REPORT ON GEOLOGICAL STUDY

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CONTENT

LIST OF FIGURES

LIST OF TABLE

1. GENERAL

1.1. Introduction

This report covers the engineering geological study for the detailed design of the pipeline system from Dok Krai reservoir to Mab Ta Pud. All of the field work were done by Royal Irrigation Department (R.I.D.) under the supervision of a Japanese expert, a member of Japan International Cooperation Agency (JICA) team. The study started on Dec. 1, 1981, and most of the field work continued from Dec. 23, 1981 til the end of January 1982. After the field investigation, some laboratory test were done from the first week of February to the middle of February, 1982.

1.2. Location

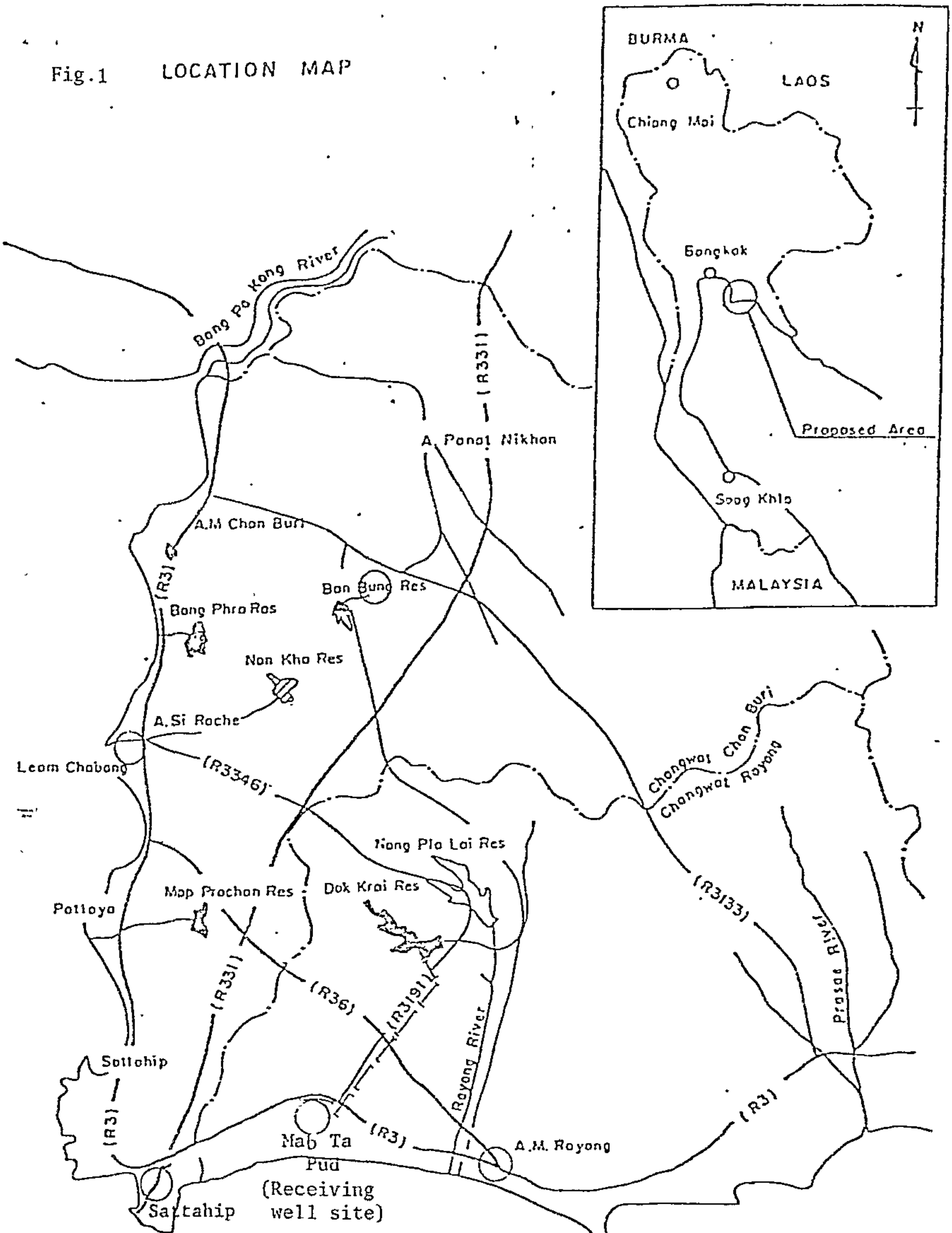
The water pipeline will run along the RID road from Dok Krai to the intersection to HWY # 3191, then along it about 19.2km to the intersection to HWY # 3 and there it will turn right to run further along HWY # 3 towards Sattahip about 4.9 km until it reaches the site of receiving facility at Ban Chak Luk Ya. Along the above pipeline route, there are some villages, like Ban Nichom and Ban Huai Pong, and streams. They are shown on Fig.1, 2, 4-1 ~ 4.

According to the survey report, the survey team has fixed OK + oo m point at Dok Krai yard temporarily. It is shown on Fig. 5 and can be refered to the survey report. All sites of boring, auger boring and test pit which are shown on Fig. 4 can be located at distances from the zero point of Dok Krai.

One of auger boring, Number A.3, is separated about 400 m away from the center of road. The point was survey for possible alternative location of the head tank.

* According to 1/50000 map, the receiving facility site is located at Ban Chak Luk Ya. However, as the name map Ta Pud has been commonly and widely used so far, this report also will use Mab Ta Pud in general, except in relation with the receiving facility site.

Fig.1 LOCATION MAP



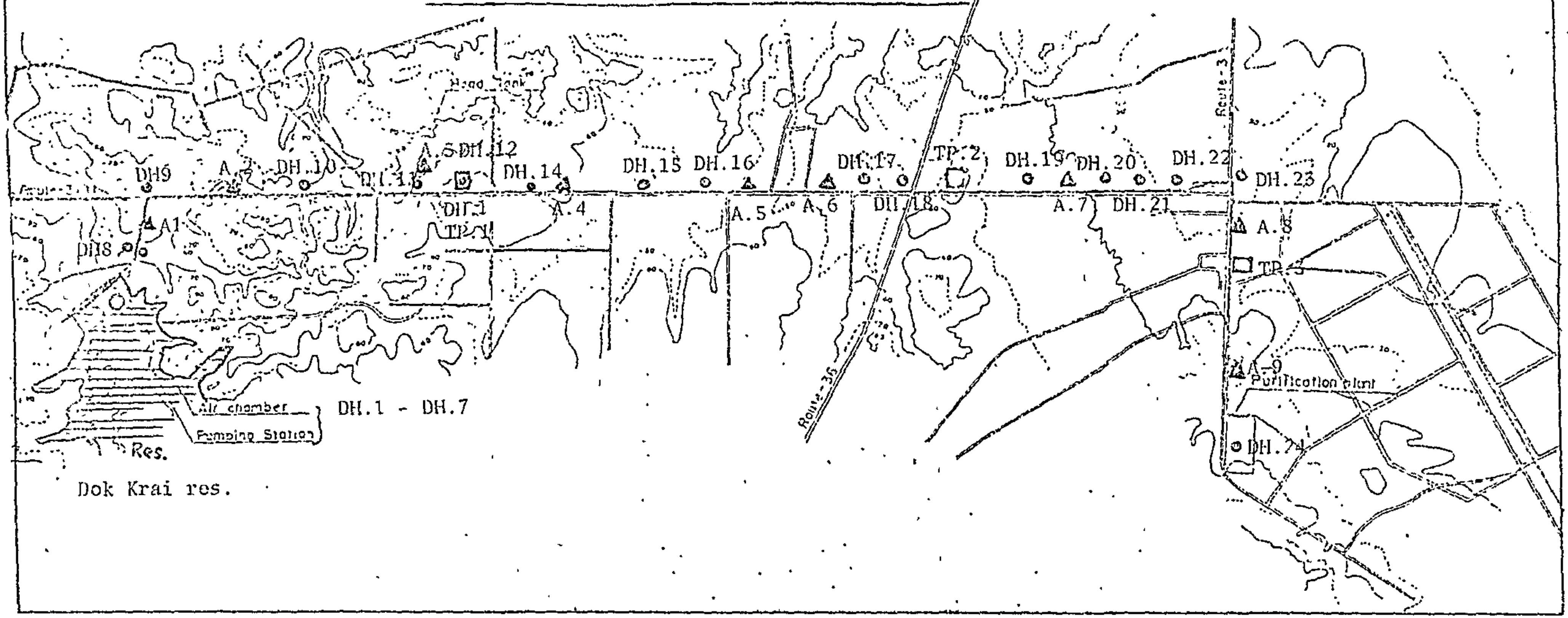
Existing Reservoir
Under Construction Reservoir
Proposed Reservoir
Center of Water Demand
Propose Water Transmission Line

5 0 10 20 30 km

Fig. 2

DOK KRAI TO MAB TA PUD

Boring sites Location Map



Legend

DH.1 .... Boring site

A.1 .... Augar boring site

TP.1 .... Test pit site

1.3. Topography and Geology

The general topography of project area is gently rolling. It can be divided into two parts. The first one is the hilly area, such as around Dok Krai, Ban Nikhom and the crossing of HWY # 36. The second one is the low plain developed along the main streams, such as Ban Map Kha, Ban Khlong Lot and near the crossing of HWY # 3. The altitude of the hilly area is 40-80 m above M.S.L., while that of the low plain less than 40 m above M.S.L.

The most parts of hilly area are cassava field and some are rubber plantation and the low plain are mostly of paddie field and land covered by palm trees dominantly. As for the general geology of the area, the basement is carboniferous granite. The low plain area is observed as some alluvial deposit consisting of sand, silty sand and clayey sand.
The granite area consists of layers. The surface layer, called decomposed granite, is made of residual soil on the top and rock beneath it. The rock part is also made of four sublayers, named and classified on the degree of weathering. From the top, they are highly weathered, moderately weathered, slightly weathered and fresh granite.

During the field survey, the granite rock was observed only at the intake and pump station site of Dok Krai reservoir. Except there, the rock was not seen along the pipeline route.

1.4. Subsurface explorations

The subsurface explorations were worked by Soil and Geological Division, RID, on the request of JICA survey team.
The purpose was to get the geological and soil condition's data for the detailed design of facilities, pipeline, etc.
All of boring logs shown as Appendix. The survey sites, shown on Table 1 and Fig.3-1~4, are described as below:

a) Intake and Pumping station including caisson yard

Intake and Pumping station	DHI-DH.5
	5 borings D = 10$\pm$m
Caisson yard	DH.6 DH.7
	2 borings D = 10m$\pm$

b) Head Tank — DH.12
1 boring D = 10m

c) Receiving facility area — DH.24
1 boring D = 9m
4 hand auger

d) Along the pipeline route include main reoad crossing and streams.
DH8 - DH.11
DH.13 - DH.23
15 borings D = 5m$\pm$
A.1 - A.9 D = 5m$\pm$
Test pit 3 points D = 3-4 m.

e) Borrow pits and Quarry sites near project area.

f) For the alternative plan of Head Tank site A.3 check 400 m East from the line.

The above mentioned works was started on Dec. 23, 1981 and finished on Jan. 20, 1982.
The following geological survey works were carried out for the data collection of defailed design.

a) Machine boring

Sampling	Boring recovery (core) were arranged in core boxes.
S.P.T.	Standard penetration test were done each one meter intervals and recovery were sealed in plastic bags for soil testing.
Log	As each boring, logs shown as Appendix
Water table	Water level was measured after finished boring.

b) Power auger boirng

Sampling	Soil sample were collected each one meter and each different soil types. Soil samples were sealed in plastic bags.
Log	As each auger hole, boring logs shown as Appendix
Water table	Water level was measured after finished auger boring.

c) Test pit

Sampling	Soil samples were collected each one meter Soil samples were sealed in plastic bags.
Log	As each test pit, soil logs shown as Appendix

d) Others — Hand auger borings were added at Receiving facility area for check the water level

<u>Point setting and levelling</u>

Point setting and levelling of boreholes and test pits were done in cooperation with the ground survey team.

Table 1 List of Boring and Location

Drill Hole No.	Depth (m)	Elevation (m)	Water level (m)	Location
DH - 1	10.20	38.41	+ 12.19	Intake tower in Res.
2	9.95	40.51	+ 10.09	
3	10.50	45.31	5.29	
4	10.30	51.20	- 0.90	Abutment
5	11.10	53.80	- 2.57	Air chamber
6	10.30	48.56	+ 2.04	Caisson yard
7	12.30	52.47	- 1.75	
8	5.10	36.38	- 0.25	ok+601,L=28
9	7.30	64.53	- 5.25	1k+524,L=14
10	5.09	52.37	- 0.45	4k+183,L=20
11	6.30	68.39	- 4.30	6k+242,L=17
12	10.20	81.79	-	6k+852,L=71
13	7.30	80.38	-	6k+814,L=14
14	5.45	50.01	- 0.50	8k+487,L= 9
15	4.09	31.51	+ 0.20	10k+078,L=14
16	5.25	30.06	- 0.20	10k+969,L=17
17	5.22	37.07	- 0.50	14k+310,L=24
18	7.30	52.67	- 7.02	14k+805,L=28
19	7.30	29.89	- 0.88	16k+686,L=26
20	6.30	27.56	- 0.55	18k+280,L=26
21	6.28	28.85	- 0.95	18k+685,L=28
22	10.25	29.77	- 0.38	19k+441,L=36
23	7.09	25.75	- 0.25	20k+741,L=20
24	9.07	58.22	- 1.70	25k+514,L=20

Auger No.	Depth (m)	Elevation (m)	Water level (m)	Location
A - 1	5.50	53.28	-	1k+054,R=12
2	4.40	59.70	-	2k+827,L= 9
3	5.00	76.11	-	6k+308,L=400
4	5.00	54.32	-	9k+171,L=14
5	4.40	53.19	-	12k+360,L=16
6	5.25	37.51	- 0.21	13k+740,L=28
7	5.00	32.01	- 1.10	17k+742,L=25
8	5.00	44.94	-	21k+945,L= 9
9	5.60	43.71	- 0.50	24k+240,L=17

Test Pit No.	Depth (m)	Elevation (m)	Water level (m)	Location
TP - 1	4.00	80.38	-	6k+814,L=14
2	3.00	57.55	-	15k+556,L=33
3	4.00	46.61	-	23k+301,L=18

1.5. Material Survey

For the construction of pipeline at the site, some materials must be studied, as shown below:

a) Sand for sand bed and aggregate
b) Crushed stone for concrete aggregate
c) Embankment materials at Receiving Well

As for sand, there are some sand borrows near Rayong. Some of them were surveyed and collected samples for testing at laboratory.
For the crushed stone, there are two commercial crushed stone mills at near Sattahip and east of Rayong.
Some crushed stone samples collected from the mill, for testing at laboratory.

For the embankment, soils from receiving facility area and two borrows are surveyed. Soil samples were tested at laboratory.

1.6. Laboratory Testing

Some of soils and other samples were collected at the field. These samples were tested at Research and Laboratory Division RID.

The tested items and numbers are described as follows.

Sample numbers and tested items

a) Soil Samples

1)	DH-1 to DH-24,	24 samples
2)	A-1 to A-9,	8 samples
3)	TP-1 to TP-3,	9 samples
4)	Receiving well site	1 samples
5)	Sand borrow pits	4 samples
6)	Others from borrow area	2 samples
	Total	48 samples

These samples were tested on the following methods of testing:

1) Gradation Test (Include Hydrometer)
2) Atterberg Limit Test
3) Soil Classification
4) Natural Water Content
5) PH Test
6) Organic content and Nacl content for Sand borrow pits
7) Compaction test (9 samples from Test Pits) and Permeability Test (3 samples from TP-2, TP-3, 3 meter depth, and 1 sample from Receiving well)

b) Rock Samples

1)	DH-1 - DH-2, DH-4	5 samples
2)	Aggregate	1 sample
	Total	6 samples

These samples were tested on the following methods of testing:

1) Uniaxial compression test for DH-1 - DH-2, DH-4 boring core.
2) Los Angels test (Abration by use of the Los Angels - Machine)

Soil tests were done to get a general properties of soil and other samples were tested for the usefull data for the design and construction.

Soil tests were done according to the ASTEM and USBR standard.
All of the test data shown as Appendix.

1.7. Specific resistance of surface soil and water

Along the proposed pipeline route, from Jan. 28 to Feb. 5 1982, the test was made to obtain a basic data of the condition of soil and water for the detailed design. The field tests was done at 80 points, using OHM METER II of the Nippon Corrosion Engineering Co., Ltd, along the proposed pipeline route from Dok Krai reservoir to the receiving facility area.

