REPUBLIC OF INDONESIA

# FUNDAMENTAL DATA
# THE STUDY
# OF
# LOW COST HOUSING PROJECT
# IN
# CENGKARENG

MARCH 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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## CONTENTS

# 1. REPORT ON SOIL INVESTIGATION IN CENGKARENG

## 1. WEST JAKARTA

The project area is located at a part of vast alluvial plain faced to the JAKART BAY and nearly 5 km. west of DKI Jakarta.

The area getting between Cisadane River and Banjil Canal which include this project area and west parts of DKI Jakarta can divided into following two regions, north and south, with boundary line of Jakarta-Tanggerang Road, topographically and geologically.

a) The Coastal Plain

b) The Upper Coastal Region

"The Coastal Plain" is in general low and very flat alluvial plain and is very swampy in part, the ground elevation in this region ranges below 5 m. contourline. In this region some coastal ridges and small natural river levees occurred by shifting of coastal line and river courses scattered belt-like and nearly parallel to the coast.

"The Upper Coastal Region" is a part of vast foothill of southern mountain region. The ground elevation ranges from El. 5 to 20 m. or more but the ground slope toward north is rather gentle. This region is composed of soft volcanic rocks or it's weathered materials geologically, and valley alluvial deposits also exist here and there because they are easily erroded by surface water.

Geologically, the upper coastal region mainly consists of volcanic rocks belonging to Pliocene to Pleistcene and volcanic deposits belonging to Pleistcene, but they are very easily weathered and product lateritic soils at upper part. These formation extends continuously toward north but at the coastal plain region they are overlay by thick alluvial deposits. Alluvial deposits consist of mainly clayey layer (clay, silt) and interbedded by sandy layer or sand lenses.

### GEOLOGICAL FORMATION

| | | |
|---|---|---|
| Quaternary | Holocene | Coastel Alluvium (mainly clay)<br>River Alluvium (clay, sand, gravel)<br>Valley Alluvium (tuffacious clay, sand)<br>Beach Ridge Deposite (fine sand) |
| | Pleistcene | Young Volcanic Rocks (tuffacious clay, sand, lahar deposite) |
| Tertiary | Pliocene | Genteng Formation (tuffacious sandstone) |

## 2. CENGKARENG DISTRICT

Cengkareng district is very flat lowland with ground elevation ranging from El. 3 to 5 m. and some coastal ridges are scattered with liniation of NW - SE which nearly parallel to the present coast. The width of coastal ridges range from 300 to 800 m., the length of them are several kilometers or more. They are forming a belt-like high zone than the surrounding alluvial plain and usually occupied by villages and roads. Alluvial plain getting between these coastal ridges are mainly cultivated as a paddy field but some part of them are used as a fish ponds or kept as non-cultivated swamp area.

Geologically the practical bed rock of this area is volcanic deposits or volcanic rocks belonging the end of Tertiary of Pleistcene and overlay by thick (10 - 30 m.) alluvial deposits. Alluvial deposits consist of very soft clay and silt containing some organic materials and interbedded sandy layer partially, but at the upper part of coastal ridges fine sand is predominant than clayey components.

Subsoil in this area is composed of mainly clay and silt and have very poor bearing capacity. The characteristics of the soil are high water contents, high saturation degree, rather high cohesion, high plasticity and low permeability.

The volcanic deposits underlying the alluvial soil mentioned above are composed of hard clay and tuffacious sand and have a high bearing capacity but depth of this layer ranges from 9 - 10 m. at Tanggerang to 16 - 20 m. at the west end of DKI Jakarta. This means that the distribution of these hard layers have same tendency with the wide topographical feature of this area as sloping toward northeast.

The groundwater level is generally very high or same level to the ground surface partially but at the coastal ridge zone it lies 0.6 - 1.5 m. below the ground surface.

