

CHAPTER 4 INVESTIGATION FOR EMBANKMENT MATERIALS

4.1 Basic Condition for Embankment Material

Embankment Material consists of Core, Rock and Filter material. Basic condition for embankment material is component from quality, quantity and cost. Candidate embankment material should be selected, considering sufficiently each components. Basic quality condition required for each of these material are shown below.

Table-B.4.1 Basic Quality Condition of Embankment Material

Material	Basic Quality Condition
Core	Non-permeability, Deformation, Construction Aspect
Rock	Strength, Draining, Endurance
Filter	Strength, Draining, Endurance

4.2 Candidate Rock

A distinctive feature of rock fill dam is to make a rational zoning of which materials are assorted from various rocks. The assortment of the materials have several cases, therefore, geological field reconnaissance executed by an experienced geotechnical engineer is necessary at an early stage. Usually, data collection, field reconnaissance and physical soil tests are carried out as a initial survey. As a result of field reconnaissance, candidates of embankment materials exposed in the vicinity of the dam sites are selected, as shown in Table-4.5.3.

Table-B.4.2 List of Candidates for Embankment Materials

Rocks		Rock Material		Core Material	
		Quality	Quantity	Quality	Quantity
1. Detritus		×	×	○	×
2. Terrace deposit		×	×	×	×
3. Coral limestone	(weathered)	×	×	○	○
	(fresh)	×	×	×	×
4. Granite	(weathered)	×	×	×	○
	(fresh)	○	○	×	×
5. Volcanic rocks	(weathered)	×	×	○	○
	(fresh)	○	×	×	×
6. Ultra basic rocks	(weathered)	×	×	○	○
	(fresh)	○	○	×	×
7. Kanikeh Formation	(weathered)	×	×	○	○
	(fresh)	○	○	×	×

○ : suitable
 × : unsuitable

4.3 Laboratory Test

4.3.1 Contents and Purpose of Laboratory Tests

The purpose of the laboratory tests is to investigate roughly the material quality of several candidate quarries. Tests are carried out for core and rock material, according to the contents focused on as follows.

Table-B.4.3 Contents and Purpose of Laboratory Tests

Material	Focusing Item	Contents of Laboratory Test		Standard
Core	Non-permeability	- Grain Size Analysis - Plasticity	- Grain size distribution	ASTM-D-422-63
			- Water contents	ASTM-D-4253-83, ASTM-D-4254-83
			- Atterberg limits	ASTM-D-4318-84
			- Specific gravity	ASTM-D-2216-80
Rock	Strength	- Strength of rock pieces	- Specific gravity	JIS-A-1110
			- Absorption	JIS-A-1110

4.3.2 Sampling for Soil Tests

Samples for soil tests are collected, as shown in Table-B.4.4 and Figure-B.4.1.

Table-B.4.4 List of Samples for Soil Tests

Material	Name	Rock	Location	Sampling Depth
Rock Material	R-A	Fresh Granite	Desa Halai/Soya	River Bed
	R-B	Fresh Granite	Desa Halai/Kayu putih	River Bed
	R-C	Fresh Ultra Basic Rock	Batu Gajah	River Bed
	R-D	Fresh Ultra Basic Rock	Batu Gajah	River Bed
	R-E	Fresh Granite	Desa Mahia	River Bed
	R-F	Fresh Granite (Boulder)	Batu Gajah	River Bed
Core Material	C-1-1	Weathered Quaternary sediment Rock	Desa Mangga Dua Atas	2 m
	C-1-2	Weathered Quaternary sediment Rock	Desa Mangga Dua Atas	2 m
	C-2	Weathered Granite	Desa Mahia	4 m
	C-3	Weathered Ultra Basic Rock	Puskesmas Urumesing	4 m
	C-4	Weathered Ultra Basic Rock	Batu Gajah	0.5 m
	C-5	Weathered Ultra Basic Rock	Desa Batu Gajah Kayu putih	0.5 m

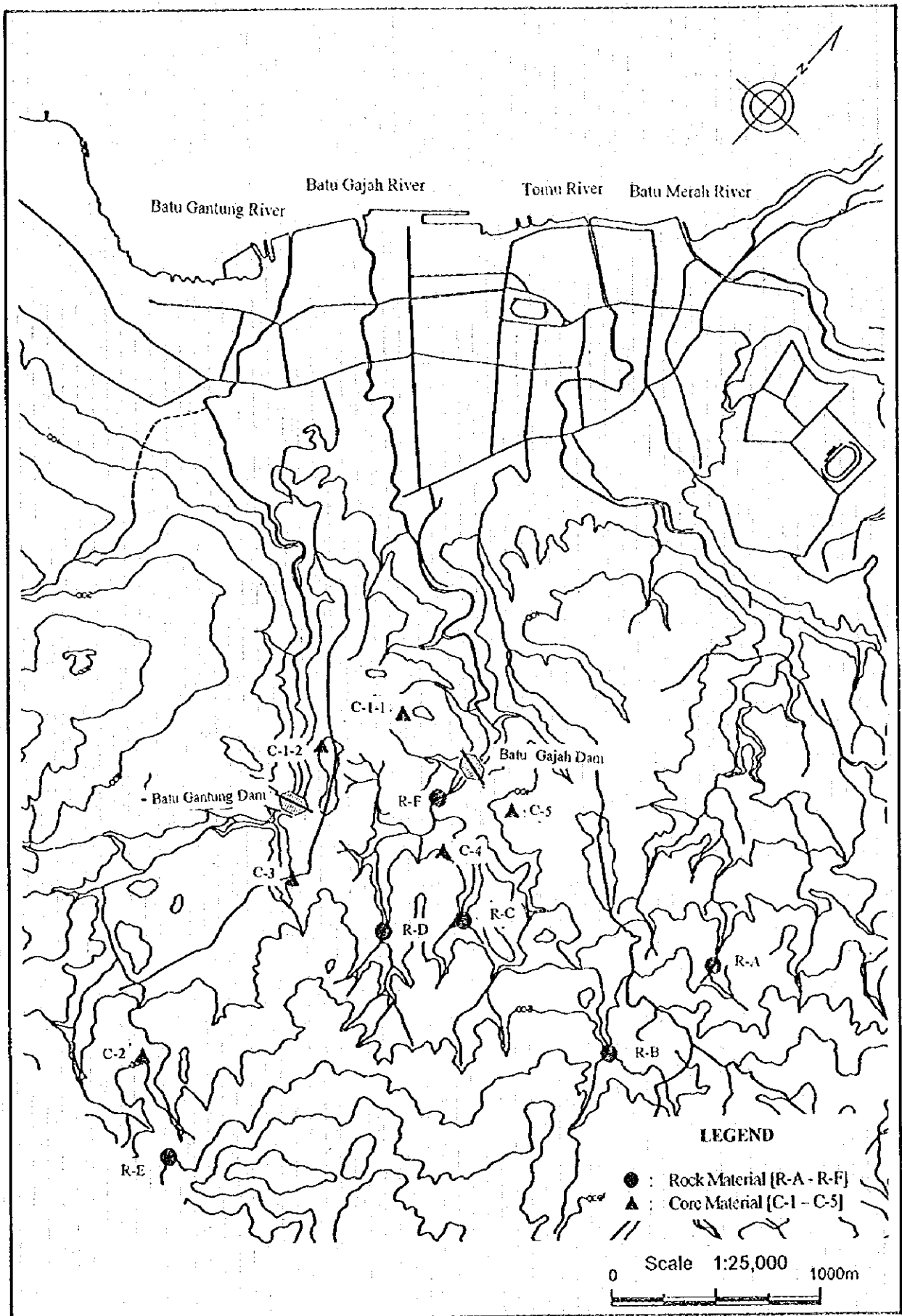


Figure-B.4.1 Location of Sampling Point for Soil Test

4.3.3 Results of Soil Tests

(1) Core Material

Test results for Core Material are indicated in Table-B.4.6. Specific gravity of all sampling is higher than 2.7 and excellent. Natural water contents are mostly between 10-30% with exception of C4 that is very high, 65%. C4 may have been caused by shallow sampling (0.5m) that must have been much weathered. In terms of Atterberg limits, index of plasticity is mostly 10-20 %. However, C4 is 50 % and excellent high, C2 is non-plastic. Grain size distribution consists of mainly silt or sand, secondly clay and there is little gravel. This main reason is that sampling was performed at shallow location. In terms of fine degree that should affect to permeability, clay consists of more than 10 %, fine degree under 0.074 mm consists of more than 40 % with exception of C2.

(2) Rock Material

Test results for rock material is shown in Table-B.4.5. Specific gravity is higher than 2.6 and absorption is generally less than 1.0 %. Therefore it is clear that so far as these samples own is concerned, these have excellent quality.

Table-B.4.5 Results of Soil Tests [Rock Material]

Sampling Location	Sample No.	Specific Gravity			Absorption (%)
		Apparent	Bulk	SSD	
RA	1	2.71	2.66	2.68	0.69
	2	2.71	2.66	2.67	0.69
	Average	2.71	2.66	2.68	0.69
RB	1	2.71	2.66	2.68	0.73
	2	2.71	2.66	2.68	0.73
	Average	2.71	2.66	2.68	0.73
RC	1	2.72	2.66	2.68	0.81
	2	2.72	2.66	2.69	0.82
	Average	2.72	2.66	2.69	0.82
RD	1	2.65	2.38	2.48	0.42
	2	2.65	2.38	2.47	0.41
	Average	2.65	2.38	2.48	0.42
RE	1	2.61	2.54	2.57	1.05
	2	2.62	2.55	2.58	1.05
	Average	2.62	2.55	2.58	1.05
RF	1	2.76	2.71	2.73	0.69
	2	2.76	2.71	2.73	0.68
	Average	2.76	2.71	2.73	0.69

Note : SSD ... Saturated Surface Dry

Table-B.4.6 Results of Soil Tests [Core Material]

Sampling Location	Sample No.	Specific Gravity G _s	Water Contents W _n (%)	Atterberg Limits			Grain Size Analysis				Soil Classification	
				W _L (%)	W _p (%)	I _p (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		Under 0.074mm
C.1.1	1	2.83	26.2	54.3	29.7	24.6	0	14	46	40	86	CH
	2	2.83	25.0	54.3	29.1	25.1						
	3	2.84	25.7	53.5	28.5	25.0						
	Average	2.84	25.6	54.4	29.1	24.9						
C.1.2	1	2.79	21.4	36.7	24.0	12.7	1	54	31	14	45	SC
	2	2.78	21.1	36.5	23.6	12.9						
	3	2.79	21.0	34.7	23.1	11.6						
	Average	2.79	21.2	36.0	23.6	12.4						
C.2	1	2.70	13.1		Non Plastic		0	76	17	7	24	SM
	2	2.69	13.0		Non Plastic							
	3	2.71	12.7		Non Plastic							
	Average	2.70	12.9		Non Plastic							
C.3	1	2.86	34.9	55.5	43.0	12.4	3	27	37	33	69	MH
	2	2.85	35.2	54.5	41.8	12.7						
	3	2.86	35.5	54.8	42.8	12.0						
	Average	2.86	35.2	54.9	42.5	12.4						
C.4	1	2.97	65.2	116.0	68.4	47.6	1	31	45	23	68	MH
	2	2.97	65.1	120.5	68.1	52.4						
	3	2.96	65.8	117.2	68.1	49.1						
	Average	2.97	65.4	117.9	68.2	49.7						
C.5	1	2.83	26.4	41.5	30.2	11.3	3	47	34	16	50	ML
	2	2.83	26.3	43.3	30.2	13.1						
	3	2.82	25.7	42.0	29.9	12.1						
	Average	2.83	26.1	42.3	30.1	12.2						

4.4 Embankment Material Potential

Potential for embankment material is studied through laboratory test results and is given as follows.