2. ENGINEERING GEOLOGY

2.1. Geology along the proposed pipeline route

Along the proposed pipeline route, the subsurface explorations using boring machines and test pit were made.
The result of these investigations, shown of fig.3 to fig.4-1 ~ 4 are the geological map and profiles from Dok Krai to Mab Ta Pud. According to the investigation, the basement of project area consists of granite, and some of the alluvial deposit covers the streams bed and low plains. The surface of granite is weathered highly and turned to the decomposed granite. The top most of this decomposed granite is covered with the residual soil which originated from granite.
According to the surface explorations, from 4 m to 10 m below the ground surface, no rock can be observed except at the intake and pumping station site of Dok Krai reservoir. The alluvial deposits observed along the streams and low plain, mainly consist of the sand, silty snad and clayey sand layers. The thickness of these layer is 3 m to 9 m approximately.
According to the result of Standard Penetration Test(S.P.T.), generally the blow count (N-value) becomes larger, following the depth. These relation is shown on table. 2 as blow count vx. depth. As shown on table. 2 , the blow count of decomposed granite layer is 2 to above 50. As for the alluvial deposit layer the blow count is 1 to 48.
From the surface to 3 m depth, the blow counts are mostly less than 30 except at some places. Also, the observation of digging the test pits proved that excavation was not difficult as the earth was not hard.
3 m is the approximate depth of ditch for laying 1.35 m dia. pipe.
Within the depth and below it, there is no layer which is seemingly too soft to lay the pipe, it was found during the survey.

Table. 2 Blow count vs. Depth

Depth / DH.No.	0	1	2	3	4	5	6	7	8	9	10	11	12 (m)
DH 1		40	50	50	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +		
" 2		4	18	50	+ + + +	+ + + +	+ + + +	+ + + + (granite rock)	+ + + +	+ + + +	+ + + +		
" 3		2	5	16	25	38	23	+ + + +	+ + + +	+ + + +	+ + + +		
" 4		8	7	20	24	24	30	21	32	+ + + +	+ + + +		
" 5		6	6	6	18	16	27	16	22	50	50	50	
" 6		3	6	36	27	24	38	40	50	50			
" 7		12	11	9	10	16	16	34	18	37	24	48	50
" 8	1	5	15	30	29	50							
" 9	36	33	24	24	16	15	10						
" 10	2	2	16	17	50	50							
" 11		5	11	22	17	16	23						
" 12		48	40	39	40	36	31	38	50	50	50		
" 13		14	19	15	15	25	28	29					
" 14	2	2	11	3	15	50							
" 15	1	8	50	50	50								
" 16	1	26	48	41	47	50							
" 17	[illegible]	7	9	10	25	50							
" 18		12	10	10	20	28	24	30					
" 19		2	19	6	22	22	34	44					
" 20		8	15	15	24	30	45						
" 21		4	7	9	27	30	50						
" 22		7	5	5	14	15	22	31	21	40	50		
" 23		5	1	25	46	26	30	50					
" 24		9	9	18	31	36	36	49	43	50			

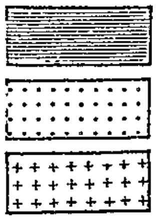
Alluvial deposit

Decomposed granite

Granite rock

Fig. 3 Explaination of geological map

(From Dok Krai to Mab Ta Pud)



Alluvial deposit

Decomposed granite (Include residual soil)

Granite rock (Highly weatherd to fresh)

DH-1 Boring site

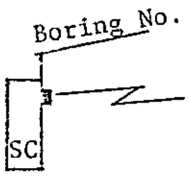
A-1 Power auger boring site

TP-1 Test pit site

Well

Water table

The area that ground water level shallow than 3.00 m. from the surface (checked on Jan.24)



blow count

unified soil classification

Typical names

Group Symbols		Group Symbols	
GW	Well graded gravels, gravel-sand mixtures, little or no fines.	ML	Inorganic silts and very fine-sands, rock flour, silty or clayey fine sands with slight plasticity.
GP	Poorly graded gravels,gravel-sand mixtures, little or no fines.	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays,silty clays,lean clays.
GM	Silty gravels,poorly graded gravel-sand-silt mixtures.	OL	Organic silts and organic silt-clays of low plasticity.
GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.	MH	Inorgonic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
SW	Well graded sands,gravelly sands; little or no fines.	CH	Inorganic clays of high plasticity, fat clays.
SP	Poorly graded sands, gravelly sands; little or no fines.	OH	Organic clays of medium to high plasticity.
SM	Silty sands,poorly graded sand-silt mixtures.	PT	Peat and other highly organic soils.
SC	Clayey sands,poorly graded sand-clay mixtures.		

Unified soil classification after Earth Manual

Fig. 4-1 Geological Map from Dok Krai to Mab Ta Pud
(0K-500^{m} to 7k+00^{m})

Scale H = 1:20,000
V = 1:500

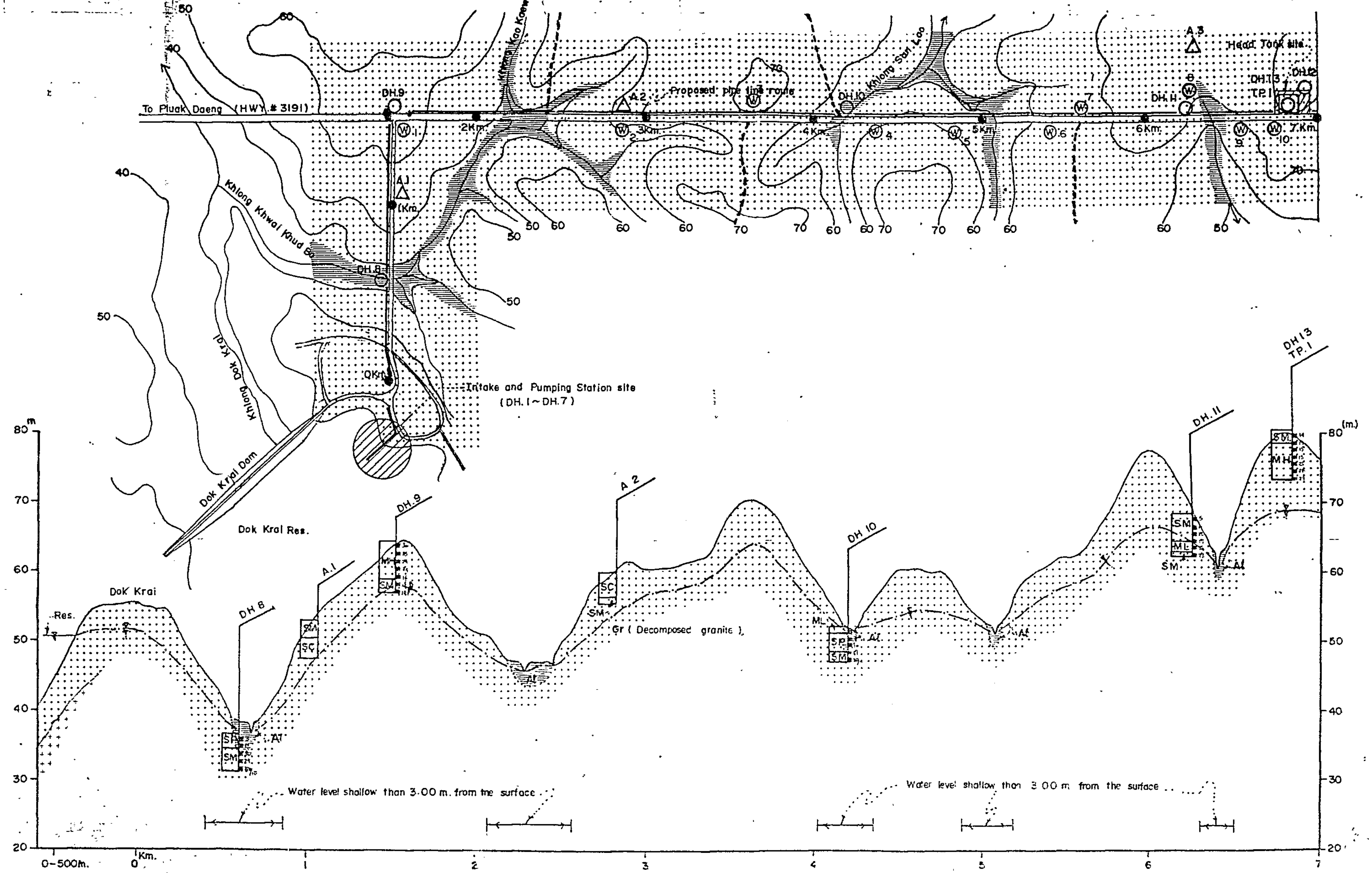
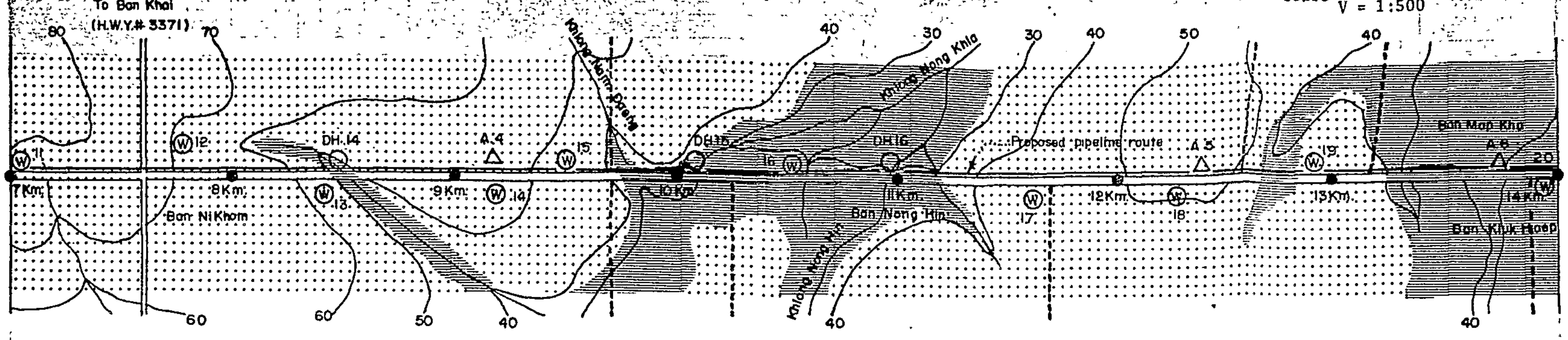


Fig. 4-2 Geological Map from Dok Krai to Mab Ta Pud (7k+00m to 14k+00m)

Scale H = 1:20,000 V = 1:500



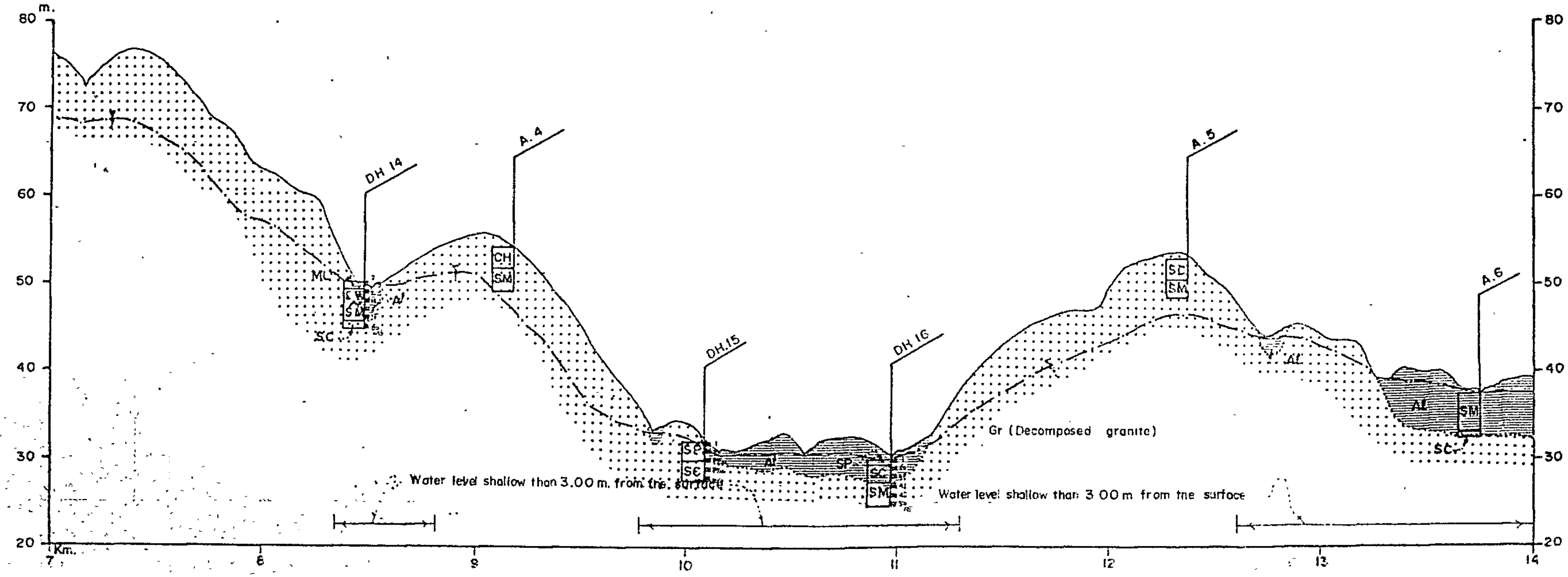


Fig. 4-3 Geological Map from Dok Krai to Mab Ta Pud
(14k+00m to 21k+00m)

