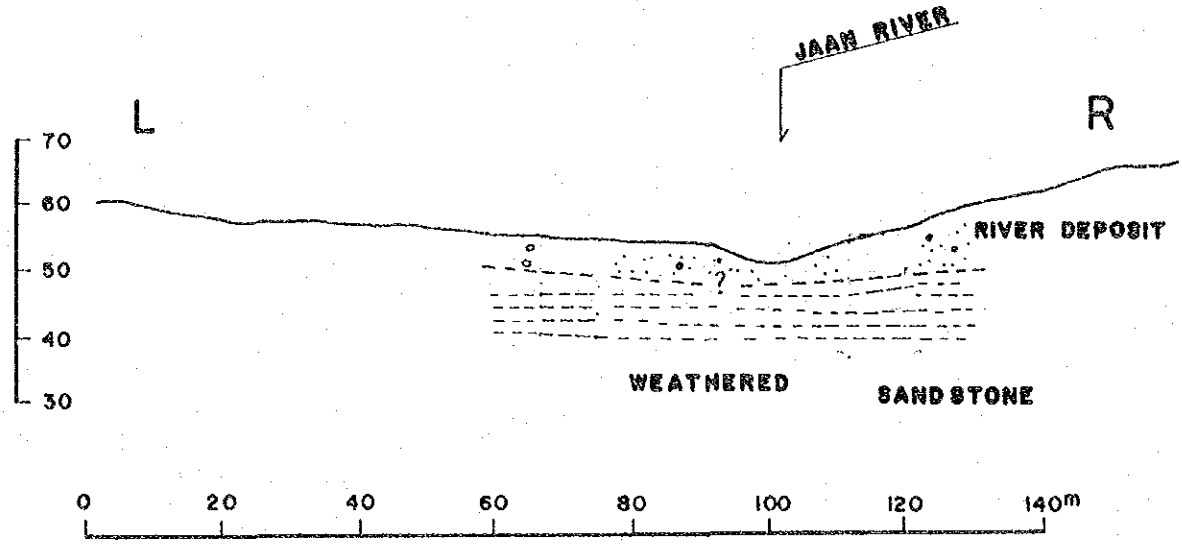


Fig. 3.2.16 GEOLOGIC PROFILE AT MAIN CANAL CROSSING - POINT WITH JAAN RIVER.

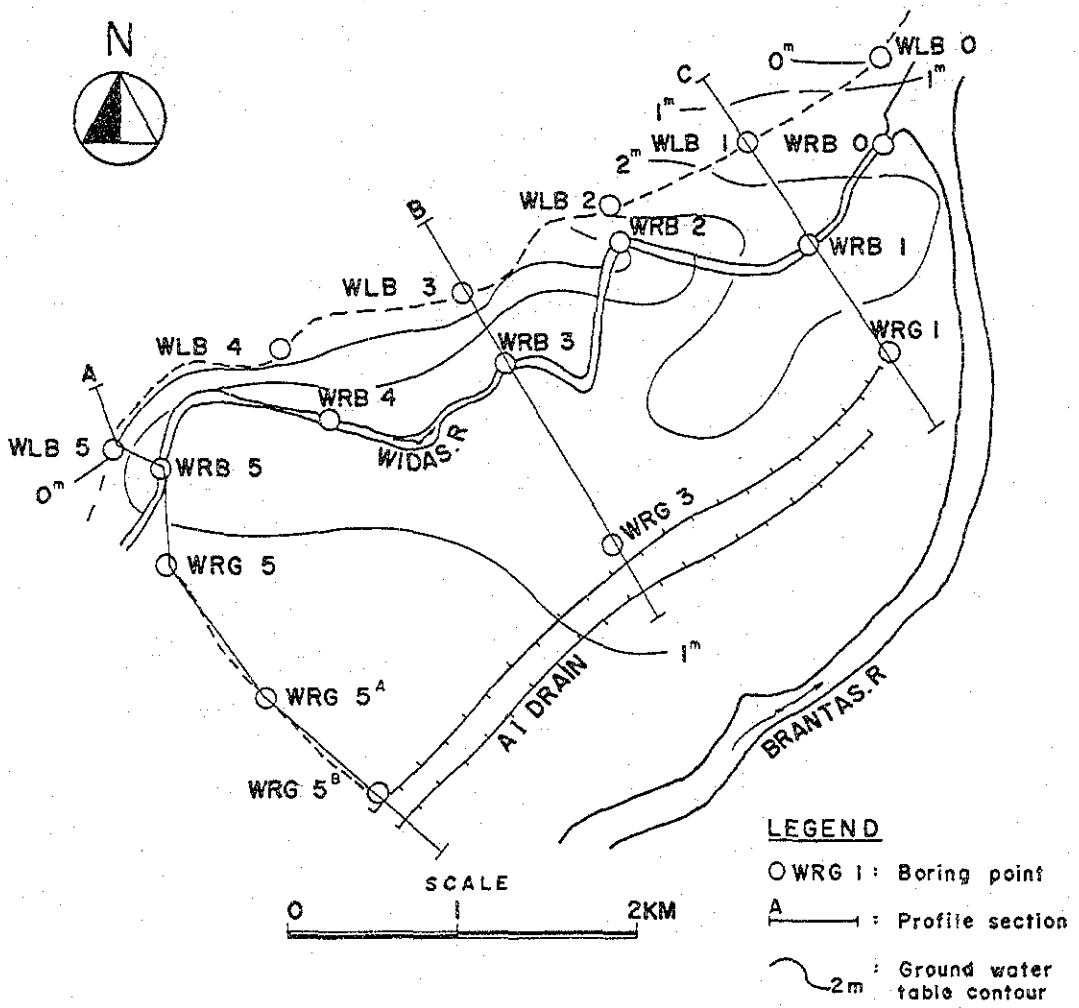


Fig. 3.2.17 LOCATION MAP OF BORING AND GROUND WATER TABLE CONTOUR (APR-MAY 1984) IN WIDAS RETARDING BASIN

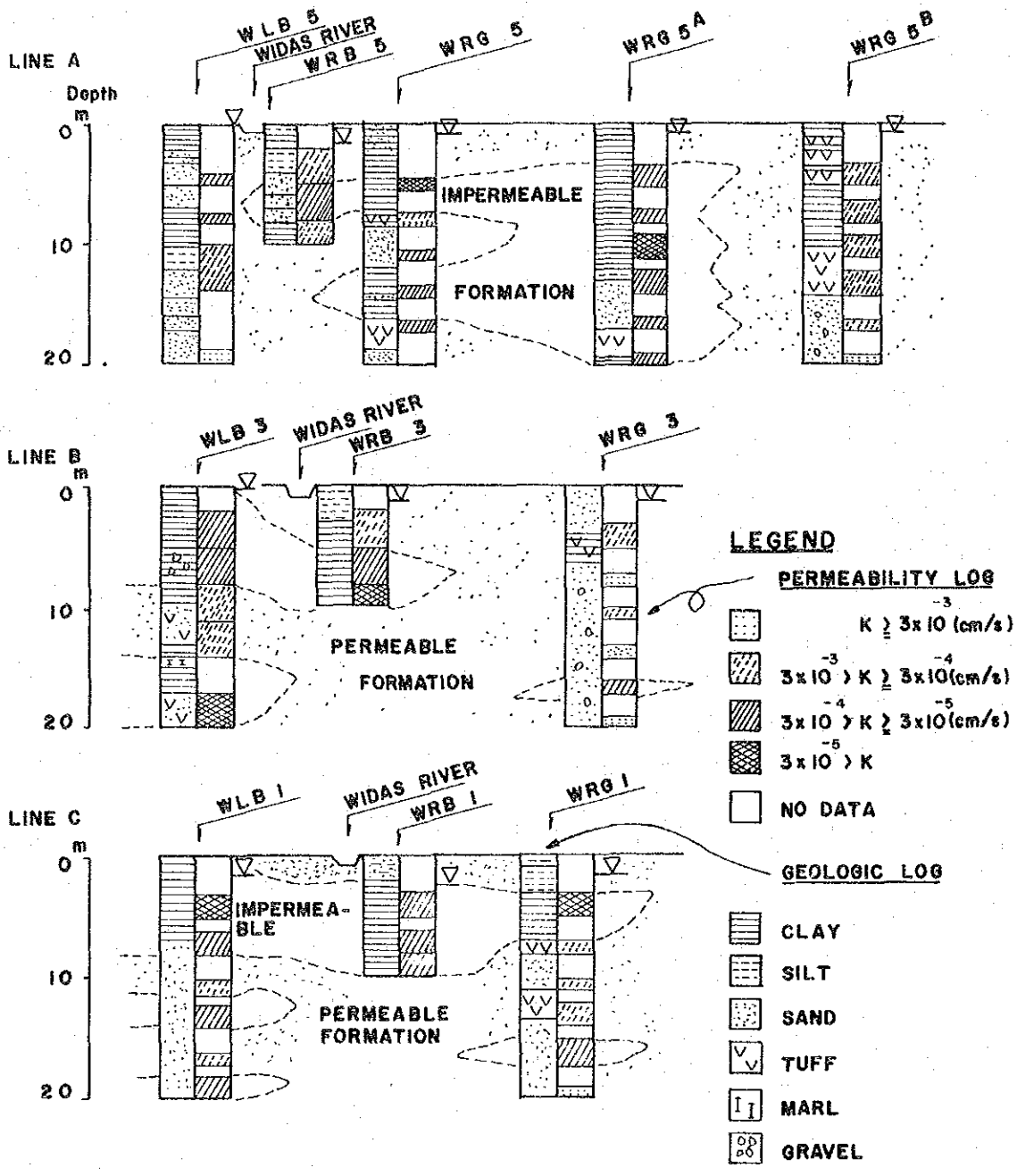


Fig. 3.2.18 PERMEABILITY PROFILE OF WIDAS RETARDING BASIN

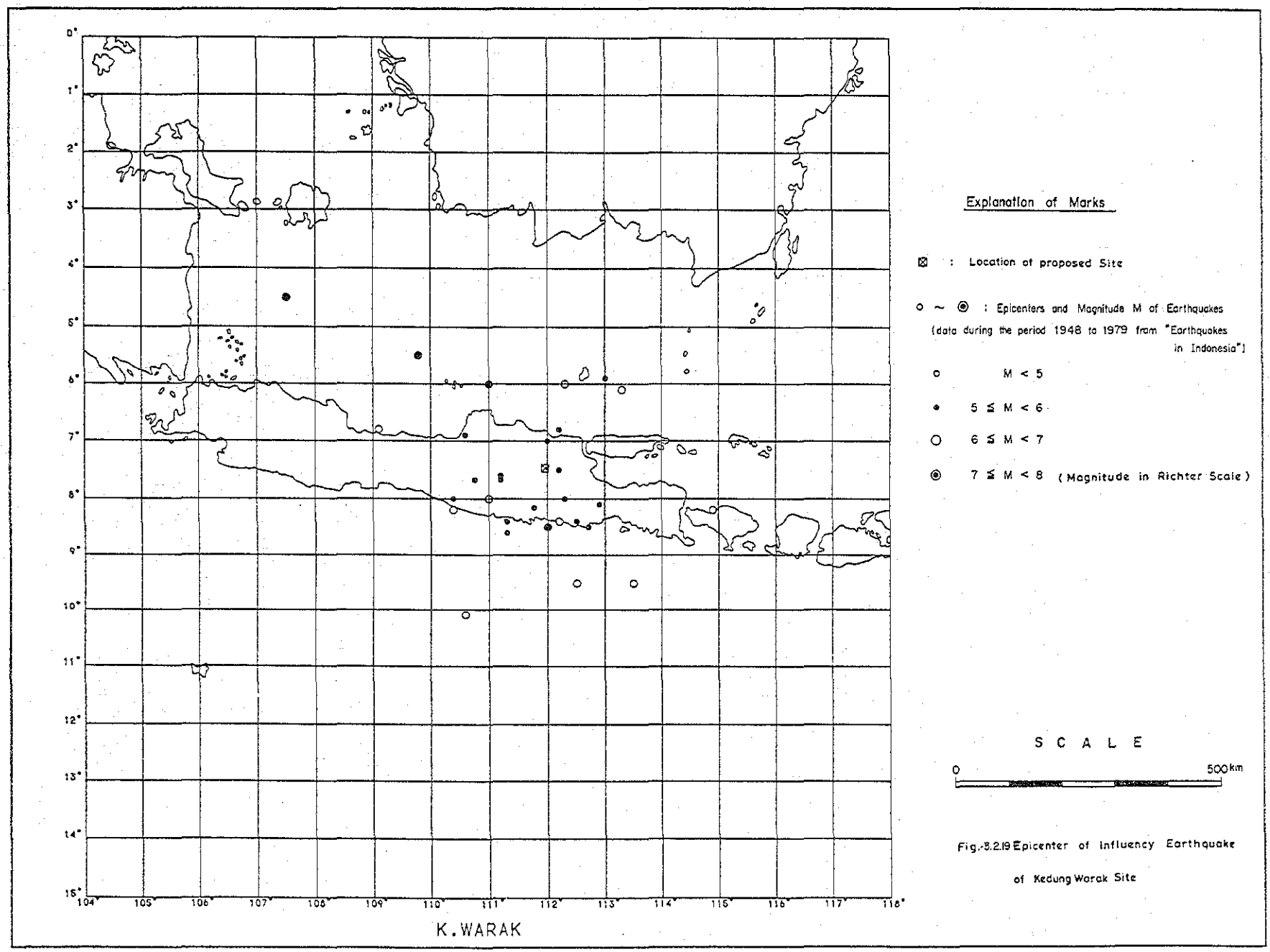


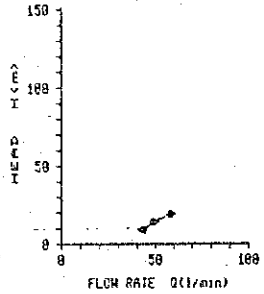
Fig.-3.2.19 Epicenter of Influency Earthquake of Kedung Warak Site

Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (1/20)

B-1

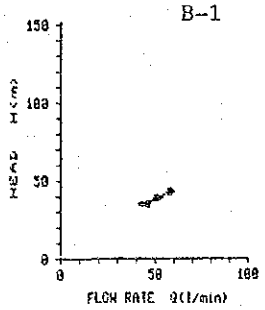
HOLE No : B-1
DEPTH : 1 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	9.3	42.7	115.2	1.5E-03
2	14.2	49.1	85.3	1.1E-03
3	19.1	58.3	76.1	1.0E-03
4	14.2	48.7	85.7	1.1E-03
5	9.3	43.9	118.2	1.6E-03



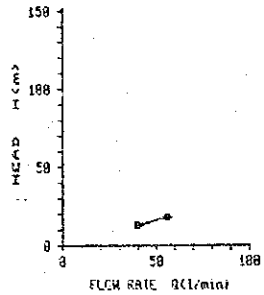
HOLE No : B-1
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	35.4	43.3	24.5	3.4E-04
2	38.2	51.3	26.4	3.6E-04
3	42.6	57.8	27.2	3.7E-04
4	39.8	58.3	26.8	3.6E-04
5	34.9	46.1	26.5	3.8E-04