(a) Core Material

Results for core material are shown in Table-B.4.7 and Figure-B.4.2. In this table and figure, the suitable condition for embankment material and examples in previous works are indicated, too. C.2 is unsuitable because there is little clay and non-plasticity in C.2. C.1.2 is most suitable because this soil classification belongs to SC that can be generally recommended as core material and this indicates actually high quality results. The remaining (C.1.1, C.3, C.4, C.5) may be expected to be excellent for non-permeability because these contain much fine degree material (clay and sand). However, these may have some problems with deformation and constructability, because these have little coarse degree material (sand and gravel, especially gravel). All material sampling was performed at 2-4m depth which is very weathered. The above may be caused by this condition. From this point of view, it is likely that the sample from deeper location may contain coarse material more than the results above. Therefore it is decided that 5 locations with exception of C.2 should be set as candidates for core material quarries. It is recommended to study quarry quantity and physical characteristics (non-permeability, strength and compaction) through boring, trench and physical prospecting, etc.

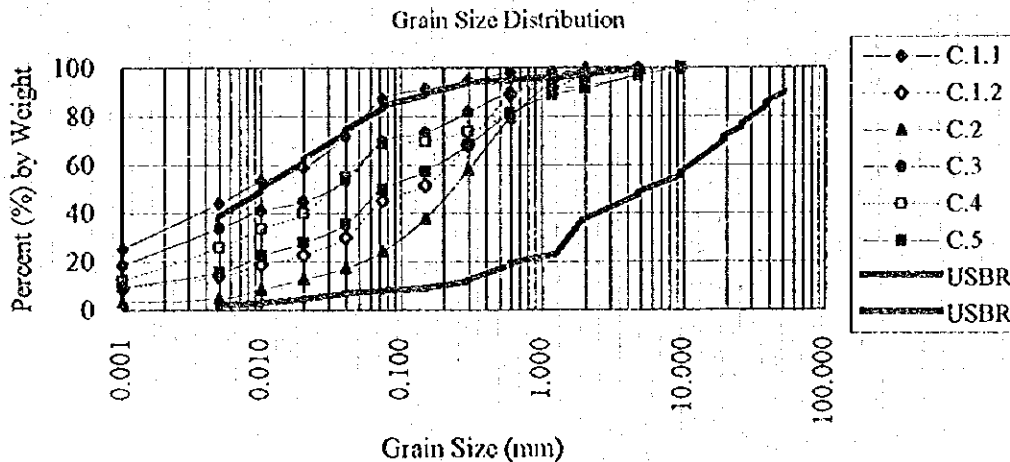


Figure-B.4.2 Grain Size Distribution [Core material]

(b) Rock Material

Results for rock material are shown in Table-B.4.8. All sampling locations can be expected to be suitable as rock material quarries, because rock piece samples at all locations indicate high quality. Therefore it is concluded that all 6 locations should be set as candidates for rock material quarries. It is recommended to study quarry quantity and physical characteristics (strength, compaction, draining, and endurance) through boring, trench and physical prospecting, etc.

Table-B.4.7 Core Material Potential by Laboratory Test Result

Sample No.	C.1.1		C.1.2		C.2		C.3		C.4		C.5		Suitable Condition
	CH	SC	SM	MH	MH	MH	MH	ML	ML	ML	ML	ML	
Soil Classification	CH	SC	SM	MH	MH	MH	MH	ML	ML	ML	ML	ML	
Ratio	40	14	7	33	33	23	16	16	16	16	16	16	Over 5%
Clay + silt	86	45	24	70	70	68	50	50	50	50	50	50	10-20%
Gravel	0	1	0	3	3	1	3	3	3	3	3	3	Previous Works: 5-60%
Natural Water Contents (%)	26	21	13	35	35	65	26	26	26	26	26	26	Previous Works: 10-40%
Index of Plasticity I.P. (%)	25	12	-	12	12	50	12	12	12	12	12	12	Over 10%
Imperviousness [Non-permeability]	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	
Plasticity	Suitable	Suitable	Non-available	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	
Aspect of Construction Potential	Available	Suitable	Suitable	Available	Available	Available	Available	Available	Available	Available	Available	Available	
Potential	Available	Suitable	Not Available	Available	Available	Available	Available	Available	Available	Available	Available	Available	

Table-B.4.8 Rock Material Potential by Laboratory Test Result

Sample No.	R.A		R.B		R.C		R.D		R.E		R.F		Suitable Condition
	Granite	Ultra Basic	Ultra Basic	Ultra Basic	Ultra Basic	Ultra Basic	Ultra Basic	Granite	Granite	Granite	Granite	Granite	
Rock Description	Granite	Ultra Basic	Ultra Basic	Ultra Basic	Ultra Basic	Ultra Basic	Ultra Basic	Granite	Granite	Granite	Granite	Granite	
Specific Gravity Gs: Apparent	2.71	2.71	2.72	2.65	2.65	2.62	2.76	2.76	2.76	2.76	2.76	2.76	Over 2.5
Absorption (%)	0.7	0.7	0.8	0.4	0.4	1.1	0.7	0.7	0.7	0.7	0.7	0.7	Under 3 %
Potential	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	Suitable	

CHAPTER 5 STANDARD PENETRATION TESTS FOR RIVER COURSE

The purpose of the standard penetration test (S.P.T) along the river course of five rivers is to understand the foundation condition necessary for design of river improvement and renewal bridges. This consists of boring investigation at 12 locations (10m depth at each location) and standard penetration test of total 120 times (10 times at each location). Figure-B.5.2 indicates locations where boring and S.P.T were performed. Test results of S.P.T. are shown in Table-B.5.1 and Figure-B.5.1. Most of them indicate that foundation is loose sand and silt. Base rock is confirmed at the location near the hill side of Batu Gantung (SGT-3). N Values of the foundation in shallow depth (0-5 m) are approximately 10 and less than 20 and not so steady.

Table-B.5.1 Latest Results of River Course Investigation

River	Ruhu				Batu Merah				Tomu			
Location	SRH-1		SRH-2		SBM-1		SBM-2		STM-1		STM-2	
Depth	Class	N	CL	N	CL	N	CL	N	CL	N	CL	N
1	Sand	3	Sand	24	Sand	2	Sand	9	Sand	14	Gravel	11
2	Gravel	5	Sand	8	Sand	5	Sand	5	Sand	10	Gravel	7
3	Gravel	8	Sand	10	Sand	9	Sand	5	Sand	11	Sand	9
4	Gravel	19	Sand	10	Sand	46	Sand	7	Sand	6	Sand	14
5	Gravel	30	Sand	16	Sand	64	Sand	10	Sand	15	Sand	17
6	Sand	19	Sand	18	Sand	70	Sand	7	Sand	7	Sand	16
7	Sand	20	Sand	16	Silt	39	Sand	9	Sand	13	Sand	12
8	Sand	24	Sand	27	Silt	44	Sand	25	Sand	11	Sand	16
9	Sand	27	Sand	29	Silt	42	Sand	24	Sand	16	Sand	17
10	Sand	29	Sand	30	Silt	42	Sand	33	Sand	16	Sand	19
11											Sand	20

River	Tomu		Batu Gajah				Batu Gantung					
Location	STM-3		SGJ-1		SGJ-2		SGT-1 *1)		SGT-2		SGT-3	
Depth	Class	N	Class	N	Class	N	Class	N	Class	N	Class	N
1	Sand	14	Sand	18	Gravel	50	Sand	5	Sand	15	Sand	24
2	Sand	10	Sand	23	Sand	9	Sand	7	Sand	3	Sand	75
3	Sand	11	Sand	6	Sand	10	Sand	9	Sand	15	Sand	14
4	Sand	6	Sand	9	Sand	11	Sand	12	Sand	14	Sand	55
5	Sand	15	Sand	10	Sand	27	Sand	14	Sand	27	Sand	67
6	Sand	7	Sand	16	Sand	23	Sand	15	Sand	29	Sand	50
7	Sand	13	Sand	22	Sand	5	Sand	10	Sand	13	Rock	50
8	Sand	11	Sand	27	Sand	13	Sand	12	Sand	35	Rock	50
9	Sand	16	Sand	33	Sand	20	Sand	13	Sand	33		
10	Sand	16	Sand	28	Rock	59	Sand	14	Sand	28		
11	Sand	18										

