A14.4 River water flow and suspended solid

The Study Team carried out the measurements of water flow (current) and suspended solid for consecutive twenty five (25) hours in the time when tidal fluctuation was remarkable i.e. during days of the spring tide on January 15 and 16, 2002.

Measuring points consist of seven (7) main points (to obtain input data for implementation of simulation of navigational channel stabilization) and thirteen (13) supplemental points (to obtain data for checking numerical values computed from simulation) as seen in **Figure A14.4.1**.

- Main measuring points

Water flow (current) and suspended solid were measured with 0.5m water depth intervals at 1 hour intervals for twenty five (25) hours at two (2) points of main points named "two (2) key points" (one point at the end of upstream (V2) and another point at the end of downstream (V19) in the Red River segment,

Two (2) current meters of high specifications were used exclusively at two (2) key points to measure current and suspended solid with 0.5 m water depth intervals for obtaining vertical distribution data.

At the same time water flow (current) and suspended solid were measured with the three (3) water depths at 1 hour intervals for 25 hours at five (5) points of main points（two (2) points at the end of upstream (V1 and V3) and other two (2) points at the end of downstream (V18 and V20) in the Red River segment, and the remaining one (1) point at the Duong River.

Current and suspended solid at five (5) main points other than the above two (2) key points and at thirteen (13) supplementary points were measured at the following three (3) water depths.

Surface layer: 0.5 meter below the surface of water
Middle layer: Intermediate depth between the surface and the bottom
Bottom layer: 0.25 meter above the surface of riverbed
Supplementary measuring points

Simultaneously with seven (7) main points, water flow (current) and suspended solid were measured at thirteen (13) supplementary points in the Red River segment with

the three (3) water depths at three to four hours intervals for twenty five (25) hours, totally seven (7) times at each supplementary point.

Distribution map of the maximum speed of river water flow measured at 0.25 m above riverbed is shown in **Figure A14.4.2**.

During the above measurements were being conducted, water level were simultaneously measured at intervals of every ten (10) minutes starting from 00 minute, then every 10, 20, 30, 40, 50 minutes at ten (10) units of levelling stuff set up at the points of riverside near waterline as seen in **Figure A14.4.2**.

The results of measurements of river water flow and suspended solid are respectively summarized as seen in **Table A14.4.1** and **Table A14.4.2.**

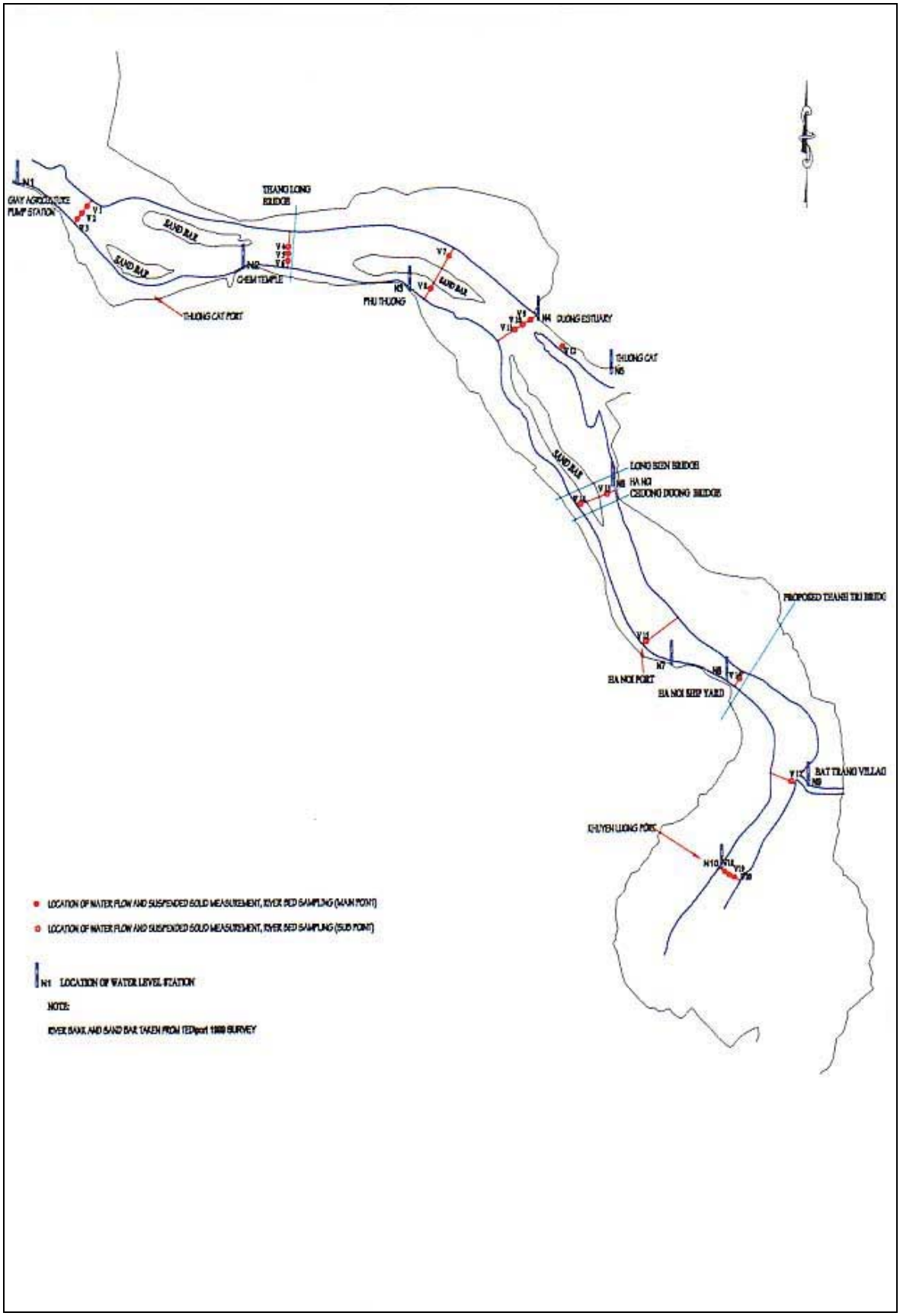


Figure A14.4.1 Location Map for Measurements of River Water Flow/Suspended Solid and Riverbed Materials in the Red River Segment