Scale H = 1:20,000
V = 1:500

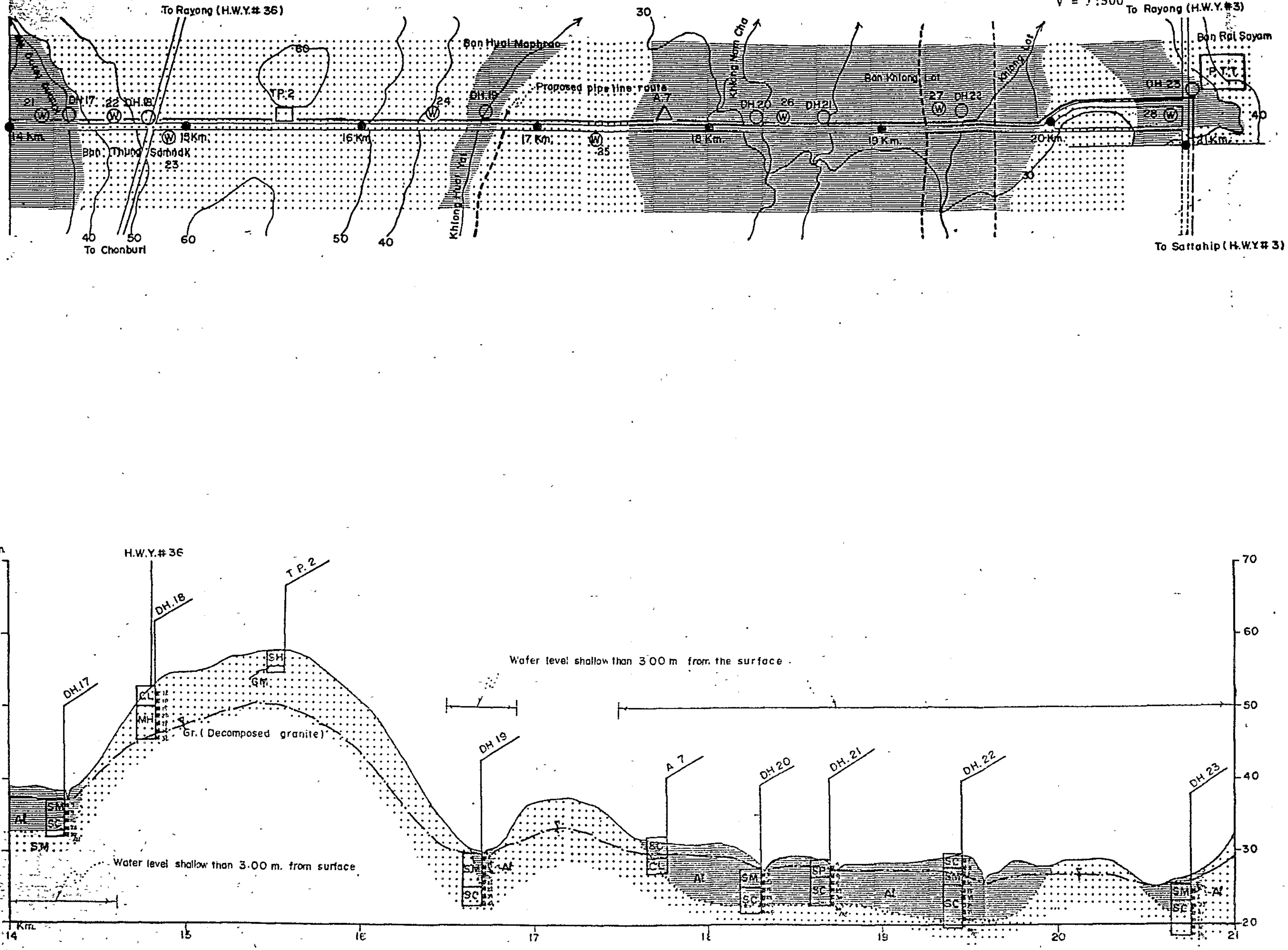
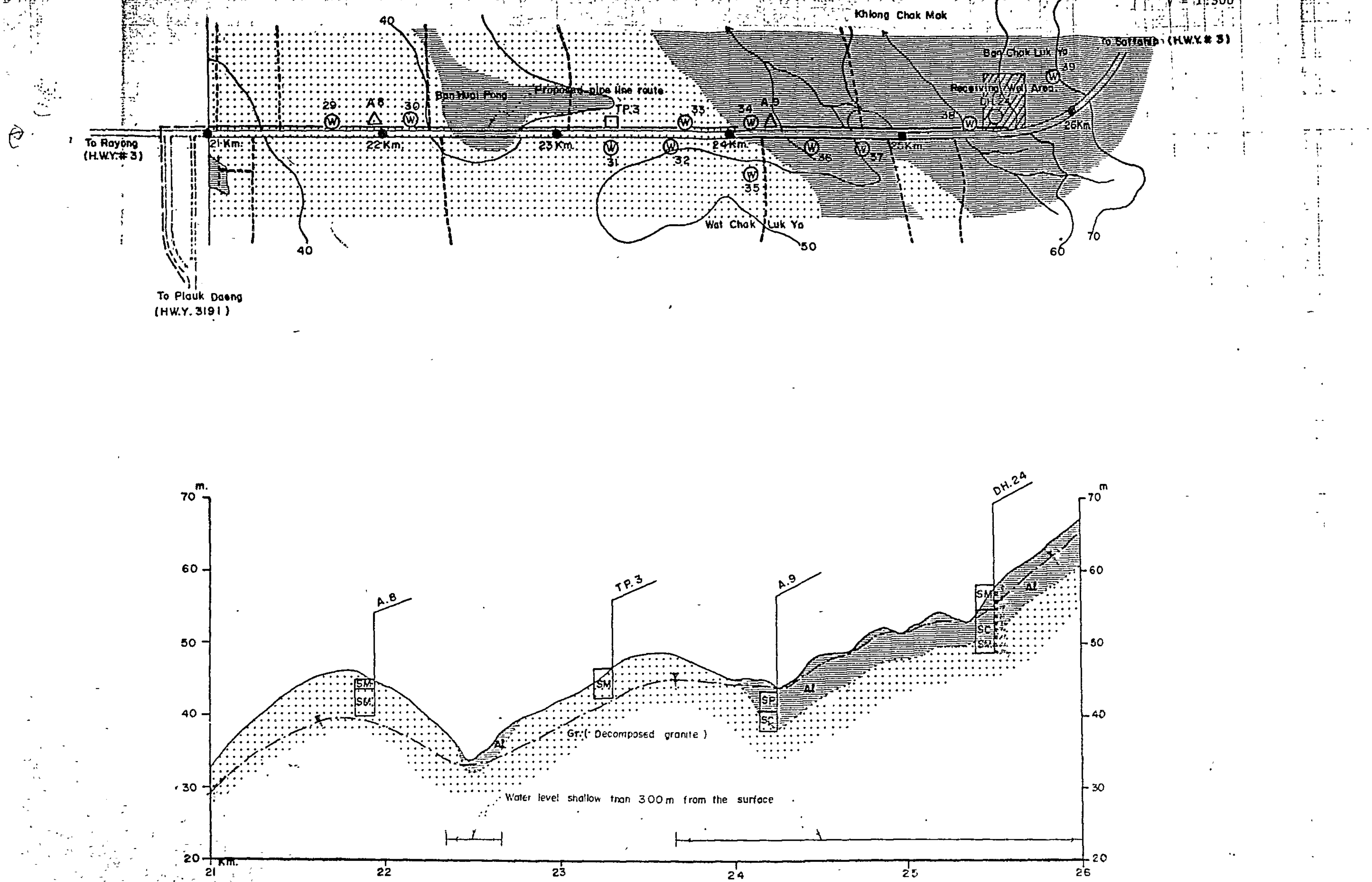


Fig. 4-4 Geological Map from Dok Krai to Mab Ta Pud

($21k+00^{m}$ to $26k+00^{m}$)

Scale H = 1:20,000
V = 1:500



2.2. Geology at Sites of Major Facilities

2.2.1. Intake and Pumping Station

Seven borings were made to study the foundation condition of the intake tower and pumping station, and the caisson yard at the right bank of Dok Krai reservoir.
Fig.5 shows the location of borings and related geological profiles. Fig.6 shows the geological progile of the intake and pumping station in a larger scale.
The geology can be classified roughly to two layers. One is of the decomposed granite at the top and the other is of the granite rock at the bottom.
Covering the said top layer, there is a thin clay or clayey sand layer, submerged in the water of reservoir. The thickness varies from 0.2 to 0.5 m depending on the location of boring. The depth of decomposed granite is 10 m or more on the shore and it becomes thinner gradually as it goes towards the center of reservoir. At the site of intake, it is 3.5 m.
The boirng test shows that the layer of granite rock can be divided into four sublayers, depending on the degree of weathering. They are highly-weathered, moderately-weathered, slightly-weathered and fresh granite, from the top downwards. Fig. 6 shows the geological profile of the layers, shaded differently. The fresh and slightly-weathered granite are of the same shade on the figure.
The depths of highly and moderately-weathered granite are 1 to 2 m and 1 to 5 m respectively.
The blow counts of decomposed granite were also made. Around the intake site, a blow count from 3 m depth underground shows the count of more than 50. At the onshore area including the caisson area, the blow counts generally grow larger as the depth increases. The counts below 8.0 m depth are mostly above 50. The soils are generally SW, SM and

SC by classification, corresponding sand, silty sand and clayey sand by commonly used name. At the onshore, some soils are CL, sandy silt, and ML, sandy clay.

The permeability tests were made in Dok Krai area. Digging two small pits, the permeability was measured at different depth. The results are tabulated as follows;

Site	Coefficient of Permeability (k)	Depth
Dok Krai Yard	6.53×10^{-6}	Surface
Borrow area	4.11×10^{-6}	3 m

The permeability of caisson yard area falls in the range of moderately impervious.

Fig. 5 Location map of Boring sites at Intake and Pumping station (with geological profiles)

Scale H = 1:2,000
V = 1:500

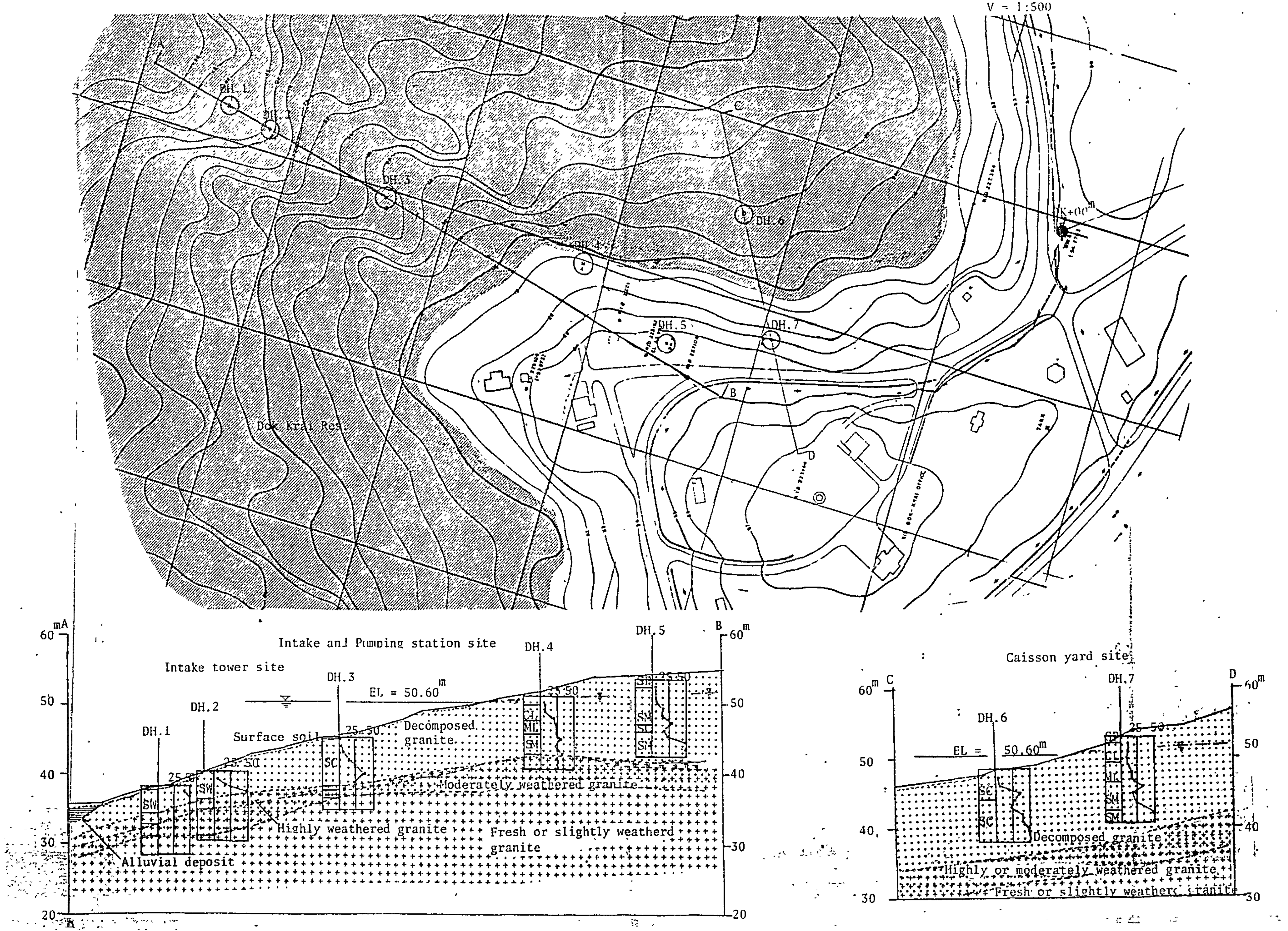
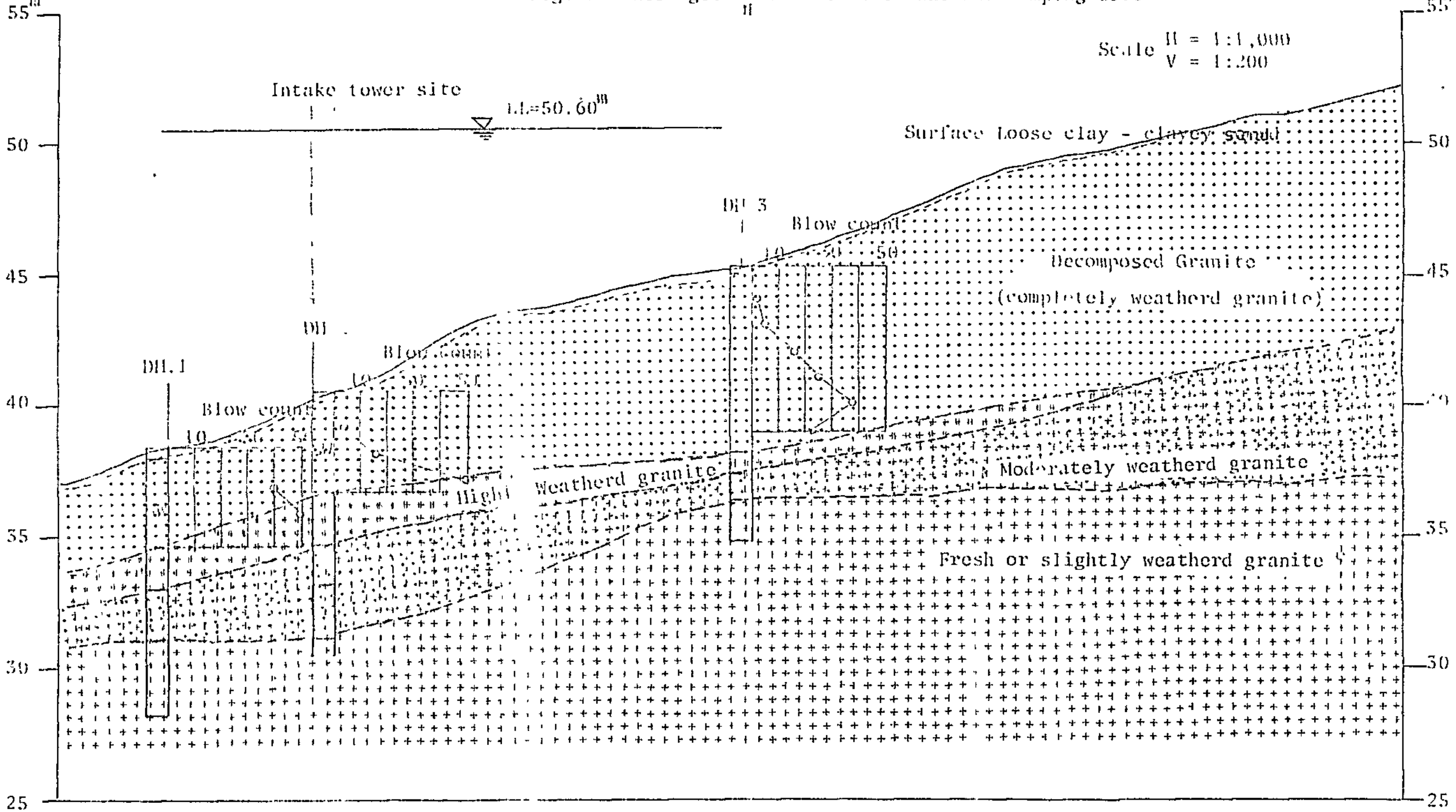


Fig. 6 Geological Profile at Intake and Pumping site



2.2.2. Head Tank Site

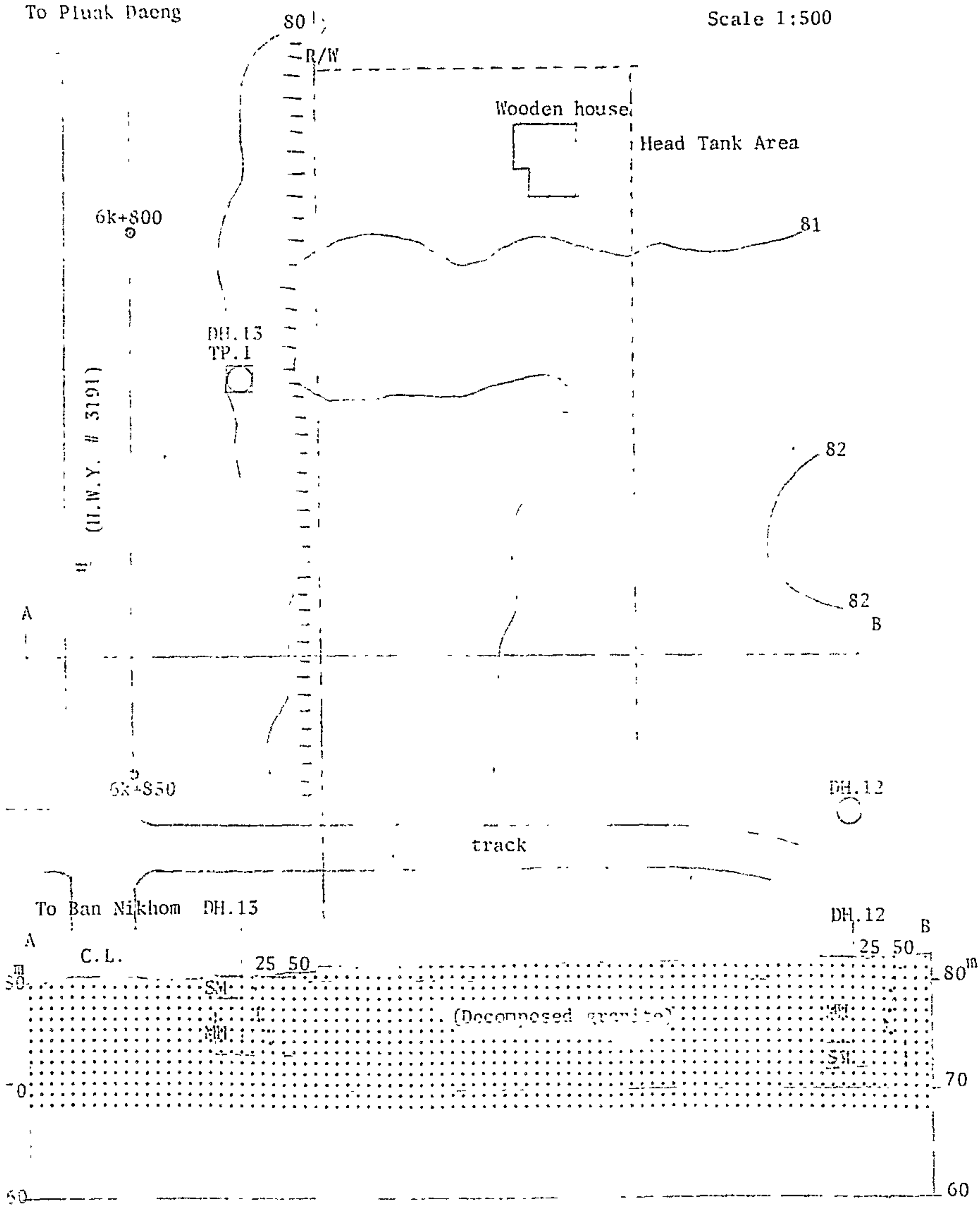
At the head tank site, two borings and one test pit digging was made. The location and geological map can be seen on Fig.7 .