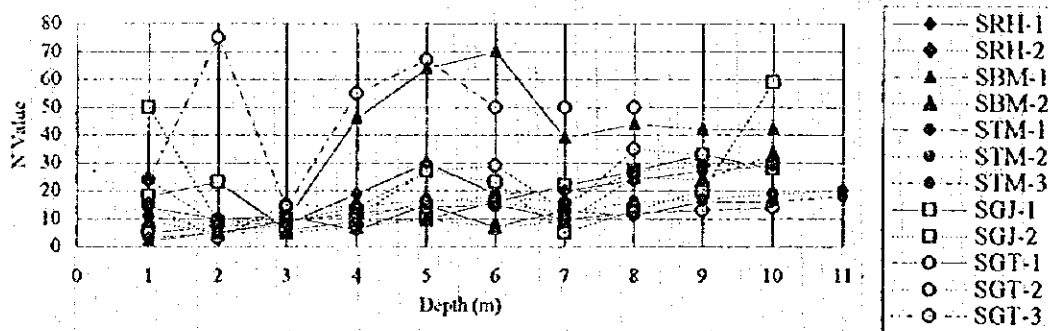


Figure-B.5.1 N Value along River Course

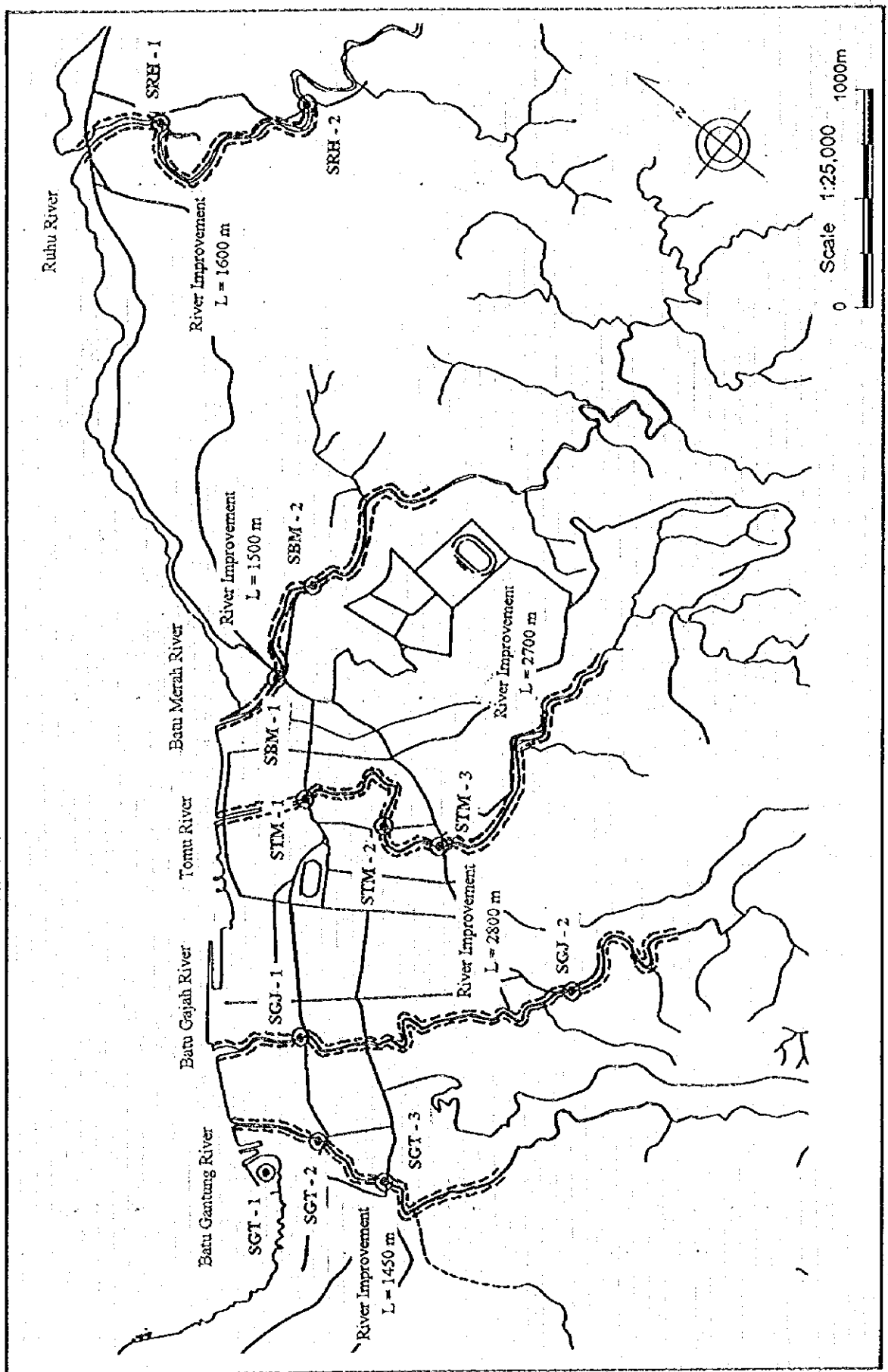


Figure-B.5.2 Location of Standard Penetration Test

CHAPTER 6 RIVERBED MATERIAL AND SEDIMENT LOAD

6.1 Field Survey

The survey of river bed material was carried out under sub-contract to the JICA Study Team. Field work was completed during December 1996 and river bed material was sampled using a bed grab sampler at six locations on each of the five rivers in the Ambon target area. Two samples were taken at each location and the sampling locations are indicated on the map in Figure-B.6.1. The samples were sealed in plastic bags and transported to the laboratory for analysis.

The sediment transport survey was undertaken at the same time as the survey of river bed material. Samples of suspended sediment load and bed load were taken at three locations on each of the five rivers in the Ambon target area. The sampling locations in Ambon city coincided with those of the water quality survey. River discharge was measured using a current meter at the same time as the sediment sampling. Sediment sampling was completed during December 1996 and the sampling locations are indicated on the map shown in Figure-B.6.1.

6.2 Results of River Bed Material Survey

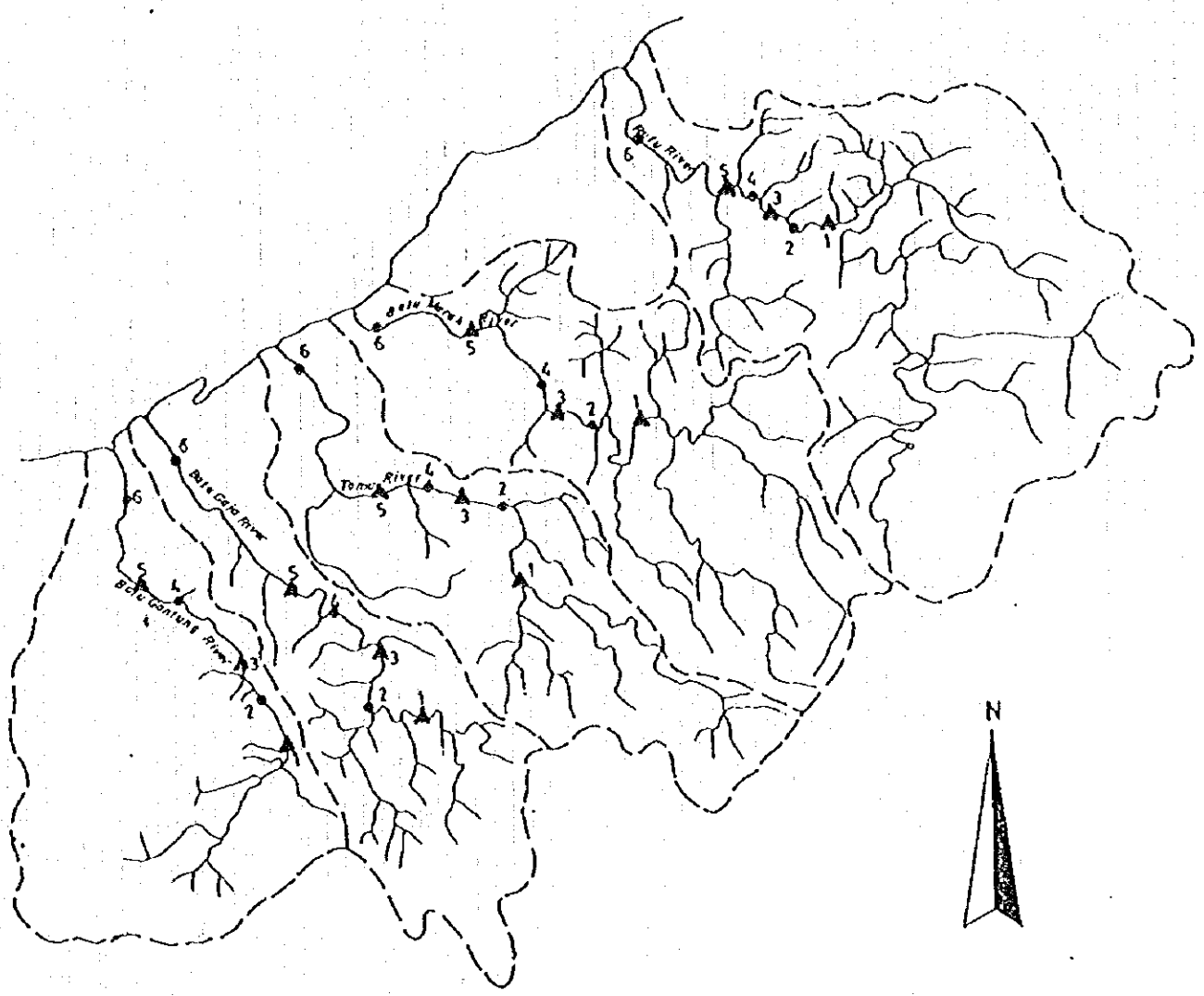
Particle size analysis and specific gravity analysis were undertaken in the laboratory and the results, including specific gravity, classification, grain size and uniformity coefficient C_u , are presented in Table-B.6.1. Summary grain size analysis curves for each of the five rivers are shown in Figure-B.6.2.

6.3 Results of Sediment Load Survey

Suspended sediment sampling was carried by means of the Point Integrated Method using a US-P.61 water sampler. Water samples were taken at a known point depth equivalent to 80% of the maximum river stream depth. Between 300 and 450 cc of water containing suspended sediment was sampled at each location. The sample bottles were then sealed and sent to the laboratory for analysis of suspended sediment concentration.

Bed load sampling was carried out by means of a Pan Sampler. The pan sampler was laid on the bed of the river at the stream center and water containing bed sediment allowed to flow over the fine gauze. Sampling continued for approximately 30 minutes and the accumulated material was removed from the fine gauze and sealed in plastic bags before being sent to the laboratory for analysis. River discharge was measured using a current meter while the bed load samples were collected.

The sediment samples were analyzed in the laboratory and the results, including specific gravity, particle size and sediment concentration, were presented in the Final Report submitted at the beginning of February 1997. The results of the suspended sediment analysis are given in Table-B.6.2 and the results of the bed load sediment analysis are given in Table-B.6.3. As the sampling was carried out during the dry season in Ambon, when river discharge is low, the observed concentrations of suspended sediment were also low. The range of values was typically between 5 and 10 mg/l, at least an order of magnitude lower than expected. Sampling should be repeated during the rainy season when river flows are higher.