Source) JICA Study Team

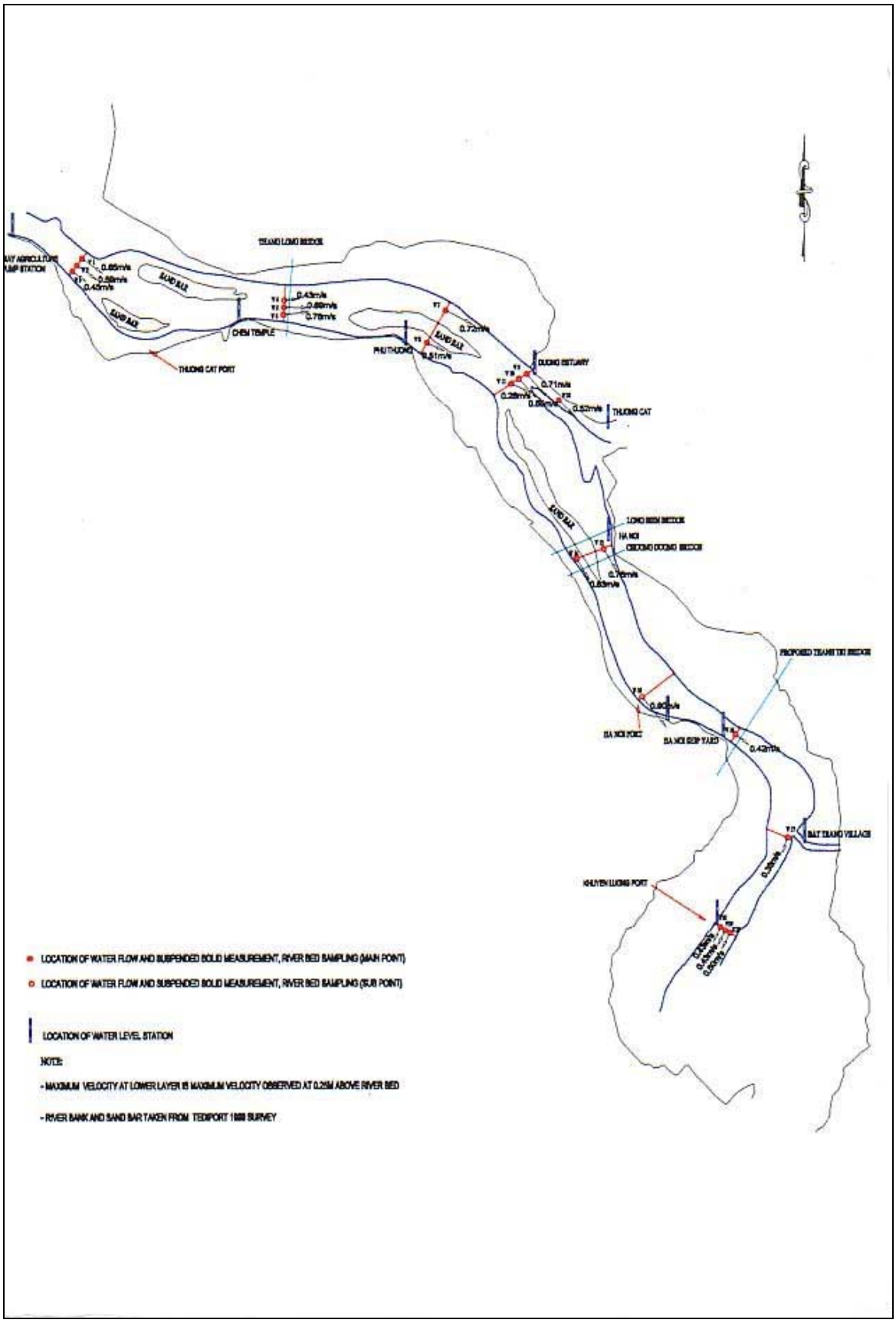


Figure A14.4.2 Distribution Map of Maximum Speed of River Water Flow at 0.25m above Riverbed in the Red River Segment

Source) JICA Study Team

Table A14.4.1 River Water Flow Speed in the Red River Segment

Water Depths	Speed Case	Speed (m/s)																			
		V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
0.5 m below water surface	Maximum	0.91	0.88	0.63	0.55	0.88	0.91	1.12	0.66	1.05	0.89	0.42	0.79	0.91	0.97	1.44	0.63	0.66	0.57	0.53	0.68
	Average	0.82	0.83	0.58	0.50	0.85	0.86	1.01	0.62	1.02	0.79	0.28	0.65	0.81	0.85	1.41	0.61	0.62	0.51	0.49	0.59
	Minimum	0.73	0.76	0.49	0.47	0.80	0.82	0.94	0.58	0.97	0.68	0.20	0.50	0.73	0.79	1.36	0.58	0.59	0.44	0.43	0.50
Middle depth	Maximum	0.83	0.86	0.58	0.51	0.84	0.84	1.04	0.62	0.97	0.82	0.40	0.79	0.95	0.81	1.29	0.60	0.56	0.53	0.52	0.59
	Average	0.70	0.73	0.52	0.47	0.79	0.80	0.97	0.57	0.91	0.73	0.29	0.61	0.81	0.79	1.19	0.57	0.53	0.47	0.44	0.53
	Minimum	0.57	0.67	0.44	0.43	0.75	0.77	0.89	0.53	0.79	0.59	0.22	0.46	0.73	0.76	1.01	0.52	0.50	0.30	0.39	0.50
0.25 m above river bed	Maximum	0.65	0.59	0.45	0.43	0.69	0.78	0.72	0.51	0.71	0.65	0.26	0.52	0.76	0.63	0.88	0.42	0.38	0.43	0.42	0.50
	Average	0.50	0.5	0.35	0.39	0.62	0.65	0.61	0.49	0.62	0.58	0.18	0.40	0.57	0.60	0.77	0.33	0.33	0.38	0.37	0.44
	Minimum	0.37	0.4	0.18	0.36	0.51	0.56	0.52	0.48	0.49	0.49	0.12	0.28	0.31	0.57	0.66	0.30	0.23	0.30	0.32	0.38