## 3. STUDY AREA

### a) Field survey

The field investigations are carried out in the study area to grasp the geological and soil mechanical conditions. The items of field investigations and laboratory tests are follows:

| | | | | |
|---|---|---|---|---|
| i. | Drillings | 2 holes | total | 50 m. |
| ii. | Standard Penetration Tests | " | " | 42 times |
| iii. | Undisturbed Soil Sampling | " | " | 12 samples |
| iv. | Dutch Cone Soundings | 18 points | | 225 m. |
| v. | Soil Laboratory Tests | | | 12 samples |

-- Series of physical tests, consolidation test, triaxial compression test --

The field investigation works and laboratory tests are performed by the contractor, P,T. P.P. TAISEI CONSTRUCTION under supervising of the geologist belonging to the project team. The location map of field investigation and the results of this investigations and tests are attached at the end of this paper.

### b) Geology and Subsoil Condition

The results of field investigations are condensed to the attached sheet "SOIL PROFILE, PANEL DIAGRAM". The soil profile of this site consists of thick very soft clay ($N<3$), soft clay ($N=3 - 10$), inter-bedded sand layers or sand lenses and underlying hard clay ($N>30$).

Very soft or soft clayey layers interbedded by sandy layers are alluvial deposits, that have high plasticity and high water contents (most of them are almost saturated) except a few parts. The characteristics of this layer is similar to the common alluvial clay such as poor permeability, low compression strength (qu), middle cohesion (C), low angle of internal friction ($\phi$) and high compression index (Cc). These characteristics are showed as a summarise table of the laboratory test data.

Underlying hard clayey layer is considered as dilvial deposits and consists of sandy clay, clayey silt and sandy silt. This layer have a rather high compression strength ($N>30$, mainly $N>50$) and enough bearing capacity. The depth of this diluvium varies from 7 to 15 m. from the ground surface and generally tend to go deep toward east. Fig. - "ISOBATH MAP OF DILUVIUM" already stated in Part I. 3 shows the distribution and tendency of the depth of diluvium.

### c) Bearing Capacity

The bearing capacity is considered from the results of S.P.T. and Dutch Cone Sounding. At first, the relationship between N-value of S.P.T. and qu-value of sounding are studied based on the results of the field investigation and the geological and/or subsoil investigation data collected at the site, then the bearing capacity of each layer in the field and distribution of safety bearing layers are studied.

The relation between N-value and qu-value is showed as a figure. From the figure, 2 tendencys are get, one is a relativity of whole data and another is relativity of low qu-value and N-value, but in this report the interrelation, N=0.437 qu is adopted finally from the view of safety evaluation.

Based on the interrelation of N-value and qu-value mentioned above, the distribution of bearing capacity was got like as an attached sheet "SOIL PROFILE, PANEL DIAGRAM". As indicated in the figure, the upmost layer at the most of all project area have very poor bearing capacity less than 3 in N-value, it means the long term allowable bearing capacity is less than 3 $t/m^2$ for the sheet base. Furthermore this very soft clayey layer lies generally thick and a depth from the ground surface varied from 5.5 to 9.0 m., it means that the risks of wide subsidence and unbalanced subsidence are very serious as a foundation of the constructions. From these consideration mentioned above, the alluvium in this site is concluded that it's not suitable for the direct foundation except some kind of very light simple housing like as bamboo and wooden house, without any special land-treatment.

Practically, the safety bearing capacity for the construction foundation is the hardness more than 30 in N-value, and the layer which has N-value more than 30 are mainly dilvium and some parts of interbedded sandy layers. Depth of these safety bearing layers also varied from 7 to 13 m. under the ground surface, and the plane delineation of the upper surface of these layers are shown as fig.- "ISOBATH MAP OF BEARING LAYER". As shown in that figure, the distribution of the layer which has enough bearing capacity is rather confusing, but there's a tendency that rather shallow at the coastal ridge zones and deep in the middle area of these ridges. Then there is another notable feature indicated in the figure that is the existing of gaps in depth to the bearing layer like as a fault. This gaps come from the discontinuity of interbedding sandy layer which has enough bearing capacity.