The area is mostly of decomposed granite geologically. At DH.12, no rock was observed from the surface to the bottom and SPT blow count was above 30 throughout the depth. At DH.13 the count was less than 30 from the top to the bottom, 7.30 m underground.

The difference can be due to the degree of weathering.

The laboratory test showed that the soil of the area is classified into SM and MH of technical terms or silty sand an silt of common language.

Fig. 7 Location Map of Head Tank Site
(with geological profile)



2.2.3. Receiving Facility Site

At the receiving facility site of the pipeline, Ban Luk Ya, one boring (DH.24) and four hand-auger borings were made. The hand-auger boring is for studying the underground water table. The location and geological map can be seen on Fig.8

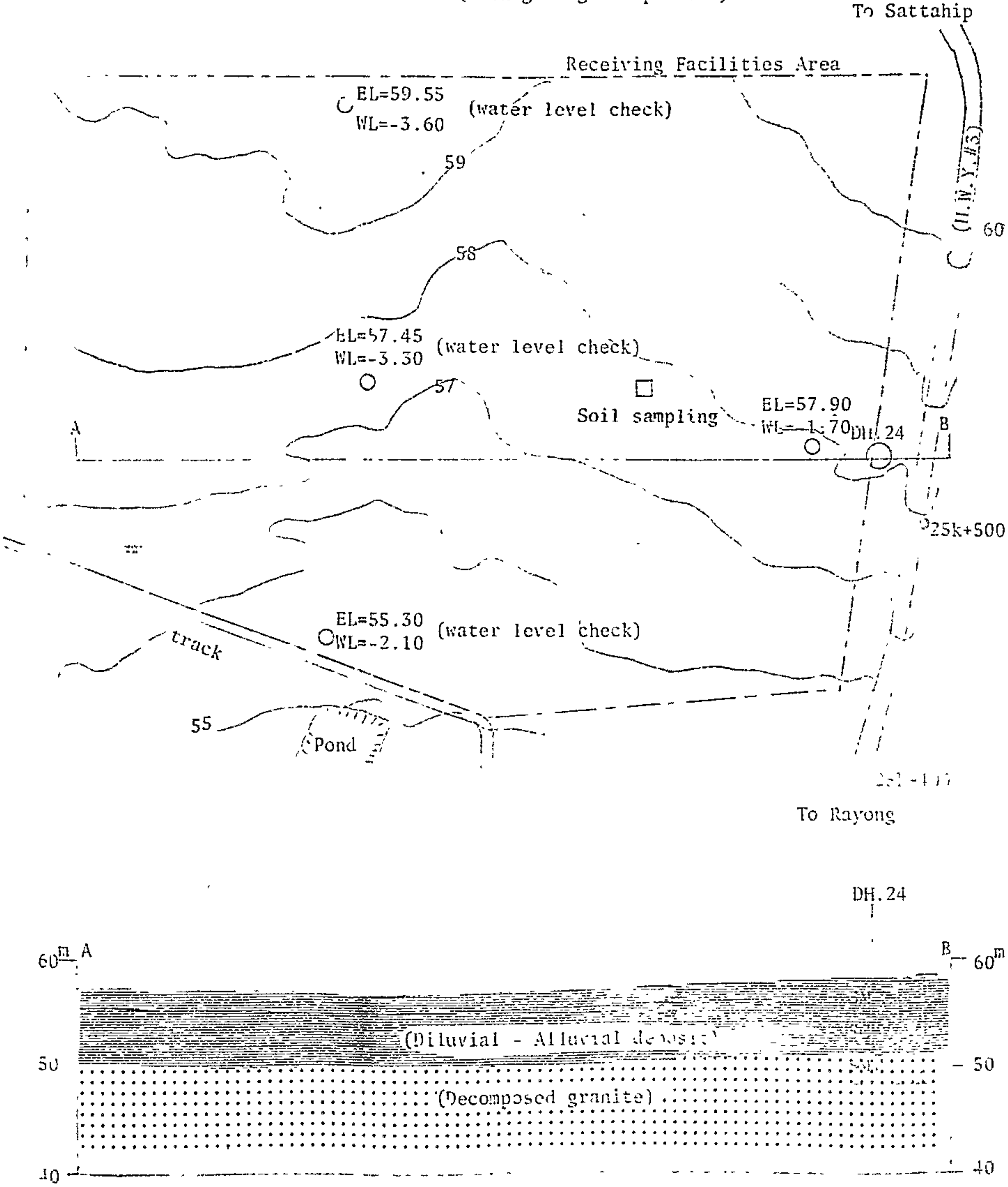
The investigation's results are that the area is of the decomposed granite geologically and the surface is covered with the diluvial or alluvial deposit.

The depth of the surface deposit is about 7 m. According to SPT at DH.24, the blow count becomes larger following the depth. Below 4 m depth it is more than 30 except at 6 m depth. The laboratory test showed that the soil of the area is classified as SM and SC, meaning silty sand and clayey sand.

The underground water table is rather shallow in the area, it being 1.70-3.60 m below the surface where the measurement is made. On the average, the underground water level is around 56 m MSL at the receiving facility site during the dry season.

In the rainy season, the level will come up by 0.5-1.0 m according to the villagers' words.

Fig.8 Location Map of Receiving Facilities Area
(with geological profile)



2.2.4. Crossing Main Roads

The pipeline route includes the crossing of roads, HWY.s # 3191, 3371, 36 and 3, of which HWY.s # 36 and 3 have heavy traffic.
As the jacking method may possibly applied for the crossing, boring was made at each of the HWY.s # 36 and 3 site to investigate the soil condition.

a) HWY # 36, DH.18
The location and geological map can be seen on Fig.9 .
The geology is of decomposed granite here and by SPT, the blow counts is about 10 to 2 m depth and it grows to 20 to 30 below 3 m depth. By the laboratory test, the soil belongs to CL and MH, meaning sandy clay and clayey sitlt with sand respectively.

b) HWY. # 3, DH.23
DH.23's location and geological map is on Fig.10 .
The geology is of decomposed granite with the surface layer of alluvial deposit.
SPT shows that the blow count is 1 to 3 to 2.6 m depth, the layer being consisted of loose silty sand. Below the depth, the blow count is above 20 and it becomes 50 at the bottom, 7 m deep from the surface.
The alluvial deposit is classified as SM, meaning silty sand and the decomposed granite, classified as SC, is clayey sand.
The underground water table is rather high here, being found at 0.25 m from the surface in the borehole.

Fig.9 Location Map of Road Crossing at H.W.Y.#36
(with geological profile)

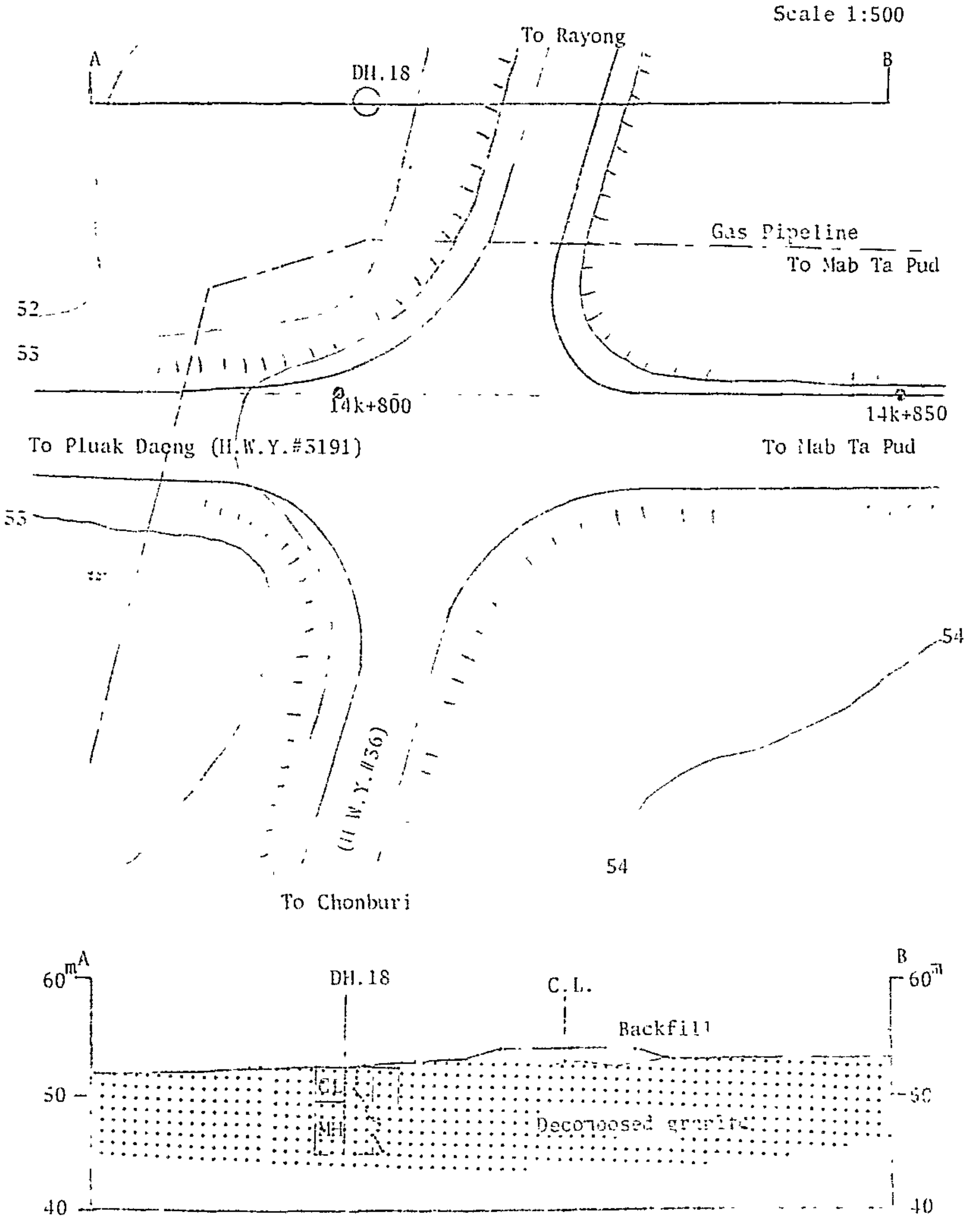
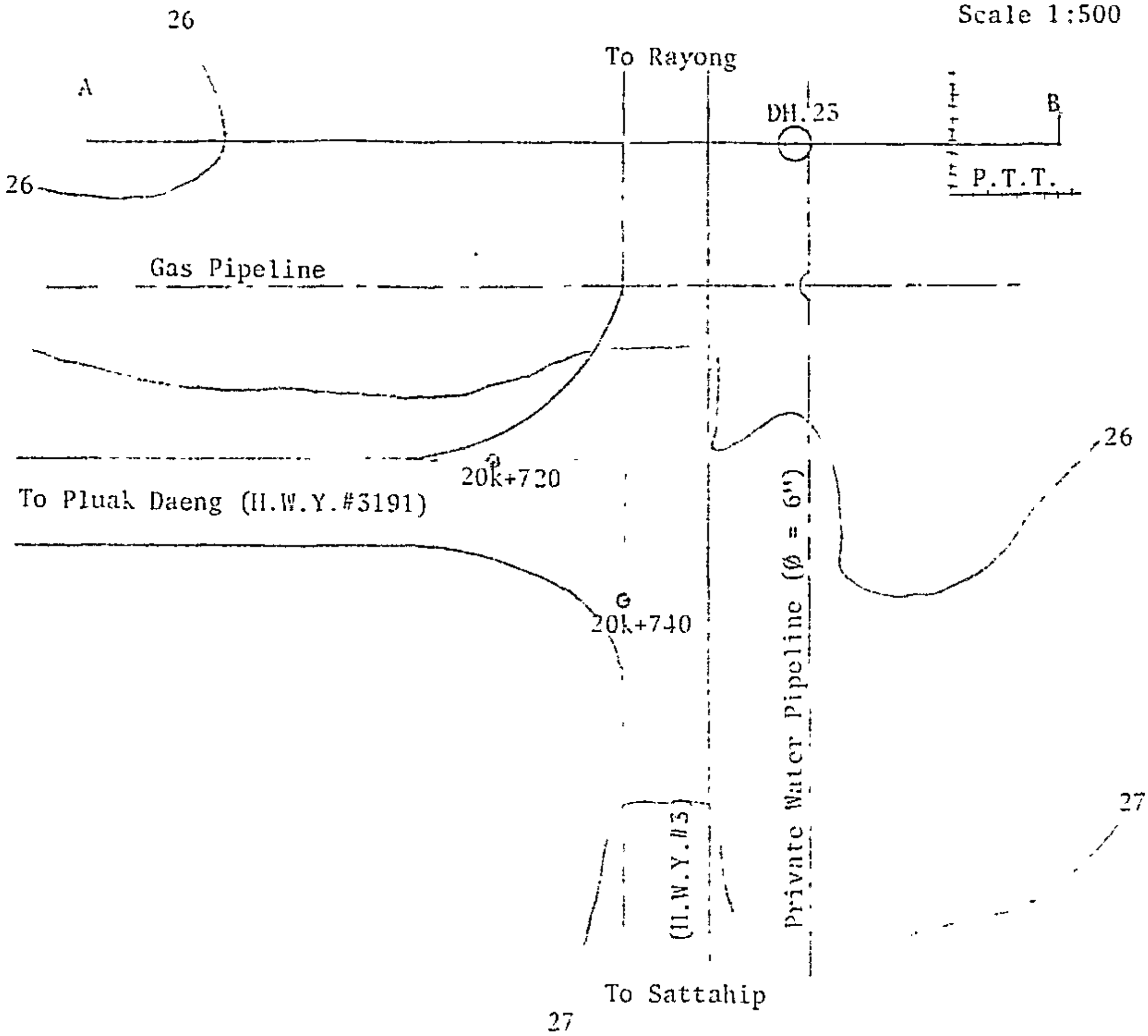
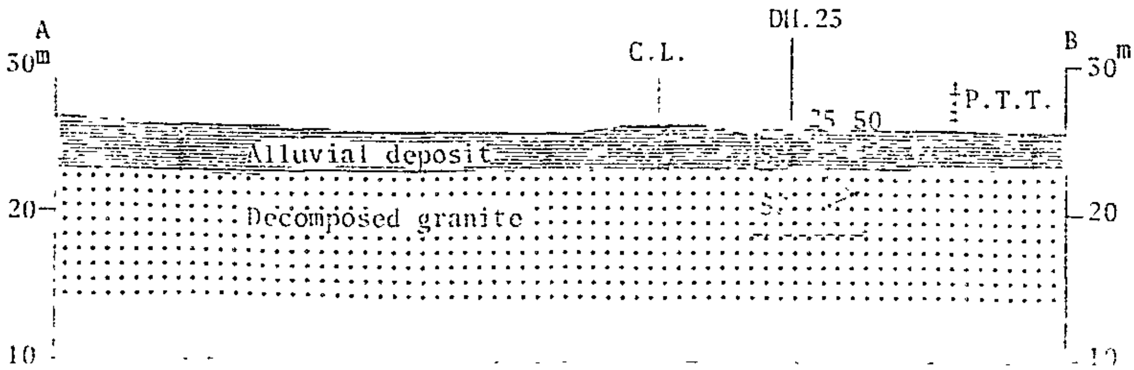


Fig. 10 Location Map of Road Crossing at H.W.Y.#3
(with geological profile)





2.2.5. Crossing Streams

The pipeline from Dok Krai to Mab Ta Pud will cross streams at 24 points. Some of the streams are dried up due to the season.
The geological checking like the depth of alluvial deposit and soft layer was made with some of large streams. Most streams flows at right angle to the pipeline alignment. Khlong Lot (19k+240) however flows parallel to the pipeline for about 100 m distance. The existing gas line is buried below the river bed.

