

Bore Hole : SB - 1	Sheet : 2 of 2	Ground Water Level (GWL) :	meter	Date :	1 - 9 - 1997 to 3 - 9 - 1997
Location : SIMOMANGAN WEIR - Right bank	Coordinate :	Angle :	x * y *	Dredged by :	Yah's Azza
Boring Depth : 20.00 meter	Beaning :	Dredging Machine :	KOMEN OE - 2L	Logged by :	Rudy Mukanto
Elevation : + 8.562 meter				Supervisor :	

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12		13	14	15	16	17	18	19					20		
									Standard Penetration Test								Acerberg Limits					Strength Test		
Date	Scale	Elevation	Stratum Thickness	Depth(m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration		Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (γ <sub>mo</sub> )	Void Ratio, e	0	40	60	100	150	Type	Angle Internal friction (°)	Cohesion (kg/cm <sup>2</sup> )
2/9 - 1997				15.70		SW	12.56	12.50 - 15.70 m: SAND, grey, fine to medium grained, well graded, wet. Occasionally some gravels with diameter up to 1.50 cm.	15		As													
3 SEPTEMBER 1997						CH		15.70 - 19.70 m: SILTY CLAY, grey to dark grey, high plasticity, soft to firm, moist.	16		Ac			2558	49.640	1722	1.221	25	36	62				
								19.70 - 20.00 m: GRAVELY SAND, brownish grey, fine to coarse grained, well graded, dense to very dense; containing gravels with diameter up to 1.50	17			Dc Ds			2653	45.320	1774	1.181	26	32	58			100
				20.00		SW	13.58	BOTTOM OF HOLE	18															
									19															
									20															
									21															
									22															
									23															
									24															
									25															
									26															
									27															
									28															
									29															
									30															

**SOIL MECHANICS SURVEY FOR  
 THE DETAILED DESIGN OF FLOOD CONTROL,  
 URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT  
 IN SEMARANG IN THE REPUBLIC OF INDONESIA**

**BORING LOG**

Bore Hole : <b>SB-2</b>	Sheet : <b>1</b> of <b>2</b>	Ground Water Level (GWL) : <b>meter</b>	Date : <b>27-8-1997 to 30-8-1997</b>
Location : <b>SIMOFAGAN WEIR, Right bank</b>	Coordinate : <b>x =                      y =</b>	Drilled by : <b>Yas Azis</b>	
Boring Depth : <b>20.00 meter</b>	Angle :                      Bearing :	Logged by : <b>Rudy Muranto</b>	
Elevation : <b>+ 3 955 meter</b>	Drilling Machine : <b>KOKEN OE-2L</b>	Supervisor :	

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12		13	14	15	16	17	18	19				20				
									Standard Penetration Test								Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (γ <sub>m</sub> )	Void Ratio, e	Atterberg Limits		
Date	Scale	Elevation	Stratum Thickness	Depth(m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration														● Plastic Limit (%)	□ Plastic Index (%)	▲ Liquid Limit (%)
									0	10	20	30	40	50											
1 SEPTEMBER 1997	1			1.30		SW		0.00 - 1.30 m: SILTY SAND, brownish grey to grey, fine to medium grained, well graded, loose.	0	0	0/30														
				2.15		CH		1.30 - 2.15 m: SILTY CLAY, grey, medium to high plasticity, soft, moist to wet.	1	1	5/30														
				4.00		SW		2.15 - 4.00 m: SAND, dark grey, medium to very coarse grained, well graded, medium dense; some amount of gravels with diameter up to 0.50 cm.	2	2	20/30														
				5.00		GP		4.00 - 5.00 m: GRAVELS & COBBLES, subrounded to rounded, diameter 0.50 to 10.00 cm.	3	3	25/30														
				8.70		SP		5.00 - 8.70 m: CLAYEY SAND, grey, fine to medium grained, poorly graded, medium dense.	4	4	59/30														
2 SEPTEMBER 1997	9							8.70 - 10.00 m: SILTY CLAY, grey, soft to firm, high plasticity, moist to wet.	5	5	24/30														
								10.53	SP	10.00 - 10.30 m: SILTY SAND, grey, fine to medium grained, poorly graded, loose, medium dense.	6													6	21/30
								14.35	VL	10.30 - 14.35 m: SANDY SILT, grey, medium to low plasticity, firm to stiff.	7													7	As
										14.35 - 14.70 m: CLAY, greish brown, high plasticity, stiff, moist.	8													8	4/30
								14.70	CH	14.70 - 20.00 m: GRAVELLY SAND, dark grey, coarse to very coarse grained, poorly graded, dense to very dense; having some amount of gravels, subrounded to angular, diameter up to 3.00 cm.	9													9	28/30
3 SEPTEMBER 1997	14			14.70					12	12	28/30														
									13	13	20/30													28/30	48/240
15	15			20.00					11	11	12/30														
14	14			14.35					10	10	12/30													2570	18 000

LEGEND: CORNO SPT UDS

SOIL MECHANICS SURVEY FOR  
THE DETAILED DESIGN OF FLOOD CONTROL,  
URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT  
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**BORING LOG**

Bore Hole : SB-2	Sheet : 2 of 2	Ground Water Level (GWL) : meter	Date : 27 - 8 - 1997 to 30 - 8 - 1997
Location : SIMONGAN WEIR, Right bank	Coordinate : x = y =	Drilled by : Yaka Azis	
Boring Depth : 20.00 meter	Angle : Bearing :	Logged by : Rudy Muranto	
Elevation : + 3.955 meter	Drilling Machine : KOKEN OE-2L	Supervisor :	

CLASSIFICATION AND DESCRIPTION OF MATERIAL

1	2	3	4	5	6	7	8	9	12					13	14	15	16	17	18	19				20								
									Standard Penetration Test											Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (γ <sub>m</sub> )	Void Ratio, e	Atterberg Limits				Type	Angle internal friction (°)	Cohesion (kg/cm <sup>2</sup> )
Date	Scale	Elevation	Station Thickness	Depth (m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration					0	40	60	120	160	● Plastic Limit (%)							□ Plastic Index	▲ Liquid Limit (%)					
15	3 SEPT. 1997								14.70 - 20.00 m: GRAVELY SAND, dark grey, coarse to very coarse grained, poorly graded, dense to very dense; having some amount of gravels, subrounded to angular, diameter up to 3.00 cm.	15	16	17	18							19	20											
16																																
17																																
18	4 SEPTEMBER 1997																															
19																																
20																																
21																																
22																																
23																																
24																																
25																																
26																																
27																																
28																																
29																																
30																																
BOTTOM OF HOLE																																