From the consideration described above, the following matters are concluded:

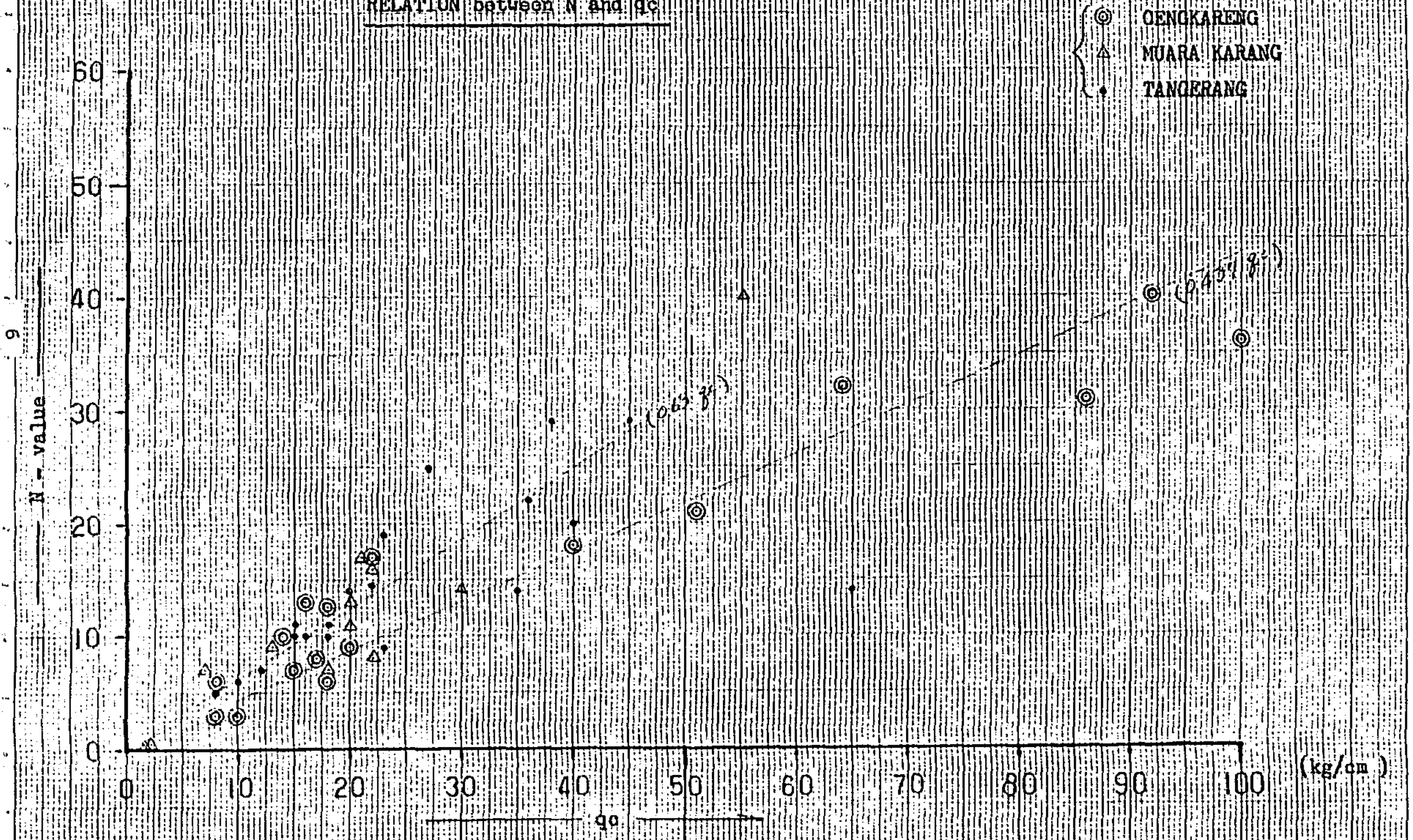
Most of all constructions at this project site must be based on the layers which have enough bearing capacity but the depth of these layers are deeper than 7 m., therefore a piar foundation shall be adopted, and it mean the construction cost should become rather high.

d) Groundwater

At this time field investigation, the systematic groundwater survey was not carried out, but the following matter is said from field reconnaissance. The natural groundwater level in this field is very high or nearly same level to the ground surface at an alluvial plain and 0.6 - 1.5 m. below from the ground surface at coastal ridge zones. Anyway concerning to the groundwater, further investigation should be carried out systematically to grasp the distribution of the groundwater surface, groundwater-flow system, and the groundwater hydrograph through a year. These data will be required to design the underground construction, the drainage system and development of the groundwater.