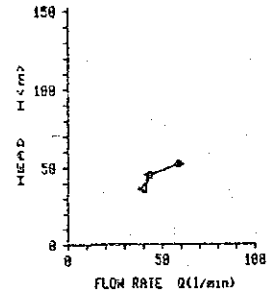
HOLE No : B-1
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	13.2	48.9	61.7	8.5E-04
2	17.7	55.6	62.7	8.6E-04
3	13.3	39.4	59.2	8.1E-04



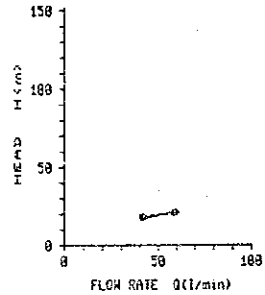
HOLE No : B-1
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	36.1	39.1	21.7	3.0E-04
2	45.4	42.9	18.8	2.6E-04
3	51.7	58.9	22.9	3.1E-04
4	45.3	43.6	19.3	2.6E-04
5	35.9	40.5	22.5	3.1E-04



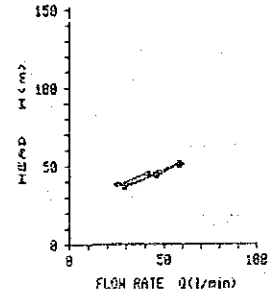
HOLE No : B-1
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	17.5	42.3	48.2	6.6E-04
2	21.3	50.7	55.1	7.6E-04
3	17.6	41.4	47.1	6.9E-04



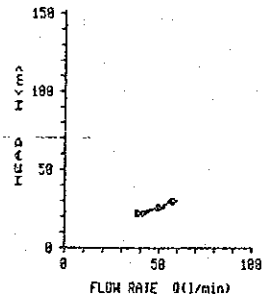
HOLE No : B-1
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	37.8	25.9	13.7	1.9E-04
2	45.8	41.7	18.5	2.5E-04
3	58.6	58.2	23.8	3.2E-04
4	44.9	46.8	28.9	2.9E-04
5	37.3	29.3	15.7	2.2E-04



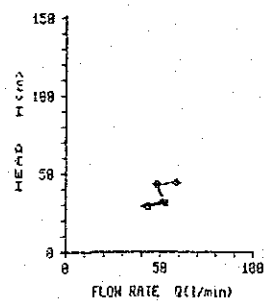
HOLE No : B-1
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	22.0	41.8	37.3	5.1E-04
2	26.8	50.7	39.8	5.4E-04
3	38.2	57.2	37.9	5.2E-04
4	26.1	49.7	38.1	5.2E-04
5	22.2	38.1	34.3	4.7E-04



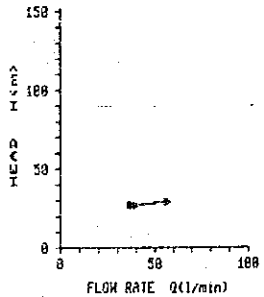
HOLE No : B-1
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	29.1	42.5	29.1	4.0E-04
2	31.3	58.6	31.3	4.4E-04
3	42.5	48.4	22.8	3.1E-04
4	44.4	58.2	26.2	3.6E-04
5	42.5	48.4	22.3	3.1E-04
6	31.2	52.7	33.8	4.6E-04
7	28.3	43.8	30.5	4.2E-04



HOLE No : B-1
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	26.6	38.7	29.1	4.0E-04
2	29.2	55.9	38.3	5.3E-04
3	26.9	36.3	27.8	3.7E-04



HOLE No : B-1
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	34.9	37.8	21.2	2.9E-04
2	44.1	48.1	18.2	2.5E-04
3	43.6	56.7	26.0	3.6E-04
4	43.6	42.8	19.3	2.6E-04
5	34.4	38.9	22.6	3.1E-04

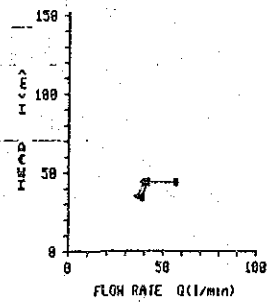
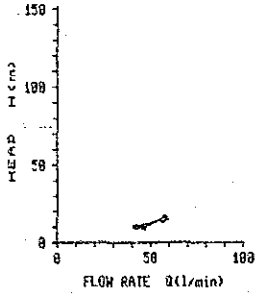


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (2/20)

B-2

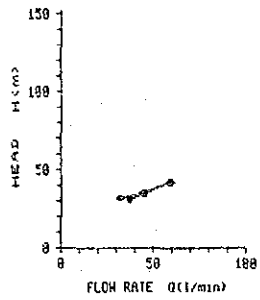
HOLE No : B-2
DEPTH : 3.5 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.1	42.6	282.3	3.8E-03
2	14.7	57.4	260.6	2.9E-03
3	10.8	47.8	314.2	3.3E-03



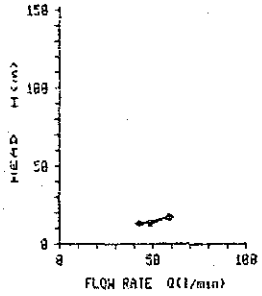
HOLE No : B-2
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	31.8	32.3	20.3	2.8E-04
2	35.2	43.7	24.8	3.4E-04
3	42.2	59.1	28.8	3.8E-04
4	34.9	45.3	25.9	3.6E-04
5	31.2	37.3	23.9	3.3E-04



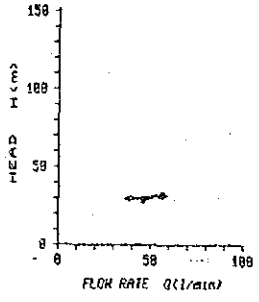
HOLE No : B-2
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	13.1	43.8	65.6	9.8E-04
2	17.5	58.8	67.2	9.3E-04
3	12.9	48.7	75.5	1.0E-03



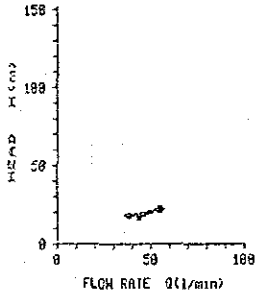
HOLE No : B-2
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	38.4	38.7	25.5	3.5E-04
2	31.6	56.3	35.7	4.9E-04
3	29.8	46.2	31.9	4.4E-04



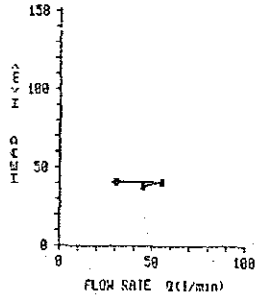
HOLE No : B-2
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	17.7	38.1	43.1	5.9E-04
2	21.5	54.9	51.0	7.0E-04
3	17.4	43.6	50.3	6.9E-04



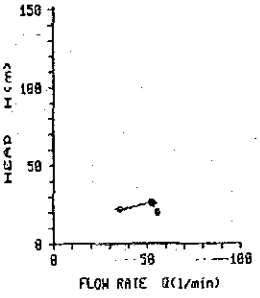
HOLE No : B-2
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	41.3	38.9	15.8	2.1E-04
2	48.7	55.3	27.2	3.7E-04
3	38.4	45.8	23.4	3.2E-04



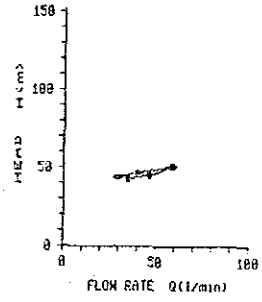
HOLE No : B-2
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	22.4	35.6	31.8	4.4E-04
2	25.7	52.6	41.0	5.6E-04
3	20.3	55.6	54.8	7.5E-04



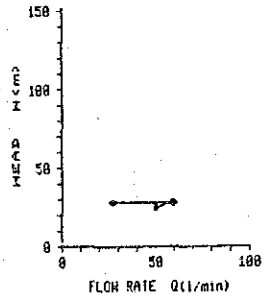
HOLE No : B-2
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	43.7	29.2	13.4	1.8E-04
2	46.6	39.5	17.0	2.3E-04
3	58.8	58.9	23.2	3.2E-04
4	44.8	46.4	28.7	2.6E-04
5	42.6	35.8	16.4	2.3E-04



HOLE No : B-2
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	27.7	27.3	19.7	2.7E-04
2	28.4	59.5	41.8	5.7E-04
3	25.1	49.8	39.7	5.5E-04



HOLE No : B-2
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	48.6	28.1	11.6	1.6E-04
2	51.8	39.4	15.4	2.1E-04
3	55.8	55.6	19.9	2.7E-04
4	46.9	52.4	22.3	3.1E-04
5	43.7	47.2	21.6	3.0E-04

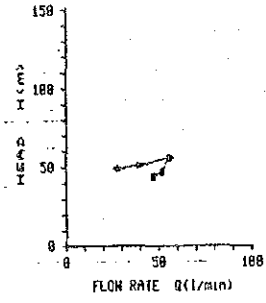
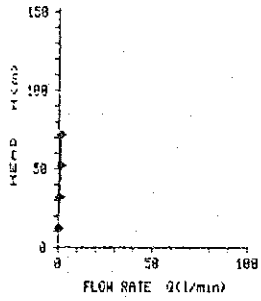


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (3/20)

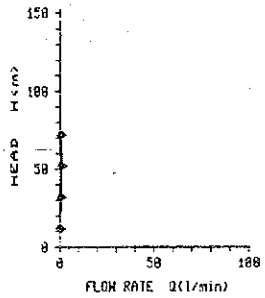
HOLE No : B-3
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.3	0.0	0.0	0.0E+00
2	31.7	0.6	0.3	4.3E-06
3	51.7	1.2	0.5	6.4E-06
4	71.7	1.0	0.3	3.3E-06
5	51.7	0.7	0.3	3.9E-06
6	31.7	0.3	0.2	2.3E-06
7	11.3	0.0	0.0	0.0E+00



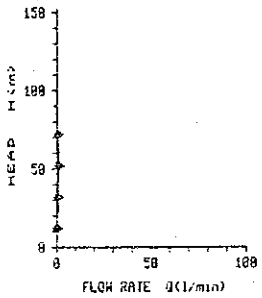
HOLE No : B-3
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.3	0.0	0.0	0.0E+00
2	31.7	0.7	0.4	6.2E-06
3	51.7	1.2	0.5	6.4E-06
4	71.7	0.3	0.2	3.4E-06
5	51.7	0.7	0.3	3.7E-06
6	31.7	0.5	0.3	3.9E-06
7	11.3	0.0	0.0	0.0E+00



HOLE No : B-3
DEPTH : 50 - 55 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.3	0.0	0.0	0.0E+00
2	31.7	0.8	0.5	6.5E-06
3	51.7	1.4	0.5	7.5E-06
4	71.7	0.9	0.2	3.4E-06
5	51.7	0.6	0.2	3.2E-06
6	31.7	0.4	0.3	3.5E-06
7	11.3	0.0	0.0	0.0E+00



HOLE No : B-3
DEPTH : 55 - 60 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.3	0.0	0.0	0.0E+00
2	31.7	0.6	0.4	5.2E-06
3	51.7	1.5	0.6	7.9E-06
4	71.7	0.3	0.2	3.1E-06
5	51.7	0.7	0.3	3.5E-06
6	31.7	0.5	0.3	4.4E-06
7	11.3	0.0	0.0	0.0E+00

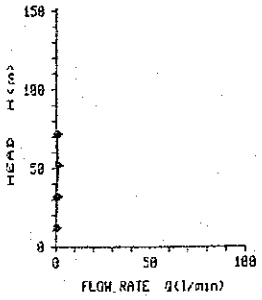
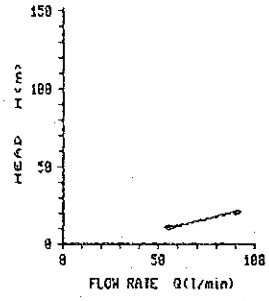


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (4/20)

B-3(1/2)

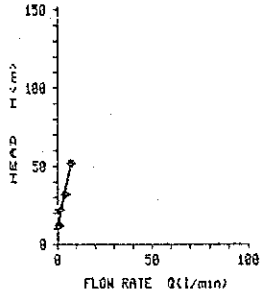
HOLE No : B-3
DEPTH : 1.2 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.5	55.5	127.3	1.7E-03
2	21.8	98.8	112.7	1.5E-03



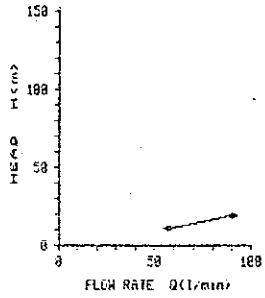
HOLE No : B-3
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	0.8	1.3	1.8E-05
2	21.7	1.2	1.1	1.6E-05
3	31.7	4.2	2.7	3.7E-05
4	51.7	7.2	2.8	3.8E-05
5	31.7	3.8	2.4	3.3E-05
6	11.7	0.6	1.1	1.5E-05



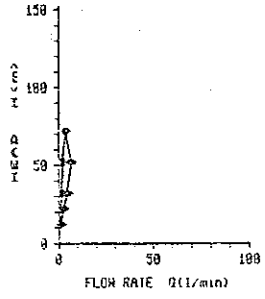
HOLE No : B-3
DEPTH : 4.5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.6	57.2	97.6	1.4E-03
2	19.8	98.8	96.2	1.2E-03



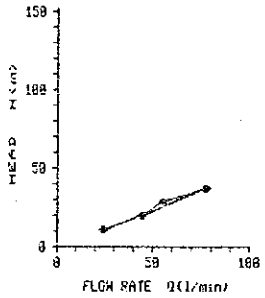
HOLE No : B-3
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	1.3	2.2	3.0E-05
2	21.7	2.7	2.5	3.5E-05
3	31.7	4.5	2.9	3.9E-05
4	51.7	6.3	2.7	3.7E-05
5	71.7	3.7	1.8	1.4E-05
6	51.7	2.5	1.8	1.3E-05
7	31.7	1.7	1.1	1.5E-05
8	11.7	1.0	1.7	2.3E-05



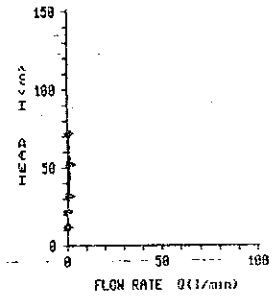
HOLE No : B-3
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.3	24.3	44.8	6.0E-04
2	20.3	44.2	43.6	6.0E-04
3	29.4	58.9	38.8	5.2E-04
4	37.3	77.1	41.4	5.7E-04
5	28.3	44.5	43.9	6.0E-04
6	11.3	24.8	42.4	5.8E-04