Source) JICA Study Team

Table A14.4.2 Concentration of Suspended Solid (SS) in the Red River Segment

Water Depths	Speed Case	Suspended (mg/l)																			
		V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
0.5 m below water surface	Maximum	160.4	202.2	136.0	162.0	174.0	148.0	132.6	120.6	165.8	191.4	131.0	165.0	192.0	192.8	168.2	153.4	150.6	152.2	149.8	135.6
	Average	85.8	132.1	96.1	134.1	125.1	110.0	105.7	99.4	142.3	143.0	104.1	118.4	167.5	134.3	142.8	120.1	132.3	116.4	85.6	89.9
	Minimum	32.8	71.0	57.8	91.2	71.0	73.0	74.4	69.2	117.2	95.8	69.8	80.4	149.4	125.8	102.8	82.0	112.4	51.6	55.4	36.4
Middle depth	Maximum	216.4	281.2	222.8	238.8	192.8	187.2	143.0	137.0	167.4	194.4	149.4	242.6	219.0	209.8	217.8	172.8	186.4	299.6	195.6	191.4
	Average	142.9	198.8	143.4	213.2	157.6	155.5	118.3	110.1	151.9	168.7	123.1	166.3	181.6	162.6	181.0	148.5	156.3	157.2	126.9	131.3
	Minimum	76.8	128.8	93.8	167.0	147.6	131.2	86.2	96.0	126.0	146.2	100.8	137.4	150.2	125.4	119.4	121.8	115.0	112.8	74.2	100.2
0.25 m above river bed	Maximum	288.2	374.4	306.0	360.0	247.0	194.6	148.2	156.8	229.2	274.0	168.6	379.0	225.2	243.8	228.8	314.2	307.6	334.0	210.8	211.6
	Average	205.7	281.3	197.8	271.8	200.4	177.2	131.2	120.5	188.3	195.7	145.0	273.9	198.4	183.7	208.5	233.1	194.7	209.7	132.4	170.0
	Minimum	151.4	170.2	142.6	209.8	159.2	146.6	100.2	102.0	149.6	147.4	128.4	168.0	153.4	151.4	167.6	178.6	138.0	149.0	96.0	151.2

Source) JICA Study Team

A14.5 Riverbed materials

The Study Team carried out measurement of riverbed materials, these samples were taken from a total of twenty eight (28) points consisting of the same twenty (20) points as those in measurements of river water flow (current) and other eight (8) points from sand bars as seen in **Figure A14.4.1**

These samples were taken from two (2) depths comprising the surface of riverbed and 0.50 to 0.55 m below the ground. Specific gravity (ASTM, D854) and analysis of grain size distribution by sieve test and hydraulic test (ASTM D422), were carried out at the laboratory to identify grain sizes (diameter) of soil particles of d25, d50 (median diameter) and d75. These values are indispensably needed for analysis of navigation channel stabilization. Distributions map of d50 (median diameter) at surface of riverbed in the Survey Area is shown in **Figure A14.5.1**.

As can be seen in **Table A14.5.1** below, these sizes (d_{50}) at surface of river bed varies from 0.133 to 0.283 mm.

Table A14.5.1 Median Diameter of River Bed Materials in the Red River Segment

Diameter	Median Diameter (mm)	
	Surface of River Bed	0.5 m below River Bed
Maximum	0.283	0.301
Minimum	0.007	0.010
Average	0.133	0.120

Source) JICA Study Team

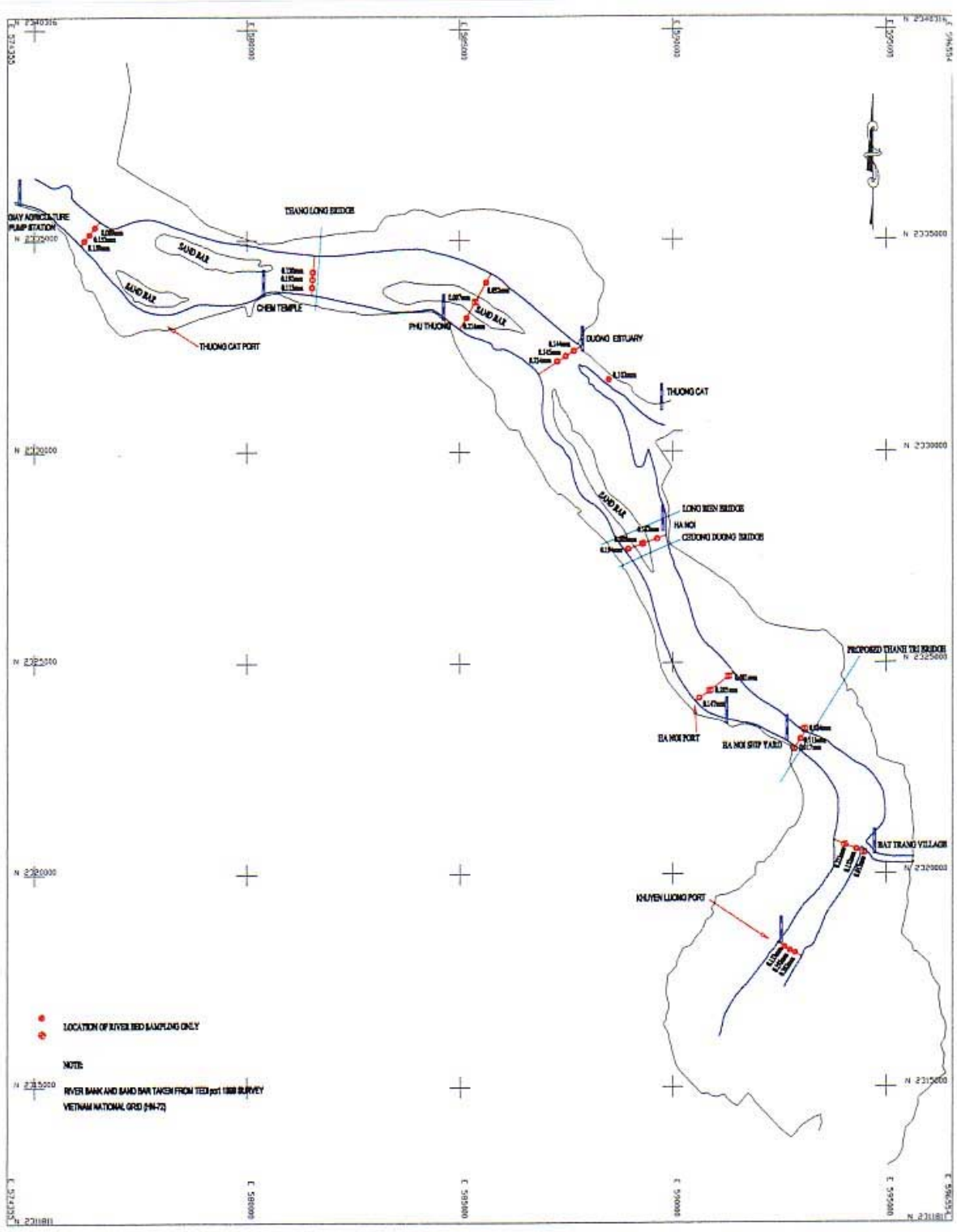


Figure A14.5.1 Distribution Map of Grain Size (d50:Median Diameter) at Surface of Riverbed in the Red River Segment