- Legend :
- ▲ Sediment Load Samples (incl. Bed Material Sample)
 - Bed Material Sample only

Figure-B.6.1 Sampling Locations for River Bed Material and Sediment Load Surveys (Ambon Area)

Table-B.6.1 River Bed Material Survey - Grain Size Analysis

River	Sample No.	Specific Gravity (γ_m)	Classification (%)			Grain Size Analysis		
			Gravel	Sand	Silt / Clay	d_{60} (mm)	d_{10} (mm)	$C_u = d_{60}/d_{10}$
Ruhu	1A	2.57	55.6	44.1	0.3	9.6	0.6	16.0
	1B	2.65	65.3	34.7	0.0	5.4	0.5	10.8
	2A	2.61	21.1	78.2	0.7	1.8	0.3	6.3
	2B	2.59	33.4	65.7	0.9	3.4	0.4	8.4
	3A	2.55	45.7	53.8	0.5	5.7	0.4	13.5
	3B	2.55	15.2	84.4	0.3	1.8	0.3	5.4
	4A	2.66	35.2	64.5	0.2	3.5	0.5	6.8
	4B	2.57	42.7	56.8	0.4	5.4	0.4	12.8
	5A	2.57	41.6	50.0	5.5	6.1	0.1	59.3
	5B	2.59	42.7	56.6	0.7	5.6	0.4	15.2
	6A	2.49	60.0	39.8	0.3	9.0	0.6	15.2
	6B	2.62	61.8	38.2	0.0	11.9	0.7	16.8
Batu Merah	1A	2.58	23.6	75.9	0.4	2.7	0.4	6.7
	1B	2.50	50.5	49.2	0.3	8.9	0.5	17.4
	2A	2.55	48.4	51.4	0.3	6.7	0.6	10.4
	2B	2.57	23.6	76.0	0.4	2.5	0.4	5.9
	3A	2.58	44.1	55.2	0.8	5.7	0.5	12.5
	3B	2.47	55.7	44.1	0.2	6.9	1.2	6.0
	4A	2.58	53.4	46.2	0.4	9.8	0.6	16.6
	4B	2.58	46.6	53.0	0.4	6.3	0.6	10.7
	5A	2.44	92.7	7.3	0.1	17.3	5.9	3.0
	5B	2.58	92.6	7.3	0.1	16.3	5.4	3.0
	6A	2.09	37.8	61.4	0.8	4.3	0.3	14.0
	6B	2.08	37.4	62.0	0.6	4.3	0.3	14.0
Tomu	1A	2.62	2.4	97.3	0.3	1.1	0.3	3.1
	1B	2.64	2.6	97.1	0.3	1.1	0.3	3.2
	2A	2.64	7.0	92.8	0.2	1.4	0.5	2.8
	2B	2.61	8.2	91.4	0.4	1.4	0.5	3.0
	3A	2.59	39.1	90.4	0.5	4.6	0.3	13.4
	3B	2.63	37.0	62.6	0.4	4.1	0.4	10.0
	4A	2.59	52.7	47.0	0.4	7.3	0.6	12.3
	4B	2.67	81.6	18.1	0.3	21.2	2.1	10.0
	5A	2.55	39.3	59.9	0.8	4.2	0.3	14.1
	5B	2.51	16.8	81.2	2.1	1.0	0.2	6.5
	6A	2.58	7.2	91.2	1.6	0.7	0.2	3.5
	6B	2.62	25.4	74.2	0.4	1.8	0.3	5.8
Batu Gajah	1A	2.60	30.1	69.5	0.4	3.1	0.4	8.2
	1B	2.60	11.4	88.1	0.5	1.4	0.3	5.1
	2A	2.62	16.4	82.6	1.1	1.3	0.3	4.9
	2B	2.61	10.7	88.5	0.8	1.3	0.3	5.0
	3A	2.66	44.5	55.1	0.4	5.9	0.5	12.9
	3B	2.66	36.4	62.9	0.7	3.1	0.3	12.1
	4A	2.57	34.3	61.9	0.9	3.6	0.2	15.2
	4B	2.63	36.5	63.2	0.4	3.9	0.4	11.2
	5A	2.58	46.4	53.0	0.6	6.2	0.6	11.0
	5B	2.62	55.4	44.3	0.3	8.2	0.3	27.5
	6A	2.56	37.0	62.6	0.4	3.9	0.3	14.5
	6B	2.51	26.6	73.0	0.5	18.4	0.3	6.4
Batu Cantung	1A	2.55	58.4	41.0	0.6	9.3	0.5	19.0
	1B	2.64	63.3	36.3	0.4	11.1	0.6	18.8
	2A	2.51	43.1	56.5	0.4	6.4	0.4	15.9
	2B	2.51	46.7	52.9	0.4	6.9	0.4	19.7
	3A	2.59	57.5	42.2	0.3	8.5	0.6	14.0
	3B	2.62	58.6	41.0	0.5	8.1	0.6	14.6
	4A	2.55	12.2	87.4	0.4	1.9	0.5	3.7
	4B	2.58	13.5	86.1	0.4	1.9	0.5	3.8
	5A	2.61	37.6	61.1	1.3	4.2	0.3	14.5
	5B	2.56	37.4	62.1	0.6	4.1	0.4	9.3
	6A	2.62	54.1	45.3	0.6	8.0	0.5	15.3
	6B	2.61	14.4	85.4	0.3	1.9	0.6	3.4

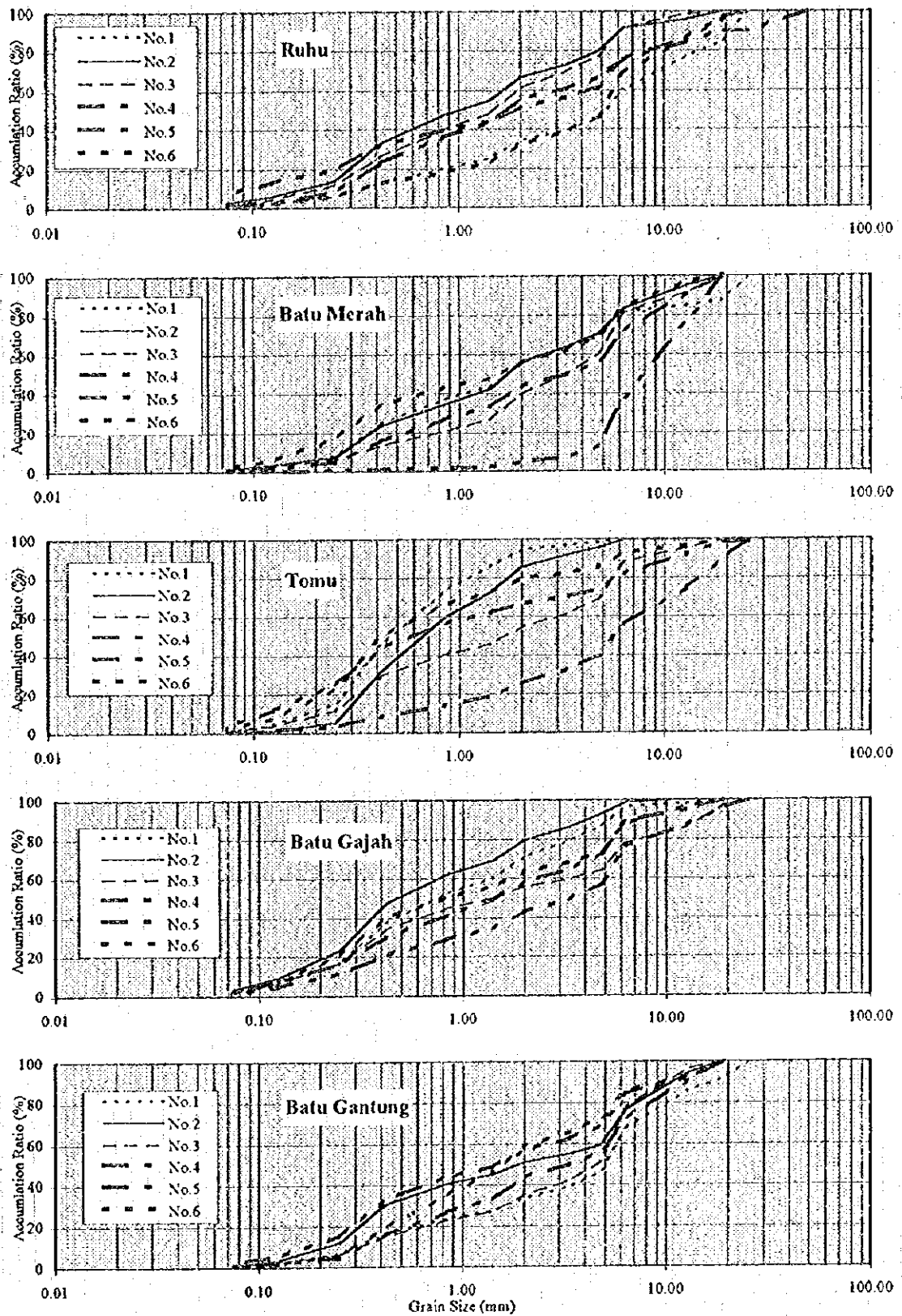


Figure-B.6.2 River Bed Material Survey - Grain Size Analysis

Table-B.6.2 Results of Suspended Sediment Analysis

River	Sampling Point		Date of Sampling	Time of Sampling	Volume of Water (ml)	Weight of Sediment (gr)	Sediment Concentration (mg/l)
	No.	Location					
Ruhu	1	Staff Gauge	11/12/96	10:45	475	0.0024	5.1
	3		09/12/96	14:53	405	0.0024	5.9
	5		09/12/96	12:25	405	0.0024	5.9
Bt Merah	1	Bridge	10/12/96	09:30	350	0.0026	7.4
	3		10/12/96	10:45	358	0.0032	8.9
	5		10/12/96	11:30	475	0.0030	6.3
Tonu	1	Staff Gauge	12/12/96	16:00	390	0.0014	3.6
	3		12/12/96	16:45	310	0.0028	9.0
	5		12/12/96	09:52	295	0.0022	7.5
Bt Gajah	1		11/12/96	14:37	350	0.0019	5.4
	3		11/12/96	09:05	475	0.0024	5.1
	5		10/12/96	15:27	410	0.0018	4.4
Bt Gantung	1		08/12/96	09:15	205	0.0016	7.8
	3		08/12/96	10:30	375	0.0020	5.3