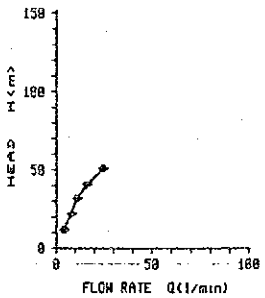
HOLE No : B-3
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	0.1	0.2	2.9E-06
2	21.7	0.5	0.4	5.7E-06
3	31.7	1.0	0.6	8.8E-06
4	51.7	1.9	0.7	1.0E-05
5	71.7	0.9	0.3	3.6E-06
6	51.7	0.6	0.2	3.6E-06
7	31.7	0.2	0.1	2.0E-06
8	11.7	0.1	0.2	2.0E-06



HOLE No : B-3
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	4.4	7.4	1.0E-04
2	21.7	8.2	7.5	1.0E-04
3	31.6	11.3	7.2	9.8E-05
4	41.4	16.3	7.9	1.1E-04
5	51.1	24.8	9.7	1.3E-04
6	31.6	18.8	6.9	9.4E-05
7	11.7	4.2	7.1	9.7E-05



HOLE No : B-3
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.8	0.0	0.0	0.0E+00
2	31.7	0.6	0.4	5.5E-06
3	51.7	1.3	0.5	7.0E-06
4	71.7	1.2	0.3	4.5E-06
5	51.7	0.7	0.3	3.7E-06
6	31.7	0.4	0.2	3.1E-06
7	11.8	0.0	0.0	0.0E+00

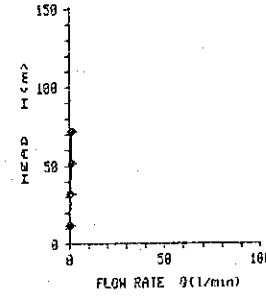
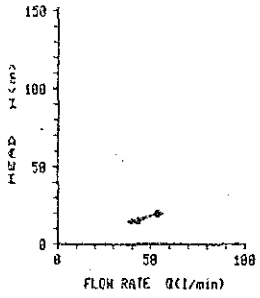


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (5/20)

B-4

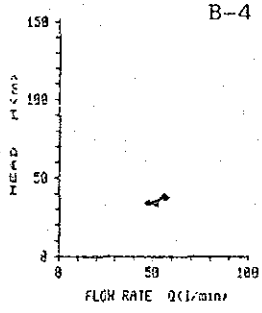
HOLE No : B-4
DEPTH : 3 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	14.3	39.6	133.5	1.3E-03
2	19.5	53.6	137.1	1.4E-03
3	14.8	43.1	145.3	1.4E-03



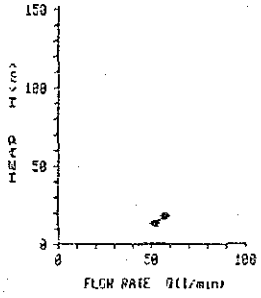
HOLE No : B-4
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	34.3	48.8	27.9	3.3E-04
2	37.7	56.5	30.8	4.1E-04
3	33.6	51.9	30.9	4.2E-04



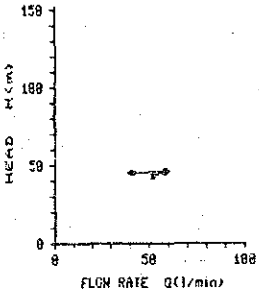
HOLE No : B-4
DEPTH : 6 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	13.8	52.1	188.5	1.2E-03
2	17.7	57.5	81.4	9.5E-04
3	12.9	52.7	181.9	1.2E-03



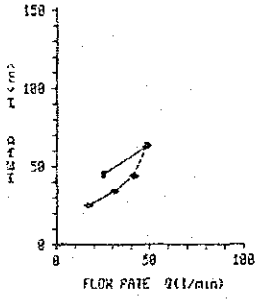
HOLE No : B-4
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	44.8	41.4	18.5	2.5E-04
2	46.8	58.2	25.3	3.5E-04
3	42.5	52.2	24.6	3.4E-04



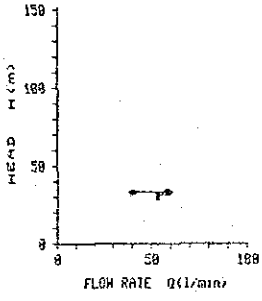
HOLE No : B-4
DEPTH : 13 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	24.9	16.3	33.7	3.3E-04
2	34.2	38.9	45.1	5.1E-04
3	43.5	41.0	47.4	5.4E-04
4	62.9	48.5	38.5	4.4E-04
5	44.6	25.3	29.4	3.3E-04



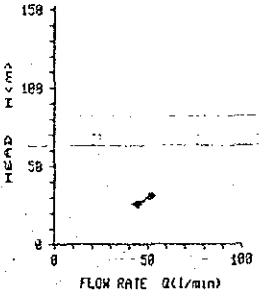
HOLE No : B-4
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.9	48.2	24.4	3.4E-04
2	33.2	58.2	35.0	4.8E-04
3	29.7	53.3	35.2	4.9E-04



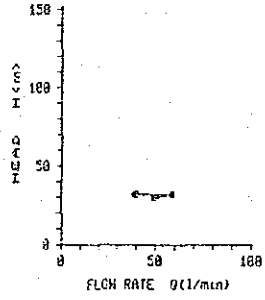
HOLE No : B-4
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	26.5	44.4	33.6	4.6E-04
2	30.7	51.8	33.8	4.6E-04
3	26.4	44.9	34.8	4.7E-04



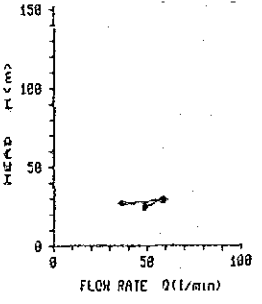
HOLE No : B-4
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.4	39.3	24.6	3.4E-04
2	31.7	58.3	37.1	5.1E-04
3	29.9	49.1	32.3	4.5E-04



HOLE No : B-4
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	26.7	36.3	27.2	3.7E-04
2	28.5	58.5	41.8	5.6E-04
3	25.2	48.8	38.1	5.2E-04



HOLE No : B-4
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	25.3	46.8	36.3	5.0E-04
2	26.8	58.3	44.9	6.2E-04
3	23.8	52.9	46.8	6.3E-04

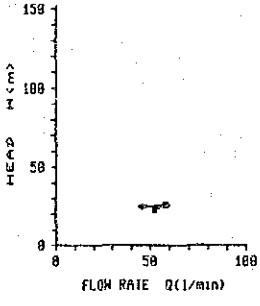
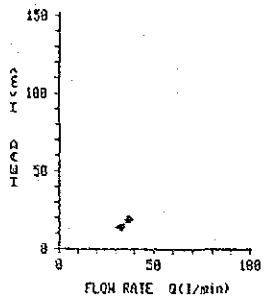


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (6/20)

B-5

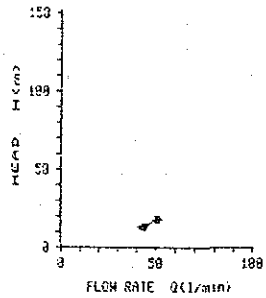
HOLE No : B-5
DEPTH : 1 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	14.4	32.2	55.8	6.9E-04
2	19.4	36.9	47.6	5.9E-04
3	14.4	32.7	56.7	7.0E-04



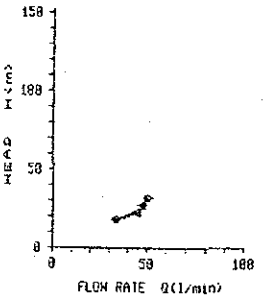
HOLE No : B-5
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	13.3	43.6	65.7	8.5E-04
2	18.8	51.2	56.3	7.4E-04
3	13.3	44.3	66.3	8.7E-04



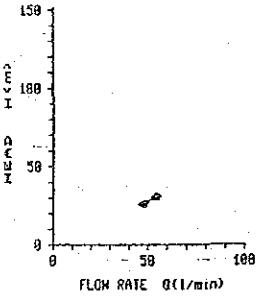
HOLE No : B-5
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	18.2	33.4	36.8	4.6E-04
2	22.5	44.5	39.6	5.1E-04
3	27.3	47.3	34.7	4.5E-04
4	32.1	50.4	31.4	4.1E-04
5	27.3	48.0	35.2	4.6E-04
6	22.4	45.7	40.8	5.3E-04
7	18.1	33.8	37.3	4.9E-04



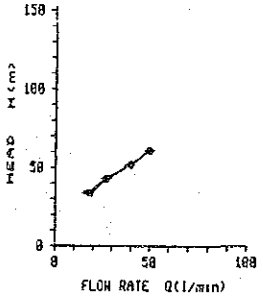
HOLE No : B-5
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	26.5	47.3	35.8	4.7E-04
2	38.6	54.8	35.8	4.7E-04
3	26.4	48.1	36.5	4.8E-04



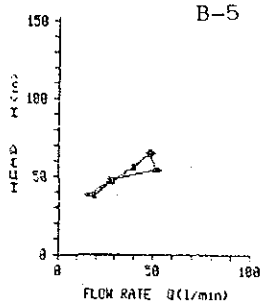
HOLE No : B-5
DEPTH : 21 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	34.8	16.9	12.4	1.6E-04
2	43.4	26.6	15.4	2.0E-04
3	52.1	39.2	18.8	2.5E-04
4	68.5	49.9	28.6	2.7E-04
5	52.8	39.9	19.2	2.5E-04
6	43.3	27.4	15.3	2.1E-04
7	33.9	18.8	13.9	1.8E-04



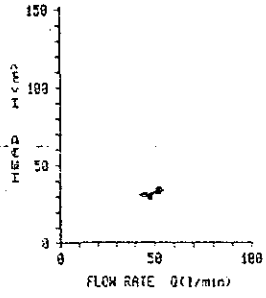
HOLE No : B-5
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	38.5	16.2	8.5	1.2E-04
2	47.5	27.9	11.7	1.6E-04
3	53.9	51.3	19.2	2.6E-04
4	64.5	48.5	15.8	2.1E-04
5	55.9	48.2	14.4	2.0E-04
6	47.4	28.9	12.2	1.7E-04
7	38.3	18.5	9.7	1.3E-04



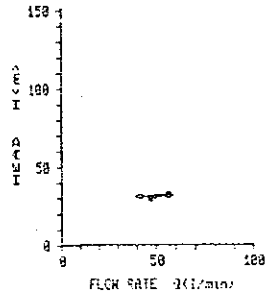
HOLE No : B-5
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	38.9	45.8	29.1	4.0E-04
2	34.3	52.4	38.6	4.3E-04
3	38.4	47.6	31.4	4.3E-04



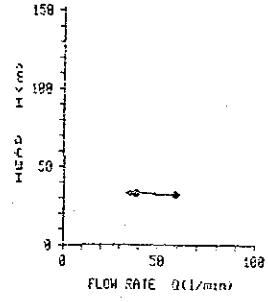
HOLE No : B-5
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	38.9	41.8	27.1	3.7E-04
2	32.1	56.5	35.2	4.8E-04
3	29.6	47.8	31.7	4.4E-04



HOLE No : B-5
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.7	38.9	23.3	3.3E-04
2	31.9	58.6	36.7	5.1E-04
3	33.5	35.6	21.3	2.9E-04



HOLE No : B-5
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	35.4	23.7	13.4	1.8E-04
2	37.8	36.4	19.3	2.7E-04
3	40.7	43.9	21.6	3.0E-04
4	40.7	58.4	28.7	3.9E-04
5	40.6	44.5	21.9	3.0E-04
6	37.3	38.1	28.4	2.9E-04
7	35.3	24.2	13.7	1.9E-04

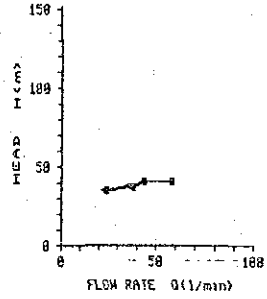
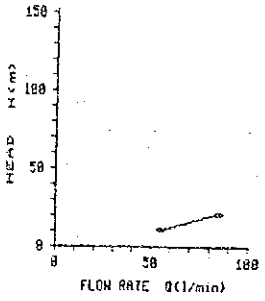


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (7/20)

B-6

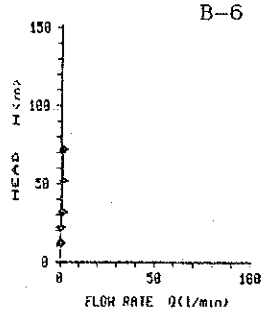
HOLE No : B-6
DEPTH : 1.4 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.4	55.3	134.4	1.7E-03
2	21.0	84.9	112.4	1.4E-03



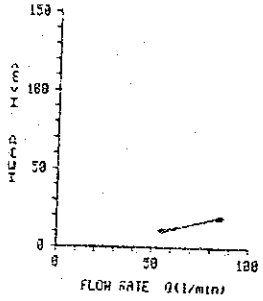
HOLE No : B-6
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	0.1	0.2	2.7E-06
2	21.7	0.4	0.4	5.6E-06
3	31.7	1.0	0.6	8.9E-06
4	51.7	1.3	0.5	7.1E-06
5	71.7	1.1	0.3	4.3E-06
6	31.7	1.8	0.6	9.2E-06
7	11.7	0.4	0.7	1.3E-05



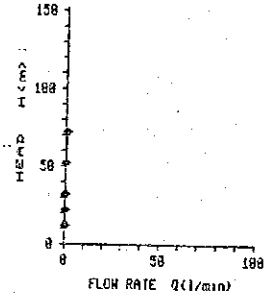
HOLE No : B-6
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.6	55.7	105.3	1.4E-03
2	19.0	84.9	89.3	1.2E-03



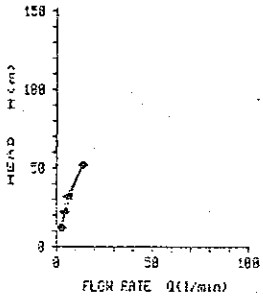
HOLE No : B-6
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.3	0.0	0.0	0.0E+00
2	21.7	0.2	0.1	1.9E-06
3	31.7	0.3	0.2	2.9E-06
4	51.7	0.5	0.2	2.4E-06
5	71.7	0.7	0.2	2.9E-06
6	31.7	0.3	0.2	2.3E-06
7	11.3	0.0	0.0	0.0E+00



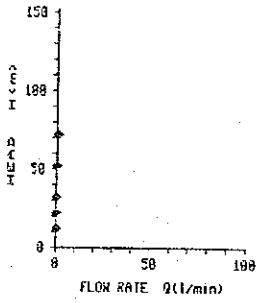
HOLE No : B-6
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	2.6	4.4	6.2E-05
2	21.7	4.3	3.9	5.4E-05
3	31.7	5.5	3.5	4.8E-05
4	51.6	14.8	5.4	7.4E-05
5	31.7	7.3	4.6	6.3E-05
6	11.7	2.5	4.3	5.9E-05