Source) JICA Study Team

A14.6 Topographic and bathymetric survey (Sectioning survey)

The Study Team carried out the topographic and bathymetric survey in the Survey Area by means of cross sectioning method at an average intervals in two hundred (200) m with a total two hundred (200) measuring sections. The result of the survey was incorporated in seven (7) sheets of topographic maps with a scale of 1/10,000 and 1/20,000, all levels are referred to National Land Survey Datum.

In this survey Vietnam National Grid (HN-72) was applied. The following geodetic parameters were applied in the survey.

- Spheroid : Krasovsky
- Semi major axis : 6,378,245m
- 1/flattening : 298.3
- Central meridian : 105 ° E
- False easting : 500 km

A network of control points for the survey were established based on traverse points developed from the 1999 survey by TEDI-Port and the 4th order bench mark GPS 4CT as seen in **Table A14.6.1** below.

Table A14.6.1 Coordinates and Elevation of Benchmarks

Name	Coordinate (HN-72, C.M105E)		Elevation (m) (HN-72)
	Northing (m)	Easting (m)	
GPS4CT	2,322,241.584	592,908.076	14.203
H8-7/1	2,328,609.445	587,629.374	14.442
H8-6/4	2,330,141.062	586,503.963	14.288

A14.7 Geotechnical conditions

(1) Existing study on geotechnical investigation

The following limited existing reports on geotechnical investigation carried out in the related areas of Red River Segment were collected by the Study Team.

- The Feasibility Study on Thanh Tri Bridge and the Southern Section of Ring Road No3 in Hanoi, JICA, September 1998 by Pacific Consultants International
- Geotechnical Investigation for Engineering Design of No. 7 Berth, No. 8 Berth and Embankment of Hanoi Port, 1999 by TEDI-Port
- Geotechnical Investigation for Engineering Design of No. 7 Berth of Hanoi Port, January 1996 by TEDI-Port
- Geotechnical Investigation for Feasibility Study of Expansion and Upgrading of Khuyen Luong Port, July 1997 by Maritime Construction Consultants Corporation

According to these existing study reports, the soil characteristics in the survey area were briefly summarized as mentioned hereinafter.

(a) Thanh Tri bridge

b) Bearing layer

According to a result of standard penetration test carried out at intervals of one (1) meter with a total boring holes of nineteen (19) at the location of the planned Thanh Tri bridge, it is found that elevation where N - value reached 50 or more (i.e. bearing layer for pile foundation) appears from –26.21m to –50.11m as shown in **Table A14.7.1** below.

Table A14.7.1 Elevation of Bearing Layer at the Planned Thanh Tri Bridge

Boring No	Elevation of N-value reached 50 and more (m)	Boring No	Elevation of N-value reached 50 and more (m)
1	-31.53	11	-32.59
2	-33.44	12	-40.40
3	-43.46	13	-34.39
4	-28.90	14	-26.21
5	-50.77	15	-35.32
6	-32.68	16	-35.28
7	-31.44	17	-38.06
8	-34.17	18	-39.57
9	-35.51	19	-38.10
10	-33.99		

Source) The Feasibility Study on Thanh Tri Bridge and the Southern Section of Ring Road No3 in Hanoi, JICA, September 1998 by Pacific Consultants International

c) Soil strength

Based on the results of direct shear, unconfined compression and triaxial compression tests of undisturbed soil samples obtained from alluvium stratum, the soil design characteristics, applied for slope stability analysis of the road/embankment structures were determined in his study as shown in **Table A14.7.2** below.

Table A14.7.2 Design Soil Strength at the Planned Thanh Tri Bridge

Test	Angle of internal friction (ϕ)	Cohesion C (kg/fcm^2)
Direct shear	15	0.15
Unconfined compression	16	0.25
Triaxial compression	12	0.26
Design condition	**15**	**0.25**

Source) The Feasibility Study on Thanh Tri Bridge and the Southern Section of Ring Road No3 in Hanoi, JICA, September 1998 by Pacific Consultants International, Consolidation Characteristics.

Based on the results of consolidation tests for undisturbed samples obtained from clay and silt layers, the design consolidation values were established in his study for consolidation settlement analysis as shown in **Table A14.7.3** below.

Table A14.7.3 Design Coefficient of Consolidation (Cv) and Consolidation Index (Cc) at the Planned Thanh Tri Bridge

Depth (m)	Coefficient of consolidation Cv (cm2/sec)	Consolidation index Cc
0-10	0.51×10^{-3}	0.10
10-20	0.43×10^{-3}	0.12
20-30	0.45×10^{-3}	0.14
Below 30	0.38×10^{-3}	0.28

Source) The Feasibility Study on Thanh Tri Bridge and the Southern Section of Ring Road No3 in Hanoi, JICA, September 1998 by Pacific Consultants International