LEGEND: [Symbol] CCARG [Symbol] SPT [Symbol] UDS

**SOIL MECHANICS SURVEY FOR  
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URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT  
IN SEMARANG IN THE REPUBLIC OF INDONESIA**

**BORING LOG**

Bore Hole : SB-3	Sheet : 1 of 2	Ground Water Level (GWL) : meter	Date : 21-8-1997 to 24-8-1997
Location : SIMOYAN WEIR, Left bank	Coordinate : x = y =	Drifted by : Yulia Azis	
Boring Dept. : 15.00 meter	Angle : Bearing :	Logged by : Rudy Murnito	
Elevation : + 8.634 meter	Drilling Machine : KOKEN OE-2L	Supervisor :	

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12		13	14	15	16	17	18	19				20		
									Standard Penetration Test								Atterberg Limits				Strength Test		
Date	Scale	Elevation	Stratum Thickness	Depth (m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration		Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (k/m <sup>3</sup> )	Void Ratio, e	● Plastic Limit (%)	□ Plastic Index	▲ Liquid Limit (%)	Type	Angle Internal Friction (°)	Cohesion (kg/cm <sup>2</sup> )	
9 SEPTEMBER 1997				0.55		SW		0.00 - 0.55 m: SILTY SAND, containing some amount of plant roots, gravels; light brown, loose, fine to coarse grained, well graded. Gravels diameter up to 1.50 cm.	0														
						ML		0.55 - 2.50 m: CLAYEY SILT, containing some plant roots, occasionally gravels, brown with white, yellow, and black spotted, very stiff, moderately to low plasticity.	2														
					2.50			2.50 - 5.40 m: SANDY-SILTY CLAY, dark brown, stiff high plasticity, become light brown to yellowish brown, wet, in 5.00 m depth.	3														
						CH			5.40 - 8.55 m: SILTY SAND, yellowish grey, fine to medium grained, medium to very dense, moderately to poorly graded; containing little amount of gravels, with diameter up to 3.00 cm.	4													
					5.43				8.55 - 10.60 m: GRAVELY SAND, grey, medium to very coarse grained, very dense, well graded, Gravels diameter up to 5.00 cm.	5													
10 SEPTEMBER 1997						SP		10.60 - 14.55 m: SAND, grey, very dense, medium very coarse grained, well graded, moist.	6														
									6														
					6.55				7														
									8														
					10.60				9														
						SP		14.55 - 16.00 m: SAND, grey, very dense, medium very coarse grained, well graded, moist.	9														
									10														
				14.55					11														
						SW			11														
									12														
									12														
									13														
									13														
									14														
									14														
									15														
									15														

LEGEND: SW ML CH SP SW



**PT. Geo ACE**  
 Jln. Pajajaran no. 123  
 BANDUNG, INDONESIA

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 IN SEMARANG IN THE REPUBLIC OF INDONESIA**

**BORING LOG**

Bore Hole : SB-3	Sheet : 2 of 2	Ground Water Level (GWL) : meter	Date : 21-8-1997 to 24-8-1997
Location : SIMOKAN WEIR, Left bank	Coordinate : x* y*	Drilled by : Yaha Azis	
Boring Depth : 15.00 meter	Angle : Bearing :	Logged by : Rudy Mukanto	
Elevation : + 8.634 meter	Drilling Machine : KOKEN OE-2L	Supervisor :	

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12		13	14	15	16	17	18	19				20		
									Standard Penetration Test								Atterberg Limits				Strength Test		
Date	Scale	Elevation	Stratum Thickness	Depth(m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration		Ceological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (γ <sub>ms</sub> )	Void Ratio, e	Plastic Limit (%)	Shrinkage Limit (%)	Liquid Limit (%)	Type	Angle internal friction (°)	Cohesion (kg/cm <sup>2</sup> )	
15								14.55 - 16.00 m: SAND, grey, very dense, medium very coarse grained, well graded, moist.	50/30		As		2.754	19.320	1.728	0.734							
16				15.00				16.00 - 18.20 m: SILTY CLAY, dark brown, very stiff, high plasticity, moist.															
17							5.50	18.20 - 18.77 m: SILTY SAND, brownish grey, fine to medium grained, medium dense, poorly to medium graded.	15/00														
18				15.20				18.77 - 19.00 m: SANDY CLAY, brownish grey, stiff, high plasticity, moist.	24/30		Ac												
19				13.77				19.00 - 20.00 m: SAND, grey, dense, coarse to very coarse grained, poorly graded, moist.	50/7														
20				13.00				BOTTOM OF HOLE	32/30		Da												
21				20.00			5.75																
22																							
23																							
24																							
25																							
26																							
27																							
28																							
29																							
30																							

LEGEND: [Symbol] CORAS [Symbol] SPT [Symbol] UDS



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SOIL MECHANICS SURVEY FOR  
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**BORING LOG**

Bore Hole : 88-4	Sheet : 1 of 2	Ground Water Level (GWL) : meter	Date : 8-9-1997 to 12-9-1997
Location : SIMONGAN WEIR	Coordinate : x = y =	Drilled by : Yulis Azis	
Boring Depth : 20.00 meter	Angle : Bearing :	Logged by : Rudy Muzanto	
Elevation : 1585 meter	Drilling Machine : KOKEN OE-2L	Supervisor :	

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12		13	14	15	16	17	18	19				20									
									Standard Penetration Test								Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (t/m <sup>3</sup> )	Void Ratio, e	Atterberg Limits				Type	Strength Test		
Date	Scale	Elevation	Stratum Thickness	Depth(m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration		● Plastic Limit (%) □ Plastic Index ▲ Liquid Limit (%)				Angle internal friction (°)	Cohesion (kg/cm <sup>2</sup> )														
									10	20	30	40	50				0	40	80	120	160									
9 SEPTEMBER 1997	1			3.50	[Soil Profile]			0.00 - 3.50 m: GRAVEL, (retaining wall).	0																					
								1																						
								2																						
								3																						
10 SEPTEMBER 1997	4			5.50	[Soil Profile]			3.50 - 5.90 m: SILTY CLAY, reddish brown, high plasticity, stiff, moist.	28/30																					
								5																						
								6																						
								7																						
11 SEPTEMBER 1997	8			11.40	[Soil Profile]		170	5.90 - 11.40 m: SILTY SAND, light brown with white speckling, very fine to medium grained, poorly graded, medium dense to dense, having some amount of gravels with diameter up to 200 cm.	16/30																					
								9																						
								10																						
								11																						
12 SEPTEMBER 1997	12			15.00	[Soil Profile]		175	11.40 - 15.00 m: SANDY SILT, light brown to brown, medium to low plasticity, firm to stiff, moist to wet; having some amount of GRAVELS with diameter up to 500 cm.	26/30																					
								13																						
								14																						
								15																						