In this paragraph, the explanation will given about the stream and another one named Khlong San Lao (4k+200) which may be a typical stream at the hilly area.

a) Khlong Lot (19k+420)
   At the left bank of Khlong Lot, a boring (DH.22) was made as shown on Fig. 11 .
   An aerial photograph taken in 1975 shows the river bed was wider then and since the stream has changed as seen now, as the bank was backfilled.
   As mentioned before, it runs parallel to the road for about 100 m before turning to the left and the gas line is laid below the bed.
   The geology of the area in general consists of three layers, the backfill soil, alluvial deposit and decomposed granite.
   DH.22 shows 2 to 3 m depth of backfill soil and 5 m of alluvial deposit. STP and the log show that the blow count is less than 10 to 4 m depth and below it, the count becomes larger following the depth to the bottom of the hole, where it is 50. It shows that the top of alluvial deposit is loose layer.
   The laboratory test's result is that all of the backfilled

soil, the most of alluvial deposit and decomposed granite belong to SC, the clayey sand while the top of alluvial deposit does to SM, the silty sand. The underground water level in the area is almost same as that of the stream.

b) Khlong San Lao (4k+200)

One boring test to study the stream bed, as shown on Fig.12 , resulted in finding that the geology consisted of decomposed granite covered by alluvial deposit at the top, the stream bed. The deposit is 2.8 m thick. At the surface part of alluvial deposit, the blow count is 2 and it is 16 to 17 in the deeper part consisting of alluvial sand. At the bottom of borehole it is more than 50. The laboratory test also shows the alluvial deposit as ML and SP, the sandy silt and sand. The decomposed granite is SM, the silty sand. The groundwater level is the same as stream water.

Fig. 11 Location Map of stream cross near Gas Pipeline (with geological profile)

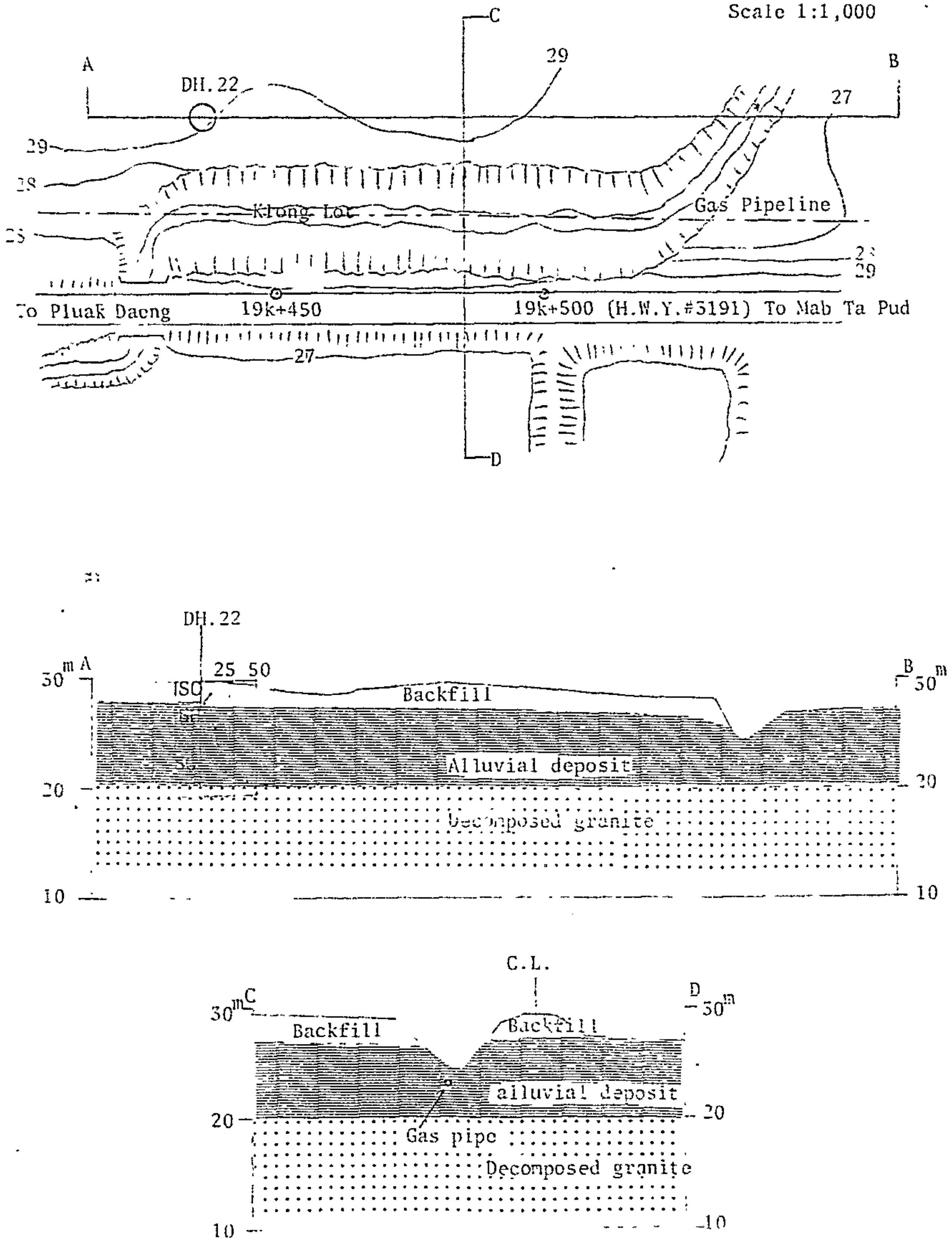
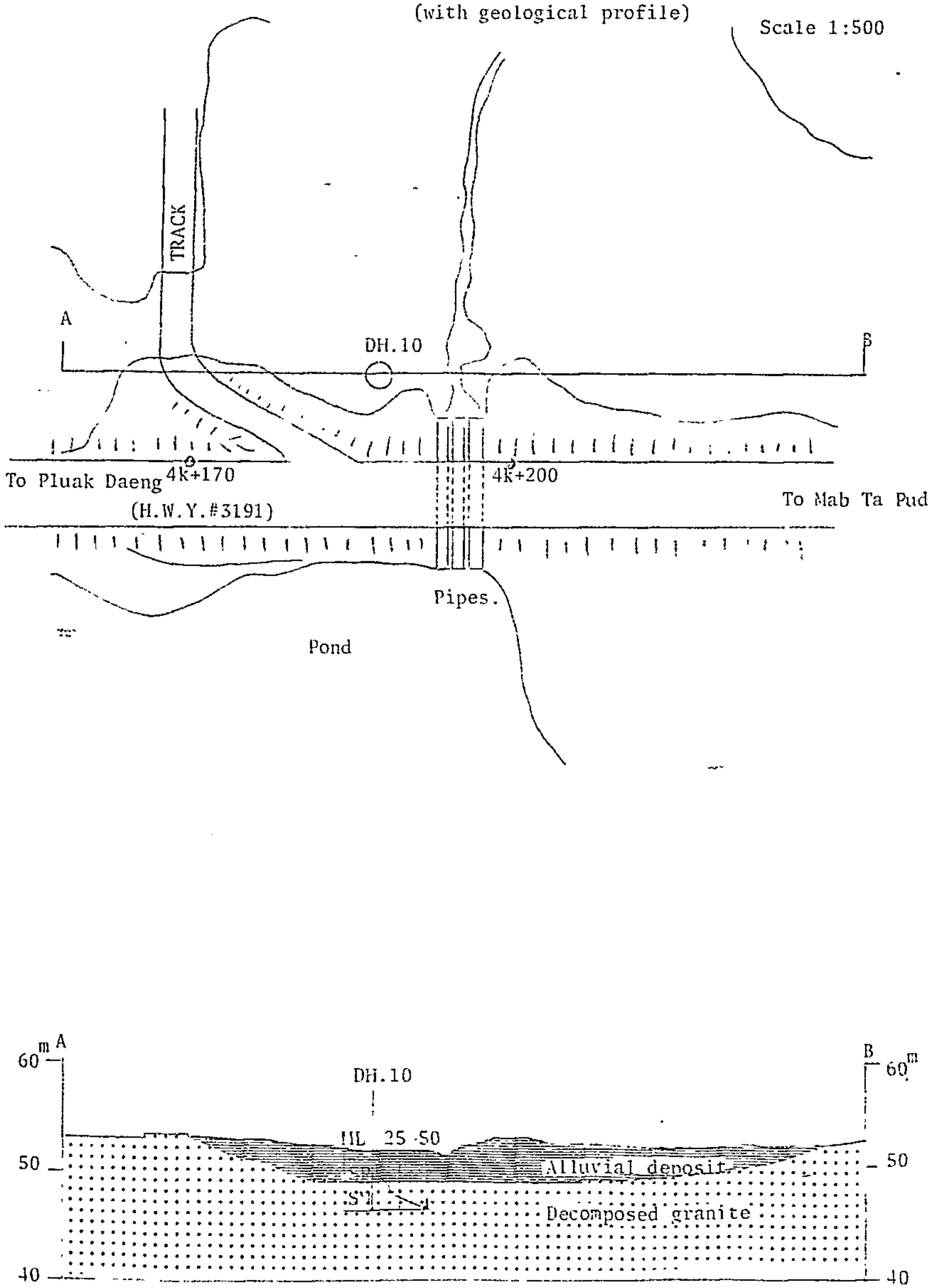


Fig. 12 Location Map of Typical Stream cross
(with geological profile)



2.3. Groundwater Condition

39 wells' water levels were measured and the result is shown on Table 3 . The boreholes were excluded. The elevations of water levels were also of both on Fig. 4-1 - Fig.4-4, so that the profiles of both groundwater table and ground surface along the pipeline route can be compared. The figure verifies the previous statement.

Generally at high places in the hilly area, the groundwater levels are 5 to 10 m below the surface and at low places close to the streams, they become shallower and converge to the streams' water levels. In the low plain area like Ban Map Kha, Ban Khlong Lot and the site of receiving facility, the groundwater levels are shallower than 3 m from the ground surface. According to the feasibility study and local peoples words, the groundwater tables in the rainy season rise by about 2.0-3.0 m in the hilly area and about 1.0-2.0 m in the low plain area, when compared in the dry season. Fig.4-1 to 4-4 shows the profile of groundwater level along the pipeline route from Dok Krai to Mab Ta Pud, as it was mentioned before. Clearly shown on the figures are the places where the groundwater table is shallower than 3m from the ground surface. As the excavation depth shall be about 3 m during the construction, groundwater seepage and flooding of the ditch must be anticipated almost certainly around the said places. Furthermore, it must be pointed out that the places will grow wider during the rainy season than shown here as the figures are based on the data of dry season.

Table 3 Water Table along the proposed pipeline route

(measured on Jan. 24, 1982)

Well No.	Water depth (GL-m)	Approx. EL.	Remarks	Well No.	Water depth (GL-m)	Approx. EL.	Remarks
1	5.90	63.0		21	3.50	39.5	
2	6.50	60.5		22	3.60	43.5	
3	6.50	70.0	Top of hill	23	8.00	55.0	5.20*M
4	7.00	63.0		24	4.80	36.0	
5	5.50	57.0		25	5.20	37.5	
6	5.50	64.0		26	2.00	30.0	
7	11.20	73.0		27	3.00	29.5	
8	4.70	65.0		28	1.10	26.5	
9	4.30	71.0	4.0*M	29	6.50	46.0	
10	11.50	80.0		30	5.50	39.0	
11	5.50	75.0		31	4.50	40.0	
12	8.20	64.0		32	5.50	49.0	
13	4.50	55.0	5.0*M	33	5.00	49.0	
14	7.50	54.0		34	1.70	45.0	
15	7.50	46.0		35	3.30	46.5	
16	2.00	33.0		36	3.00	47.0	
17	6.50	46.5		37	1.20	48.0	
18	7.00	55.0		38	1.50	55.0	
19	2.00	44.5		39	3.70	60.5	
20	2.80	37.0					

Well No. showed on Fig. 4-1 - 4

* Remarks well water level measured at FS study.

2.4. Material Survey

2.4.1. Borrow Area for Sand Bed and Concrete Aggregate

Sand borrow area was look for because the pipelaying requires sand bed at the bottom of ditch and the concrete mixing uses sand for the fine aggregate.
There are two commerical sand borrow area, one called Kong Ton Po near Rayong city and another Laem Ban Yoan near Mab Ta Pud. Their locations are shown on Fig.13 .
Both of them were visited and the sand samples were taken to the laboratory for testing. Observation showed that they would be able to supply sufficiently for the construction.

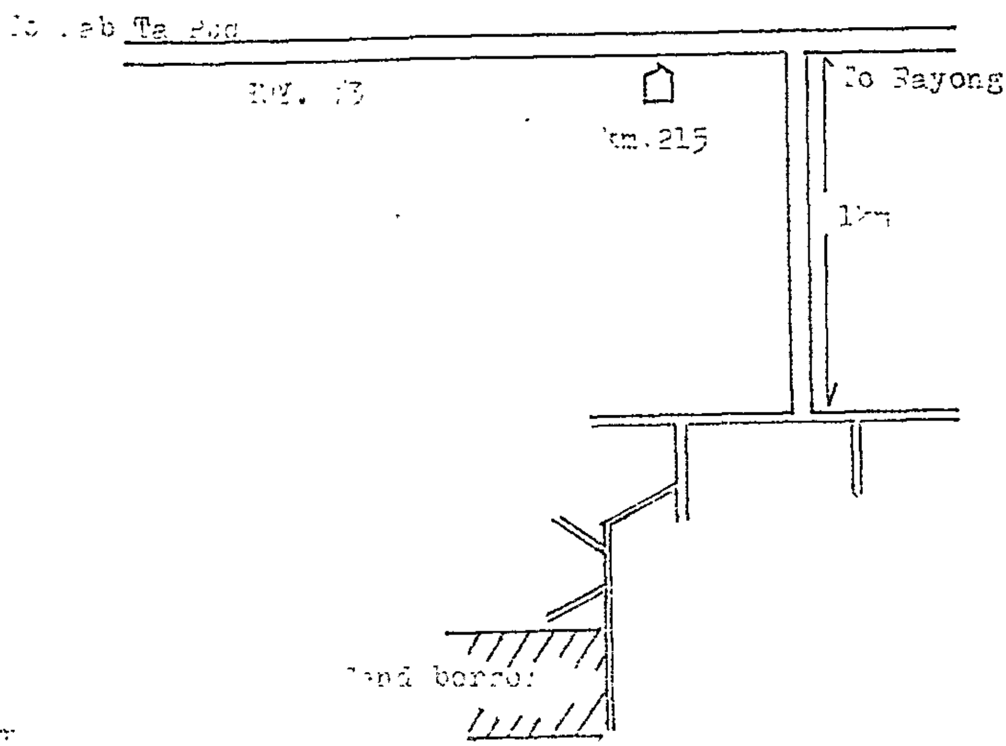
The laboratory tests included the following items:

a) Gradation test and Soil classification
b) NaCl content
c) Organic matters content
d) PH test

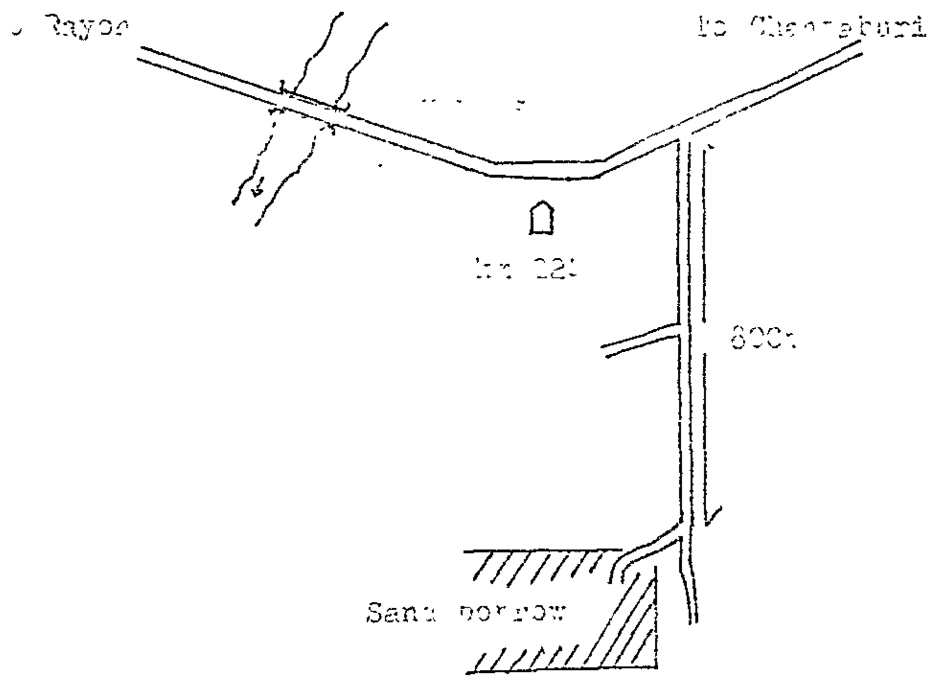
The summery of tests can be seen on Table 4-1 - 2 Both of the two sands are classified as SP (poorly graded sand, gravely sand, little or no fines). PH is 5.0-6.0 and NaCl contents are 0.0004 to 0.0009 gr/100 gr. Organic matters contents are less than 0.17%.
The judgement is that the sand can be used for the quoted purposes.