(b) Ha Noi port

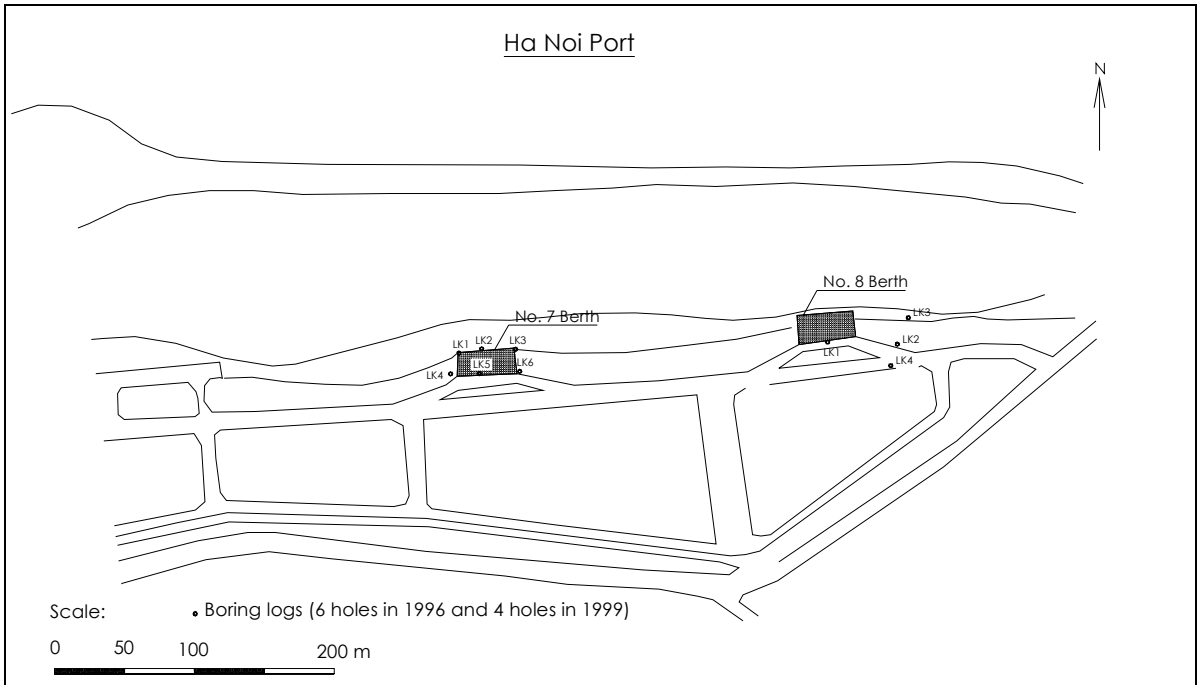
The Study Team collected the two (2) existing reports of geotechnical investigation carried out in 1999 (4 boring logs) and 1996 (6 boring logs) around Berth No.7 and Berth No.8, in this connection standard penetration test was not carried out in this investigation at Ha Noi port as seen in **Figure A14.7.1**.

Based on the results of laboratory tests in his reports, the Study Team prepared soil profile as shown in **Figure A14.7.2.**

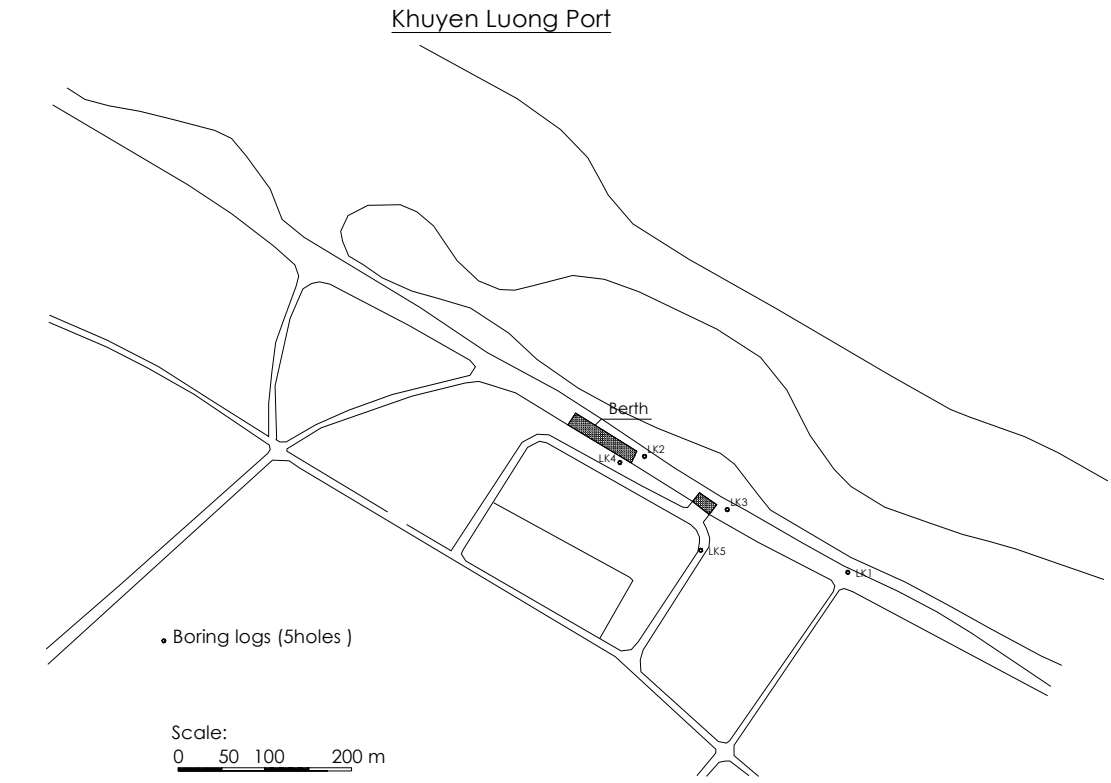
(c) Khuyen Luong port

The Study Team collected the existing report of geotechnical investigation carried out in 1997 (5 boring logs) along the face line of the planned berth, standard penetration test was not carried out too in this investigation at Khuyen Luong port as seen in **Figure A14.7.1**.

Based on the results of laboratory tests, the Study Team prepared soil profile as seen in **Figure A14.7.2.**



Source: Geotechnical Investigation for Engineering Design, 1996 and 1999



Source: Geotechnical Investigation for Feasibility Study of Expansion and Upgrading, July 1997

Figure A14.7.1 Location Map of Boring Holes in Existing Studies at Ha Noi Port and Khuyen Luong Port

Ha Noi Port

+6.00 m	
(1) SAND	Gs = 2.68 tf/m^3 γt = 1.81 tf/m^3 ϕ = 26^o to 30^o
+3.00 m	
(2) Midium dense silty SAND	γt = 1.75 tf/m^3 C = 1.60 tf/m^2 ϕ = 15^0
-7.00 m	
(3) Dense CLAY	γt = 1.90 tf/m^3 C = 1.70 tf/m^2 ϕ = 16^0
-26.00 m	

Source: Geotechnical Investigation for Engineering Design, 1996 and 1999

Khuyen Luong Port

+2.00 m to +0.30 m	
(1) Very soft sandy CLAY	Gs = 2.67 tf/m^3 γt = 1.79 tf/m^3 C = 0.90 tf/m^2
-0.10 m to -3.20 m	
(2) Silty SAND	γt = 2.00 tf/m^3 ϕ = 30^0
-16.70 m to -18.30 m	
(3) Very soft CLAY	γt =1.93 tf/m^3 C = 0.60 tf/m^2 ϕ = 30^0
-23.00 m to -24.70 m	

Source: Geotechnical Investigation for Feasibility Study of Expansion and Upgrading, July 1997

Figure A14.7.2 Soil Profiles in Existing Studies at Ha Noi and Khuyen Luong Port

(2) Result of geotechnical investigation by the Study Team

The Study Team carried out geotechnical investigation at the three (3) candidate sites for new port construction comprising Thuong Cat port, Van Kiep port and Khuyen port (layout of borehole location shown in **Figure A14.7.3(1))** . Total six (6) holes of under-water boring with a total boring length of about 210 m was carried out.