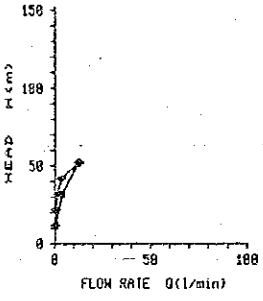
HOLE No : B-6
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.8	0.0	0.0	0.0E+00
2	21.7	0.1	0.1	1.3E-06
3	31.7	0.3	0.2	2.3E-06
4	51.7	0.5	0.2	2.4E-06
5	71.7	0.7	0.2	2.5E-06
6	31.7	0.2	0.1	2.0E-06
7	11.8	0.0	0.0	0.0E+00



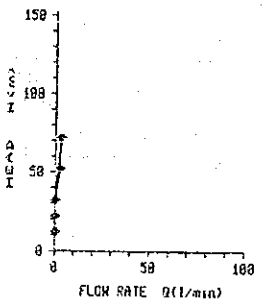
HOLE No : B-6
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	0.1	0.2	2.6E-06
2	21.7	0.9	0.8	1.2E-05
3	31.7	1.9	1.2	1.6E-05
4	41.7	3.8	1.8	2.5E-05
5	51.6	12.5	4.9	6.7E-05
6	31.7	4.4	2.7	3.8E-05
7	11.7	0.6	1.0	1.4E-05



HOLE No : B-6
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	0.1	0.2	2.7E-06
2	21.7	0.2	0.2	2.8E-06
3	31.7	0.3	0.2	2.0E-06
4	51.7	2.9	1.1	1.5E-05
5	71.7	3.4	1.0	1.3E-05
6	31.7	0.4	0.3	3.8E-06
7	11.7	0.1	0.2	2.4E-06



HOLE No : B-6
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.7	0.1	0.2	2.7E-06
2	21.7	1.0	0.9	1.2E-05
3	31.7	2.0	1.2	1.7E-05
4	41.7	3.7	1.8	2.5E-05
5	51.5	11.3	4.6	6.3E-05
6	31.7	4.5	2.8	3.9E-05
7	11.7	0.5	0.9	1.2E-05

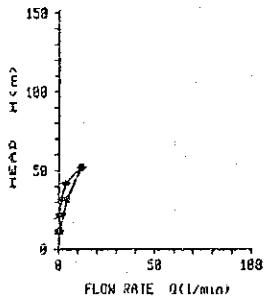
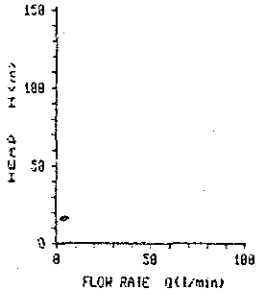


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (8/20)

B-7

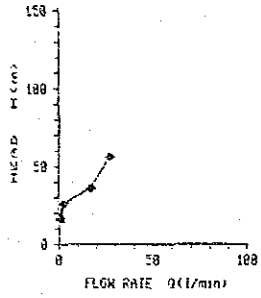
HOLE No : B-7
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	4.2	5.2	7.1E-05



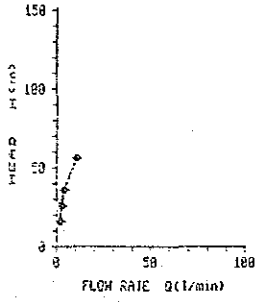
HOLE No : B-7
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	0.3	0.3	4.4E-06
2	26.1	2.5	2.8	3.7E-05
3	35.9	17.1	9.6	1.2E-04
4	55.8	27.4	9.9	1.4E-04
5	35.9	17.3	9.7	1.3E-04
6	26.1	2.5	2.8	3.7E-05
7	16.1	1.6	2.8	2.7E-05



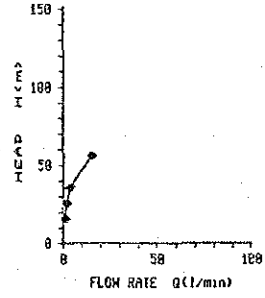
HOLE No : B-7
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	1.8	2.2	3.1E-05
2	26.1	2.7	2.8	2.3E-05
3	36.1	4.1	2.2	3.1E-05
4	56.8	10.7	3.3	5.3E-05
5	36.1	4.8	2.2	3.1E-05
6	26.1	2.1	1.6	3.2E-05
7	16.1	1.9	2.4	3.3E-05



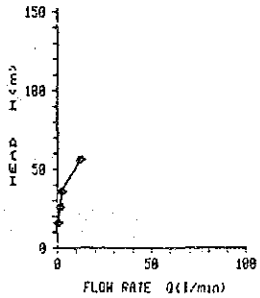
HOLE No : B-7
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	1.1	1.4	1.9E-05
2	26.1	2.3	1.8	2.5E-05
3	36.1	3.9	2.2	3.8E-05
4	55.3	15.2	5.4	7.5E-05
5	36.1	4.8	2.2	3.1E-05
6	26.1	2.2	1.7	2.4E-05
7	16.1	1.2	1.4	2.0E-05



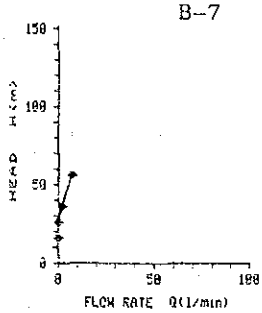
HOLE No : B-7
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	0.7	0.8	1.2E-05
2	26.1	2.0	1.5	2.1E-05
3	36.1	2.3	1.6	2.1E-05
4	55.3	12.0	4.3	5.9E-05
5	36.1	2.3	1.6	2.2E-05
6	26.1	2.2	1.7	2.3E-05
7	16.1	0.9	1.1	1.5E-05



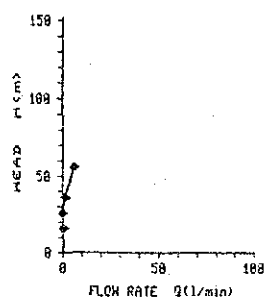
HOLE No : B-7
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	0.0	0.0	0.0E+00
2	26.1	0.3	0.2	3.4E-06
3	36.1	2.3	1.3	1.7E-05
4	56.0	7.2	2.6	3.5E-05
5	36.1	1.9	1.1	1.5E-05
6	26.1	0.3	0.3	3.5E-06
7	16.1	0.0	0.0	0.0E+00



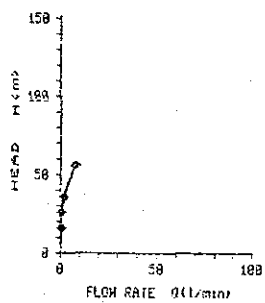
HOLE No : B-7
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	0.0	0.0	0.0E+00
2	26.1	0.1	0.1	1.5E-06
3	36.1	1.6	0.9	1.2E-05
4	56.0	6.2	2.2	3.0E-05
5	36.1	1.4	0.8	1.1E-05
6	26.1	0.2	0.1	1.3E-06
7	16.1	0.0	0.0	0.0E+00



HOLE No : B-7
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	0.0	0.0	0.0E+00
2	26.1	0.2	0.2	2.1E-06
3	36.1	1.0	1.0	1.4E-05
4	55.9	7.6	2.7	3.8E-05
5	36.1	2.1	1.1	1.5E-05
6	26.1	0.2	0.1	2.0E-06
7	16.1	0.0	0.0	0.0E+00



HOLE No : B-7
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.1	0.0	0.0	0.0E+00
2	26.1	0.2	0.1	1.9E-06
3	36.1	1.6	0.9	1.2E-05
4	56.0	5.3	1.9	2.6E-05
5	36.1	1.6	0.9	1.3E-05
6	26.1	0.2	0.1	2.0E-06
7	16.1	0.3	0.3	0.0E+00

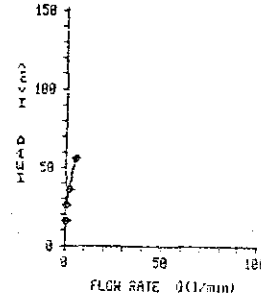
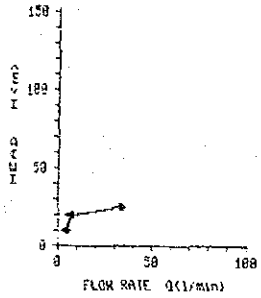


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (9/20)

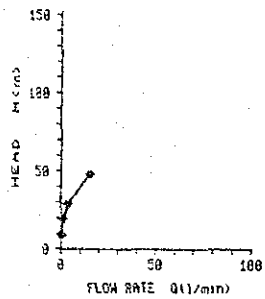
HOLE No : B-8
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.4	4.0	7.7	1.1E-04
2	20.4	6.1	6.1	8.4E-05
3	25.0	33.9	27.2	3.7E-04
4	20.4	7.5	7.4	1.0E-04
5	10.4	4.7	9.1	1.3E-04



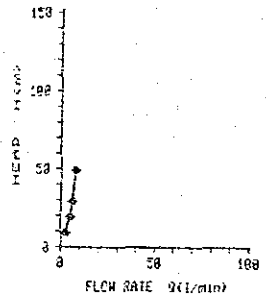
HOLE No : B-8
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	8.9	0.0	0.0	0.0E+00
2	18.9	1.0	1.0	1.4E-05
3	29.9	3.9	2.7	3.8E-05
4	48.4	15.1	6.2	8.6E-05
5	28.9	4.8	2.8	3.9E-05
6	18.9	1.1	1.2	1.7E-05
7	3.9	0.0	0.0	0.0E+00



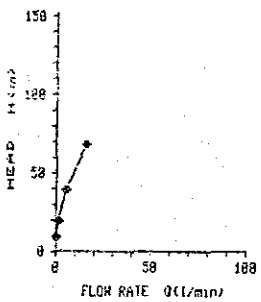
HOLE No : B-8
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	9.4	2.8	6.0	8.3E-05
2	19.4	5.1	5.3	7.3E-05
3	29.4	6.3	4.0	5.9E-05
4	49.4	8.8	3.2	4.4E-05
5	29.4	6.7	4.6	6.3E-05
6	19.4	5.5	5.7	7.8E-05
7	9.4	2.9	6.3	8.6E-05



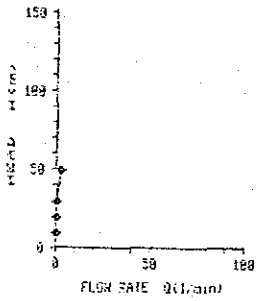
HOLE No : B-8
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	8.9	0.3	0.6	7.7E-06
2	18.9	1.5	1.7	2.4E-05
3	38.8	5.1	2.6	3.6E-05
4	68.3	15.5	4.5	6.2E-05
5	38.8	5.4	2.8	3.8E-05
6	18.9	1.7	1.8	2.4E-05
7	8.9	0.3	0.6	8.7E-06



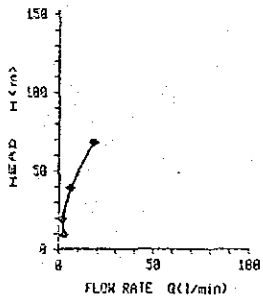
HOLE No : B-8
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	9.4	0.0	0.0	0.0E+00
2	19.4	0.0	0.0	5.7E-07
3	29.4	0.1	0.1	1.1E-06
4	49.4	2.3	1.2	1.6E-05
5	29.4	0.1	0.1	1.3E-06
6	19.4	0.0	0.0	4.2E-07
7	9.4	0.0	0.0	2.9E-07



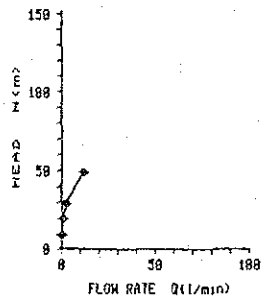
HOLE No : B-8
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	8.9	2.8	6.3	8.6E-05
2	18.9	1.9	2.0	2.8E-05
3	28.8	3.0	3.1	4.2E-05
4	67.9	18.2	5.3	7.4E-05
5	38.8	6.4	3.3	4.5E-05
6	19.9	2.2	2.3	3.1E-05
7	8.9	3.1	7.0	9.6E-05



HOLE No : B-8
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	8.9	0.0	0.0	0.0E+00
2	18.9	0.7	0.7	1.0E-05
3	28.9	2.9	2.0	2.8E-05
4	48.6	11.0	4.9	6.7E-05
5	28.9	3.0	2.1	2.9E-05
6	18.9	0.7	0.8	1.0E-05
7	8.9	0.0	0.0	0.0E+00



HOLE No : B-8
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	8.9	0.4	0.8	1.2E-05
2	18.9	2.1	2.2	3.0E-05
3	38.7	6.7	3.5	4.8E-05
4	67.7	19.8	5.6	7.7E-05
5	38.7	7.0	3.6	4.9E-05
6	18.9	2.3	2.4	3.3E-05
7	8.9	0.4	0.9	1.2E-05

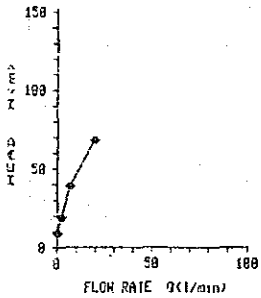
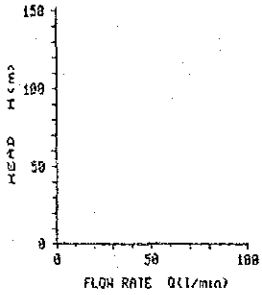


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (10/20)

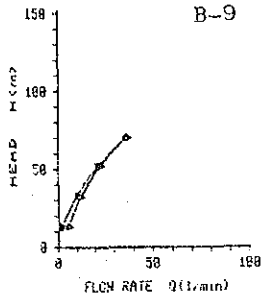
HOLE No : B-9
DEPTH : 1 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.8	56.4	117.4	1.5E-03



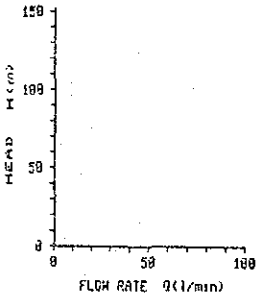
HOLE No : B-9
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.6	5.4	8.5	1.2E-04
2	32.4	11.8	7.0	1.0E-04
3	51.7	22.6	8.7	1.2E-04
4	70.2	36.1	10.3	1.4E-04
5	51.9	21.9	8.1	1.1E-04
6	32.5	9.6	5.9	8.1E-05
7	12.7	1.6	2.6	3.5E-05



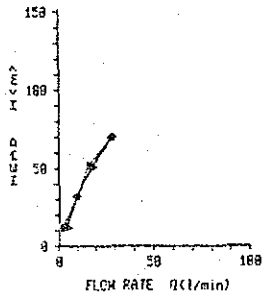
HOLE No : B-9
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	6.1	66.8	218.2	3.0E-03



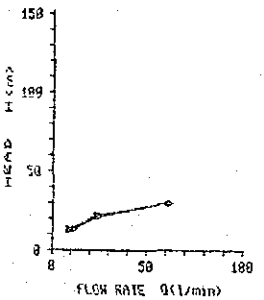
HOLE No : B-9
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.1	4.1	6.3	9.4E-05
2	32.8	9.1	5.7	7.9E-05
3	51.4	18.1	7.8	9.7E-05
4	70.3	28.3	8.2	1.1E-04
5	51.5	16.3	6.3	8.7E-05
6	31.9	9.7	6.1	8.3E-05
7	12.1	2.4	3.9	5.3E-05