Fig-

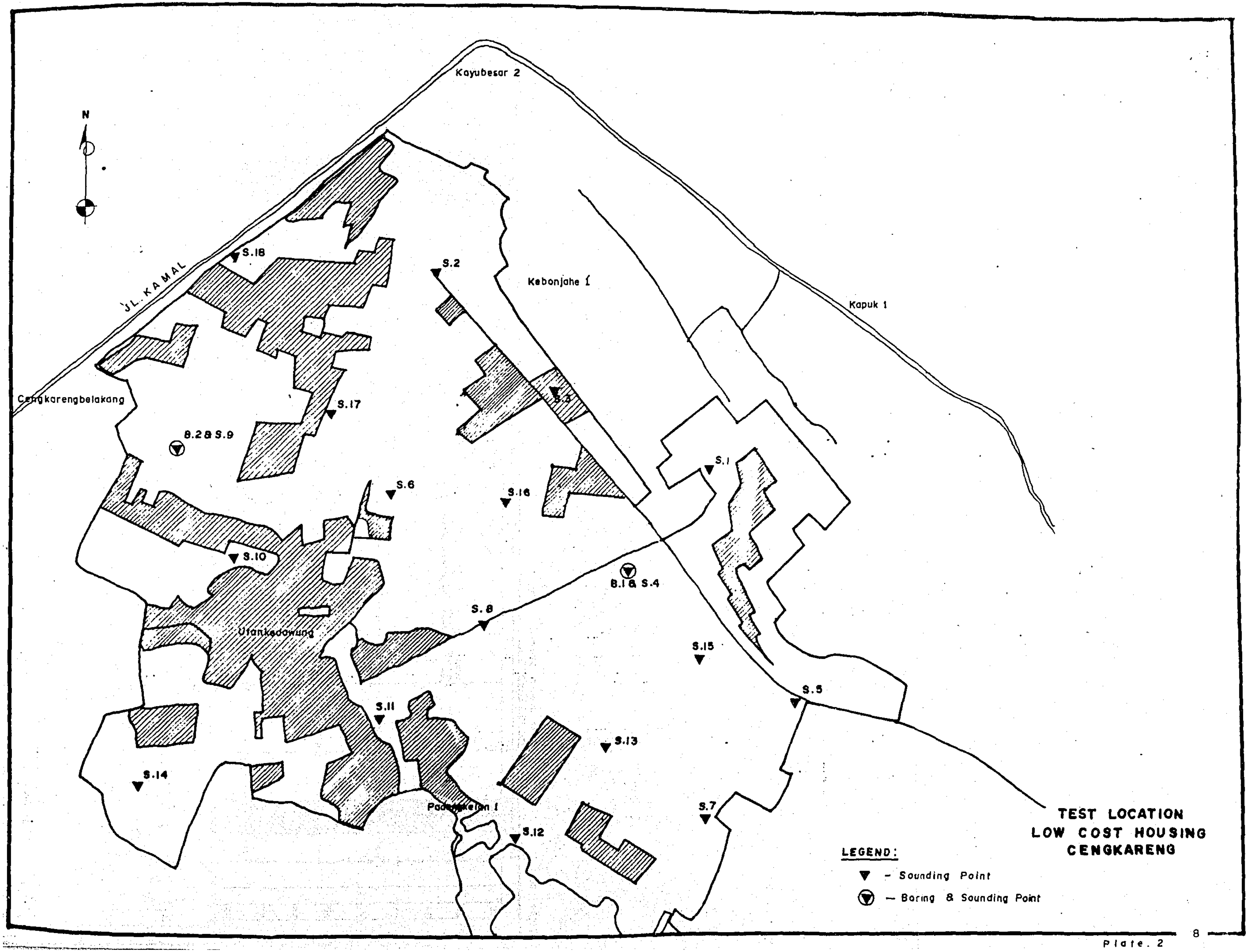
RELATION between N and qc



# TERMS and SYMBOLS

As recommended by the International Society of Soil Mechanics and Foundation Engineering, as adopted in Paris, July, 1961.