There are, generally the following two (2) main purposes in this geotechnical investigation.

- To confirm elevation and strength of bearing layer for pile foundation structure related to the project facilities including wharf, revetment and others.
- To confirm and establish design soil condition of soil stratum at the Survey Area.

1) Confirmation of bearing Layer

It is estimated that bearing layer (sand stratum) exists below 20 m depth from ground surface in the Survey Area. It is quite important to confirm the exact elevation of this bearing layer for the determination of design conditions, therefore, at least one (1) boring hole shall reach this bearing layer, then the depth of other one (1) boring hole shall be adjusted within a total length of two hundred and ten (210) m. Standard penetration test (SPT) to measure N-value and to obtain samples of disturbed soil were carried out at every one (1) m interval. And in case cohesive soil layer was found, sampling of four (4) undisturbed soil per hole were taken.

Table A14.7.4 Coordination and Elevation of Boring Holes

Location	Boring No.	Coordination (m)		Ground Elevation (m)	Boring Depth (m)	Bearing Layer (m)
		E	N			
Thuong Cat	TC1	577192.63	2334532.98	+2.6	29.00	-23.8
	TC2	577287.72	2334507.68	+3.2	29.05	-24.3
Van Kiep	VK1	589921.72	2325346.03	-4.4	38.20	-40.4
	VK2	589957.92	2325229.83	-4.2	37.75	-40.7
Khuyen Luong	TC1	592339.67	2318128.89	-0.7	32.40	-28.9
	TC2	592277.62	2318046.89	-0.7	32.00	-28.7

Note) Elevation of N-value reached 50 and more, express above NLSD
Source) JICA Study Team

As seen in **Figure A14.7.3(2)~(4)**, elevation of bearing layer exceeds N-value fifty (50) varies from about - 24 m to - 40 m.

2) Laboratory test

All samples to be used for laboratory test were obtained and testing works are undergoing now, the result will be incorporated in Interim Report later. The laboratory tests comprises the following items.

Table A14.7.5 Items of Laboratory Test

Disturbed Sample	ASTM	Undisturbed Sample	ASTM
Bulk density	Slide caliper method	Unconfined compression test	D2116
Specific gravity	D854	Triaxial compression test	CU
Grain size analysis	D422 (D_{25}, D_{50}, D_{75})	Consolidation test	D2435
Moisture content test	D2216		
Atterberg limit	D423 & D424		