LEGEND [Symbol] CORING [Symbol] SPT [Symbol] UDE

Bore Hole : SB-4	Sheet : 2 of 2	Ground Water Level (GWL)	meter	Date	8-9-1997 to 12-9-1997
Location : SIMONGAN WEIR	Coordinate	X *	Y *	Drilled by	Yeha Azis
Boring Depth : 20.00 meter	Angle	Bearing :		Logged by	Rudy Mukarto
Elevation : 1.955 meter	Drilling Machine	KOKEN OE-2L		Supervisor	

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12					13	14	15	16	17	18	19				20										
									Standard Penetration Test											Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (γ <sub>mo</sub> )	Void Ratio, e	Atterberg Limits				Strength Test				
Date	Scale	Elevation	Stratum Thickness	Depth(m)	Soil Profile	Classification	GWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration																	● Plastic Limit (%)	□ Plastic Index	▲ Liquid Limit (%)	Type	Angle internal friction (°)	Cohesion (kg/cm <sup>2</sup> )			
									0	10	20	30	40	50	60						0	40	80	120	160									
11 SEPTEMBER 1997	15				.....			15.00 - 20.00 m: SANDY GRAVEL, yellowish brown to grey, (andesitic rock), extremely weak rock.	15																									
	16				.....																													
	17				.....																													
	18				.....		GP																											
	19				.....																													
	20		20.00		.....		175																											
	21								BOTTOM OF HOLE																									
	22																																	
	23																																	
	24																																	
	25																																	
	26																																	
	27																																	
	28																																	
	29																																	
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LEGEND: CORAG SPI UDS



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**BORING LOG**

Bore Hole : SB-5	Sheet : 1 of 2	Ground Water Level (GWL) :	meter	Date :	
Location : SIMONGAN WEIR		Coordinate :	x =      y =	Drilled by :	26-9-1997 to 28-9-1997
Boring Depth : 20.00 meter		Angle :	Bearing :	Logged by :	Yella Azis
Elevation : - 1.856 meter		Drilling Machine :	KOKEN OE-2L	Supervisor :	Rudy Mutanto

**CLASSIFICATION AND DESCRIPTION OF MATERIAL**

1	2	3	4	5	6	7	8	9	12		13	14	15	16	17	18	19				20		
									Standard Penetration Test								Aterberg Limits				Strength Test		
Date	Scale	Elevation	Stratum Thickness	Depth (m)	Soil Profile	Classification	CWL	DESCRIPTION	N-Value Number of Blows per 30 Cm Penetration	Geological Strata	Method of Sampling	Specific Gravity	Water Content (%)	Unit Weight (kN/m <sup>3</sup> )	Void Ratio, e	Liquid Limit (%)	Plastic Limit (%)	Shrinkage Limit (%)	Type	Angle Internal Friction, (°)	Cohesion (kg/cm <sup>2</sup> )		
26 SEPTEMBER 1997					..... ..... ..... ..... ..... ..... ..... ..... ..... .....	SW		0.00 - 2.05 m: GRAVELLY SAND, brownish grey, medium to coarse grained, well graded, very dense, gravels with diameter up to 4.00 cm.	0 1 2 3 4 5 6 7 8 9 10	50/3 50/15	rd												
				2.10	..... ..... ..... ..... ..... ..... ..... ..... ..... .....	CH		2.05 - 3.55 m: TUFACEOUS-SANDY CLAY, reddish brown, high plasticity, firm to stiff, moist.		12/30													
				3.55	..... ..... ..... ..... ..... ..... ..... ..... ..... .....	ML		3.55 - 5.10 m: TUFACEOUS-CLAYEY SILT, yellowish brown, low plasticity, firm, moist.		20/30													
				5.10	..... ..... ..... ..... ..... ..... ..... ..... ..... .....			5.10 - 10.00 m: TUFACEOUS-SILTY SAND, reddish brown with white mottled, moderately dense, fine to medium grained, poorly graded.		19/30 22/30 19/00 25/30													
				10.00	..... ..... ..... ..... ..... ..... ..... ..... ..... .....			10.00 - 11.40 m: VOLCANIC BRECCIA Components: andesitic & with diameter up to 4.00 cm. Matrix sand, grey, medium to coarse grained, moderately cemented.		33/30	Da												
				11.40	..... ..... ..... ..... ..... ..... ..... ..... ..... .....	EX		11.40 - 11.85 m: SANDY SILT, light brown, hard, low plasticity, moist.			Op												
				11.85	..... ..... ..... ..... ..... ..... ..... ..... ..... .....	ML		11.85 - 16.70 m: VOLCANIC BRECCIA Components: andesitic & with diameter up to 4.00 cm. Matrix: sand, grey, medium to coarse grained, moderately cemented.			Os												
	27 SEPTEMBER 1997					..... ..... ..... ..... ..... ..... ..... ..... ..... .....	EX																
						..... ..... ..... ..... ..... ..... ..... ..... ..... .....																	
						..... ..... ..... ..... ..... ..... ..... ..... ..... .....																	
					..... ..... ..... ..... ..... ..... ..... ..... ..... .....																		
					..... ..... ..... ..... ..... ..... ..... ..... ..... .....																		