Fig.13 Location map of Sand borrow area

LANT BAN YOAT



KONG TON PO



2.4.2. Quarry Site

Quarry sites were also looked for as quary shall be used as the coarse aggregate of concrete. Two commerical crush stone mills were found, one near Sattahip and another east of Rayong.
The former is located at Chichan Mt, 12.5 km northeast of Sattahip city and the latter, about 55 km east of Rayong city, along HWY # 3. Both of the two mills' products are of gray hard limestone.
As the latter mill is seemingly too far from the construction site, the samples were collected at the former mill of Chichan Mt and sent to the laboratory for testing.

The test result, the abration ratio 30.00% by Los Angels Machine Loss, shows that the quarry can be used for the purpose mentioned before. Also the investigation at the site revealed that the supply capacity of the mill, as well as the quality, had been well established.

2.4.3. Embankment

To test materials for the embankment of receiving well, the samples were taken at 3 points, the area close to the well, Khao Talian (9 km towards Rayong from HWY.36 & 3191 crossing) and the borrow pit on the left bank of Dok Krai.

The Soil taken at the well site belongs to SM (silty sand) and as it is poor fine particle portion the permeability coefficient is 3.71×10^{-3}, and it is judged as permeable.
In case where the soil is used for the embankment the surface of reservoir, bottom and slope, shall be covered by impermeable materials like rubber and/or concrete.

Khao Talian & Dok Krai's soils belong to ML(silt) and SM(silty sand) respectively.
They are rich in fine particles portion and can be used for the embankment as impervious or moderately impervious material.

In case where the earth material is expected to prevent seepage mostly, the soils of Khao Talin and Dok Krai can be used.
When some other soils are used, it must be observed that fine particles portion is around 10-15%, and the soil contains more than 5% clay.

2.5 Laboratory Tests on Samples of Pipeline Route

The results of laboratory tests on the samples collected, during the field subsurface exploration, along the pipeline route are summerized on Table 4-1 and Table 4-2.

The results show some of the important properties of soil to to useful for designing and constructing.

2.5.1 Classification of Soil, Excavation and Backfilling

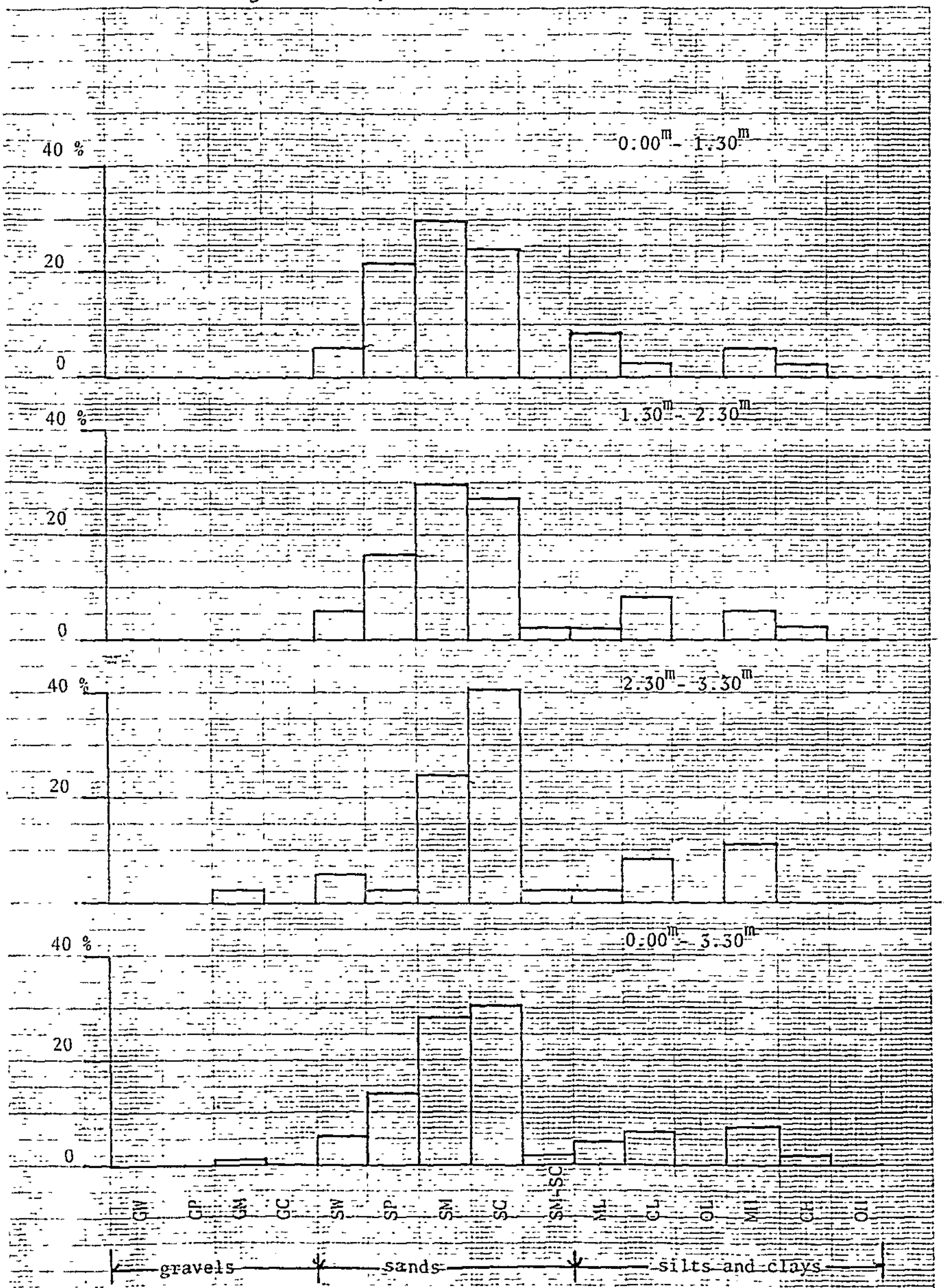
According to the unified soil classification, the most of collected samples can be classified as the coarse grained sand with fines.

Fig. 14 shows the distribution of classified soils in four different ranges of depth, on 0 1.3 m, 1.3 2.3 m, 2.3 3.3 m and 0 3.3 m as the total.

According to the figure, 70 to 80% of samples between the surface and 3 m depth are classified as the clean sands or sand with fine with the symbols of SW, SP, SM and SC. The rest of samples are the fine soils by classification.

The soils' properties are expected to be mostly good excavation and backfilling exception case of the place where the fine soil is contained richly.

Fig. 14 Summary of surface soil classification



Symbols according unified soil cassification after U S B R.

Table 4-1 Summary of test result

Bor No.	Sample Depth(m)	Description	Gradation Percent Passing 1½"	3/4"	3/8"	No.4	No.10	No.40	No.200	Atterberg Limit LL	PL	PI	Soil Class	Nat Moist%	PH	Others
DH. 1	1.60-2.00	Coarse sand			100	98	60	14	2.4	Non -Plastic			SW		4.9	
"	6.00-6.15	Granite core														uniaxial comp. test 589kg/cm^2
DH. 2	3.00-3.50	Coarse sand				100	76	22	2	Non - plastic			SW		5.2	
	5.90-6.00	Granite core														uniaxial comp.test 303kg/cm^2
	6.10-6.20	"														uniaxial comp. test358kg/cm^2
	7.50-7.65	"														uniaxial comp. test589kg/cm^2
DH. 3	4.00-6.30	Clayed sand			100	93	70	40	22	40.0	19.9	20.1	SC			
4	4.00-6.30	Silty sand		100	99	96	87	54	24	Non -	Plastic		SM			
"	9.00-9.10	Granite core														uniaxial comp. test184kg/cm^2
DH. 5	1.00-2.30	Silty sand			100	99	82	64	49	47.0	28.7	18.3	SM			
"	10.00-11.10	Silty sand		100	99	95	80	48	23	-	-	-				inadequate Sample
6	5.00-7.30	Clayey sand			100	97	83	55	33	38.5	23.8	14.7	SC		4.6	
7	11.00-12.30	Silty sand		100	97	92	80	47	23	38.5	28.7	9.8	SM			inadequate Sample
8	2.00-2.30	Clayey-Silty sand			100	94	82	58	41	-	-	-				
9	2.00-5.30	Sandy silt			100	94	75	60	51	70.1	37.6	32.5	MH		4.8	
10	3.00-4.22	Silty sand			100	94	65	31	17	-	-	-			5.1	inadequate Sample
11	2.00-3.30	Silty sand			100	99	62	40	31	41.4	27.3	14.1	SM		5.0	
12	3.00-6.30	Sandy silt			100	96	80	63	53	59.2	35.-	24.2	MH		4.7	
14	2.00-3.30	Medium sand		100	99	98	88	37	7	Non -	plastic		SW-SM		6.0	
15	2.00-409	Clayey sand			100	92	72	41	21	39.9	25.3	14.6	SC			
16	1.00-2.30	Clayey sand		100	94	84	65	38	23	33.5	27.7	11.8	SC			
17	3.00-4.30	Clayey sand		100	94	78	60	36	19	40.9	24.9	16.0	SC		4.8	
18	4.00-7.30	Clayey silt		100	95	92	83	67	56	60.0	35.2	24.8	MH		5.0	
19	5.00-6.30	Clayey sand		100	98	90	70	33	17	35.7	22.2	13.5	SC		6.9	
20	4.00-4.30	Clayey sand		100	98	97	88	54	31	36.8	19.3	17.5	SC		4.9	
21	4.00-5.30	Clayey sand			100	99	75	43	31	38.8	21.2	17.6	SC		4.9	
22	6.00-7.30	Clayey sand				100	99	51	28	43.1	24.9	18.2	SC		4.8	
23	3.00-4.30	Clayey sand			100	99	87	52	31	28.2	17.7	10.5	SC		5.0	
24	5.00-7.30	Clayey-Silty sand			100	96	81	47	23	19.8	14.8	5.0	SC-SM		6.0	
A. 2	1.00-2.00	Clayey sand			100	98	85	67	50	520	29.0	23.0	SC	17.2	4.7	
A. 2	2 00-3.00	Clayey sand			100	98	82	61	43	48.2	25.9	22.3	SC	15.6	4.8	
4	1.00-2.00	Sandy clay			100	99	87	72	59	51.7	28.4	23.3	CH	16.6	5.1	
5	1.00-2.00	Clayey sand			100	95	82	61	47	43.9	26.6	17.3	SC	12.6	5.1	
6	2.00-3.00	Silty sand				100	89	50	13	Non -	Plastic		SM	15.6	4.6	
7	1.00-2.00	Clayey sand			100	99	97	70	38	23.3	14.5	8.8	SC	11.6	5.0	
8	2.00-3.00	Silty sand		100	94	89	82	60	50	49.0	30.1	18.9	SM	16.6	4.7	
9	3.00-4.00	Clayey sand			100	99	78	44	27	46.0	22.3	23.7	SC	12.9	4.6	

Table 4-2 Summary of test result

Bor.No.	Depth(m)	Description	Gradation Percent Passing 1½"	3/4"	3/8"	No.4	No.10	No.40	No.200	Atterberg Limit LL	PL	PI	Soil Class	Nat Moist%	PH	Others		
																Comp.test Max.d.d.g/cm^3	O.M.C.%	
TP. 1	1.00	Silty sand			100	88	48	26	29	46.2	28.6	17.6	SM	8.3	4.6	1.93	11.2	
TP. 1	2.00	Sandy silt		100	99	95	78	67	62	62.0	38.1	23.9	MH	16.1	4.7	1.68	19.6	
TP. 1	3.00	Sandy silt			100	96	80	66	59	60.9	39.1	21.8	MH	20.8	4.5	1.63	20.7	
TP. 2	1.00	Silty sand				100	99	64	44	39.3	25.5	13.8	SM	9.6	4.7	1.84	14.2	
TP. 2	2.00	Silty sand		100	99	98	88	48	37	44.2	30.5	13.7	SM	8.6	4.8	1.88	12.7	
TP. 2	3.00	Silty sand	100	95	81	67	56	44	35	48.5	31.2	17.3	GM	17.1	5.1	1.72	18.7	k =2.58x10^{-7}cm/sec.
TP. 3	1.00	Silty sand				100	95	58	43	37.5	25.2	12.3	SM	10.0	5.0	1.91	12.6	
TP. 3	2.00	Silty sand				100	83	42	30	40.3	27.3	13.0	SM	8.6	5.2	1.97	11.1	
TP. 3	3.00	Silty sand			100	99	78	54	40	46.0	30.4	15.6	SM	11.2	5.1	1.86	13.5	k =6.17x10^{-8}cm/sec.
Receiving well site	1.00	Silty sand			100	99	86	46	14	Non -	Plastic		SM	3.6	5.0			k =3.71x10^{-3}cm/sec.
Laem Ban	1.00	Sand				100	96	40	-	Non -	Plastic		SP	2.0	6.0	Nacl.cont.=0.0009g/100g,organic matter=0.06%		
Yoam	2.00	Sand		100	99	99	70	14	-	Non -	Plastic		SP	1.0	5.7	0.0004 , =0.16%		
Kong Tan	1.00	Sand				100	97	32	-	Non -	Plastic		SP	1.8	5.0	0.0009 , =0.05%		
Po	2.00	Sand				100	80	11	-	Non -	Plastic		SP	1.4	5.1	0.0004 , =0.17%		
Khao Talian	-	Silt		100	99	98	96	91	71	49.0	30.3	18.7	ML	18.8		Commercial borrow along HWY. #36		
Dok Krai	-	Silty sand	100	99	95	89	70	55	48	61.0	36.7	24.3	SM	12.6		Left abutment of Dok Krai Dam		
Chichan mt.	-	Crushed lime - stone														Los Angels abration test. 30.0%		
																unite weight g/cm^3		
																Wet	dry	
Fs 1(DH.24)	Surface	Silty sand												8.0		1.61	1.48	
Fs 2(25K+320)	"	Sand	—			-		—		—			—	16.7		---	-	
Fs 3(DH.23)	"	Silty sand												17.0		2.33	1.93	
Fs 4(20K+00)	"	Clayey sand												13.3		1.41	1.22	
Fs 5(DH.22)	"	Clayey sand												6.4		1.71	1.63	
Fs 6(DH.21)	"	Sand												8.0		1.83	1.68	
Fs 7(TP.2)	"	Silty sand												4.4		1.75	1.67	
Fs 8(DH.17)	"	Silty sand												26.7		1.65	1.21	
Fs 9(A. 6)	"	Sand												10.6		1.77	1.58	weighed at field
Fs 10(A. 5)	"	Clayey sand												4.3		1.97	1.89	
Fs 11(DH.5)	"	Sand												24.4		2.06	—	
Fs 12(8K+00)	"	Clayey sand												4.0		1.80	1.73	
Fs 13(TP.1)	"	Sandy silt												10.6		1.85	1.65	
Fs 14(3K+500)	"	Clayey sand												4.4		1.94	1.85	
Fs 15(0K+900)	"	Sandy clay												14.0		1.87	1.61	

* Samples as Fs. tested at field

2.5.2 PH, Moisture Content, Compaction

The samples showed PH range of 4.6 to 5.2 and no tendency due to the depth or the location was identified.