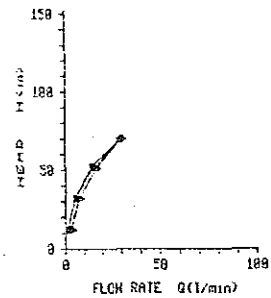
HOLE No : B-9
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.6	10.6	16.3	2.3E-04
2	22.2	24.7	22.2	3.1E-04
3	29.9	68.9	48.8	5.6E-04
4	22.3	22.3	28.4	2.8E-04
5	12.7	8.1	12.3	1.6E-04



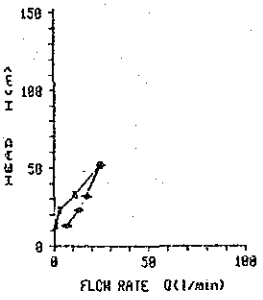
HOLE No : B-9
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.1	3.5	5.7	7.3E-05
2	32.9	7.2	4.5	6.1E-05
3	51.4	16.3	6.5	9.0E-05
4	69.7	38.2	8.6	1.2E-04
5	51.6	14.8	5.4	7.5E-05
6	32.1	5.2	3.2	4.5E-05
7	12.1	1.6	2.7	3.7E-05



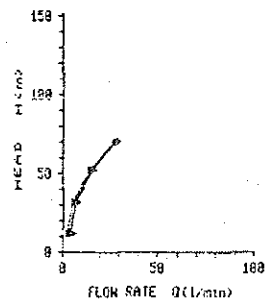
HOLE No : B-9
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.6	6.7	10.6	1.5E-04
2	22.5	12.7	11.3	1.6E-04
3	32.4	17.8	10.5	1.4E-04
4	52.8	24.8	9.5	1.3E-04
5	32.6	11.8	6.8	9.3E-05
6	22.7	2.7	2.4	3.3E-05
7	12.7	0.7	1.1	1.5E-05



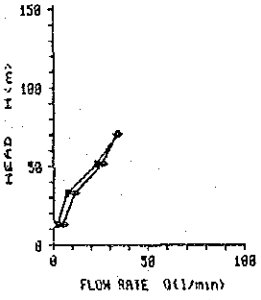
HOLE No : B-9
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.2	4.1	6.7	9.3E-05
2	32.2	6.3	4.2	5.8E-05
3	51.5	15.3	6.1	8.4E-05
4	69.9	28.2	8.1	1.1E-04
5	51.7	14.2	5.5	7.6E-05
6	32.2	5.2	3.2	4.5E-05
7	12.3	2.3	4.6	6.3E-05



HOLE No : B-9
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.7	5.3	8.3	1.1E-04
2	32.5	11.4	7.8	9.6E-05
3	51.7	26.2	10.1	1.4E-04
4	70.9	34.3	9.7	1.3E-04
5	51.9	23.1	8.9	1.2E-04
6	32.6	7.1	4.3	6.0E-05
7	12.7	2.2	3.5	4.9E-05



HOLE No : B-9
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.3	2.3	3.7	5.2E-05
2	32.2	5.1	3.2	4.4E-05
3	51.9	11.2	4.3	5.9E-05
4	70.2	24.8	7.1	9.7E-05
5	51.9	10.9	4.2	5.9E-05
6	32.3	3.2	2.8	3.7E-05
7	12.3	1.2	2.8	3.7E-05

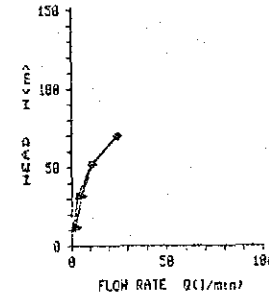
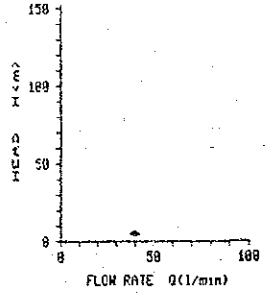


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (11/20)

B-10

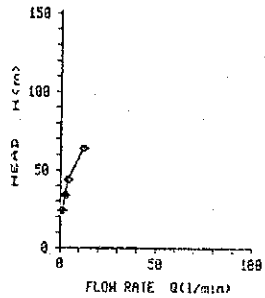
HOLE No : B-10
DEPTH : 3 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	5.4	39.7	368.8	4.2E-03



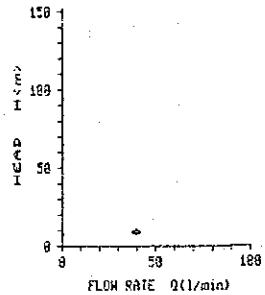
HOLE No : B-10
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	24.2	1.3	1.1	1.5E-05
2	34.2	2.5	1.5	2.0E-05
3	44.2	4.2	1.9	2.6E-05
4	64.1	12.1	3.8	5.2E-05
5	44.2	4.4	2.8	2.9E-05
6	34.2	2.6	1.5	2.1E-05
7	24.2	1.3	1.0	1.4E-05



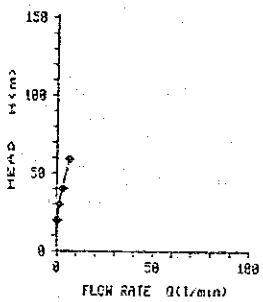
HOLE No : B-10
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	9.7	39.3	92.0	1.3E-03



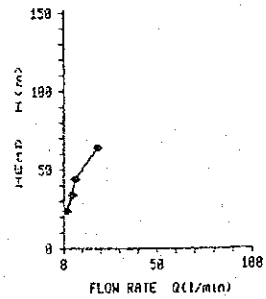
HOLE No : B-10
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	19.6	0.8	0.8	4.9E-07
2	29.5	1.2	0.8	1.1E-05
3	39.5	3.3	1.7	2.2E-05
4	59.5	6.6	2.2	3.1E-05
5	39.5	3.4	1.7	2.3E-05
6	29.5	1.2	0.8	1.1E-05
7	19.6	0.0	0.0	5.8E-07



HOLE No : B-10
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	24.2	1.3	1.6	2.3E-05
2	34.2	4.5	2.7	3.7E-05
3	44.2	6.2	2.8	3.9E-05
4	64.0	18.5	5.8	7.9E-05
5	44.2	6.3	2.9	3.9E-05
6	34.2	4.4	2.6	3.6E-05
7	24.2	1.3	1.5	2.1E-05



HOLE No : B-10
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	19.6	0.0	0.0	2.0E-07
2	29.5	0.9	0.6	8.1E-06
3	39.5	3.2	1.6	2.2E-05
4	59.5	6.2	2.1	2.9E-05
5	39.5	3.1	1.5	2.1E-05
6	29.5	0.3	0.6	9.7E-06
7	19.6	0.0	0.0	3.1E-07

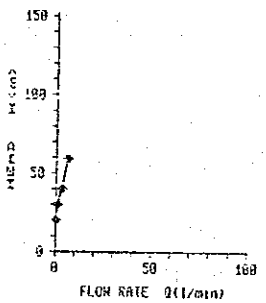
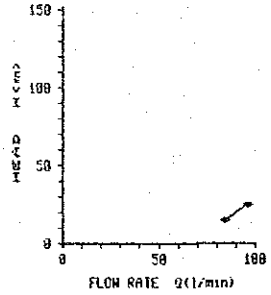


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (12/20)

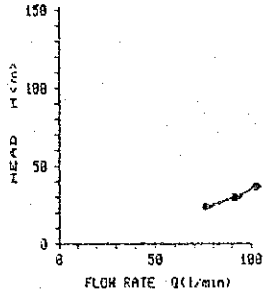
HOLE No : B-11
DEPTH : 1.2 - 6 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	14.7	84.1	119.1	1.6E-03
2	24.5	96.4	82.0	1.1E-03



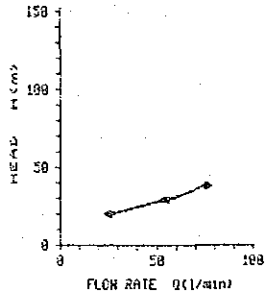
HOLE No : B-11
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	23.9	76.5	64.0	8.3E-04
2	29.6	92.5	62.1	8.5E-04
3	36.6	102.6	55.7	7.7E-04
4	30.2	91.0	60.2	8.3E-04
5	24.1	75.5	62.5	8.6E-04



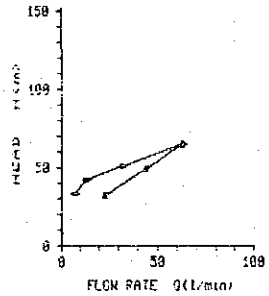
HOLE No : B-11
DEPTH : 6 - 11.2 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	28.1	25.0	24.0	3.3E-04
2	39.1	53.0	35.1	4.9E-04
3	37.7	75.9	38.7	5.4E-04
4	29.0	55.0	36.5	5.1E-04
5	28.0	26.1	25.0	3.5E-04



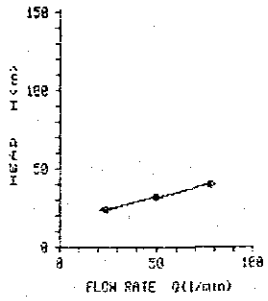
HOLE No : B-11
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.7	7.2	4.4	6.8E-05
2	42.4	13.1	6.2	8.5E-05
3	58.8	32.0	12.6	1.7E-04
4	65.3	62.3	19.2	2.6E-04
5	49.1	44.2	18.0	2.5E-04
6	31.7	23.0	14.5	2.8E-04



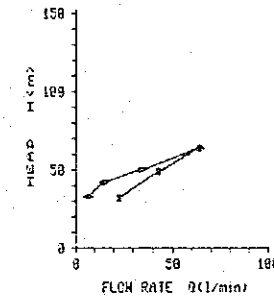
HOLE No : B-11
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	33.3	23.1	19.4	2.7E-04
2	32.4	49.5	30.6	4.2E-04
3	39.7	77.5	39.8	5.4E-04
4	32.4	49.5	30.6	4.2E-04
5	23.3	24.8	28.2	2.3E-04



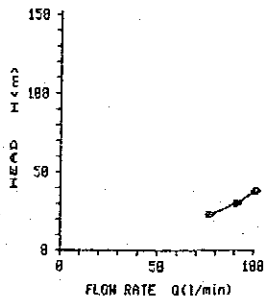
HOLE No : B-11
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.6	6.7	4.1	5.7E-05
2	42.3	14.5	6.9	9.4E-05
3	58.2	33.3	13.5	1.9E-04
4	63.6	63.5	20.8	2.7E-04
5	48.6	42.5	17.5	2.4E-04
6	31.6	22.7	14.4	2.8E-04



HOLE No : B-11
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	22.5	77.1	68.5	9.4E-04
2	29.7	91.6	61.6	8.5E-04
3	37.6	101.1	53.7	7.4E-04
4	29.9	90.5	60.4	8.3E-04
5	22.6	76.7	68.0	9.3E-04



HOLE No : B-11
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.6	7.3	4.4	6.1E-05
2	42.4	11.5	5.4	7.9E-05
3	58.3	38.6	12.2	1.7E-04
4	62.6	62.8	19.3	2.7E-04
5	48.1	42.8	17.5	2.4E-04
6	31.5	22.8	14.8	1.9E-04

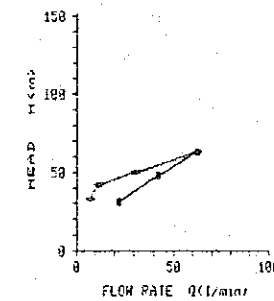
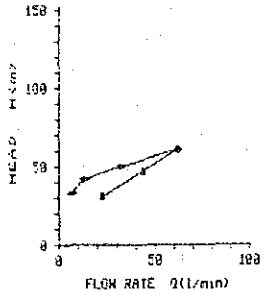


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (13/20)

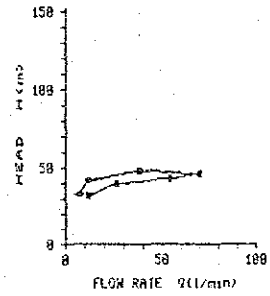
HOLE No : B-11
DEPTH : 40 - 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.6	6.9	4.2	5.8E-05
2	42.2	13.4	6.3	9.1E-05
3	49.7	31.6	12.7	1.7E-04
4	61.2	61.8	28.2	2.6E-04
5	46.3	43.8	18.7	2.6E-04
6	31.2	22.7	14.6	2.0E-04



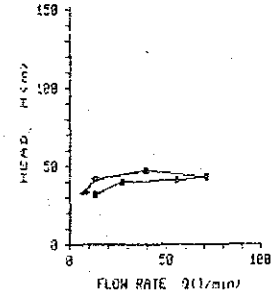
HOLE No : B-11
DEPTH : 45 - 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.6	7.1	4.4	6.0E-05
2	42.2	12.2	5.8	7.9E-05
3	47.8	38.8	15.9	2.2E-04
4	46.1	78.8	38.4	4.2E-04
5	42.7	54.3	25.4	3.5E-04
6	40.3	26.3	13.3	1.9E-04
7	32.2	12.5	7.7	1.1E-04



HOLE No : B-11
DEPTH : 50 - 55 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.5	7.9	4.9	6.7E-05
2	42.1	13.5	6.4	8.8E-05
3	46.8	39.5	16.9	2.3E-04
4	43.4	71.5	32.9	4.5E-04
5	41.2	55.2	26.8	3.7E-04
6	39.9	27.2	13.6	1.9E-04
7	32.1	13.2	8.2	1.1E-04



HOLE No : B-11
DEPTH : 55 - 60 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	32.5	7.1	4.4	6.0E-05
2	42.1	12.2	5.8	7.9E-05
3	46.7	38.9	16.3	2.2E-04
4	42.3	78.0	33.1	4.5E-04
5	40.5	54.3	26.8	3.7E-04
6	39.9	26.3	13.5	1.9E-04
7	32.1	12.5	7.8	1.1E-04

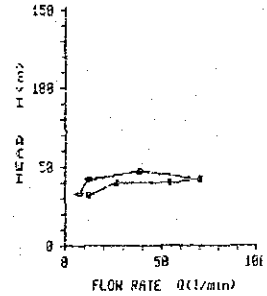
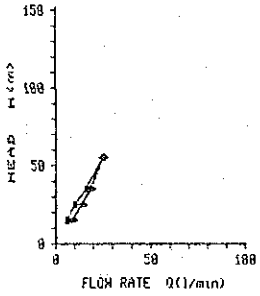


Fig. 3. 2. 20 P - Q CURVE OF FIELD PERMEABILITY TEST (14/20)

B-12

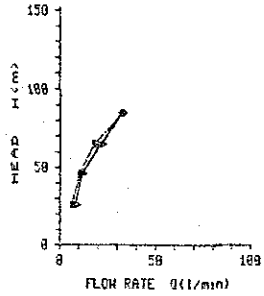
HOLE No : B-12
DEPTH : 2 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.0	8.7	19.2	2.4E-04
2	25.0	14.3	19.1	2.4E-04
3	35.0	19.8	13.8	2.2E-04
4	55.0	25.3	15.3	1.9E-04
5	35.0	16.5	15.7	1.9E-04
6	25.0	10.3	13.7	1.7E-04
7	15.0	6.4	14.1	1.7E-04