$\gamma_m$ = volumetric weight, bulk density
$\gamma_s$ = unit weight of solid particles
$\gamma_d$ = dry density
$w_{opt}$ = optimum water content
$w_N$ = natural water content
$e_o$ = void ratio
$n$ = porosity
$S_r$ = degree of saturation
$w_L$ = liquid limit
$w_P$ = plastic limit
$I_P$ = plasticity index
$w_S$ = shrinkage limit
$D_S$ = degree of shrinkage
$R_S$ = shrinkage ratio
$L_S$ = linear shrinkage
$D_{10}$ = effective size
$C_u$ = uniformity coefficient
$q_u$ = unconfined compressive strength
$S_t$ = $\frac{\text{undisturbed } q_u}{\text{remolded } q_u}$ = *sensitivity*
$c$ = apparent cohesion
$\phi$ = apparent angle of internal friction
$\bar{c}$ = true or intergranular cohesion
$\bar{\phi}$ = true or intergranular angle of internal friction
$k$ = coefficient of permeability
$D_r$ = relative density
$E_u$ = unsaturated modulus of elasticity
$E_s$ = saturated modulus of elasticity
$C_c$ = compression index
$c_v$ = coefficient of consolidation



## TEST LOCATION
## LOW COST HOUSING
## CENGKARENG

Plate. 2

ELEVATION : -1.850
DEPTH : 30.45 M.
BEGUN : OCTOBER 30, 1979
FINISHED : NOVEMBER 4, 1979
GROUND WATER LEVEL : -0.27 M. IN DEPTH

SAMPLING METHOD : THIN WALLED (SHELBY) TUBE
D : DISTURBED SAMPLE U : UNDISTURBED SAMPLE
NOTE :

FOREMAN : BISMA
DRILL MASTER : A.UNANG MAKBUL
LOGGED BY : WAHYU WIDODO
REVIEWED BY: DJUMHANI
DRAWN BY : DEDDY S.
CHECKED BY: WIRASTUSRINI
APPROVED BY : RISMANTOJO

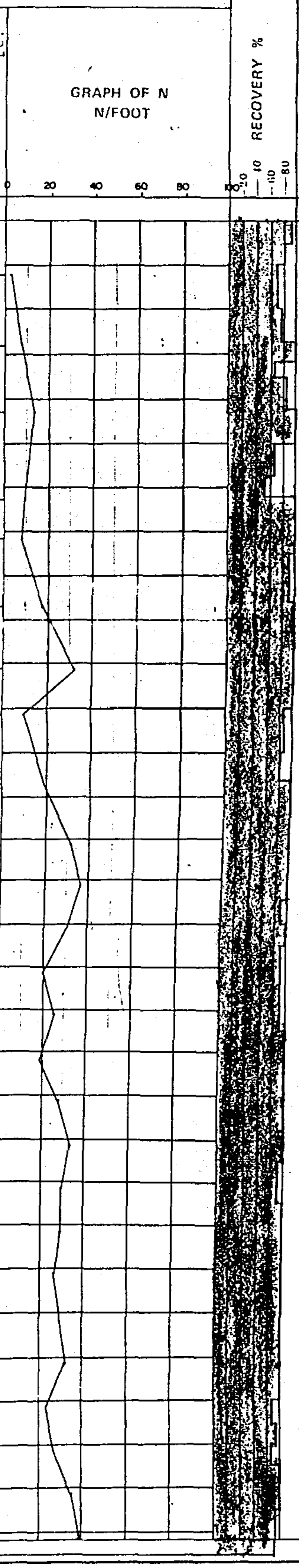
SAMPLE: 2.00–2.70; 3.50–4.20; 5.00–5.70–6.20; 8.00–8.55; 12.00–12.60