LEGEND: [Symbol] CORNO [Symbol] SPI [Symbol] UDS







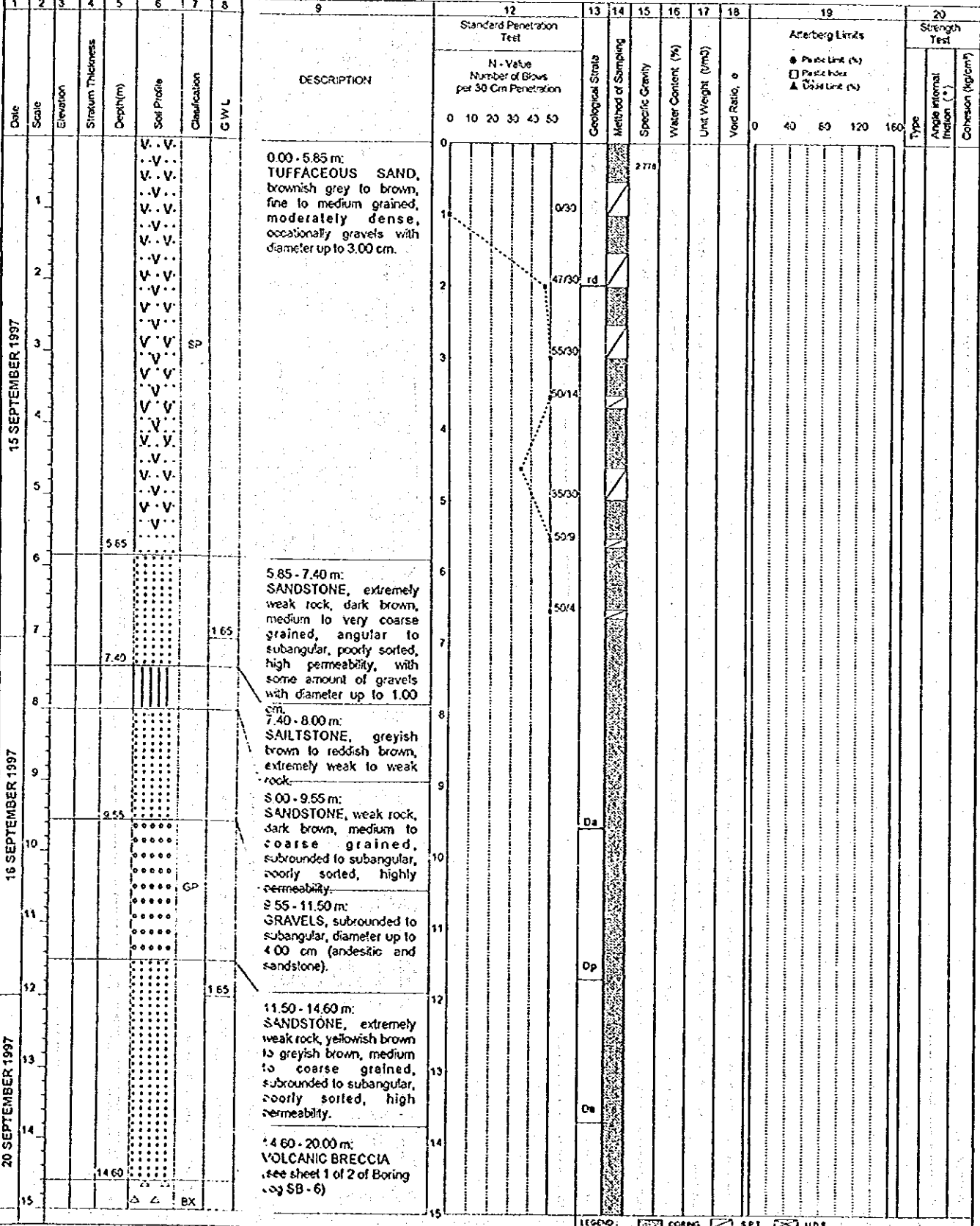
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### BORING LOG

Bore Hole : SB-6	Sheet : 1 of 2	Ground Water Level (GWL)	meter	Date :	15-9-1997 to 21-9-1997
Location : SIMONGAN WEIR		Coordinate	x"      y "	Drilled by :	Yala Aziz
Boring Depth : 20.00 meter		Angle	Bearing :	Logged by :	Rudy Muranti
Elevation : - 2.005 meter		Drilling Machine	KOKEN DE-2L	Supervisor :	

#### CLASSIFICATION AND DESCRIPTION OF MATERIAL



LEGEND: [Symbol] CORES [Symbol] SPT [Symbol] VDS

SOIL MECHANICS SURVEY FOR  
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BORING LOG

Bore Hole : SB-6	Sheet : 2 of 2	Ground Water Level (GWL) : meter	Date : 15-9-1997 to 21-9-1997
Location : SIMONGAN WEIR	Coordinate : X* Y*	Drilled by : Yulia Azra	
Boring Depth : 20.00 meter	Angle : Bearing :	Logged by : Rudy Mulranio	
Elevation : - 2.005 meter	Drilling Machine : KOKEN OE-2L	Supervisor :	

CLASSIFICATION AND DESCRIPTION OF MATERIAL

1 Date	2 Scale	3 Elevation	4 Stratum Thickness	5 Depth (m)	6 Soil Profile	7 Classification	8 GWL	9 DESCRIPTION	12 Standard Penetration Test					13 Geological Strata	14 Method of Sampling	15 Specific Gravity	16 Water Content (%)	17 Unit Weight (γ <sub>m</sub> )	18 Void Ratio, e	19 Atterberg Limits				20 Strength Test															
									N-Value Number of Blows per 30 Cm Penetration											● Plastic Limit (%) □ Plastic Index (%) ▲ Liquid Limit (%)				Type	Angle internal friction (φ)	Cohesion (kg/cm <sup>2</sup> )													
									0	10	20	30	40	50																									
2019-97 21 SEPTEMBER 1997	15				▲ ▲			14.60 - 20.00 m: VOLCANIC BRECCIA, with tuff and andestic rock fragments. Components: angular to subangular, diameter up to 10 cm. Metric sand, medium to coarse grained, subrounded to sub angular, well cemented.	15																														
	16				▲ ▲																																		
	17				▲ ▲																																		
	18				▲ ▲																																		
	19				▲ ▲																																		
	20				▲ ▲																																		
					▲ ▲																																		
					▲ ▲																																		
					▲ ▲																																		
					▲ ▲																																		
				20.00																																			
								BOTTOM OF HOLE																															
21																																							
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28																																							
29																																							
30																																							

LEGEND: SPT UDS

## 2.3 Laboratory Test

### (1) Purpose

The laboratory test is subjected to determine the physical and mechanical properties of soil sample.

### (2) Method

The laboratory test for soil sample followed the standard method of ASTM as can be seen below:

Table 2.2 STANDARD METHOD AND VOLUME OF LABORATORY TESTING

Item	Standard Method	Volume
<b>Soil Samples</b>		
Gradation Analysis	ASTM D422	200
Moisture Content	ASTM D4959	200
Specific Gravity	ASTM D854	200
Liquid and Plastic Limits	ASTM D431	200
Density	USBR 5370	200
One dimensional consolidation	ASTM D2435	25
Triaxial compression UU	ASTM D2850	59

### (3) Result

The result of laboratory tests in detail is presented in Appendix 2.

## 2.3.1 Engineering Geology

### (i) Simongan Weir

#### (1) General

The Core drilling at this area consists of 6 (six) hole of 20 m each depth, they are SB - 1 to SB - 6.