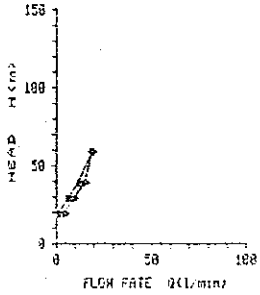
HOLE No : B-12
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	25.0	8.6	6.7	9.2E-05
2	45.7	11.7	5.1	7.1E-05
3	65.3	21.3	6.6	9.1E-05
4	84.6	32.7	7.7	1.1E-04
5	65.5	18.4	5.6	7.7E-05
6	45.7	10.3	4.7	6.5E-05
7	25.0	6.0	5.3	7.3E-05



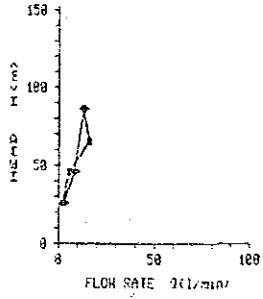
HOLE No : B-12
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	19.0	4.1	4.3	6.0E-05
2	29.0	9.4	6.5	8.5E-05
3	39.0	15.4	7.9	1.1E-04
4	58.2	19.2	6.5	8.3E-05
5	39.0	11.5	5.9	8.1E-05
6	29.0	6.4	4.4	6.1E-05
7	19.0	1.3	1.3	1.8E-05



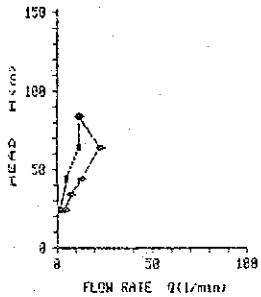
HOLE No : B-12
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	25.3	2.7	2.1	2.9E-05
2	45.7	8.6	3.8	5.2E-05
3	65.6	13.4	3.1	4.3E-05
4	65.5	16.2	5.0	6.9E-05
5	45.8	5.8	2.5	3.5E-05
6	25.9	2.5	1.9	2.6E-05



HOLE No : B-12
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	24.0	4.2	3.5	4.8E-05
2	34.0	7.4	4.4	6.0E-05
3	43.3	13.4	6.1	8.4E-05
4	63.6	23.5	7.4	1.0E-04
5	83.9	11.7	2.3	3.2E-05
6	63.9	11.7	3.6	5.0E-05
7	44.0	5.1	2.3	3.2E-05
8	24.0	1.7	1.4	2.0E-05



HOLE No : B-12
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	25.8	3.2	2.5	3.4E-05
2	45.7	9.0	3.9	5.4E-05
3	65.5	14.2	4.3	6.0E-05
4	85.4	20.3	4.8	6.6E-05
5	65.4	15.2	4.6	6.4E-05
6	45.7	7.6	3.3	4.6E-05
7	25.8	3.8	2.4	3.2E-05

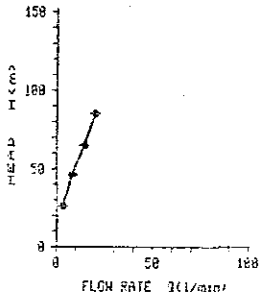
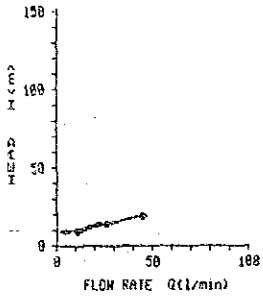


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (15/20)

TB-1

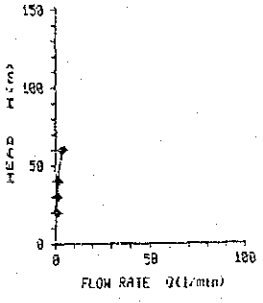
HOLE No : TB-1
DEPTH : 1 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	9.3	4.6	12.4	1.6E-04
2	14.3	21.6	37.9	5.0E-04
3	19.1	44.3	59.6	7.7E-04
4	14.2	26.8	45.6	6.0E-04
5	9.3	10.7	28.3	3.8E-04



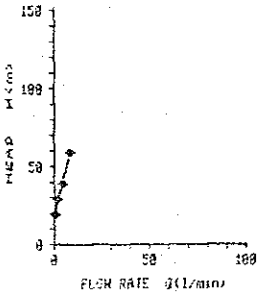
HOLE No : TB-1
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	20.4	0.5	0.5	7.0E-06
2	30.4	1.0	0.6	8.7E-06
3	40.4	1.4	0.7	9.6E-06
4	60.4	3.7	1.2	1.7E-05
5	40.4	1.5	0.7	10.0E-06
6	30.4	1.2	0.8	1.1E-05
7	20.4	0.5	0.5	6.9E-06



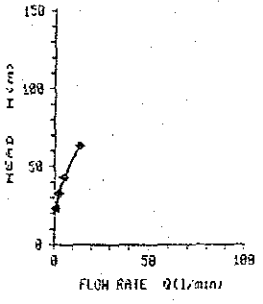
HOLE No : TB-1
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.3	0.6	0.6	8.3E-06
2	20.8	1.5	1.9	1.4E-05
3	30.6	4.6	2.4	3.3E-05
4	50.3	8.8	2.7	3.7E-05
5	30.8	4.7	2.4	3.3E-05
6	20.3	1.3	1.9	1.7E-05
7	10.9	0.7	0.7	1.2E-05



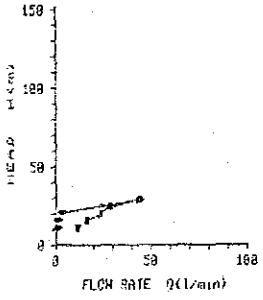
HOLE No : TB-1
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	23.0	0.8	0.7	9.4E-06
2	33.0	2.2	1.3	1.3E-05
3	43.0	4.7	2.2	3.0E-05
4	62.7	13.2	4.2	5.3E-05
5	43.0	5.2	2.4	3.2E-05
6	33.0	2.8	1.7	2.4E-05
7	23.0	1.7	1.5	2.0E-05



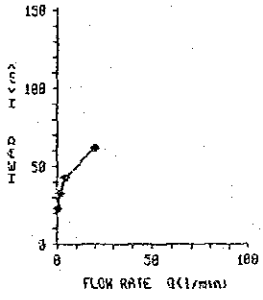
HOLE No : TB-1
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.7	0.7	1.3	1.3E-05
2	15.7	1.3	1.7	2.3E-05
3	20.7	3.9	3.8	5.2E-05
4	25.3	24.3	19.2	2.6E-04
5	29.3	43.6	29.7	4.1E-04
6	25.1	29.9	33.0	3.2E-04
7	20.3	23.7	23.3	3.3E-04
8	15.5	16.3	21.6	3.0E-04
9	10.7	11.8	20.6	3.3E-04



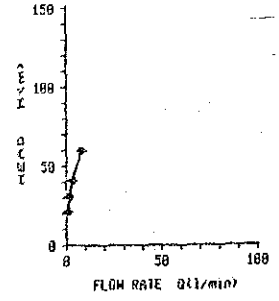
HOLE No : TB-1
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	23.1	0.4	0.4	5.3E-06
2	33.1	1.6	0.9	1.3E-05
3	43.1	4.1	1.9	2.6E-05
4	62.2	20.3	6.5	9.8E-05
5	43.8	4.9	2.3	3.2E-05
6	33.1	2.4	1.4	2.0E-05
7	23.1	1.0	0.8	1.2E-05



HOLE No : TB-1
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	20.5	0.9	0.9	1.2E-05
2	30.5	1.7	1.1	1.5E-05
3	40.5	3.4	1.7	2.3E-05
4	60.5	8.3	2.7	3.8E-05
5	40.5	3.7	1.8	2.5E-05
6	30.5	2.4	1.6	2.2E-05
7	20.5	1.3	1.3	1.8E-05



HOLE No : TB-1
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	23.5	0.6	0.5	6.7E-06
2	33.5	1.3	0.8	1.1E-05
3	43.5	3.3	1.5	2.1E-05
4	63.2	11.7	3.7	5.1E-05
5	43.8	3.7	1.7	2.3E-05
6	33.5	1.9	1.1	1.6E-05
7	23.5	1.0	0.9	1.2E-05

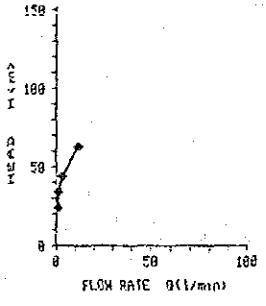
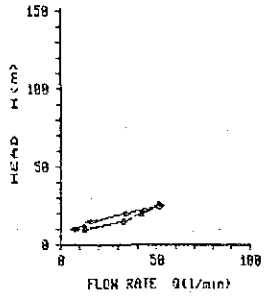


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (16/20)

TB-2(1/2)

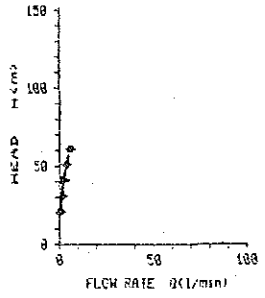
HOLE No : TB-2
DEPTH : 2 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	10.8	7.6	25.2	3.1E-04
2	15.0	15.3	35.2	4.4E-04
3	19.3	33.9	56.3	7.1E-04
4	24.6	51.2	69.3	8.6E-04
5	19.7	42.2	71.3	8.9E-04
6	14.3	32.5	73.1	9.1E-04
7	10.0	13.8	43.3	5.4E-04



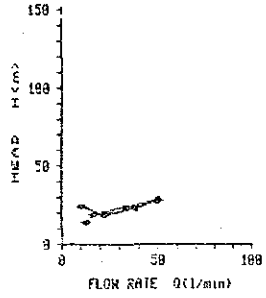
HOLE No : TB-2
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	21.5	0.5	0.5	6.7E-06
2	31.5	1.7	1.1	1.5E-05
3	41.5	2.7	1.3	1.6E-05
4	51.5	3.7	1.4	2.0E-05
5	61.4	5.9	1.9	2.6E-05
6	51.5	4.3	1.7	2.3E-05
7	41.5	1.9	0.9	1.2E-05
8	31.5	1.1	0.7	9.7E-06
9	21.5	0.1	0.1	1.4E-06



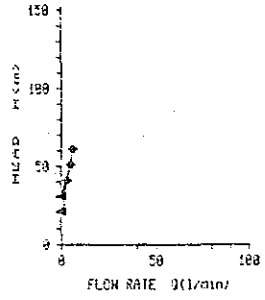
HOLE No : TB-2
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	13.9	13.1	18.9	2.6E-04
2	13.9	17.8	18.8	2.5E-04
3	23.6	33.8	28.7	3.9E-04
4	28.8	50.2	35.3	4.9E-04
5	23.4	36.9	33.2	4.6E-04
6	18.3	22.9	24.4	3.4E-04
7	24.8	10.8	9.8	1.2E-04



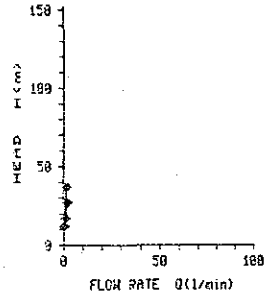
HOLE No : TB-2
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	28.6	0.1	0.1	1.3E-06
2	38.6	0.4	0.3	3.6E-06
3	48.6	2.4	1.7	2.2E-05
4	58.5	5.2	2.1	2.8E-05
5	68.5	6.1	2.8	2.3E-05
6	58.5	5.4	2.2	3.0E-05
7	48.6	3.4	1.7	2.3E-05
8	38.6	1.7	1.1	1.5E-05
9	28.6	1.7	1.7	2.2E-05



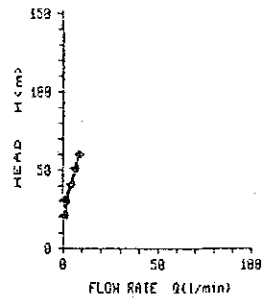
HOLE No : TB-2
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.8	0.1	0.1	1.5E-05
2	17.8	0.8	0.9	1.2E-05
3	27.6	1.5	1.1	1.6E-05
4	37.8	2.0	1.1	1.5E-05
5	27.8	1.6	1.2	1.7E-05
6	17.8	1.0	1.2	1.6E-05
7	12.8	0.2	0.4	5.6E-06



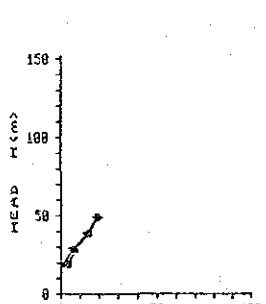
HOLE No : TB-2
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	28.6	0.5	0.5	6.5E-06
2	38.6	0.9	0.6	7.9E-06
3	48.6	4.1	2.8	2.8E-05
4	58.6	6.4	2.5	3.5E-05
5	68.5	8.6	2.8	3.9E-05
6	58.5	7.1	2.8	3.9E-05
7	48.6	5.3	2.6	3.6E-05
8	38.6	2.4	1.6	2.1E-05
9	28.6	1.3	1.3	1.7E-05



HOLE No : TB-2
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	19.5	1.6	1.6	2.2E-05
2	29.5	6.1	4.1	5.7E-05
3	39.3	14.8	7.1	9.8E-05
4	49.1	19.2	7.8	1.1E-04
5	39.2	15.3	7.8	1.1E-04
6	29.4	7.5	5.1	7.1E-05
7	19.5	4.3	4.4	6.1E-05



HOLE No : TB-2
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	28.3	13.6	13.4	1.8E-04
2	27.6	35.8	25.4	3.5E-04
3	35.3	45.6	25.8	3.6E-04
4	50.8	63.9	25.6	3.5E-04
5	36.3	41.8	22.6	3.1E-04
6	27.9	32.3	23.5	3.2E-04
7	19.4	22.6	23.3	3.2E-04

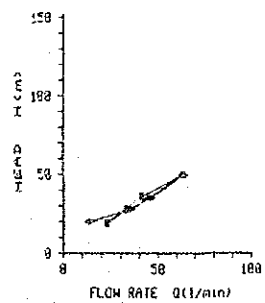
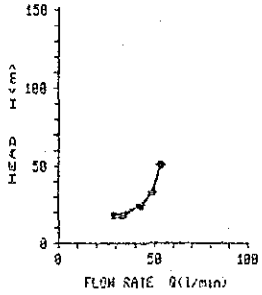


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (17/20)

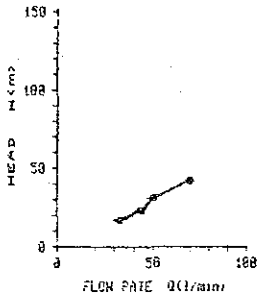
HOLE No : TB-2
DEPTH : 45 ~ 50 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	17.0	33.3	39.2	5.4E-04
2	24.5	42.9	35.0	4.9E-04
3	32.7	48.9	29.9	4.1E-04
4	51.2	53.2	20.8	2.9E-04
5	32.6	49.2	30.2	4.2E-04
6	24.4	43.2	35.3	4.9E-04
7	17.9	29.2	32.6	4.5E-04