The Natural moisture test showed that the optimum moisture content and the natural moisture content are rather close in the value. Moreover, the most of optimum moisture contents, when compared with the natural moisture content, are on the wet side of it. These data will imply that the soil is suitable for compaction.

2.5.3 Nacl, Organic Matters, Construction Material

With the samples taken at the prospective sand borrows, Nacl contents are 0.0004 to 0.0009 g/100 g and organic matters content are 0.05 to 0.17 %. The data shows that the sand is free from the sea waters' intrusion and also from the biological pollution and will be good as a construction material, fine aggregate of concrete here.

With the Samples of crushed stone of Chichan Mt. mill, Los Angels test showed the abration rate of 30%. It means that the crushed stone is hard and strong, suitable for the coarse aggregate of concrete.

2.6 Specific Resistance of Surface Soil and Water

The specific resistances of the surface soil and water were tested in the field to collect basic data for studying about corrosion.

The result is shown on Fig. 15 .

Factors affecting the corrosion of buried pipes in the soil are seemingly various and many. The specific resistance of the soil and water is said to be one of the factors. The table below shows the relationship between the specific resistance and the degree of corrosiveness, as reported by the named researchers.

Relationship between Soil's Corrosiveness and Specific Resistance

No.	Corrosiveness degree	S. Resistance (Ω cm) Waters	Applegate	Pritula	Shepard
5	very aggressive	0 ~ 900	0 ~ 1000	0 ~ 500	0 ~ 500
4	aggresive	900 ~ 2300	1000 ~ 5000	500 ~ 1000	500 ~ 1000
3	moderately	2300 ~ 5000	5000 ~ 10000	1000 ~ 2000	indefinable
2	slightly aggresive	5000 ~ 10000	10000 ~ 100000	2000 ~ 10000	
1	non aggresive	> 10000	> 100000	> 10000	

The data were collected in the following three conditions:

a) Surface soil

b) Surface soil saturated with water

c) Water

The values of specific resistance for the three were:

$1 \times 10^5 < \text{surface soil} < 1 \times 10^6$

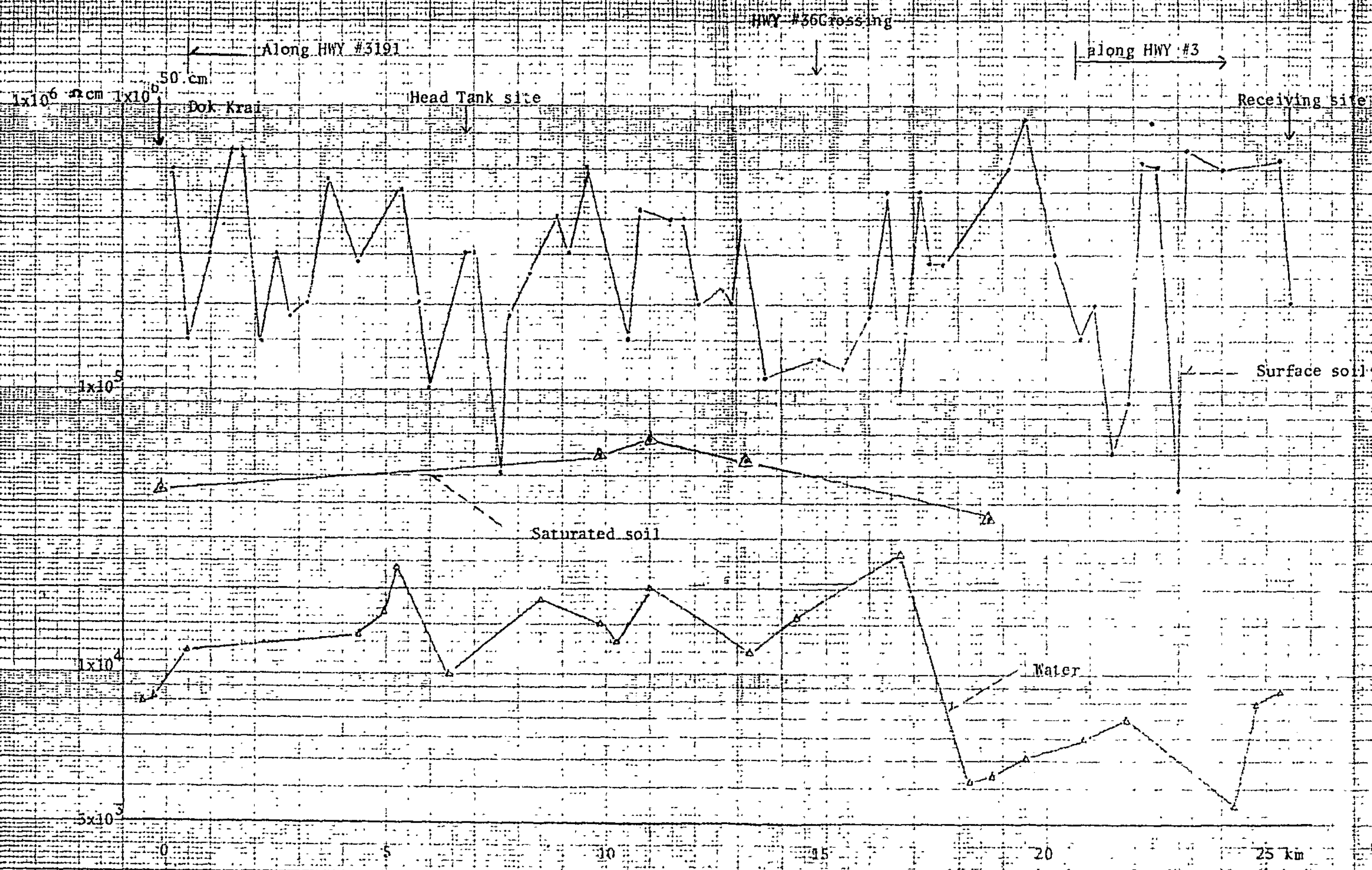
$3 \times 10^4 < \text{surface soil saturated with water} < 7 \times 10^4$

$3.5 \times 10^3 < \text{water} < 2.7 \times 10^4$

As for the surface soil and the surface soil satureted with water, the specific resistance was rather stable.

Noticable is the low specific resistance of water in the last past of pipeline route. The water of streams located between 17 km point and the receiving facility showed low resistance due to unknown reasons which will need further studying.

Fig.15 Specific resistance along the proposed pipeline route



3. CONCLUSION

a) General

The geology along the pipeline route consists of decomposed granite and alluvial deposit. Granite rocks and soft layer of the earth were found only at the pump station site of Dok Krai.

b) Pipelaying

Most of the soils are classified as sand, silty sand and clayey sand. The soils are suitable for digging, backfilling and compaction. For the use of sand bed cushioning up the pipes, most soils are suitable except silt and/or clay rich ones.

c) Foundation

At the site of head tank and receiving facility, the bearing layers are found in rather shallow underground depth, presenting a hopeful condition of foundation.
Also at the intake and pumping station site, a bearing layer is at several meters depth below the bottom surface.

d) Groundwater condition

In the hilly area, the groundwater conditions are favorable for pipelaying as the water table is below 3m depth in the most part, except in the vicinity of stream.
In the low plain area, however, the water table is high, above 3 m depth, and preparation of pumps to lift the water in ditch must be expected. The situation will worser in the rainy season.

e) Materials

The sand and crushed stone suitable for concrete aggregate are abundant near the project area.

f) Specific resistance

Because of the low specific resistance of water in the low plain area, protection against the corrosion of pipes and concrete structures may be considered .
Further study is preferable.

Appendix 1

Boring Logs

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System

WORK: From Dok Krai to Nab Ta Pud

HOLE NO. DH.1

DEPTH 10.20 M.

LOCATION Intake tower in Res.

ELEVATION OF HOLE + 36.41 m

DATE Jan.10-12,1982

FOREMAN ____________ METHOD OF BORING ____________

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
	0.50				Very soft silt-clayey sand	WATER TABLE
			1.00		Poorly graded sand 95% fine-	
1.00			1.50 2.00	40	coarse sand but mostly coarse	+ 12.19 M.
2.00			2.10 3.00	50	grain, 5% low plasticity fines,	DATE
3.00	3.80		3.35	50	wet, brown (SW)	Jan.10,1982
4.00					Biotite granite, highly weathered,	
5.00	5.50				gray to brown, most of the mafic	
6.00					minerals are oxidised, brittle	
7.00	7.25				and partly friable, core is	
8.00					broken into small pieces.	
9.00					Biotite granite, moderately-	
10.00	10.20				slightly weathered, light gray,	
11.00					biotite are partly oxidised,	
12.00					hard, fracture dip 10°-15°, 60°,	
					maximum core size 30 cm.	
					Biotite granite, fresh, gray,	
					very hard, at depth 6.25-7.10 m.	
					maximum core size 84 cm.	
					at depth 7.10-7.82 m. fracture	
					dip 5°-10° prominent	
					at depth 7.82-8.80 m. cores are	PLATE NO.
					much broken by 90°-70° dipped	

VERTICAL SCALE 1:100 (1CM = 1 M.) Traced ________ Checked ________ Sheet ________

BORING LOG

Division of Soil and Geology
Royal Irrigation Department

PROJECT: Detailed Design for The " Pipeline System

WORK: From Dok Krai to Mab Ta Pud

HOLE NO. DH.1

DEPTH 10.20 M.

LOCATION [illegible]

ELEVATION OF HOLE - 38.41 m

DATE Jan.10-12,1982

FOREMAN ____ METHOD OF BORING ____

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
					fracture.	WATER TABLE
1.00					at depth 8.80-9.70 m. fracture	+ 12.19 M.
2.00					dip 40°-60° and maximum core	DATE
3.00					size 35 cm.	Jan.10,1982
4.00					- 0.50-3.50 m. residual soil	
5.00						
6.00						
7.00						
8.00						
9.00						
10.00						
11.00						
12.00						

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) Traced ____ Checked ____ Sheet ____

BORING LOG

Division of Soil and Geology
Royal Irrigation Department

PROJECT Detailed Design for The Pipeline System	HOLE NO. DH.2	LOCATION Intake tower in Res.	
WORK From Dok Krai to Mab Ta Pud	DEPTH 9.95 M.	ELEVATION OF HOLE + 40.51 m	DATE Jan.7-9,1982
FOREMAN		METHOD OF BORING	

Scale M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
	0.30				Very soft clay-clayey sand	WATER TABLE
			1.00		Poorly graded sand 90% fine-	
1.00			1.50	4		+ 10.09 M.
			2.00		coarse sand, 10% low plastici-	
2.00			2.50	18		DATE
			3.00		ty fines, grayish brown, wet.	
3.00			3.05	50		Jan.10,1982
	3.80				(SW)	
4.00					Biotite granite, highly wea-	
5.00	5.80				thered, gray, brittle, cores	
6.00					are broken into small pieces.	
7.00	7.30				Biotite granite, moderately	
8.00					weathered, gray to brown,	
9.00	9.30				biotite is mostly altered to	
10.00	9.65				iron oxide, hard, fracture	
11.00					dip 10°-20°, maximum core size	
12.00					15 cm.	
					Hornblende-Biotite granite,	
					moderately-slightly weathered	
					gray, hard.	
					at depth 7.00-7.80 m. maximum	
					core size 53 cm.	
					at depth 8.20-8.55 m. core is	
					broken into pieces by 30°-70°	PLATE NO.
					dipped fracture	

VERTICAL SCALE 1:100 (1CM = 1 M.)	Traced	Checked	Sheet

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The " Pipeline System
WORK: From Dok Krai to Mab Ta Pud

HOLE NO. DF.2
DEPTH 9.95 M.

LOCATION Intake tower in Res.
ELEVATION OF HOLE + 40.51 m
DATE Jan.7-9,1982

FOREMAN ____ METHOD OF BORING ____

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
1.00					at depth 8.55-9.00 fracture	WATER TABLE
2.00					dip 30°-45° and maximum core	- 10.09 M.
3.00					size27 cm.	DATE
4.00					Hornblende-Biotite granite,	Jan.10,1982
5.00					slightly weathered, gray,very	
6.00					hard, fracture dip 50°-60°,	
7.00					maximum core size 46 cm.	
8.00					* 0.30 - 3.80 m. residual soil	
9.00					3.80 - 5.80 m. decomposed	
10.00					granite	
11.00						
12.00						

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) Traced ____ Checked ____ Sheet ____

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT Detailed Design for The Pipeline System
WORK From Dok Krai to Mab Ta Pud
HOLE NO. [illegible]
DEPTH 10.50 M.
LOCATION [illegible]
ELEVATION OF HOLE + [illegible].31 m
DATE Jan.13-14,1982
FOREMAN ______ METHOD OF BORING ______

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
	0.20					WATER TABLE
			1.00		Very soft clay-clayey sand	
1.00			1.30	2		
			2.00		Clayey sand, 50% fine-medium	+ 5.29 M.
2.00	2.20		2.30	5		
			3.00		sand, 50% low plasticity fines,	DATE
3.00			3.30	14		
			4.00		dark gray, saturate. (SC)	Jan.10,1982
4.00			4.30	25		
			5.00		Sand 70% fine-coarse sand;	
5.00			5.30	30		
			6.00		5% fine gravel, subangular;	
6.00			6.30	23		
					25% low plasticity fines,	
7.00	7.10					
	7.85				brown, wet. (SC)	
8.00						
	8.90				Muscovite granite, highly	
9.00					weathered, yellowish gray,	
10.00						
	10.50				brittle and partly friable,	
11.00					core is broken into fragments	
12.00					of less than 10 cm. long,	
					fracute dip vary and iron	
					oxide staining along fracture	
					plane.	
					Granite, moderately weathered,	
					gray, Tourmaline is dominant	
					mafic mineral, brittle and	
					partly friable, fracture	PLATE NO.
					dip 20°-40°	

VERTICAL SCALE 1:100 (1CM = 1 M.) Traced ______ Checked ______ Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT Detailed Design for The Pipeline System From

WORK Dok Krai to Mab Ta Pud

HOLE NO. DH.3

DEPTH 10.50 M.

LOCATION Intake tower in Res.

ELEVATION OF HOLE + 45.31 m

DATE Jan.13-14,19.2

FOREMAN ______ METHOD OF BORING ______

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
					Biotite granite, fresh, gray,	WATER TABLE
1.00					hard, fracture dip 60°-90°	+ 5.29 M.
2.00						DATE
3.00					* 0.20 - 2.20 m. residual soil	Jan.10,1982
4.00					2.20 - 7.10 m. decomposed	
5.00					granite	
6.00						
7.00						
8.00						
9.00						
10.00						
11.00						
12.00						
						PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced ______ | Checked ______ | Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System

WORK: From Dok Krai to Mab Ta Pud

HOLE NO. DH.4

DEPTH 10.30 M.

LOCATION Abutment

ELEVATION OF HOLE + 51.20 m

DATE Dec.25,1981

FOREMAN ______

METHOD OF BORING ______

Layer Depth M.	Soil Description
1.50	Clayey sand 85% fine-coarse sand predominantly coarse sand 15% low plasticity fines, reddish brown, moist. (SP)
3.50	Sandy clay 80% medium plasticity fines; 20% coarse sand, subround; reddish brown, moist. (CL)
5.50	Sandy silt 60% slightly plasticity fines, 40% fine-medium grained sand, gray and brown when oxidised, moist. (ML)
8.90	Silty sand 70% fine-coarse sand, predominantly medium grain; 30% slightly plasticity fines, brown-gray, moist. (SM)
90.30	Biotite granite, moderately weathered, light gray, hard, brittle fracture dip 0°-10°, 40°-50°, 90°, maximum core size 10 cm.