The aim of the survey at this area is to determine the foundation layer and its soil mechanical properties. The result is presented in form of geological cross section along the weir axis.(refer to Fig.2.5 and 2.6)

## (2) Soil Types and Overburden

Based on the core drilling result, the soil layer at the Simongan weir site consists of Riverbed deposit (Rd), Embankment fill (B), Fine coarse Sand (As) and Very soft Clay (Ac).

- Embankment (B) consists of earthfill and it is found at the left and right wings of Simongan weir. The thickness of this layer is about 6 m.
- Riverbed Deposit (Rd) consists of sand and gravel, dense to very dense, having SPT N value of 20 to more than 50. This riverbed deposit is found at the borehole SB - 2, Sb - 4, SB - 5 and SB - 6.
- The Fine grain Sand (As) consists of fine medium grain sand and intercalated with clay and silt, loose to very dense. This layer was found at the boreholes SB - 1, SB - 2 and SB - 3, lying beneath the embankment or riverbed deposit. The thickness of this layer varies from 8.5 m to 10 m.
- Clay and Sandy Clay (Ac) is lying beneath As layer. It is gray, consisting of clay and sandy clay, soft to medium stiff clay with SPT N value range of 11 to 20. This layer was found at the boreholes SB - 1, SB - 2 and SB - 3 at the elevation of approximately -10 m.
- Intercalation of Volcanic and Sedimentary rocks are considered as the base rock at this area. It is fractured, poor RQD and very weak rock.

## (3) Foundation Layer

According to the result of core drilling, it is suggested to footing the foundation of weir at base rock, due to the covered soil which, in general, has low consistency and SPT N value less than 30. Bored pile can be considered as alternative foundation.

### (ii) West Floodway

#### (1) General

The Core drilling at this area consist of 52 bore holes, with total depth of 824 m. They are RB - 1 to RB - 52.

The aim the survey at this area is to determine the foundation layer and its soil mechanical properties in relation with design of various structures along this floodway canal alignment. The result is presented in form of geological cross section along the West Floodway. (refer to Fig.2.3)

(2) Soil Types and Soil Mechanical Properties

(a) Left Bank

Based on the result of core drilling, the soil layer along the left bank of west floodway canal can be classified as follows:

Bore holes RB - 1 to RB - 19

The soil profile along this section, from the surface to bottom is as follows:

- Embankment (B) consists of earth fill. The thickness of this layer varies from 2 to 3 m.
- Very soft clay (Ac) with lenses of fine to middle grained Sand (As). This layer was found beneath the Embankment (B), up to 18 m depth.  
The very soft clay (Ac) is gray, consisting of clay and sandy clay, containing shell, very soft with average of SPT N value of 5.
- The lenses (As) layer consists of fine to medium grain sand and it is intercalated with clay and silt, loose with average SPT N value of 6. The thickness of this lenses is about 1 m to 3 m.
- Hard clay (Dc) layer with lenses of Gravelly SAND (Ds) lies beneath Ac layer up to the bottom of the hole.  
The hard clay is dark brown and the surface part is characterized by oxidation, containing coral limestone. The average SPT N value of this layer is 25.
- The Gravelly SAND (Ds) consists of fine to coarse grain sand with small amount of gravel. The SPT N value of this lenses is more than of 50.

### **Bore holes RB - 21 to RB - 27**

The soil profile along this section can be described as follows: (from the surface to the bottom).

- Embankment (B) consists of earth fill, partly found along this section with maximum thickness of 1 m.
- Very soft Clay (Ac) alternates with As of fine to middle grained Sand (As) was found beneath the Embankment (B) with thickness varies from 1 m to 12 m.

The very soft clay (Ac) is gray, consisting of clay and sandy clay, containing shell, very soft with average N SPT of 6

Fine to medium grain SAND (As) layer lies beneath the Ac layer, consisting of fine to medium grain sand and intercalated with clay and silt. The thickness of this layer is varies from 1 to 8 m.

- Interfingering between Hard Clay (Dc) and Sedimentary rock (Da) was found in the bottom part of the boreholes. This layer was found at the depth of 1 m (RB - 27) and 19 m (RB - 21).

The hard Clay is dark brown, the surface part is characterized by oxidation, containing coral limestone. The SPT N value of this layer varies from 16 to more than 50.

The sedimentary rock, consisting of alternation of conglomerate, sandstone, mudstone, with SPT N value more than 50.

### **Bore holes RB - 29 to RB - 39**

The soil profile along this section can be described as follows: (from surface to the bottom).

- Embankment (B) consists of earth fill, locally was found in this section with thickness ranges from 2 m to 3 m.

- Very soft Clay (Ac) was found beneath the Embankment (B), with thickness of about 4 m.

The very soft clay (Ac) is gray, consisting of clay and sandy clay, containing shell, very soft with average N SPT of 7.

- The lenses As layer, as lenses, lies in between of Ac and Da layers, consisting of fine to medium grain sand, and intercalated with clay and silt, medium dense with SPT N value of 20. The maximum thickness of lenses is 4 m.
- The bottom part of boreholes is Sedimentary Rock (Da) with a lenses of Hard Clay layer (Dc). This layer was found at the depth of 1 m (RB - 39) and 8 m (RB - 33). Standard penetration test performing in this layer gives the SPT N value of 13 to more than 50, with average of 35.

#### Bore holes RB - 41 to RB - 49

The soil profile along this section in general can be describe as follows:

- Embankment fill (B) and Riverbed deposit (Rd) were found at the bore holes RB - 47 and RB - 49. They overlies the Ac layer. Beneath the Ac layer is usually Da layer, except at the borehole RB - 45 which contains lenses of As.
- Embankment (B) consists of earthfill, found in the upper part of borehole Rb - 47, with thickness of 3.5 m. This layer has the average of SPT N value of 19.
- Riverbed Deposit (Rd) consists of sand and clay and very soft. It was found at the borehole RB - 49 at depth of 0 – 1.40 m.
- Very soft Clay (Ac) was found beneath the Embankment (B) or Riverbed deposit (Rd), consisting of clay and sandy clay, medium stiff with average of N SPT value of 15. The thickness of this layer varies from to 4 m.
- The lenses As layer, as lenses , lies in between Ac and Da layers and found at the borehole RB - 45. It consists of fine to medium grain sand, and intercalated with clay and silt. The maximum thickness of lenses is 1 m.



- The bottom part of boreholes is Sedimentary Rock (Da), having SPT N value of 39 to more than 50, with average SPT N value is more than 50.