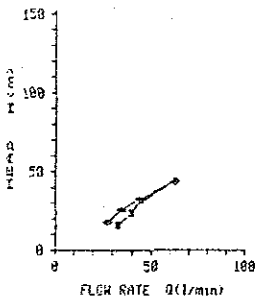
HOLE No : TB-2
DEPTH : 50 ~ 55 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	17.0	31.6	37.1	5.1E-04
2	23.5	43.3	37.3	5.1E-04
3	31.4	49.3	31.7	4.4E-04
4	42.5	69.6	32.3	4.5E-04
5	31.1	50.6	32.5	4.5E-04
6	23.3	44.3	38.7	5.3E-04
7	16.7	32.3	39.3	5.4E-04



HOLE No : TB-2
DEPTH : 55 ~ 60 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	17.3	27.1	30.5	4.2E-04
2	25.3	34.6	26.8	3.7E-04
3	32.7	44.2	27.1	3.7E-04
4	44.4	62.3	28.3	3.9E-04
5	32.2	45.5	28.2	3.9E-04
6	24.3	33.6	33.6	4.5E-04
7	16.3	32.9	40.2	5.5E-04



HOLE No : TB-2
DEPTH : 40 ~ 45 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	19.8	17.9	18.1	2.5E-04
2	29.1	23.7	15.3	2.2E-04
3	37.5	33.1	17.6	2.4E-04
4	53.4	49.4	18.5	2.5E-04
5	38.8	38.6	16.1	2.2E-04
6	29.2	22.9	15.7	2.2E-04
7	20.0	16.3	16.3	2.2E-04

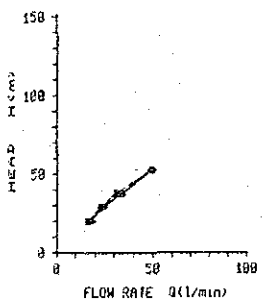
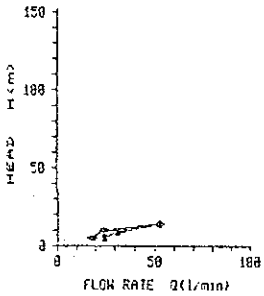


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (18/20)

TB-3

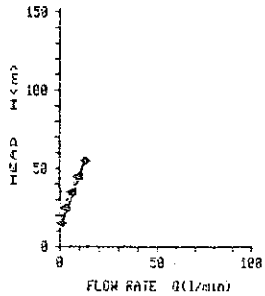
HOLE No : TB-3
DEPTH : 1 - 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	4.5	18.8	99.4	1.3E-03
2	9.5	24.2	63.7	8.4E-04
3	14.5	52.1	90.8	1.2E-03
4	9.5	31.9	84.3	1.1E-03
5	4.5	24.9	133.2	1.8E-03



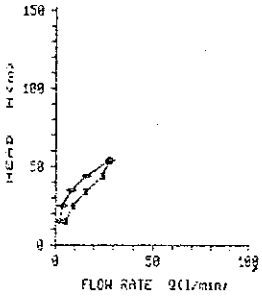
HOLE No : TB-3
DEPTH : 20 - 25 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.4	0.6	0.8	1.1E-05
2	25.4	2.5	2.0	2.7E-05
3	35.4	5.6	3.1	4.3E-05
4	49.3	9.1	4.8	5.5E-05
5	55.2	13.3	4.8	6.6E-05
6	45.3	10.6	4.7	6.4E-05
7	35.4	7.4	4.2	5.8E-05
8	25.4	4.1	3.2	4.4E-05
9	15.4	1.3	1.7	2.4E-05



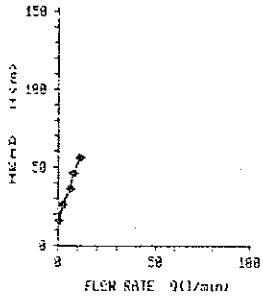
HOLE No : TB-3
DEPTH : 5 - 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	14.5	2.4	3.4	4.6E-05
2	24.5	3.9	3.1	4.2E-05
3	34.5	8.2	4.8	6.5E-05
4	44.5	16.2	7.3	1.0E-04
5	54.3	28.1	10.4	1.4E-04
6	44.3	24.9	11.2	1.5E-04
7	34.5	15.6	9.0	1.2E-04
8	24.5	9.2	7.5	1.0E-04
9	14.5	5.8	6.9	9.5E-05



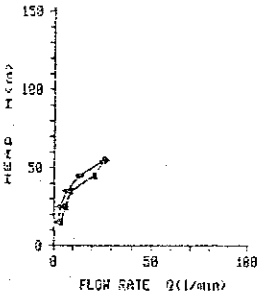
HOLE No : TB-3
DEPTH : 25 - 30 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.3	0.4	0.5	7.5E-06
2	25.3	2.2	1.7	2.3E-05
3	35.7	5.1	3.4	4.7E-05
4	45.7	7.9	3.5	4.8E-05
5	55.6	11.1	4.0	5.5E-05
6	45.7	8.1	3.6	4.9E-05
7	35.7	6.2	3.5	4.8E-05
8	25.3	2.7	2.1	2.9E-05
9	15.3	0.8	1.1	1.5E-05



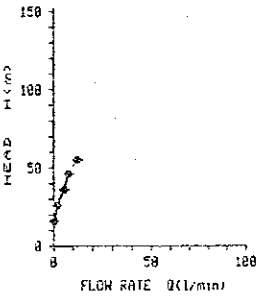
HOLE No : TB-3
DEPTH : 10 - 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.2	2.2	2.9	3.9E-05
2	25.2	3.7	2.9	4.0E-05
3	35.2	6.8	3.9	5.3E-05
4	45.1	13.3	5.8	8.1E-05
5	54.7	25.3	9.5	1.3E-04
6	44.9	21.2	9.5	1.3E-04
7	35.2	8.8	5.8	8.0E-05
8	25.2	6.1	4.8	6.7E-05
9	15.2	3.9	5.1	7.0E-05



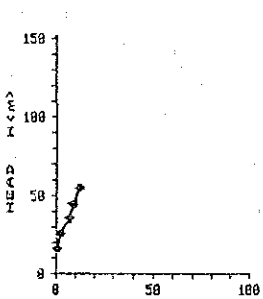
HOLE No : TB-3
DEPTH : 30 - 35 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.8	0.5	0.6	8.1E-06
2	25.8	1.9	1.4	2.0E-05
3	35.7	5.5	3.1	4.2E-05
4	45.7	7.6	3.3	4.6E-05
5	55.4	12.4	4.5	6.2E-05
6	45.7	7.8	3.4	4.7E-05
7	35.7	5.8	3.3	4.5E-05
8	25.8	2.1	1.7	2.3E-05
9	15.8	0.7	0.8	1.1E-05



HOLE No : TB-3
DEPTH : 15 - 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.5	0.1	0.1	1.4E-06
2	25.5	2.1	1.6	2.3E-05
3	35.5	6.5	3.7	5.1E-05
4	45.5	8.2	3.6	5.0E-05
5	55.4	12.1	4.4	6.0E-05
6	45.4	9.0	4.3	5.9E-05
7	35.5	6.7	3.8	5.2E-05
8	25.5	2.9	2.2	3.1E-05
9	15.5	0.8	1.0	1.4E-05



HOLE No : TB-3
DEPTH : 35 - 40 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.0	0.7	0.9	1.2E-05
2	25.0	1.9	1.5	2.1E-05
3	35.3	5.2	3.0	4.1E-05
4	44.8	8.8	3.9	5.4E-05
5	54.5	13.8	5.1	7.0E-05
6	44.3	9.9	4.4	6.1E-05
7	34.9	6.2	3.6	4.9E-05
8	25.3	2.5	2.6	2.7E-05
9	15.0	0.9	1.3	1.7E-05

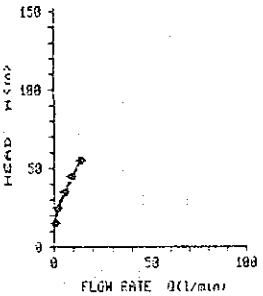
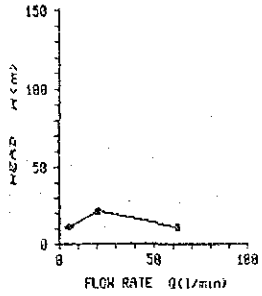


Fig. 3.2.20 P-Q CURVE OF FIELD PERMEABILITY TEST (19/20)

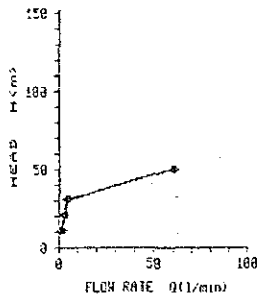
HOLE No : IB-1
DEPTH : 1.5 ~ 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.5	5.1	12.7	1.6E-04
2	21.5	20.5	27.3	3.5E-04
3	11.1	62.1	160.4	2.1E-03



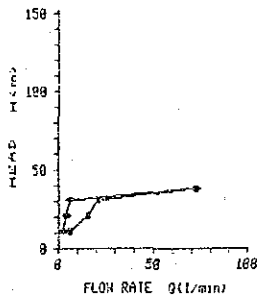
HOLE No : IB-1
DEPTH : 5 ~ 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.5	1.6	2.8	3.8E-05
2	21.5	2.8	2.6	3.6E-05
3	31.5	4.9	3.1	4.3E-05
4	50.1	60.3	24.1	3.3E-04
5	31.5	5.1	3.2	4.4E-05
6	21.5	3.7	3.5	4.8E-05
7	11.5	1.9	3.3	4.5E-05



HOLE No : IB-1
DEPTH : 10 ~ 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.5	2.7	4.6	6.3E-05
2	21.5	4.2	3.9	5.4E-05
3	31.5	6.5	4.1	5.6E-05
4	37.6	72.1	38.4	5.3E-04
5	31.2	21.4	13.7	1.9E-04
6	21.3	15.8	14.8	2.0E-04
7	11.5	6.2	10.8	1.5E-04



HOLE No : IB-1
DEPTH : 15 ~ 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	11.4	8.7	15.2	2.1E-04
2	21.2	16.4	15.5	2.1E-04
3	39.8	24.9	16.2	2.2E-04
4	35.8	78.6	39.4	5.4E-04
5	29.4	43.8	29.2	4.0E-04
6	28.9	23.2	22.2	3.1E-04
7	11.3	12.2	21.5	3.0E-04

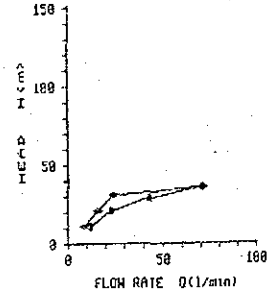
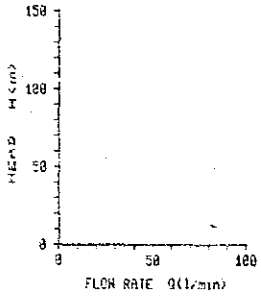


Fig. 3.2.20 P - Q CURVE OF FIELD PERMEABILITY TEST (20/20)

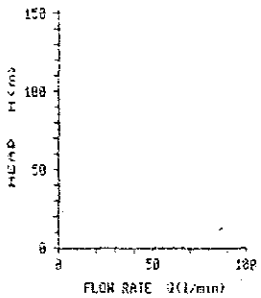
HOLE No : IB-2
DEPTH : 1.5 ~ 5 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	13.8	82.7	182.1	2.3E-03



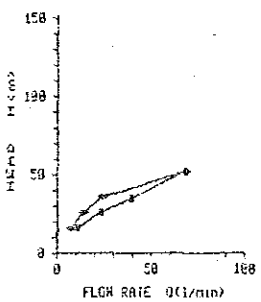
HOLE No : IB-2
DEPTH : 5 ~ 10 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	12.8	84.8	122.7	1.9E-03



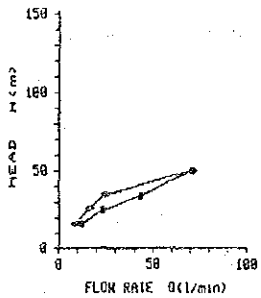
HOLE No : IB-2
DEPTH : 10 ~ 15 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	16.8	7.4	9.3	1.3E-04
2	25.8	14.1	18.9	1.5E-04
3	35.5	24.4	13.7	1.9E-04
4	52.4	68.8	36.3	3.8E-04
5	24.8	39.0	22.6	3.1E-04
6	25.6	23.3	18.2	3.5E-04
7	15.9	10.7	13.4	1.8E-04



HOLE No : IB-2
DEPTH : 15 ~ 20 m

STEP	H (m)	Q (l/min)	Lu	K (cm/sec)
1	15.9	8.7	10.9	1.5E-04
2	25.7	16.4	12.3	1.9E-04
3	35.3	24.9	14.1	1.9E-04
4	50.3	70.6	28.0	3.9E-04
5	33.9	43.0	25.4	3.5E-04
6	25.4	23.2	18.3	2.5E-04
7	15.8	12.2	15.4	2.1E-04



3.3 Construction Material

3.3.1 General

Construction material survey was carried out to clarify the quality and available quantity at the surrounding area of the Kedungwarak weir site and along the proposed Widas river improvement section in the Part -I Study period. For the ketandan dam, the survey on the availability of earth and rock material was carried out in the Part II Study period.

3.3.2 Kedungwarak Weir Site

Kedungwarak weir is planned to be a combined type weir with concrete and homogeneous earthfill taking into account the geologic and topographic conditions of the weir site and embankment materials available. Location of the weir site is shown on Fig.3.3.1 and 3.3.2.

1. Earth Materials

BRBDEO had conducted the first survey for earth materials at Borrow Areas I, II and III which are located around the weir site. Locations of test pitting and soil auger boring are shown in Figs. 3.3.3 to 3.3.4 and laboratory test results are summarized in Tables 3.3.1 to 3.3.3.

The results of laboratory test show that these materials mentioned above are not so adequate for homogeneous earthfill because the particle size is too fine and the maximum dry density is comparatively low level as 1.1 to 1.3 g/cm3 in the condition of standard compaction effort. Consequently, additional survey was required and carried out at just downstream of the weir site in the Part-I study period. Location of Test pitting is shown in Fig.3.3.5, and laboratory test results are summarized in Table 3.3.4 and outline of the test results are tabulated hereunder.

Index Properties

- Natural moisture content	Wn	:	20.5 %
- Specific gravity	Gs	:	2.75
- Plasticity Index	Ip	:	NP to 30.7 %
- Unified soil classification		:	SC . SM . CH

Engineering Properties

- Optimum moisture content	Wopt	:	17 to 27%
- Maximum dry density	$\gamma_{d\ max}$	:	1.40 to 1.80 g/cm3
- Coefficient of permeability	K	:	2.5×10^{-4} to 1×10^{-6} cm/s
- Shear strength			
Cohesion	C	:	0.2 to 0.5 kg/cm2
Angle of internal friction	ϕ	:	15° to 37°

The results of laboratory test listed above show that these materials are deemed to be adequate in quality as an earth fill material.