| DEPTH in meter | LETTER SYMBOL | CLASSIFICATION BY FIELD IDENTIFICATION | COLOR | DESCRIPTION |
|---|---|---|---|---|
| .90 | CH | SILTY CLAY, | yellowish gray, | medium to high plastic fines - small amount of fine sand, very moist. |
| 1.40 | CH-CL | SILTY CLAY, | pale yellowish brown, | medium plastic - mixture of fine to medium grained sand, moist. |
| 1.50 | ML | SANDY SILT, | dark yellowish brown, | loose - fine to coarse grained subangular to subrounded shaped - small amount of clay. |
| 3.50 | ML | SANDY SILT, | dark yellowish brown, | loose - fine to medium grained - small amount of clay. |
| 6.20 | MH-CL | CLAYEY SILT, | brownish gray, | medium to low plastic - small amount of fine sand - moist. |
| 6.65 | MH | CLAYEY SILT | reddish gray, | low plastic - small amount of fine sand. |
| 8.55 | MH-CL | SILTY CLAY, | brownish gray, | medium to low plastic - trace fine sand - moist. |
| 10.46 | ML | SANDY SILT, | dark yellowish brown, | fine to medium grained sand - loose. |
| 12.60 | ML-CL | CLAYEY SILT, | grayish brown, | low plastic - trace fine sand mixture. |
| 14.00 | ML | SANDY SILT, | brownish gray, | fine to medium grained sand - small amount of clay - non plastic. |
| 15.00 | ML | SANDY SILT, | dark yellowish brown, | fine to medium grained sand - loose. |
| 16.45 | ML | SANDY SILT, | pale yellowish brown, | fine grained sand - small amount of clay - non plastic. |
| 20.00 | MH-CL | SILTY CLAY, | pale yellowish brown, | medium plastic - trace fine grained sand - moist. |
| 22.45 | ML | CLAYEY SILT, | dusky yellow, | low plastic - mixture of fine grained sand. |
| 26.45 | CL | SILTY CLAY, | brownish gray, | medium to low plastic - small amount of fine sand. |
| 30.45 | CH-CL | SILTY CLAY, | pale yellowish brown, | medium plastic - small amount of fine sand. |

| DEPTH in meter | RELATIVE DENSITY & CONSISTENCY qu kg/cm² |
|---|---|
| 0.50 | 0.75 |
| 1.00 | 0.50 |
| 1.50 | 0.50 |
| 2.00 | 0.50 |
| 2.70 | 1.25 |
| 3.15 | 1.00 |
| 3.50 | 0.75 |
| 4.20 | 1.75 |
| 4.65 | 2.00 |
| 5.00 | 1.25 |
| 5.70 | 1.50 |
| 6.20 | 1.25 |
| 6.65 | 1.50 |
| 7.00 | 0.50 |
| 7.45 | 0.75 |
| 8.00 | 1.25 |
| 8.85 | >4.5 |
| 9.00 | >4.5 |
| 10.00 | >4.5 |
| 10.45 | >4.5 |
| 11.00 | >4.5 |
| 11.45 | 1.75 |
| 12.00 | 1.00 |
| 12.60 | 4.25 |
| 13.05 | 4.00 |
| 14.00 | >4.5 |
| 14.45 | >4.5 |
| 15.00 | >4.5 |
| 15.45 | >4.5 |
| 16.00 | >4.5 |
| 16.45 | >4.5 |
| 17.00 | 2.75 |
| 17.45 | 3.25 |
| 18.00 | 2.50 |
| 18.45 | 2.75 |
| 19.00 | 2.75 |
| 19.45 | 2.50 |
| 20.00 | 1.75 |
| 20.45 | 2.75 |
| 21.00 | 3.00 |
| 21.45 | 3.25 |
| 22.00 | 2.75 |
| 22.45 | 3.00 |
| 23.00 | 2.50 |
| 23.45 | 2.75 |
| 24.00 | 2.00 |
| 24.45 | 2.25 |
| 25.00 | 2.25 |
| 25.45 | 2.25 |
| 26.00 | 2.25 |
| 26.45 | 2.25 |
| 27.00 | 1.25 |
| 27.45 | 2.00 |
| 28.00 | 1.50 |
| 28.45 | 2.00 |
| 29.00 | 2.50 |
| 29.45 | 3.25 |
| 30.00 | 3.00 |
| 30.45 | 1.75 |