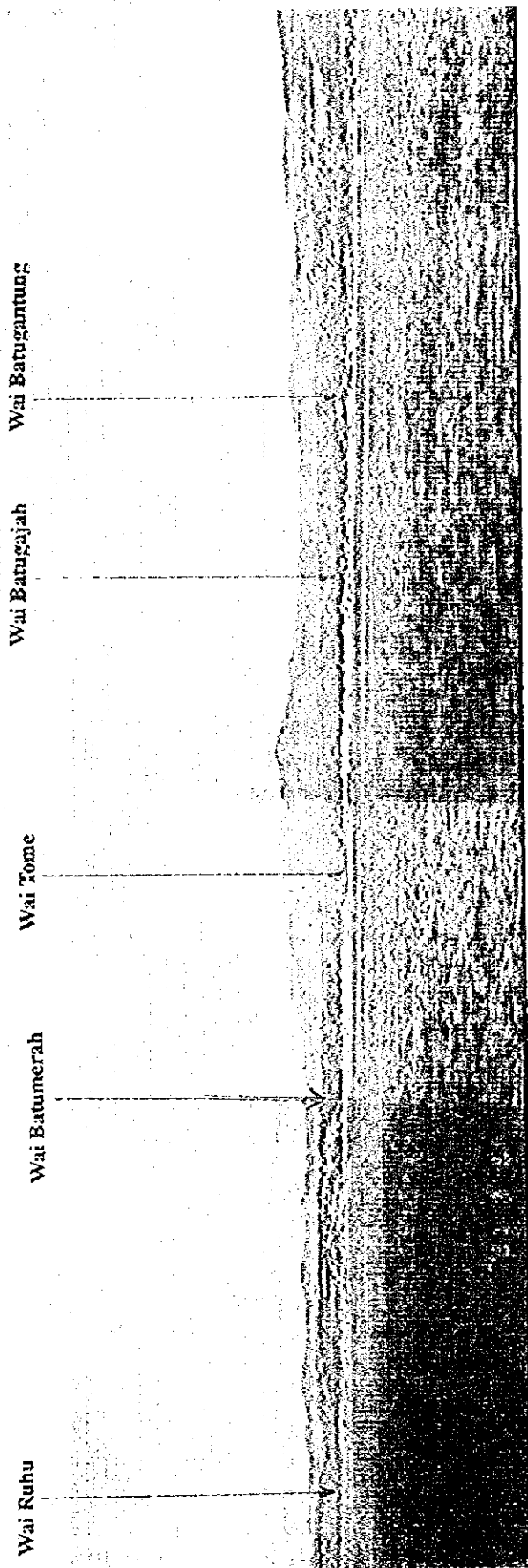
Table-B.6.3 Results of Bed Load Sediment Analysis

River	Sampling Point		Date	Time of Survey	Specific Gravity (t/m ³)	Weight of Soil (gr)	Grain Size Analysis		
	No.	Location					Gravel %	Sand %	Silt & Clay
Ruhu	1	Staff Gauge	09/12/96	14:50 - 15:25	1.66	0.35	-	91.4	8.6
	3		11/12/96	12:45 - 13:05	2.37	0.19	-	86.3	13.7
	5		09/12/96	12:45 - 12:55	0.92	0.11	-	90.5	9.5
Bt Merah	1	Bridge	10/12/96	09:15 - 09:55	2.44	0.22	-	91.2	8.8
	3		10/12/96	11:00 - 11:35	2.08	4.19	-	33.1	66.9
	5		10/12/96	10:27 - 10:55	2.26	1.61	-	47.3	52.8
Tonu	1	Staff Gauge	12/12/96	15:30 - 15:50	1.80	1.46	-	70.3	29.7
	3		12/12/96	16:40 - 17:05	1.92	0.96	-	81.2	18.8
	5		12/12/96	09:30 - 10:00	2.10	2.12	-	76.5	23.5
Bt Gajah	1		10/12/96	15:10 - 15:45	1.44	0.26	-	90.2	9.8
	3		11/12/96	08:40 - 09:00	1.40	0.14	-	94.1	5.9
	5		11/12/96	14:00 - 14:30	1.61	0.37	-	92.6	7.4
Bt Gantung	1		08/12/96	09:15 - 09:45	2.13	0.62	-	45.2	81.5
	3		08/12/96	10:15 - 10:45	2.72	1.20	-	70.8	29.2

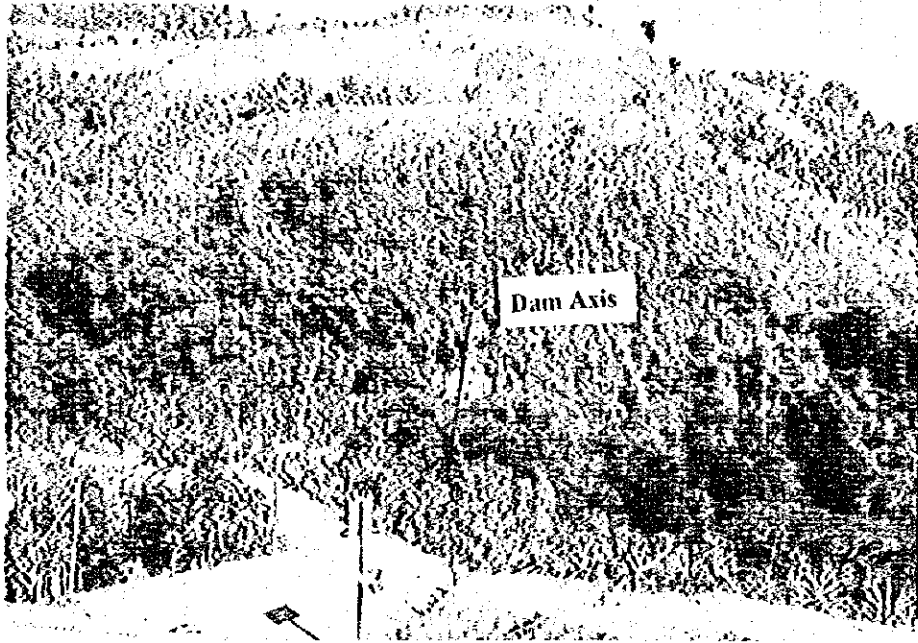
APPENDIX 1

Photograph of Candidate Dam Sites





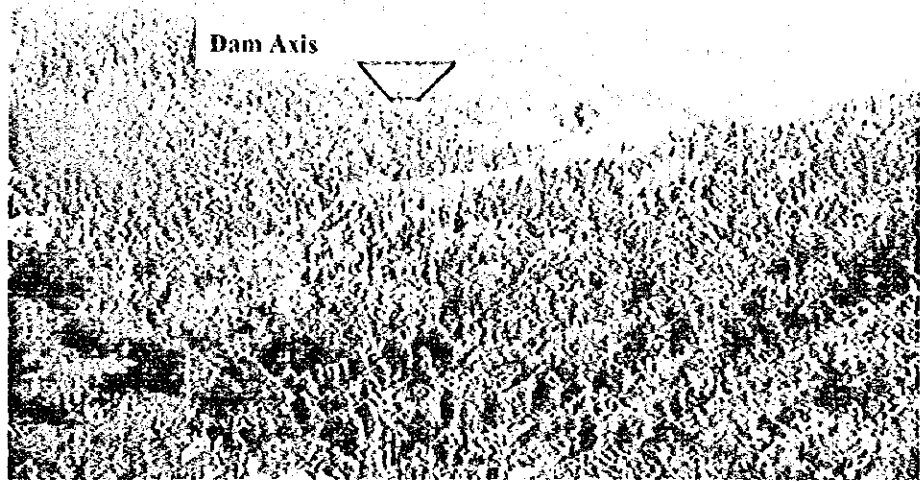
Ph-1 Whole View of the Study Area



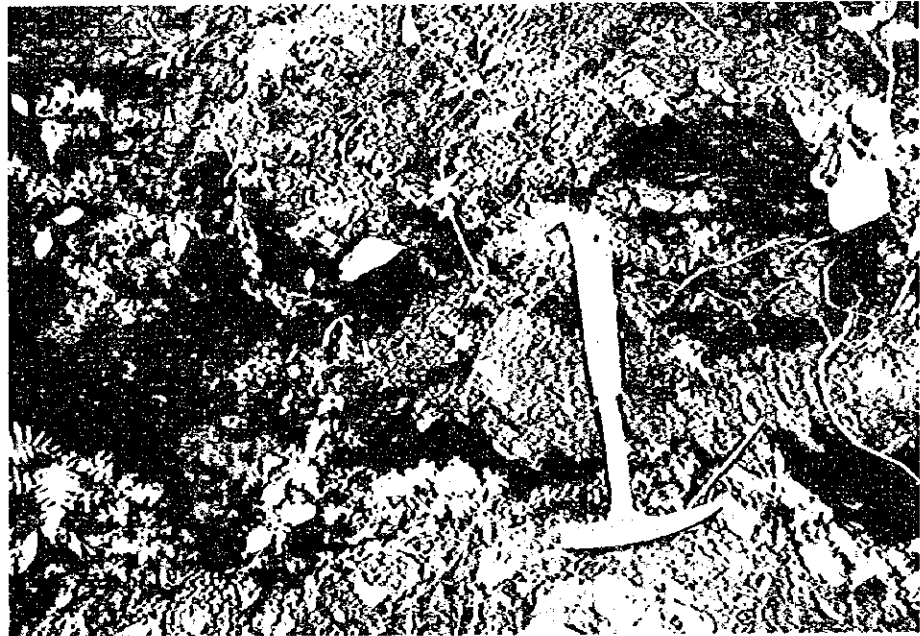
Ph-2 Batugajah Dam Site from Right Bank



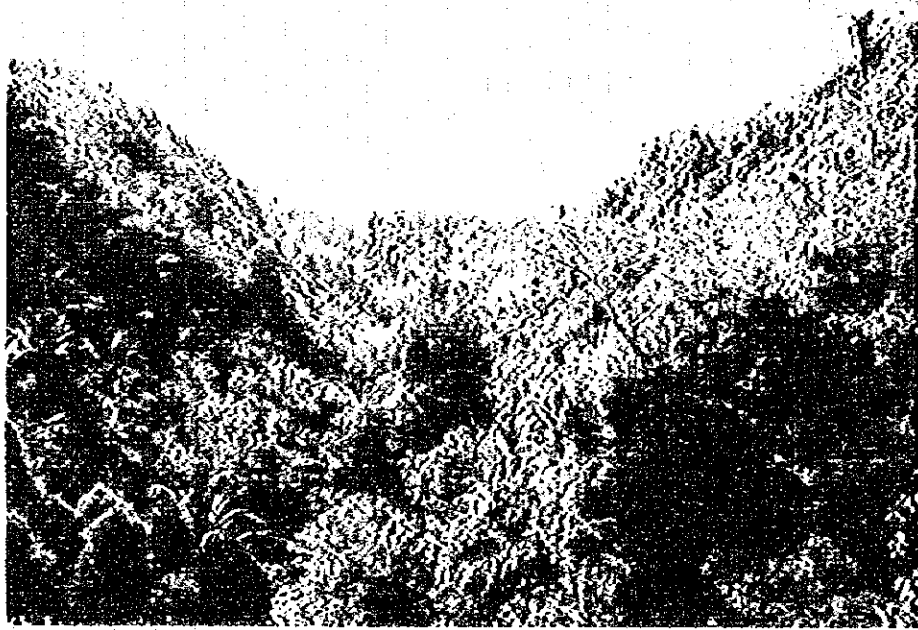
Ph-3 River Bed of Batugajah Dam Site from Downstream