(b) Right Bank

Based on the result of core drilling, the soil layer along the right bank of west floodway canal can be classified as follows:

**Bore holes RB - 2 to RB - 20**

The soil profile along this section in general can be described as follow:

- Embankment fill (B) with 1 m thick was found at the uppermost of the boreholes. The Ac layer with As lenses lies beneath the B layer. The bottom part of the boreholes is dominated by Dc layer.
- Embankment (B) consists of earthfill, and found in the upper part of boreholes with average thickness of 1 m.
- Very soft Clay (Ac) was found beneath the Embankment (B), consisting of clay and sandy clay, very soft with average of N SPT of 3 except in the borehole RB - 16 (14.55 – 15.00 m) and RB - 10 (3.55 – 4.00 m) which give the SPT N value of 18 and 26, respectively. The thickness of this layer, including As lenses, varies from 8 m to 19 m.

The lenses As layer, as lenses in the Ac layer, consists of fine to medium grained Sand, and intercalated with clay and silt. The thickness of the As lenses varies from 1 m to 4 m.

- At the bottom of the boreholes is alternation of Hard Clay (Dc), Coarse grained Sand (Ds), and Gravelly Clay (Dg). This layer was found at the depth of 14 m (RB - 14) and 20 m (RB - 6).

**Bore holes RB - 22 to RB - 38**

The soil profile along this section, in the upper part, is alternation between Very soft Clay (Ac) and Fine grain Sand (As) layers with embankment (B) which locally covered this layer. The thickness of the Ac and As layer varies from 10 to 14 m.

In the lower part of the boreholes Rb - 22 to Rb - 26 is Hard Clay (Dc) whereas Rb - 28 to Rb - 36 is Sedimentary Rock (Da). The Standard Penetration Test conducted at this layer gives the SPT N value of 15 to 50 with average of 35.

#### **Bore holes RB - 40 to RB - 50**

The soil profile along this section, from the surface to the bottom, consists of embankment fill (B), Very soft Clay (Ac), and Sedimentary Rock (Da).

- Embankment (B) was found at the boreholes RB - 42, RB - 46, RB - 48 and RB - 50 from the surface into 2 m to 4 m depth. This layer has SPT N value of 8 to 50 with average of about 20.
- Very soft Clay (Ac), in general, was found beneath the Embankment (B), except in the borehole RB - 40 and RB - 44 which is directly found from the surface. It consists of clay and sandy clay, soft with average N SPT of 12. The thickness of this layer varies from 1.5 to 3.5 m.
- Sedimentary Rock (Da) is composed of alternation of conglomerate, sandstone, and mudstone. This layer lies beneath the Embankment (B) and Very soft Clay (Ac). The Standard Penetration Test performing at this layer gives the SPT N value ranges of 29 to more than 50 with average more than 50.

#### **2.3.2 Conclusion**

- The project area geologically belongs to Damar Foundation and alluvium deposit.
- Alluvium deposit is sedimented as river, lake, swamp or coastal, deposit. Each type of deposit is physically and mechanically varied.
- According to the lithological sequence, floodway area is geologically assumed to be a flood plain area.

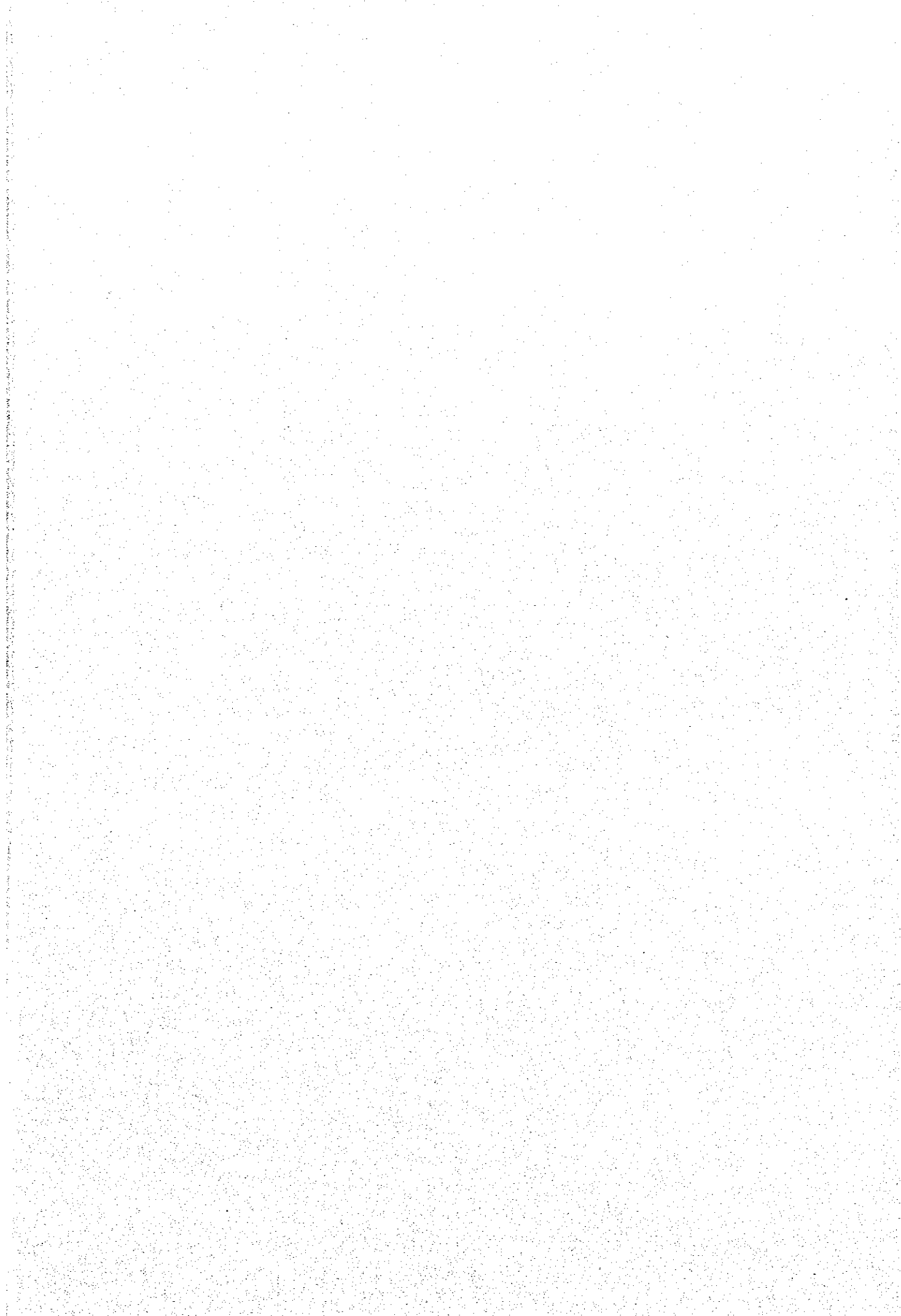


Table 2.2 (1/4) SUMMARY OF LABORATORY TEST (STANDARD PENETRATION TEST SAMPLES)