STANDARD PENETRATION TEST

| DEPTH in meter | NUMBER OF BLOWS (BLOWS / CM) |
|---|---|
| 1.27 | 2/23 |
| 2.85 | 7/30 |
| 4.35 | 13/30 |
| 6.35 | 9/30 |
| 7.16 | 8/29 |
| 8.70 | 17/30 |
| 10.16 | 32/30 |
| 11.16 | 10/30 |
| 12.75 | 18/30 |
| 14.15 | 31/30 |
| 15.15 | 36/30 |
| 16.15 | 30/30 |
| 17.15 | 20/30 |
| 18.15 | 25/30 |
| 19.15 | 19/30 |
| 20.15 | 27/30 |
| 21.15 | 33/30 |
| 22.15 | 30/30 |
| 23.15 | 30/30 |
| 24.15 | 26/30 |
| 26.15 | 29/30 |
| 26.15 | 34/30 |
| 27.15 | 29/30 |
| 28.15 | 26/30 |
| 29.15 | 36/30 |
| 30.15 | 39/30 |



PERMEABILITY
DEPTH in meter
GRAVITY K (cm/s 10⁻ˣ) -5 -4 -3 -2
PRESSURE Lugeon (L/m.min) 5 10 15 20

END OF THIS BORING.
CASING DOWN TO -22.00 METERS DEPTH.

G 004 – 0477 S

PLATE. A 1.1

ELEVATION : 1.300
DEPTH : 20.00 M.
BEGUN : OCTOBER 25, 1979
FINISHED : OCTOBER 27, 1979
GROUND WATER LEVEL : -0.20 M. IN DEPTH

SAMPLING METHOD : THIN WALLED (SHELBY) TUBE
D : DISTURBED SAMPLE U : UNDISTURBED SAMPLE
NOTE :

FOREMAN : BISMA
DRILL MASTER : A.UNANG MAKBUL
LOGGED BY : WAHYU WIDODO
REVIEWED BY: DJUMHANI
DRAWN BY : DEDDY S.
CHECKED BY: WIRASTUSRINI
APPROVED BY : RISMANTOJO

| SAMPLE | ELEVATION in meter |
|---|---|
| 2.00 – 2.70 | |
| 3.50 – 4.70 | 4.20 |
| 5.50 – 6.20 | |
| 7.00 – 7.70 | |
| 8.80 | |