Ph-4 Batugantung Dam Site



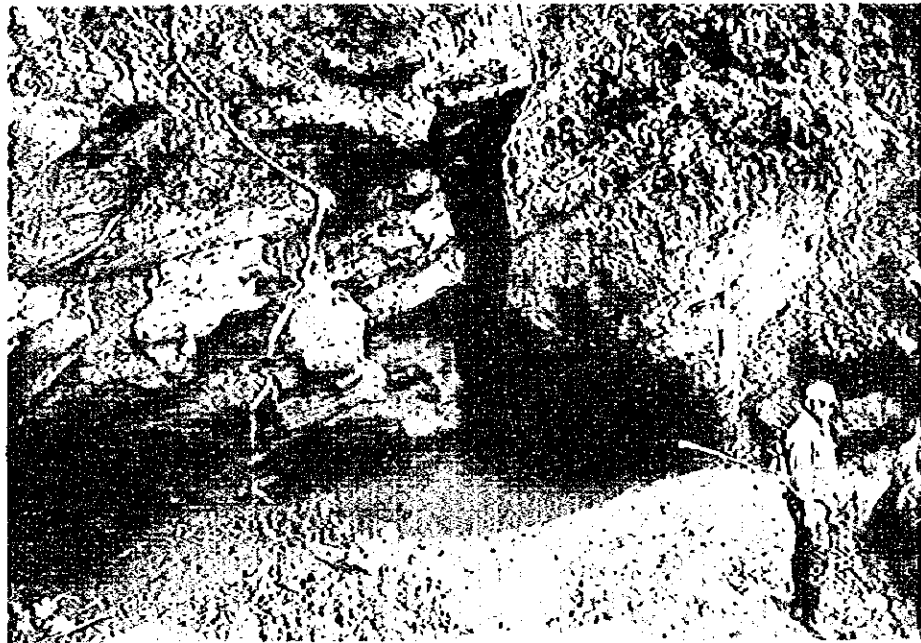
Ph-5 Kanikeh Formation at the River Bed
(Sandstone and Shale)



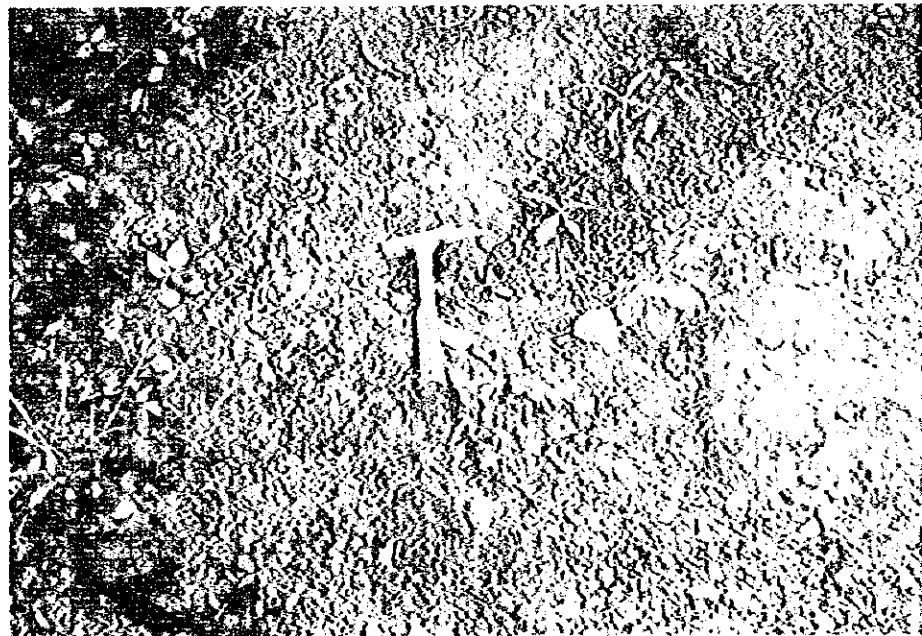
Ph-6 **Ruhu Dam Site**



Ph-7 **River Bed of Ruhu Dam Site**



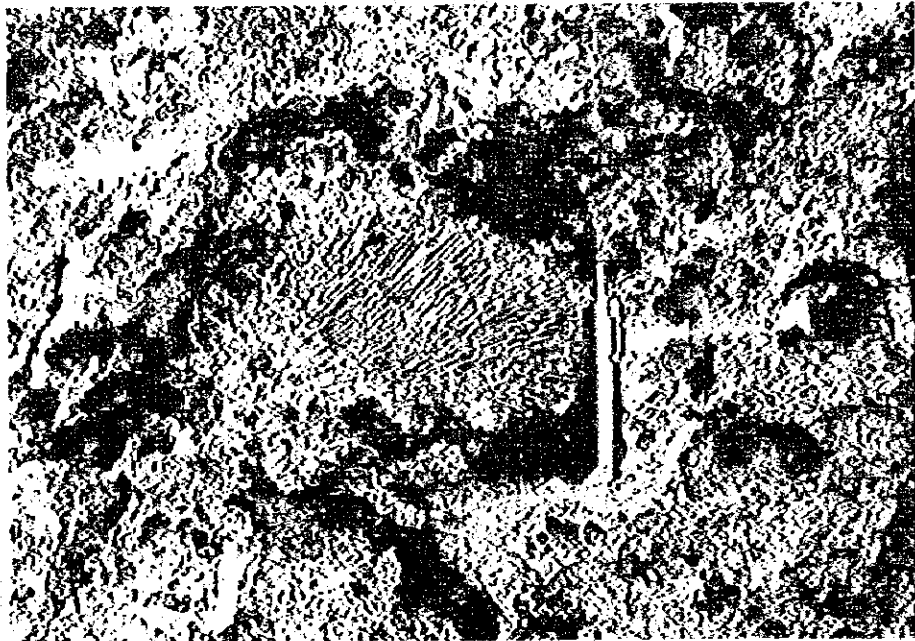
Ph-8 Coral Limestone in the Reservoir of the Batugantung Dam



Ph-9 Kanikeh Formation at the Right Bank of the Batugajah Dam



Ph-10 Coral Limestone Plateau near Gunung Nona



Ph-11 Fossil in the Coral Limestone

RC candidate of Rock Material

C3 candidate of Core Material

Dam Axis

C4 candidate of Core Material



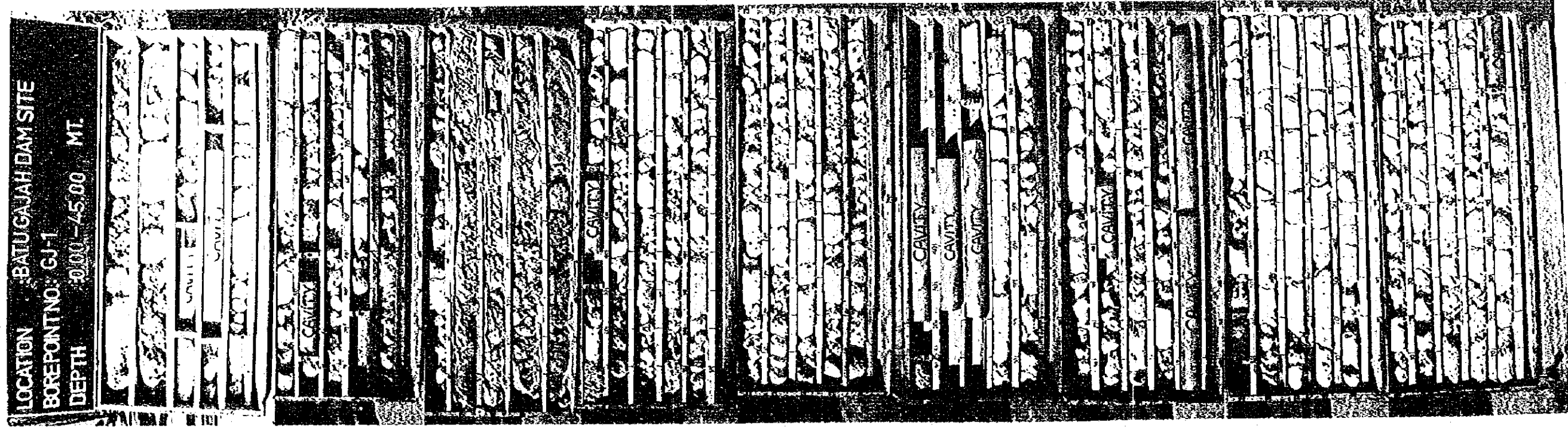
Ph-12 Left Bank view of Batugajah Dam Reservoir