Relationship between cohesian and angle of internal friction for earth material is shown in Fig. 3.3.11. Proposed design values of embankment materials for Kedungwarak weir are shown in Table 3.3.9.

2. Filter, Drain and Fine Aggregate

Filter, drain and fine aggregate can not be obtained from the surrounding areas of the weir site. Consequently, these materials are scheduled to be taken fromthe sand borrow area in K.Brantas which is located at 20 km southeastward from the weir site. Sand of the borrow area is judged to be adequate for filter, drain and fine aggregate on the basis of the quality control results on Bening dam construction. Typical gradation curve is shown in Fig. 3.3.6. Available quantity is estimated much greater than requirement which is shown in Table 3.3.8.

3. Coarse Aggregate

Since the coarse aggregate can not be obtained from the river course in the vicinity areas of the weir site, two alternative sites were studied as sources of rock material which is crushed to coarse aggregate by using crushing plant. One is K.Kuncir quarry site which is located 25 km southearstward from the weir site, and 9 km southeast ward from the weir site or 3 km south from Ketandan dam site. (Refer to Figs. 3.3.1, 3.3.7 and 3.3.10).

Quarry site for coarse aggregate was selected at K. Kuncir site in accordance with comparative study based on the results of rock material survey in Ketandan quarry site, because the rock material in Ketandan quarry site is too much weathered and deteriorated. The requirement of coarse aggregate is shown in Table 3.3.8.

4. Rock Riprap Materials

Rock of material for riprap can be obtained from the Kedungwarak quarry site. However, since the rock is composed of tuff breccia which consists much tuff matrix and andesite, careful treatment is required, i.e., placement of the rock riprap has to be carried out by using crane, backhoe or other equipments, because the rock is easy to crush by passing of caterpillar or wheel of heavy equipments. Requirement of rock riprap material is shown in Table 3.3.8.

3.3.3 Ketandan Dam Site

Ketandan dam is planned to be constructed a homogeneous earthfill taking into account geologic and topographic conditions, and available embankment materials around the proposed dam site. Construction materials around the proposed dam site. Construction materials survey was conducted on the basis of the above mentioned viewpoints.

1. Earth Materials

Reconnaissance survey was carried out to graspe the general condi-

tion of dam site and its surrounding areas. Based on the survey results, Ketandan earth borrow area and quarry site were tentatively proposed and after that the boring and test pitting were carried out in the Part-II study period. Executed survey item on core boring and test pitting and its quantity are shown in Table 3.3.6.

According to the reconnaissance survey results, upstream site of proposed dam axis which is composed of dominant marl is judged to be inadequate for embankment material because it has a possibility of occurence of swelling and slaking phenomena in saturated and weathered conditions. On the other hand, downstream site of the proposed dam axis is composed of tuffaceous sandstone, tuff breccia etc. These materials can be used for earth material of homogeneous earthfill dam of 40 m high because they generally have properties of high shear strength of 30 degree or more on internal friction angle, relatively high density, low compressibility and sufficient imperviousness. Moreover, trafficability and workability are very good.

Usable material is divided into two kinds of rocks. One is tuffaceous sandstone and another is tuff breccia. To investigate the available quantity and material suitability, boring and test pitting are scheduled to be done on the both rock zones in proposed borrow area. (Refer Fig.3.3.8). To clarify the soil properties of both materials, laboratory test was carried out.

The laboratory test results are shown in Table 3.3.7, and outline of test results are tabulated hereunder.

Index Properties

- Natural moisture content	Wn	: 43 %
- Specific gravity	Gs	: 2.76
- Plasticity Index	Ip	: 18 to 34 %
- Unified soil classification		: GC . SC . SM

Engineering Properties

- Optimum moisture content	Wopt	: 34 to 50%
- Maximum dry density	$\gamma_{d\ max}$	: 1.07 to 1.29 g/cm3
- Coefficient of prmeability	K	:
- Shear strength		
Cohesion	C'	: 0.1 to 0.9 kg/cm2
Angle of internal friction	ϕ'	: 20° to 30°

The results listed above show that these materials are basically deemed to be adequate inquality as an earthfill material. Relationship between cohesion and angle of internal friction for earth material is shown in Fig.3.3.12 Proposed design values of embankment materials for Ketandan dam are shown in Table 3.3.11.

2. Filter, Drain and Fine Aggregate

The materials for filter, drain and fine aggregate are not obtainable from the river course in the vicinity area of the dam site because the river deposit is composed of much soft sand and gravel of marl which is unsuitable for the materials mentioned above. Consequently, these materials must be taken from K.Brantas sand borrow area.

3. Coarse Aggregate

Since no coarse aggregate is available at the suurounding area of the dam site, rock material for coarse aggregated was investigated at Ketandan quarry site (Refer to Fig. 3.3.9). However, the results of test pitting in this quarry site indicated that no suitable rock material is available in the aspect of quality and quantity. A few andesitic rock can be used for rock material for coarse aggregate but the greater part of the rock is too much weathered and deteriorated. This situation was clarified by test pitting.

4. Rock Riprap Material

To survey an availability of rock riprap material, two sites were investigated, i.e, one is a zone of tuff breccia in the Ketandan borrow area and another is Ketandan quarry site which is situated at 3 km south from the dam site. However, investigation results suggested that these rocks cann't use for rock riprap material because the same reason as mentioned above 3. Coarse Aggregate.

Consequently, it is recommended that the rock riprap should be taken from K.Kuncir quarry site or purchased from supplier to make cost saving, the thickness of riprap zone should be minimized.

3.3.4 Widas Lower Reach

It is scheduled that embankment of the levee is carried out using the material available along the river stretch. To investigate the soil properties, test pitting and sampling were carried out at twelve sites along the proposed levee embankment alignment. Location of the test pitting sites is shown in Fig. 3.3.10, laboratory test results are summarized in Table 3.3.5, and details are shown in Attachment.

According to the laboratory test results, these materials mentioned above are adequate in quality as a levee embankment of 3 m high in the dry season to keep a good trafficability.

Relationship between cohesion and angle of internal friction angle for earth material in Wids lower reach borrow area is shown in Fig. 3.3.13.

Sieving analysis test was carried out to clarify the gradation of river bed material in Widas lower reach. The locationof sampling and test result are shown in Fig. 3.3.10 and Fig. 3.3.13 respectively.

3.3.5 Summary and Recommendation

1. According to the field reconnaissance and boring investigation the geology of the Ketandan dam site is formed of calcareous sandstone of Plistocene to Pliocene and marl of Pliocene. Reservoir area and transbasin tunnel is underlain by marl of Pliocene.

2. These calcareous sandstone are classified as soft rock, category CH,CM, CL and D.

3. However, almost all of the rock from the bore hole are belongs to category CM and CL.

   Generally, rock bearing strength of drilling core at the Ketandan dam site shows rather low compresive strength of C = 50 to 150 kg/cm2.

5. Numerous field permeability coefficient of sandstone K = 3.0×10^{-4} cm/sec to K 3.0×10^{-3} cm/sec even in the deeper part of the deeper part of the abutment, and marl shows low permeability ranging from K = 3×10^{-6} to 3×10^{-4} cm/sec.

6. Extensive and intensive geological assessment can be considered on the basis of seismic investigation results and supplement borings.

7. This would permit an assessment of the fractured weak rock zone and would indicate the distribution of land sliding zone.

R E F E R E N C E

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   (in Indonesian)

2. BRBDEO / DJP / DPU , Survai dan Investigasi Untuk Penyusunan Feasibility Study Untuk Proyek Pengembangan Widas Basin Laporan Geologi, Feb. 1985
   (in Indonesian)

3. Van Bemmelen , Geology of Indonesia, 1949

4. GSD , Geological Map (East Java) Scale 1 : 500,000 , Second Edition 1977

5. Japanese National Committee of the International Commission on Large Dams, "Standards for Geological Investigation of Dam Foundation", 1978
   (in English)

Table 3.3.1 SUMMARY OF LABORATORY TEST FOR EARTH MATERIAL IN KEDUNGWARAK BORROW AREA I

	TP. I	TP. I
Sampling depth (m)	0.60 - 2.00	2.00 - 3.00
Natural Moisture Content W (%)	44.60	46.55
Specific Gravity GS	2.708	2.583
Grain Size Analysis		
Maximum Particle Size (mm)	2.0	2.0
Gravel (2.0 - 76.2 mm) (%)	-	-
Sand (0.074 - 2.0 mm) (%)	5	23
Silt (0.005 - 0.074 mm) (%)	44	38
Clay (< 0.005 mm) (%)	51	39
Unified Soil Classification System	MH	MH
Consistency		
Liquid Limit WL (%)	76.40	76.60
Plastic Limit WP (%)	34.70	41.64
Plasticity Index IP (%)	41.70	34.96
Optimum Moisture Content (%)	46.60	57.90
Maximum Dry Density γ_d (g/cm^3)	1.092	0.982
Cohesion Intercept C' (kg/cm^2)		1.03
Angle of Internal Friction ϕ'		14
Initial Void Ratio Co		1.59
Compression Index Cc		0.335
Coefficient of Permeability K (cm/s)		1.31×10^{-6}

Table 3.3.2 SUMMARY OF LABORATORY TEST FOR EARTH MATERIAL IN KEDUNGWARAK BORROW AREA II

	TP.1	TP. 2	TP. 3	TP. 4	TP. 5	AG. 3	AG. 3	AG. 4
Sampling Depth (m)	2.00-3.00	0.30-3.00	1.50-3.00	2.00-3.00	0.60-3.00	0.00-1.00	1.00-4.35	0.00-4.5
Natural Moisture Content W (%)	46.02	37.75	41.74	36.35	49.24	22.55	47.17	48.23
Specific gravity Gs	2.633	2.660	2.670	2.661	2.610	2.659	2.713	2.686
Grain Size Analysis								
Maximum Particle Size (mm)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Gravel (2.0-76.2 mm) (%)	-	-	-	-	-	-	-	-
Sand (0.074-2.0 mm) (%)	19	9	9	4	22	21	20	12
Silt (0.005-0.074 mm) (%)	33	52	58	47	33	40	38	45
Clay (< 0.005 mm) (%)	48	39	33	49	45	39	42	43
Unified Soil Classification System	OH	OH	OH	CH	OH	CH	CH	CH
Consistency								
Liquid Limit W_L (%)	75.10	60.60	59.00	73.80	68.70	57.05	50.70	71.05
Plastic Limit W_p (%)	39.31	35.99	34.85	30.43	39.16	19.27	20.70	29.00
Plasticity Index I_p (%)	35.79	24.61	24.15	43.37	29.54	37.78	30.00	42.05
Optimum Moisture Content (%)	44.95	40.80	45.60	34.40	40.20	-	-	-
Maximum Dry Density γ_d (g/cm^3)	1.104	1.196	1.142	1.284	1.172	-	-	-
Cohesion Intercept C' (kg/cm^2)	0.3	1.55	0.75	0.45	0.10			
Angle of Internal Friction ø'	27	19	26	17	17			
Initial Void Ratio e_o	1.29		1.06					
Compression Index C_c	0.19		0.398					
Coefficient of Permeability K (cm/s)	3.05×10^{-5}		1.12×10^{-6}	3.67×10^{-7}				

Table 3.3.3 SUMARY OF LABORATORY TEST FOR EARTH MATERIAL IN KEDUNGWARAK BORROW AREA III

		TP. 1	TP. 2	TP. 3	TP. 4	TP. 5	TP. 6
Sampling Depth	(m)	0.30-2.40	0.60-2.40	0.50-2.00	0. -2.00	0.50-3.00	0.60-2.00
Natural Moisture Content W	(%)	51.31	41.02	44.42	26.18	27.12	28.42
Specific Gravity Gs		2.736	2.611	2.742	2.665	2.735	2.759
Grain Size Analysis							
Maximum Particle Size	(mm)	2.0	2.0	2.0	25.4	50.0	38.1
Gravel (2.0-76.2 mm)	(%)	-	-	-	5	31	13
Sand (0.074-2.0 mm)	(%)	49	31	40	28	22	37
Silt (0.005 - 0.074 mm)	(%)	28	42	31	44	26	27
Clay (< 0.005 mm)	(%)	23	27	29	23	21	23
Unified Soil Classification System		MH	MH	MH	MH	MH	MH
Consistency							
Liquid Limit W_L	(%)	58.99	59.60	65.80	55.85	59.75	58.40
Plastic Limit W_p	(%)	32.30	42.35	45.73	38.73	41.56	49.28
Plasticity Index Ip	(%)	26.69	17.25	20.07	17.12	18.19	9.12
Optimum Moisture Content	(%)	42.14	42.80	39.80	38.20	37.60	37.80
Maximum Dry Density γd	(g/cm^3)	1.157	1.181	1.201	1.254	1.168	1.217
Cohesion Intercept C'	(kg/cm^2)	0.95	0.65	0.82	1.10	0.52	1.0
Angle of Internal Friction ϕ'		21	29	20	27	28	25
Initial Void Ratio e_o		1.36	1.33		1.33		1.32
Compression Index Cc		0.225		0.181		0.303	
Coefficient of Permeability K(cm/s)		1.49×10^{-6}		1.22×10^{-5}	1.04×10^{-4}	1.25×10^{-5}	

		TP. 7	TP. 8	TP. 9	AG 1	AG 2
Sampling Depth	(m)	0.50-2.00	0.50-1.50	0.50-1.50	0.60-2.00	0.30-2.50
Natural Moisture Content W	(%)	36.45	27.62	25.69	50.03	49.25
Grain Size Analysis						
Maximum Particle Size	(mm)	25.4	2.0	38.1	2.0	2.0
Gravel (2.0 - 76.2 mm)	(%)	12	-	16	-	-
Sand (0.074-2.0 mm)	(%)	13	56	29	17	16
Silt (0.005 - 0.074 mm)	(%)	35	19	25	36	58
Clay (< 0.005 mm)	(%)	40	25	20	47	26
Unified Soil Classification System						
Consistency		OH	CL	CL	CH	CH
Liquid Limit W_L	(%)	80.25	49.12	47.10	84.60	75.46
Plastic Limit W_p	(%)	39.23	24.55	26.21	26.87	26.82
Plasticity Index IP	(%)	41.02	24.57	20.89	57.73	48.64
Optimum Moisture Content	(%)	39.40	27.40	33.20	-	-
Maximum Dry Density γd	(g/cm^3)	1.210	1.356	1.320	-	-
Cohesion Intercept C'	(kg/cm^3)	0.38	0.50	0.70		
Angle of Internal Fricition ϕ' ?		26	24			
Initial Void Ratio : e_o 1.28						
Compression Index Cc		0.345				
Coefficient of Permeability K(cm/s)		3.67×10^{-8}	$1.16-10^{-4}$	7.69×10^{-5}		