LOCATION	BOREHOLE No.	TEST DEPTH (m)	PHYSICAL PROPERTIES											USCS SOIL CLASSIFICATION	MECHANICAL PROPERTIES						GEOLOGICAL STRATE SYMBOL	S. P. T N VALUE		
			Gs	Wn (%)	r <sub>n</sub> (g/cm <sup>3</sup> )	Sr (%)	e	GRAIN SIZE (%)				CONSISTENCY			SHEARING STRENGTH				CONSOLIDATION PROPERTIES					
								GRAVEL >4.75mm	SAND 4.75-0.075mm	SILT 0.075-0.002mm	CLAY <0.002mm	LL (%)	PL (%)		PI (%)	UU		CU		P <sub>c</sub> (kg/cm <sup>2</sup> )			C <sub>c</sub>	
																C (kg/cm <sup>2</sup> )	φ (°)	C (kg/cm <sup>2</sup> )	φ (°)					C' (kg/cm <sup>2</sup> )
WEST FLOODWAY	RB - 1	7.50 - 8.00	2.70	40.36																		Ac	3	
		12.50 - 13.00	2.64	59.39																			Ac	6
	RB - 2	3.50 - 4.00	2.79	37.52																			As	3
		12.50 - 13.00	2.77	95.42																			Ac	0
	RB - 3	4.50 - 5.00	2.78	75.81																			Ac	0
		14.50 - 15.00	2.71	83.32																			Ac	6
	RB - 4	3.50 - 4.00	2.68	48.13																			Ac	0
		6.50 - 7.00	2.68	60.08																			Ac	3
	RB - 5	4.50 - 5.00	2.55	49.11																			Ac	0
		18.50 - 19.00	2.75	88.00																			Ac	7
		22.50 - 23.00	2.55	38.88																			Dc	29
	RB - 6	3.50 - 4.00	2.66	47.82																			Ac	8
		9.50 - 10.00	2.62	90.47																			Ac	3
		16.50 - 17.00	2.66	43.59																			Ac	6
	RB - 7	3.50 - 4.00	2.66	67.24																			Ac	3
		14.50 - 15.00	2.64	69.35																			Ac	4
	RB - 8	2.50 - 3.00	2.75	56.52																			Ac	3
		5.50 - 6.00	2.70	59.29																			Ac	3
	RB - 9	4.50 - 5.00	2.78	71.58																			Ac	1
		19.50 - 20.00	2.66	46.48																			Dc	13
		23.50 - 24.00	2.76	42.28																			Dc	23
	RB - 10	3.50 - 4.00	2.78	52.65																			Ac	26
	RB - 11	4.50 - 5.00	2.67	82.45																			Ac	1
		17.50 - 18.00	2.65	54.98																			Ac	16
		20.50 - 21.00	2.65	36.89																			Dc	51
	RB - 12	5.50 - 6.00	2.79	67.77																			Ac	3
		14.50 - 15.00	2.66	74.65																			Ac	3
	RB - 13	4.50 - 5.00	2.66	75.97																			Ac	3
		6.50 - 7.00	2.67	74.93																			Ac	3
	RB - 14	2.50 - 3.00	2.62	51.80																			Ac	7
		14.50 - 15.00	2.75	63.57																			Ac	6
	RB - 15	3.50 - 4.00	2.67	49.66																			As	3
		14.50 - 15.00	2.70	49.46																			Dc	24
	RB - 16	4.50 - 5.00	2.75	82.83																			Ac	3
		14.50 - 15.00	2.64	59.85																			Ac	18
	RB - 17	3.50 - 4.00	2.54	79.60																			Ac	3
		5.50 - 6.00	2.66	52.77																			Ac	4
		16.50 - 17.00	2.55	35.56																			Ds	52
		27.50 - 28.00	2.55	42.46																			Dc	40
	RB - 18	3.50 - 4.00	2.56	50.96																			As	3
		5.50 - 6.00	2.60	60.92																			Ac	3
		17.50 - 18.00	2.62	40.67																			Dc	52
	RB - 19	4.50 - 5.00	2.73	46.65																			Ac	7
		8.50 - 9.00	2.71	46.64																			As	13
14.50 - 15.00		2.62	58.26																			Ac	19	
RB - 20	2.50 - 3.00	2.63	48.24																			Ac	6	
	6.50 - 7.00	2.68	46.77																			Ac	3	
	12.50 - 13.00	2.60	57.41																			Ac	3	
RB - 21	4.50 - 5.00	2.64	41.28																			As	3	

Table 2.2 (2/4) SUMMARY OF LABORATORY TEST (STANDARD PENETRATION TEST SAMPLES)