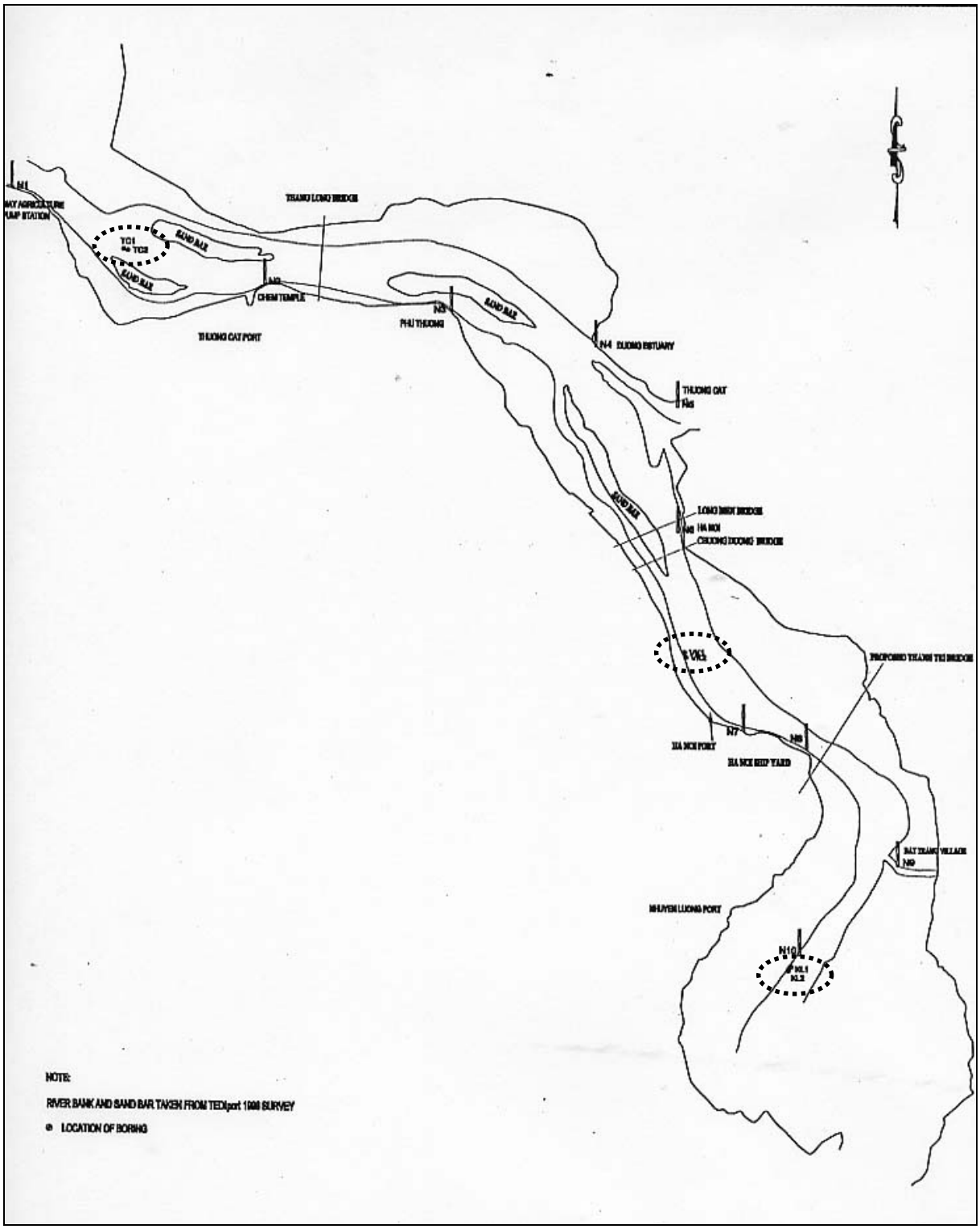


Figure A14.7.3 (1) Layout of Borehole Location

Source) JICA Study Team

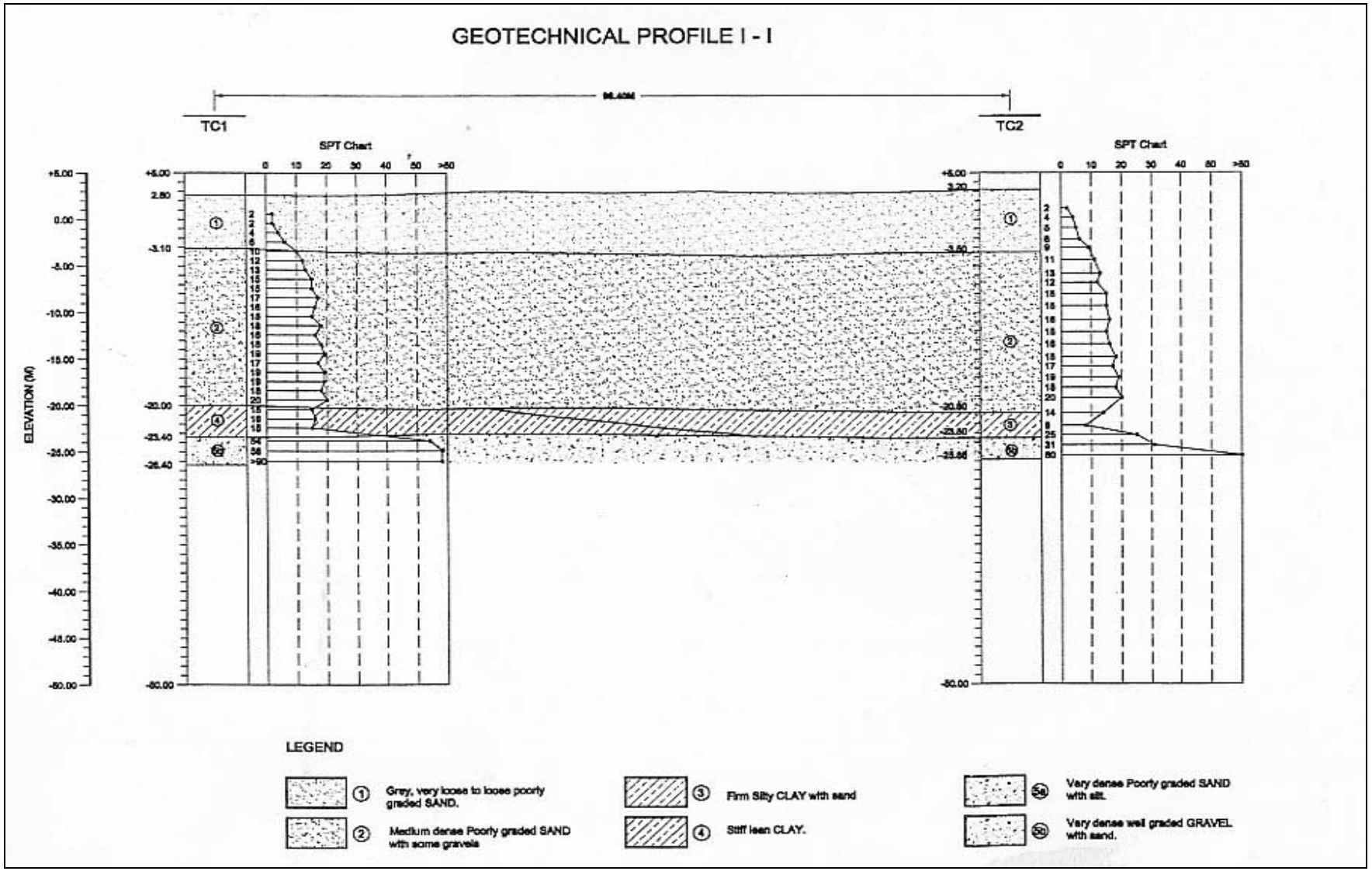


Figure A14.7.3 (2) Soil Profile in Thuong Cat Port

Source) JICA Study Team