Tested Depth M.	N
1.00	
1.30	6
2.00	
2.30	7
3.00	
3.30	20
4.00	
4.30	24
5.00	
5.30	24
6.00	
6.30	30
7.00	
7.30	21
8.00	
8.30	32

Scale M.: 1.00, 2.00, 3.00, 4.00, 5.00, 6.00, 7.00, 8.00, 9.00, 10.00, 11.00, 12.00

Remarks	
WATER TABLE	- 0.00 M.
DATE	Jan. 10,1982

* 0.00 - 1.50 m. residual soil
1.50 - 8.90 m. decomposed granite

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.)

Traced ______ Checked ______ Sheet ______

BORING LOG

Division of Soil and Geology
Royal Irrigation Department

PROJECT Detailed Design for The Pipeline System
WORK From Dok Krai to Mab Ta Pud

HOLE NO. DH-5
DEPTH 11.10 M.

LOCATION Airchamber
ELEVATION OF HOLE +53.80 m
DATE Dec.26,1981

FOREMAN ______ METHOD OF BORING ______

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
	1.00		1.00		Poorly graded sand 90% fine-	WATER TABLE
1.00			1.30 2.00	6	coarse sand predominantly	- ..57 M.
2.00	2.50		2.30 3.00	6	coarse sand, sub...;10%	DATE
3.00	3.50		3.30 4.00	6	low plastic fines, brown,	Jan.10,1982
4.00			4.30 5.00	10	moist. (SP)	
5.00			5.30 6.00	19	Silty sand ?0% low plasticity	
6.00	6.50		6.30 7.00	27	fines, 20% fine-coarse sand,	
7.00	7.50		7.30 8.00	16	brownish gray, moist. (SM)	
8.00			8.30 9.00	22	Sandy silt 60% slightly plas-	
9.00			9.20 10.00	50	ticity fines, 40% fine-coarse	
10.00			11.18 11.00	50	sand, light gray to brown,	
11.00	11.10		11.10	50	wet. (SM)	
12.00					Silty sand 65% fine-coarse	
					sand, 5% fine gravel, subangular;	
					30% slightly plasticity fines	
					brownish gray, wet (SM)	
					Clayey sand 70% fine-coarse	
					sand, predominatly coarse sand,	
					30% low plasticity fines,	
					gray, wet. (SC)	PLATE NO.
					Silty sand 85% fine-coarse	

VERTICAL SCALE 1:100 (1CM = 1 M.) Traced ______ Checked ______ Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System

WORK: From Dok Krai to Mab Ta Pud

HOLE NO. DH.5

DEPTH 11.10 M.

LOCATION Airchamber

ELEVATION OF HOLE +53.60 m

DATE Dec.26,1981

FOREMAN ______ METHOD OF BORING ______

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
						WATER TABLE
1.00					sand, 15% slightly plasticity	
2.00					fines, gray to brown, wet. (SM)	- 2.57 M.
3.00					- 0.00-1.00m. residual soil	DATE
4.00					1.00 m. decomposed granite	Jan.10,1982
5.00						
6.00						
7.00						
8.00						
9.00						
10.00						
11.00						
12.00						
						PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) Traced ______ Checked ______ Sheet ______

BORING LOG

Division of Soil and Geology
Royal Irrigation Department

PROJECT Detailed Design for The Pipeline System	HOLE NO. DH.6	LOCATION ,isson yard
WORK From Dok Krai to Mab Ta Pud	DEPTH 10.30 M.	ELEVATION OF HOLE + 46.56 m
		DATE Jan. 15,1982

FOREMAN ______ METHOD OF BORING ______

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
	0.70		1.00		Clayey sand 60% fine-medium sand, 40% low plasticity fines, dork gray, saturate (SC)	WATER TABLE
1.00			1.30	3		+ 2.04 M.
			2.00			
2.00			2.30	6		DATE
			3.00			
3.00			3.30	36		Jan. 10,1982
	3.50		4.00		Clayey sand 85% fine-coarse sand, 15% low plasticity fine, brown, wet. (SC)	
4.00	4.50		4.30	27		
			5.00		Same as 0.00-0.70 but wet.	
5.00			5.30	24		
			6.00			
6.00			6.30	36		
			7.00		Clayey sand 60% slightly plasticity fines, 40% fine-coarse sand, grayish brown, moist. (SC)	
7.00			7.30	38		
			8.00			
8.00			8.30	48		
			9.00			
9.00			9.26	50		
			10.00			
10.00	10.30		11.15	50		
11.00					* 0.00-3.50 m. residual soil	
12.00					3.50 decomposed granite	
						PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced ______ | Checked ______ | Sheet ______

BORING LOG

Division of Soil and Geology
Royal Irrigation Department

PROJECT: Detailed Design for The Pipeline System
WORK: From Dok Krai to Mab Ta Pud
HOLE NO. DH.7
DEPTH 12.30 M.
LOCATION Caisson yard
ELEVATION OF HOLE + 52.47 m
DATE Dec.27,1981
FOREMAN ______ METHOD OF BORING ______

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N
	1.00		1.00	
1.00			1.30	12
			2.00	
2.00			2.30	11
			3.00	
3.00	3.50		3.30	9
			4.00	
4.00			4.30	10
			5.00	
5.00			5.30	16
			6.00	
6.00	6.50		6.30	16
			7.00	
7.00			7.30	34
			8.00	
8.00	8.50		8.30	18
			9.00	
9.00			9.30	37
			10.00	
10.00	10.50		10.30	24
			11.00	
11.00			11.30	46
			12.00	
12.00	12.30		12.30	50

Soil Description

SP. Poorly graded sand 80% fine-coarse sand; 10% fine gravel, subround; 10% low plasticity fines, brown, moist. (SP)

Sandy clay 75% low plasticity fines; 25% fine-coarse sand, predominantly coarse sand, gray to brown, moist. (CL)

Sandy silt 70% slightly plasticity fines, 30% fine-coarse sand, predominantly coarse sand, gray to brown, moist (ML)

Sandy silt 55% low plasticity fines, 45% fine-coarse sand and some fine gravels, light gray-black, moist (SM)

Silty sand 70% fine-coarse sand; 5% fine gravel, angular; 25% slightly plasticity fines reddish brown, moist (SM)

Silty sand 65% fine-coarse

Remarks

WATER TABLE 1.75 M.

DATE Jan.10,1982

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.)	Traced ______	Checked ______	Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT Detailed Design for The Pipeline System
WORK From Dok Krai to Mab Ta Pud

HOLE NO. DH.7
DEPTH 12.30 M.

LOCATION Caisson yard
ELEVATION OF HOLE + 52.47 m
DATE Dec.27,1981

FOREMAN ______ METHOD OF BORING ______

Scale M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
					sand, 35/ low plasticity fines,	WATER TABLE
1.00						- 1.75 M.
					light gray, moist. (SM)	
2.00						DATE
3.00						
					0.00-1.00 m. residual soil	Jan.10,1982
4.00						
					1.00 m. decomposed granite.	
5.00						
6.00						
7.00						
8.00						
9.00						
10.00						
11.00						
12.00						
						PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced ______ | Checked ______ | Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System
WORK: From Dok Krai to Mab Ta Pud Chalam.
HOLE NO. DH.8
DEPTH 5.10 M.
LOCATION 0K + 601, L= 23
ELEVATION OF HOLE 36.38 m
DATE Dec,27,81
FOREMAN Prasiiath. Amarit
METHOD OF BORING Std.Pent.Resis.Test.

Scale M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
		☒	0.00–0.30	1		WATER TABLE
1.00			1.00–1.30	3	Poorly graded sands, non - plastic, very loose, sand is predominantly medium, brown (SP)	-0.25 m.
2.00	1.90		2.00–2.30	13		DATE
3.00	2.75		3.00–3.30	30	Clayey and silty sand, low plasticity, Medium density, sand is fine to coarse, some fine gravel, gray (SM)	Dec.27,81
4.00			4.00–4.30	29		
5.00	5.10		5.00–5.10	50/10cm.	Silty sand, non-plastic, Medium density to very dense, sand is fine to coarse, some fine gravel, brown and light gray (SM)	
6.00						
7.00						
8.00						
9.00						
10.00						
11.00						
12.00					Bottom of Hole	

0.00-2.75 m. alluvial deposit

2.75- decomposed granite

☒ No core Recovery

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced______ | Checked______ | Sheet______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT Detailed Design for The Pipeline System	HOLE NO. DH.9	LOCATION 1K+524, L = 14
WORK From Dok Krai to Mab Ta Pud	DEPTH 7.30 M.	ELEVATION OF HOLE 64.53 m
		DATE Dec.27,81
FOREMAN Surachai. Thavil. Thongkum.		METHOD OF BORING std.Pent. Resis. Test.

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
					Ground surface	WATER TABLE
1.00			1.00 – 1.30	36		-5.25 m.
2.00			2.00 – 2.30	33	Sandy silt, high plasticity,	DATE
3.00			3.00 – 3.30	24	dense to medium density,	Dec. 27,81
4.00			4.00 – 4.30	24	sand is fine to coarse, some	
5.00	5.50		5.00 – 5.30	16	fine gravel, brownish gray (MH)	
6.00			6.00 – 6.30	15		
7.00	7.30		7.00 – 7.30	10	Silty sand, low plasticity,	
8.00					Medium density, sand is fine	
9.00					to coarse, some fine gravel,	
10.00					brownish gray (SM)	
11.00					Bottom of Hole	
12.00						

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced ____ | Checked ____ | Sheet ____

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System
WORK: From Dok Krai to Mab Ta Pud
HOLE NO. DH.10
DEPTH 5.09 M.
LOCATION 4K+183, L=20
ELEVATION OF HOLE 52.37 m
DATE Dec.27,81
FOREMAN: Chalam. Prasilath. Amarit.
METHOD OF BORING: Std.Pent.Resis. Test.

Sclae M.	Layer Depth M.	Tested Depth M.	N	Soil Description	Remarks
		0.00 – 0.30	2		WATER TABLE
1.00	0.70	1.00 – 1.30	2	Sandy silt, low plasticity, very loose, sand is fine, brown (ML)	-0.45 m.
2.00		2.00 – 2.30	16		DATE
3.00	2.80	3.00 – 3.30	17	Poorly graded sands, non-plastic, very loose to medium density, sand is predominantly medium, brown (SP)	Dec.27,81
4.00		4.00 – 4.22	50/22cm.		
5.00	5.09	5.00 – 5.09	50/09cm.	Silty sand, non-plastic, medium density to very dense, sand is fine to coarse, some fine gravel, dark gray (SM).	
6.00 – 12.00				Bottom of Hole.	

0.00-2.80 m. alluvial deposit

2.80 - decomposed granite

☒ No core Recovery

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.)

Traced____ Checked____ Sheet____

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System

WORK: From Dok Krai to Mab Ta Pud

HOLE NO. DH.11

DEPTH 6.30 M.

LOCATION 6K+242, L = 17

ELEVATION OF HOLE 68.39 m

DATE Dec.28,81

FOREMAN: Throngrit. Chalam. Thavil.

METHOD OF BORING: std. Pent. Resis. Test.

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
						WATER TABLE
1.00			1.00 1.30	5	Silty sand, Medium plasticity, loose to medium density, sand is fine to coarse, brown (SM)	-4.30 m.
2.00			2.00 2.30	11		DATE
3.00			3.00 3.30	22		Dec.28,81
4.00	3.80		4.00 4.30	17	Sandy silt, low plasticity, Medium, sand is fine, light gray (ML)	
5.00			5.00 5.30	16		
6.00	5.50		6.00 6.30	23	Silty sand, low plasticity, Medium density, sand is fine to coarse, some gravel, grayish brown (SM)	
7.00	6.30				Bottom of Hole.	
8.00						
9.00						
10.00						
11.00						
12.00						
						PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced ______ | Checked ______ | Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT Detailed Design for The Pipeline System
WORK From Dok Krai to Mab Ta Pud
FOREMAN Throngrit. Chalam. Thavil.

HOLE NO. DH.12
DEPTH 10.20 M.

LOCATION 6K+852, L =71
ELEVATION OF HOLE 81.79 m
DATE Jan.8,81
METHOD OF BORING std. Pent. Resis. Test.

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
					Ground surface	WATER TABLE
1.00			1.00 – 1.30	48		–
2.00			2.00 – 2.30	40	Sandy silt, high plasticity, dense, sand is fine to coarse, brown (MH)	DATE
3.00			3.00 – 3.30	39		Jan 8,81
4.00			4.00 – 4.30	40		
5.00			5.00 – 5.30	36	Silty sand, non-plastic, very dense, sand is fine to medium, brown (SM)	
6.00			6.00 – 6.30	31		
7.00			7.00 – 7.30	38		
8.00	8.00		8.00 – 8.29	50/29cm.	(Weathered Rock)	
9.00			9.00 – 9.28	50/28cm.		
10.00	10.20		10.00 – 10.20	50/20cm.	Bottom of Hole	
11.00						
12.00						

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.)

Traced ______ Checked ______ Sheet ______

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System

WORK: From Dok Krai to Mab Ta Pud

HOLE NO. DH.13

DEPTH 7.30 M.

LOCATION 6K=814, L=14

ELEVATION OF HOLE 80.38 m

DATE Dec.26,81

FOREMAN: Throngrit. Chalam. Thagkum.

METHOD OF BORING Std. Pent. Resis. Test.

Scale M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
						WATER TABLE
1.00			1.00 / 1.30	14		
2.00	1.90		2.00 / 2.30	19	Silty sand, Medium plasticity, Medium density, sand is fine to coarse, brown (SM).	DATE
3.00			3.00 / 3.30	15		
4.00			4.00 / 4.30	15		
5.00			5.00 / 5.30	25	Sandy silt, high plasticity, Medium density, sand is fine to coarse, some fine gravel, grayish brown (MH)	
6.00			6.00 / 6.30	28		
7.00	7.30		7.00 / 7.30	29		
8.00						
9.00						
10.00					Bottom of Hole	
11.00						
12.00						

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.)

Traced_____ Checked_____ Sheet_____

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System
HOLE NO. DH.14
LOCATION 8k+487, L=9

WORK: From Dok Krai to Mab Ta Pud
DEPTH 5.45 M.
ELEVATION OF HOLE 50.01 m

FOREMAN: Surachai. Prasilath. Amarit.
DATE Dec.26,81
METHOD OF BORING Std. Pent. Resis. Test.

Sclae M.	Layar Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
			0.00–0.30	2		WATER TABLE
1.00	0.80		1.00–1.30	2	Silt, slight plasticity, very loose, some fine sand, brown (ML)	-0.50 m.
2.00			2.00–2.30	14		DATE
3.00			3.00–3.30	3		Dec.26,81
4.00			4.00–4.30	15		
	4.60				Poorly graded sands, non-plastic, loose to medium density, sand is predominantly medium, brown (SW-SM)	
5.00			5.00–5.25	25		
	5.45		5.25–5.45	50/15cm		
6.00						
7.00						
8.00					Clayey sand, Medium plasticity, Medium density to very dense, sand is fine to coarse, some fine gravel, light gray (SC)	
9.00						
10.00						
11.00						
12.00						
					Bottom of Hole	

0.00-4.60 m. alluvial deposit

4.60 - decomposed granite

☒ No core Recovery

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced | Checked | Sheet

Division of Soil and Geology
Royal Irrigation Department

BORING LOG

PROJECT: Detailed Design for The Pipeline System | HOLE NO. DH.15 | LOCATION 10K+078, L = 14

WORK: From Dok Krai to Mab Ta Pud | DEPTH 4.09 M. | ELEVATION OF HOLE 31.51 m

DATE Dec.25,81

FOREMAN: Chalam. Surachal Prasilath. | METHOD OF BORING Std. Pent. Resis. Test.

Sclae M.	Layer Depth M.	Log	Tested Depth M.	N	Soil Description	Remarks
			0.00 – 0.30	1		WATER TABLE
1.00			1.00 – 1.30	8		
2.00	1.90		2.00 – 2.22	50/22cm	Poorly graded sands, non-plastic, loose, sand is predominantly medium, brown (SP)	+0.20
						DATE
3.00			3.00 – 3.16	50/16cm.		Dec.25,81
4.00	4.09		4.00 – 4.09	50/09cm.		
5.00						
6.00					Clayey sand, Medium plasticity, very dense, sand is fine to coarse, brown (SC)	
7.00						
8.00						
9.00						
10.00					Bottom of Hole	
11.00					0.00-1.90m. alluvial deposit	
12.00					1.90 - decomposed granite	
					⊠ No core Recovery	

PLATE NO.

VERTICAL SCALE 1:100 (1CM = 1 M.) | Traced_____ | Checked_____ | Sheet_____