APPENDIX 2

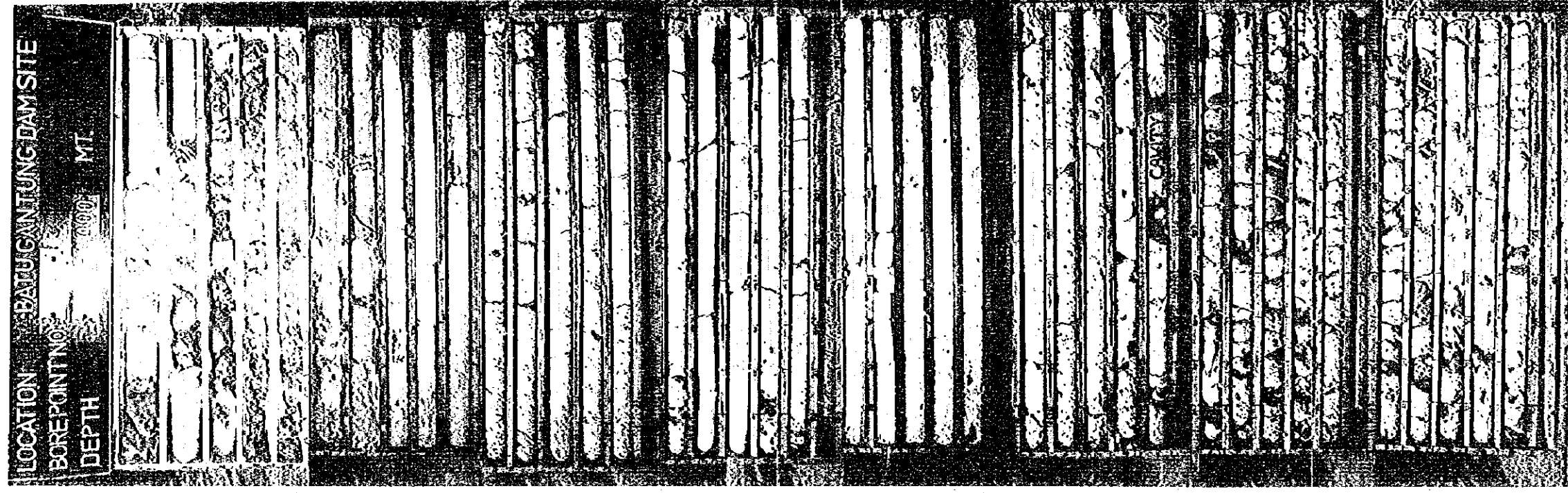
Photograph of Boring Core in Dam Sites



Batugajah GJ-1



Batugajah GJ-2



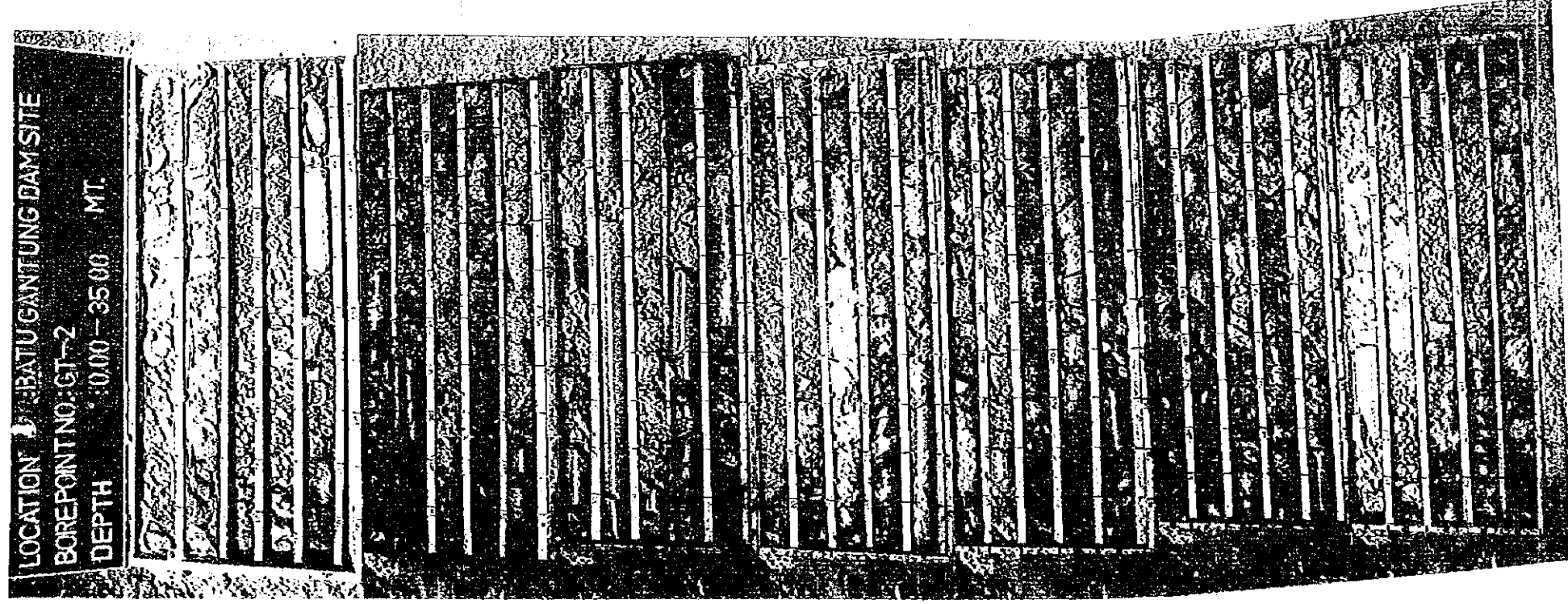
Batugajah Gj-3



Batugantung Gt-1



Batugantung Gt-2



Batugantung Gt-3



APPENDIX 3

Borehole Log in Dam Sites

BORING LOG

P.T. SOILENS

PROJECT	: THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m)	: -0.40
JOB NO.		DATE	: August 18 to August 19, 1997
CLIENT	: JICA Study Team	BORING METHOD	: Coring
LOCATION	: Bola Meroh River	SAMPLING METHOD	: Core barrel dia. 89, 73 & SPT
BORE HOLE NO.	: SBM-1	SPT	: Automatic Hammer (AH)
ELEVATION		DRILLER	: Ujang S.
COORDINATES		LOGGER	: Yono Sumaryono
DEPTH	: 10.45 m		

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _s (kg/cm ³)	SPT - N value		RECOVERY (%)
							Blows per CM	N per Foot	
							40	80	
	0.00			SAND, brown coloured, fine to coarse grained, well graded, few gravels, trace shell fragments, medium dense.					
		SW					1.15	2/30	
	3.00			SILTY SAND, brown coloured, fine to coarse grained sand, few gravel, diameter sized 1 to 2 cm, medium dense to dense.			2.15	5/30	
		SM					3.15	9/30	
							4.15	46/30	
							5.15	64/30	
	7.00			CLAYEY SILT, whitish brown coloured, trace fine grained sand, low plastic, stiff to very stiff.			6.15	70/30	
		MH					7.15	39/30	
							8.15	44/30	
							9.15	42/30	
	10.45			END OF THIS BORING. CASING DOWN TO -3.20 METERS DEPTH.			10.15	42/30	

BORING LOG

P.T. SOILENS

PROJECT : THE STUDY ON FLOOD CONTROL FOR AMBON
 JOB NO.
 CLIENT : JICA Study Team
 LOCATION : Bata Merah River
 BORE HOLE NO. : SBM-2
 ELEVATION
 COORDINATES
 DEPTH : 10.45 m

WATER TABLE (m) : +0.20
 DATE : August 12 to August 13, 1997
 BORING METHOD : Coring
 SAMPLING METHOD : Core barrel dia. 89, 73 & SPT
 SPT : Automatic Hammer (AH)
 DRILLER : Aep Rohmat
 LOGGER : Yono Sumaryono

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _s (g/cm ³)	SPT - N value		RECOVERY (%)
							Depth (m)	BLOWS PER CM	
								40 80	
	0.00	SW	•••••	SAND, brown coloured, fine to coarse grained sand, well graded, gravel diameter sized 1 - 3 cm, loose.					
	1.00			SILTY SAND, dark gray coloured, trace organic matter, fine grained sand, becoming greenish gray coloured below 5.00 meters depth, loose to medium dense.			1.15	9/30	
		SM					2.15	5/30	
							3.15	5/30	
							4.15	7/30	
							5.15	10/30	
							6.15	7/30	
							7.15	9/30	
	8.30						8.15	25/30	
		SW	•••••	SAND, gray coloured, fine to coarse grained sand, well graded, becoming whitish gray coloured below 9.10 meters depth, few limestone gravels, medium dense to dense.			9.15	24/30	
	10.45			END OF THIS BORING CASING DOWN TO -9.00 METERS DEPTH.			10.15	33/30	

BORING LOG

P.T. SOILENS

PROJECT	: THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m)	: none
JOB NO.	:	DATE	: August 7, 1997
CLIENT	: JICA Study Team	BORING METHOD	: Coring
LOCATION	: Batu Gajah River	SAMPLING METHOD	: Core barrel dia. 73 & SPT
BORE HOLE NO.	: SG-J-1	SPT	: Automatic Hammer (AH)
ELEVATION	:	DRILLER	: Aep Rochmat
COORDINATES	:	LOGGER	: Yono Sumaryono
DEPTH	: 10.45 m		

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ (kg/cm ³)	SPT - N value		RECOVERY %
							Depth (m)	BLOWS PER CM	
							40	80	40 80
	0.00	SW		SAND, dark gray coloured, fine to coarse grained sand, well graded, few gravels, diameter sized 1 to 3 cm, medium dense.			1.15	18/30	
	2.00	SW		SAND, blackish gray coloured, fine to coarse grained, well graded, few silt mixed, trace organic matter, loose.			2.15	23/30	
	4.00	SW		SAND, gray coloured, fine to coarse grained sand, well graded, loose to medium dense.			3.15	6/30	
	8.00	SM		SILTY SAND, gray coloured, fine to medium grained sand, poorly graded, medium dense to dense.			4.15	9/30	
	10.45			END OF THIS BORING. CASING DOWN TO 9.00 METERS DEPTH.			5.15	10/30	
							6.15	16/30	
							7.15	22/30	
							8.15	27/30	
							9.15	33/30	
							10.15	28/30	

BORING LOG

P.T. SOILENS

PROJECT : THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m) : -1.40
JOB NO. :	DATE : August 12 to August 13, 1997
CLIENT : JICA Study Team	BORING METHOD : Coring
LOCATION : Batu Gajah River	SAMPLING METHOD : Core barrel dia.73 & SPT
BORE HOLE NO. : SGJ-2	SPT : Automatic Hammer (AH)
ELEVATION :	DRILLER : Ujang
COORDINATES :	LOGGER : Yono Sumaryono
DEPTH : 10.45 m	

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	SPT - N value			RECOVERY (%)
						Depth (m)	BLOWS PER CM	N PER FOOT	
							40	80	
	0.80	SM		SILTY SAND, brown coloured, fine to medium grained sand, loose.					
	1.25	SW		SAND, gray coloured, fine to coarse grained sand, few gravels, dense.	1.15	50/10			
	1.75			SANDSTONE BOULDER, gray coloured, strong	2.15	9/30			
				SILTY SAND, greenish gray coloured, fine grained sand, medium dense.	3.15	10/30			
		SM			4.15	11/30			
	5.75				5.15	27/30			
	6.75	SW		SAND, brown coloured, fine to coarse grained, well graded, few gravels, diameter sized 1 - 2 cm, medium dense.	6.15	23/30			
	8.30	SM		SILTY SAND, gray coloured, fine grained sand, loose.	7.15	5/30			
	9.90				8.15	13/30			
	10.45	SW		SAND, brown coloured, fine to coarse grained sand, well graded, few gravels, diameter sized 1 to 2 cm, found sandstone boulder at 9.00 - 9.40 meters depth, medium dense to dense.	9.15	20/30			
				BRECCIA, blackish brown coloured, sandstone fragments, strong.	10.15	59/25			
				END OF THIS BORING. CASING DOWN TO -9.45 METERS DEPTH.					