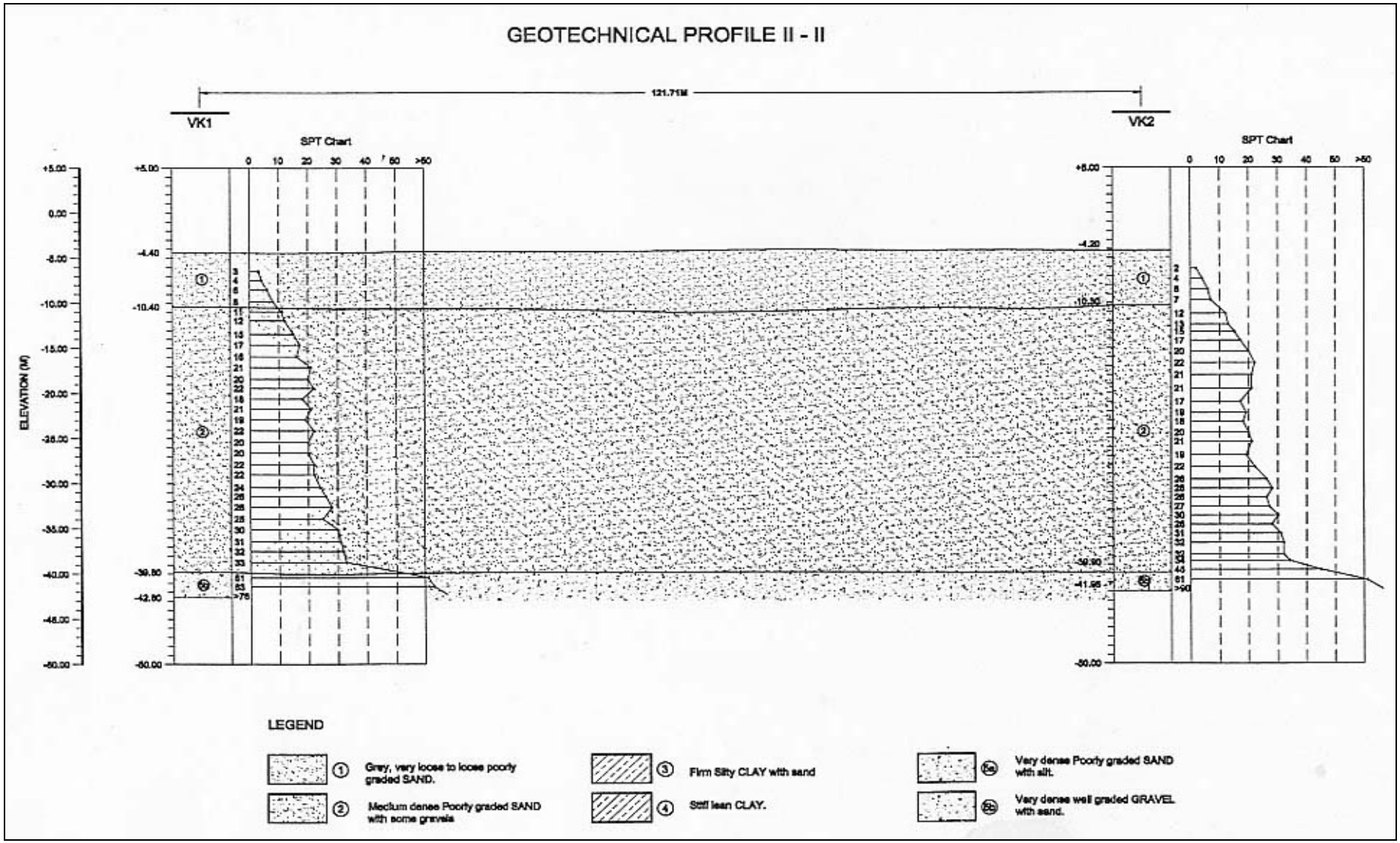


Figure A14.7.3 (3) Soil Profile in Van Kiep Port

Source) JICA Study Team

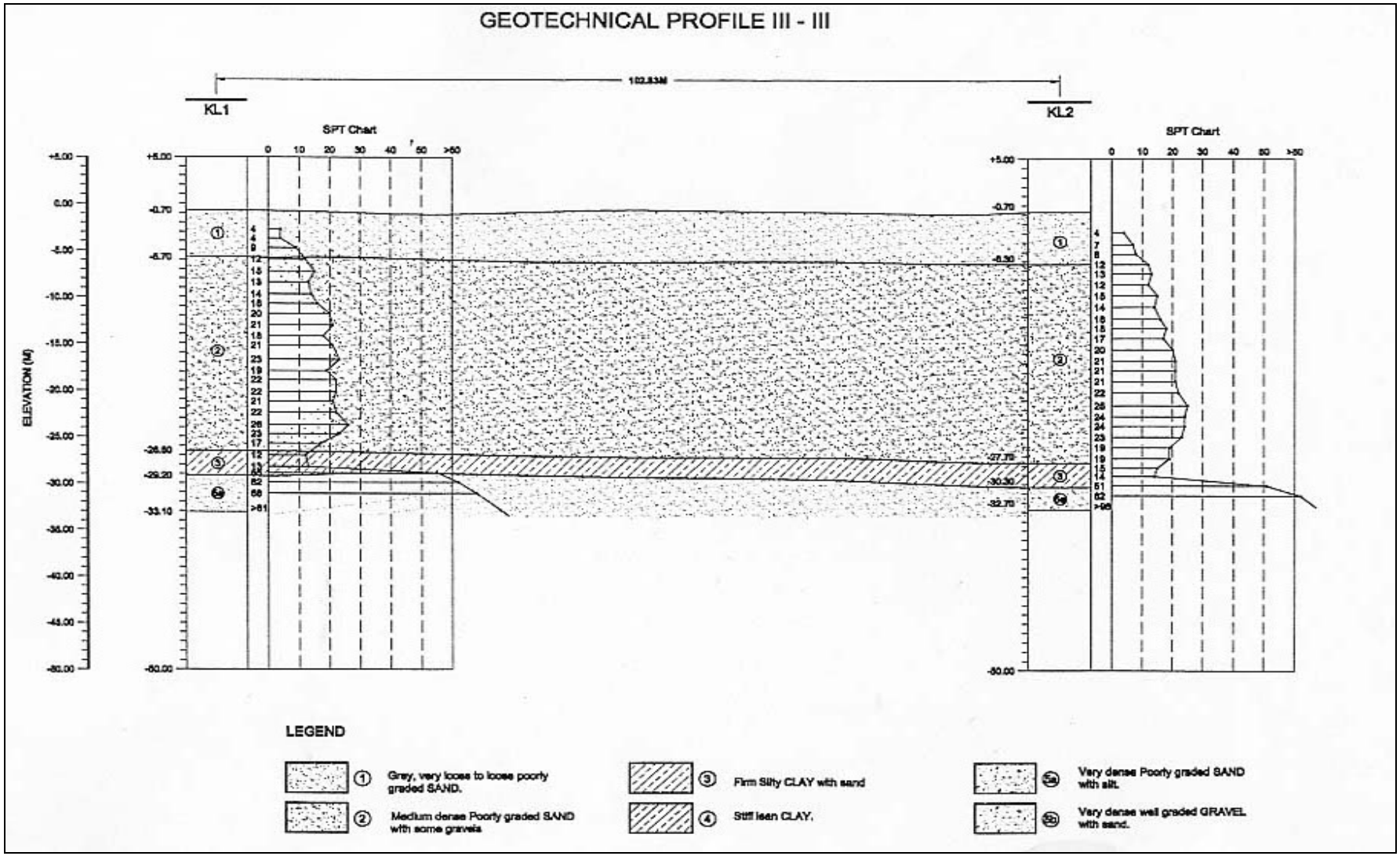


Figure A14.7.3 (4) Soil Profile in Khuyen Luong Port

Source) JICA Study Team