LOCATION	BOREHOLE No.	TEST DEPTH (m)	PHYSICAL PROPERTIES										USCS SOIL CLASSIFICATION	MECHANICAL PROPERTIES						GEOLOGICAL STRATE SYMBOL	S. P. T N VALUE			
			Gs	Wn (%)	γn (g/cm3)	Sr (%)	e	GRAIN SIZE (%)				CONSISTENCY			SHEARING STRENGTH				CONSOLIDATION PROPERTIES					
								GRAVEL >4.75mm	SAND 4.75-0.075mm	SILT 0.075-0.002mm	CLAY <0.002mm	LL (%)		PL (%)	PI (%)	UU		CU				Pc (kg/cm2)	Cc	
																C (kg/cm2)	φ (°)	C' (kg/cm2)	φ' (°)					
WEST FLOODWAY	RB - 22	6.50 - 7.00	2.58	52.70																	Ac	6		
		13.50 - 14.00	2.71	60.30																		As	11	
		18.50 - 19.00	2.62	40.59																			Dc	30
	RB - 23	2.50 - 3.00	2.58	52.44																			Ac	3
		6.50 - 7.00	2.74	59.20																			Ac	3
		12.50 - 13.00	2.56	51.23																			Ac	3
	RB - 24	16.50 - 17.00	2.65	43.70																			Dc	29
		6.50 - 7.00	2.68	41.81																			As	11
		9.50 - 10.00	2.61	43.89																			As	11
	RB - 25	11.50 - 12.00	2.64	35.70																			Dc	67
		2.50 - 3.00	2.64	44.61																			Ac	11
	RB - 26	12.50 - 13.00	2.75	35.61																			Ds	34
		2.50 - 3.00	2.57	44.06																			Ac	10
	RB - 27	12.50 - 13.00	2.57	44.46																			Dc	16
		4.50 - 5.00	2.65	68.17																			Ac	13
	RB - 28	14.50 - 15.00	2.50	55.58																			Dc	44
		7.50 - 8.00	2.78	36.72																			Da	50<
	RB - 29	11.50 - 12.00	2.74	46.47																			Da	50<
		4.50 - 5.00	2.64	26.81																			Da	50<
	RB - 30	13.50 - 14.00	2.66	41.55																			Dc	45
		16.50 - 17.00	2.64	51.23																			Dc	26
	RB - 31	24.50 - 25.00	2.68	29.05																			Dc	43
		28.50 - 29.00	2.70	47.68																			Dc	40
	RB - 32	2.50 - 3.00	2.54	42.21																			Ac	6
9.50 - 10.00		2.55	52.97																			Ac	7	
RB - 33	3.50 - 4.00	2.62	36.91																			Ac	23	
	9.50 - 10.00	2.52	55.11																			Ac	8	
RB - 34	2.50 - 3.00	2.53	36.56																			Ac	10	
	8.50 - 9.00	2.89	13.18																			Da	46	
RB - 35	11.50 - 12.00	2.85	26.57																			Da	50	
	10.50 - 11.00	2.78	26.57																			Da	24	
RB - 36	12.50 - 13.00	2.73	38.17																			Da	60	
	3.50 - 4.00	2.63	51.58																			Ac	3	
RB - 37	6.50 - 7.00	2.86	14.12																			As	20	
	12.50 - 13.00	2.77	43.21																			Dc	13	
RB - 38	3.50 - 4.00	2.79	34.49																			As	7	
	7.50 - 8.00	2.69	39.28																			Dc	15	
RB - 39	3.50 - 4.00	2.74	42.86																			Da	8	
	8.50 - 9.00	2.75	17.22																			Da	50<	
RB - 40	3.50 - 4.00	2.83	19.46																			As	5	
	8.50 - 9.00	2.86	9.06																			Da	48	
RB - 41	3.50 - 4.00	2.75	40.33																			Ac	10	
	9.50 - 10.00	2.53	29.49																			Da	24	
RB - 42	4.50 - 5.00	2.65	62.91																			Ac	6	
	8.50 - 9.00	2.78	49.51																			Ac	5	
RB - 43	9.50 - 10.00	2.68	30.21																			Da	43	
	2.50 - 3.00	2.79	20.61																			Ac	11	
RB - 44	9.50 - 10.00	2.87	5.03																			Da	52	
	4.50 - 5.00	2.75	36.54																			Da	66	

Table 2.2 (3/4) SUMMARY OF LABORATORY TEST (STANDARD PENETRATION TEST SAMPLES)

LOCATION	BOREHOLE No.	TEST DEPTH (m)		PHYSICAL PROPERTIES										USCS SOIL CLASSIFICATION	MECHANICAL PROPERTIES						GEOLOGICAL STRATE SYMBOL	S. P. T N VALUE						
				Gs	Wn (%)	γn (g/cm3)	Sr (%)	e	GRAIN SIZE (%)				CONSISTENCY			SHEARING STRENGTH				CONSOLIDATION PROPERTIES								
									GRAVEL >4.75mm	SAND 4.75-0.075mm	SILT 0.075-0.002mm	CLAY <0.002mm	LL (%)		PL (%)	PI (%)	C (kg/cm2)	φ (°)	C' (kg/cm2)	φ' (°)			Pc (kg/cm2)	Cc				
GARANG RIVER		5.50 - 6.00	2.56	28.90						1.80	24.10	62.54	11.56	58.40	28.57	29.82	CH									Da	63	
	RB - 42	3.50 - 4.00	2.55	28.42						1.60	17.60	59.06	21.74	61.94	23.67	38.27	CH									Ac	21	
	RB - 43	2.50 - 3.00	2.75	29.48						-	19.20	58.17	22.63	64.33	20.81	43.52	CH									Ac	18	
		4.50 - 5.00	2.78	34.18							13.80	57.52	28.68	61.38	31.15	30.24	CH									Da	86	
	RB - 44	5.50 - 6.00	2.64	34.85							3.60	49.60	45.99	0.81	44.19	28.37	15.82	SM									Da	73
		4.50 - 5.00	2.58	32.87							2.20	41.50	48.87	7.43	55.77	25.26	30.51	CH									Da	65
		7.50 - 8.00	2.54	28.50							6.40	26.90	60.76	5.94	77.93	39.64	50.29	CH									Da	24
	RB - 45	2.50 - 3.00	2.61	42.50							-	28.20	47.70	24.10	52.23	15.34	36.89	CH									Ac	13
		4.50 - 5.00	2.75	15.50							47.74	39.53	12.74	0.00				GM									Da	65
		5.50 - 6.00	2.71	13.81							67.58	31.25	0.68	0.00				GP									Da	50<
	RB - 46	1.50 - 2.00	2.56	40.60							-	11.60	66.97	21.43	66.35	21.43	44.92	CH									B	8
		2.50 - 3.00	2.66	40.29							-	16.50	66.32	17.18	60.23	21.95	38.28	CH									B	15
	RB - 47	1.50 - 2.00	2.66	37.14							4.30	37.40	44.03	14.27	56.87	24.54	32.33	CH									B	24
		2.50 - 3.00	2.57	39.67							-	30.30	54.55	15.15	61.30	30.18	31.12	CH									B	15
	RB - 48	2.50 - 3.00	2.67	24.36							43.67	52.13	4.20	0.00	-	-	-	SP									B	50<
		8.50 - 9.00	2.75	33.35							3.80	41.40	53.29	1.51	48.75	22.34	26.41	CL									Da	29
	RB - 49	3.50 - 4.00	2.72	14.06							63.09	31.78	5.13	0.00				GP									Da	50<
		5.50 - 6.00	2.63	27.84							6.20	45.90	47.25	0.65	37.48	31.88	15.61	SC									Da	39
	RB - 50	1.50 - 2.00	2.67	43.80							-	41.70	48.94	9.36	58.73	22.58	36.15	CH									Ac	3
		2.50 - 2.85	2.66	37.14							55.74	34.70	9.56	0.00				G.P									Da	50<