BORING LOG

P.T. SOILENS

PROJECT	: THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m)	: -0.40
JOB NO.		DATE	: August 2, 1997
CLIENT	: JICA Study Team	BORING METHOD	: Coring
LOCATION	: Mayame Dock	SAMPLING METHOD	: Core barrel dia 89, 73 & SPT
BORE HOLE NO.	: SGT-1	SPT	: Automatic Hammer (AHT)
ELEVATION	:	DRILLER	: Aep Rohmat
COORDINATES	:	LOGGER	: Yono Sumaryono
DEPTH	: 10.45 m		

SAMPLE DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _s (kg/cm ³)	SPT - N value		RECOVERY (%)		
						Depth (cm)	BLOWS PER CM		N PER FOOT	
						40	80	40	80	
0.00	SM		SILTY SAND, brown coloured, fine to coarse grained sand, few gravels, loose (FILL MATERIAL)							
1.00				SILTY SAND, dark gray coloured, fine to coarse grained sand, trace gravels, organic matter included, medium dense.						
	SM					1.15	5/30			
5.00	SP		SAND, gray coloured, fine to medium grained sand, poorly graded, trace silt mixed, medium dense.			4.15	12/30			
7.00	SW		SAND, gray coloured, fine to coarse grained sand, found few gravels of 8.00 to 9.00 meters depth, diameter sized 0.50 to 1.00 cm, medium dense.			5.15	14/30			
10.45			END OF THIS BORING CASING DOWN TO 9.00 METERS DEPTH.			10.15	14/30			

BORING LOG

P.T. SOILENS




PROJECT :	THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m) :	-0.70
JOB NO. :		DATE :	August 3 to August 4, 1997
CLIENT :	JICA Study Team	BORING METHOD :	Coring
LOCATION :	Batu Gantung River	SAMPLING METHOD :	Core barrel dia. 89, 73 & SPT
BORE HOLE NO. :	SGT-2	SPT :	Automatic Hammer (AH)
ELEVATION :		DRILLER :	Aep Rohmat
COORDINATES :		LOGGER :	Yono Sumaryono
DEPTH :	10.45 m		

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	qc (kg/cm2)	SPT - N value		RECOVERY (%)	
							Depth (m)	BLOWS PER CM		N PER FOOT
								40	80	
	0.86	CL		SILTY CLAY, brown coloured, trace fine grained sand, soft.						
	2.45	SW		SAND, gray coloured, fine to coarse grained sand, well graded, few gravels, diameter sized 1 to 2 cm, loose.			1.15	15/30		
							2.15	3/30		
		SM		SILTY SAND, gray coloured, fine to medium grained sand, medium dense.			3.15	15/30		
							4.15	14/30		
	5.60						5.15	27/30		
		SW		SAND, gray coloured, fine to coarse grained sand, well graded, trace shell fragments, medium dense to dense.			6.15	29/30		
							7.15	13/30		
							8.15	35/30		
							9.15	33/30		
	10.45			END OF THIS BORING. CASING DOWN TO -9.00 METERS DEPTH.			10.15	28/30		

BORING LOG

P.T. SOILENS

PROJECT	: THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m)	: none
JOB NO.		DATE	: August 5 to August 6, 1997
CLIENT	: JICA Study Team	BORING METHOD	: Coring
LOCATION	: Batu Gantung River	SAMPLING METHOD	: Core barrel dia. 89, 73 & SPT
BORE HOLE NO.	: SGT-3	SPT	: Automatic Hammer (AH)
ELEVATION	:	DRILLER	: Aep Rohmat
COORDINATES	:	LOGGER	: Yono Sumaryono
DEPTH	: 8.06 m		

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _s (kg/cm ³)	SPT - N value		RECOVERY (%)
							Depth (m)	BLOWS PER CM	
							40	80	40
	0.00	SW		SAND, some gravels, brown coloured, fine to coarse grained, well graded, gravel diameter sized 1 to 3 cm, medium dense to dense.			1.15	24/30	
	2.60					SAND, whitish gray coloured, fine to coarse grained, well graded, some coral gravels, dense to very dense.			2.15
		SW					3.15	14/150	
	6.30					LIMESTONE, white coloured, coralloid fragments, hard.			4.15
	8.00						5.15	67/25	
				END OF THIS BORING. CASING DOWN TO -7.00 METERS DEPTH.			6.15	50/15	
							7.15	50/15	
							8.00	50/15	

BORING LOG

P.T. SOILENS



PROJECT : THE STUDY ON FLOOD CONTROL FOR AMBON JOB NO. : CLIENT : JICA Study Team LOCATION : Ruhu River BORE HOLE NO. : SRH-1 ELEVATION : COORDINATES : DEPTH : 10.45 m	WATER TABLE (m) : -0.50 DATE : August 16, 1997 BORING METHOD : Coring SAMPLING METHOD : Core barrel dia. 73, 89 & SPT SPT : Automatic Hammer (AH) DRILLER : Ujang Sorifudin LOGGER : Yono Sumaryono
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SAMPLE DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _s (kg/cm ³)	SPT - N value		RECOVERY (%)
						Depth (m)	BLOWS PER CM	
0.00	SM		SILTY SAND, brownish gray coloured, fine to medium grained sand, loose.				40	80
1.00								
	GW		SANDY GRAVELS, brown coloured, fine to coarse grained sand, well graded, becoming gray coloured below 3.80 meters depth, loose to medium dense.	1.15		3/30		
			2.15		5/30			
			3.15		8/30			
			4.15		19/30			
5.40	SM		SILTY SAND, dark gray coloured, fine to coarse grained sand, trace organic matter, medium dense.	5.15		30/30		
7.00					6.15		19/30	
	SW		SAND, gray coloured, fine to coarse grained, well graded, trace gravels and silt, medium dense to dense.	7.15		20/30		
			8.15		24/30			
			9.15		27/30			
10.45					10.15		29/30	
			END OF THIS BORING. CASING DOWN TO - 8.30 METERS DEPTH.					

BORING LOG

P.T. SOILENS

PROJECT : THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m) : -0.50
JOB NO. :	DATE : August 14 to August 15, 1997
CLIENT : JICA Study Team	BORING METHOD : Coring
LOCATION : Ruhu River	SAMPLING METHOD : Core barrel dia 73, 89 & SPT
BORE HOLE NO. : SRH-2	SPT : Automatic Hammer (AH)
ELEVATION :	DRILLER : Ujang Sorifudin
COORDINATES :	LOGGER : Yono Sumaryono
DEPTH : 10.45 m	

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	qu (kg/cm ²)	SPT - N value		RECOVERY (%)			
							Blows per CM	N per Foot				
							40	80	30 80			
	0.00	SW		SAND, brown coloured, fine to coarse grained, well graded, few gravels, diameter sized 1 to 2 cm, medium dense.			1.15	24/30				
	2.00	SM		SILTY SAND, yellowish brown coloured, fine to coarse grained sand, few gravels, diameter sized 0.50 - 1.00 cm, medium dense.			2.15	8/30				
										3.15	10/30	
										4.15	10/30	
										5.15	16/30	
										6.15	18/30	
										7.15	16/30	
										8.15	27/30	
										9.15	29/30	
	10.45						END OF THIS BORING. CASING DOWN TO -8.30 METERS DEPTH.			10.15	30/30	

BORING LOG

P.T. SOILENS

PROJECT : THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m) : -3.00
JOB NO. :	DATE : August 8 to August 9, 1997
CLIENT : JICA Study Team	BORING METHOD : Coring
LOCATION : Tomu River	SAMPLING METHOD : Core barrel dia. 73, 89 & SPT
BORE HOLE NO. : STM-1	SPT : Automatic Hammer (AH)
ELEVATION :	DRILLER : Aep Rochmat
COORDINATES :	LOGGER : Yono Sumaryono
DEPTH : 10.45 m	

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	q _v (kg/cm ²)	SPT - N value			RECOVERY (%)	
							Depth (m)	BLOWS PER CM	N PER FOOT		
								40	80		
	0.00	SW		SAND, brownish gray coloured, fine to coarse grained sand, well graded, trace gravel's mixture, diameter sized 1 - 2 cm, at 1.45 to 2.00 meters depth found white coloured limestone boulder, medium dense.							
	2.00										
		SP		SAND, gray coloured, fine to coarse grained, well graded, medium dense.							
	4.00										
		SM		SILTY SAND, dark gray coloured, trace organic matter, fine to medium grained sand, poorly graded, loose to medium dense.							
	10.45			END OF THIS BORING. CASING DOWN TO -9.00 METERS DEPTH.							

BORING LOG

P.T. SOILENS

PROJECT	: THE STUDY ON FLOOD CONTROL FOR AMBON	WATER TABLE (m)	: -3.00
JOB NO.	:	DATE	: August 8 to August 9, 1997
CLIENT	: JICA Study Team	BORING METHOD	: Coring
LOCATION	: Tomu River	SAMPLING METHOD	: Core barrel dia. 73, 89 & SPT
BORE HOLE NO.	: SIM-2	SPT	: Automatic Hammer (AH)
ELEVATION	:	DRILLER	: Aep Rochmat
COORDINATES	:	LOGGER	: Yono Sumaryono
DEPTH	: 11.45 m		

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _d (g/cm ³)	SPT - N value			RECOVERY (%)		
							Depth (m)	BLOWS PER CM	N PER FOOT			
								40	80	40	80	
	0.00	GW		SANDY GRAVELS, brownish gray coloured, fine to coarse grained sand, well graded, gravel diameter sized 1 to 2 cm, trace silt, loose to medium dense.			1.15	11/30				
	2.20				SILTY SAND, greenish gray coloured, fine to medium grained sand, poorly graded, trace dark gray coloured organic matter at 3.00 to 5.50 meters depth, medium dense.			2.15	7/30			
		SM					3.15	9/30				
								4.15	14/30			
								5.15	17/30			
								6.15	16/30			
								7.15	12/30			
								8.15	16/30			
								9.15	17/30			
								10.15	19/30			
	11.45					END OF THIS BORING. CASING DOWN TO -11.00 METERS DEPTH.			11.15	20/30		

BORING LOG

P.T. SOILENS

PROJECT : THE STUDY ON FLOOD CONTROL FOR AMBON
 JOB NO. :
 CUENT : JICA Study Team
 LOCATION : Tomu River
 BORE HOLE NO. : STM-3
 ELEVATION :
 COORDINATES :
 DEPTH : 11.45 m

WATER TABLE (m) : -3.00
 DATE : August 10 to August 11, 1997
 BORING METHOD : Coring
 SAMPLING METHOD : Core barrel dia. 73, 89 & SPT
 SPT : Automatic Hammer (AH)
 DRILLER : Aep Rochmat
 LOGGER : Yono Sumaryono

SAMPLE	DEPTH (meter)	USCS CHART	GRAPH SYMBOL	ROCK/SOIL DESCRIPTION	DEPTH (meter)	γ _s (kg/cm ³)	SPT - N value		RECOVERY (%)	
							Depth (cm)	BLOWS PER CM		N PER FOOT
								40	80	
	0.00	GH		SILTY CLAY, brown coloured, trace fine grained sand, soft.						
	1.50	SW		SAND, whitish gray coloured, fine to coarse grained sand, well graded, few gravels, diameter sized 1 - 2 cm, medium dense.	1.15		14/30			
	3.00	SW		SAND, dark gray coloured, fine to coarse grained sand, trace gravels, some organic matter, medium dense.	2.15		10/30			
	4.50	SW			3.15		11/30			
	6.00	SW			4.15		6/30			
	7.50	SW			5.15		15/30			
	9.00	SW			6.15		7/30			
	10.50	SM		SILTY SAND, dark gray coloured, fine to medium grained sand, few organic matter, medium dense.	7.15		13/30			
	11.45	SM		END OF THIS BORING. CASING DOWN TO -9.00 METERS DEPTH.	8.15		11/30			
					9.15		16/30			
					10.15		16/30			