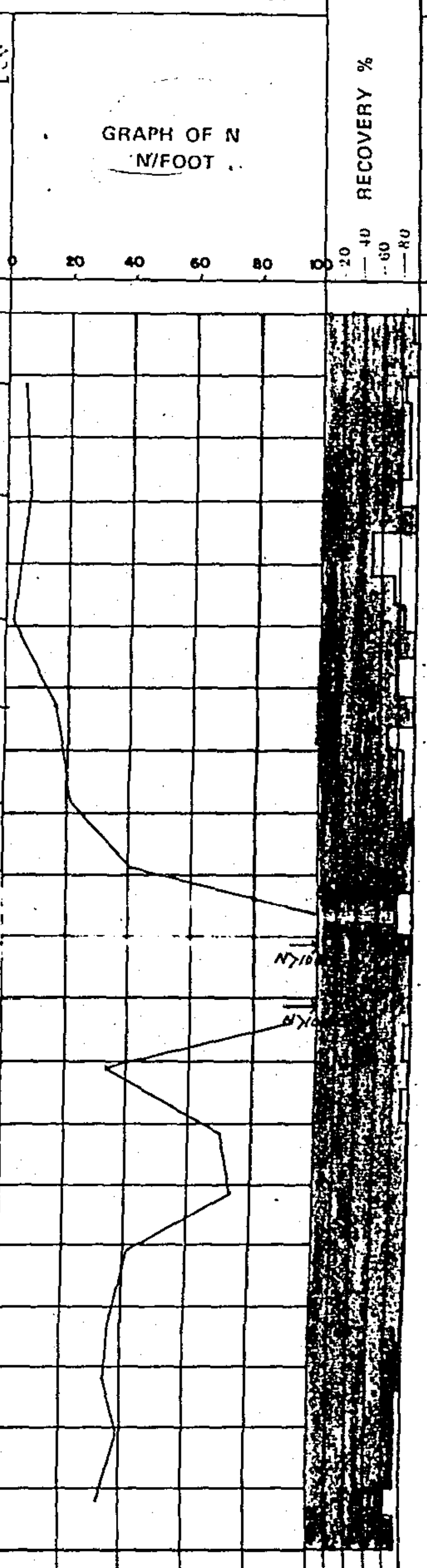
| DEPTH in meter | SOIL TYPE<br>GRAPHIC SYMBOL | LETTER SYMBOL | CLASSIFICATION BY FIELD IDENTIFICATION | COLOR | DESCRIPTION |
|---|---|---|---|---|---|
| 0 – 2.00 | ▨ | CH | SILTY CLAY, | medium dark gray. | small amount of fine sand, medium to high plastic. |
| 2.00 – 4.20 | ▤ | ML | SANDY SILT, | brownish gray. | mixture of fines and few fine to coarse grained subangular to subrounded shaped – non plastic. |
| 4.20 – 5.50 | ▨ | CL | SILTY CLAY, | grayish black, | few organized matter, low plastic. |
| 5.50 – 7.00 | ▤ | MH | CLAYEY SILT, | medium dark gray. | small amount of fine sand - medium to high plastic. |
| 7.00 – 8.80 | ▦ | SM | SILTY SAND, | dusky yellow, | mixture of fine to medium grained, small amount of clay - non plastic. |
| 8.80 – 10.80 | ▦ | SM | SILTY SAND, | dark yellowish brown, | mixture of fine to coarse grained subangular to subrounded shaped. |
| 10.80 – 12.00 | ▤ | ML | SANDY SILT, | dark brown, | mixture of fine to coarse grained - subangular to subrounded shaped - non plastic. |
| 12.00 – 13.00 | ▨ | CL | SANDY CLAY, | dusky yellow, | mixture of fine to medium grained, medium to low plastic. |
| 13.00 – 14.45 | ▤ | ML | SANDY SILT, | pale brown, | mixture of fine to medium grained - small amount of clay - non plastic. |
| 14.45 – 19.00 | ▦ | SM | SILTY SAND, | brownish gray. | mixture of fine to medium grained - small amount of clay - non plastic. |
| 19.00 – 20.00 | ▨ | CL | SANDY CLAY, | grayish brown, | mixture of fine to medium grained - non plastic |

END OF THIS BORING.
CASING DOWN TO -12.00 METERS DEPTH

| DEPTH in meter | RELATIVE DENSITY & CONSISTENCY qu kg/cm² |
|---|---|
| 0.50 | 0.50 |
| 1.00 | 0.50 |
| 1.45 | 0.50 |
| 2.00 | 0.25 |
| 2.70 | 2.25 |
| 3.15 | 2.50 |
| 3.50 | 2.75 |
| 4.20 | 1.50 |
| 4.70 | 0.10 |
| 5.15 | 0.25 |
| 5.50 | 0.25 |
| 6.20 | 0.50 |
| 6.65 | 2.00 |
| 7.00 | 1.25 |
| 7.70 | 4.00 |
| 8.15 | >4.5 |
| 8.50 | >4.5 |
| 8.80 | >4.5 |
| 9.25 | >4.5 |
| 10.00 | >4.5 |
| 10.32 | >4.5 |
| 10.80 | >4.5 |
| 11.00 | >4.5 |
| 11.45 | >4.5 |
| 12.00 | >4.5 |
| 12.45 | >4.5 |
| 13.00 | >4.5 |
| 13.45 | >4.5 |
| 14.00 | >4.5 |
| 14.45 | >4.5 |
| 15.00 | >4.5 |
| 15.45 | >4.5 |
| 16.00 | 3.25 |
| 16.45 | 4.25 |
| 17.00 | 2.50 |
| 17.45 | 3.25 |
| 18.00 | 2.50 |
| 18.45 | 2.75 |
| 19.00 | 2.50 |
| 19.45 | 3.00 |
| 20.00 | 2.50 |

STANDARD PENETRATION TEST

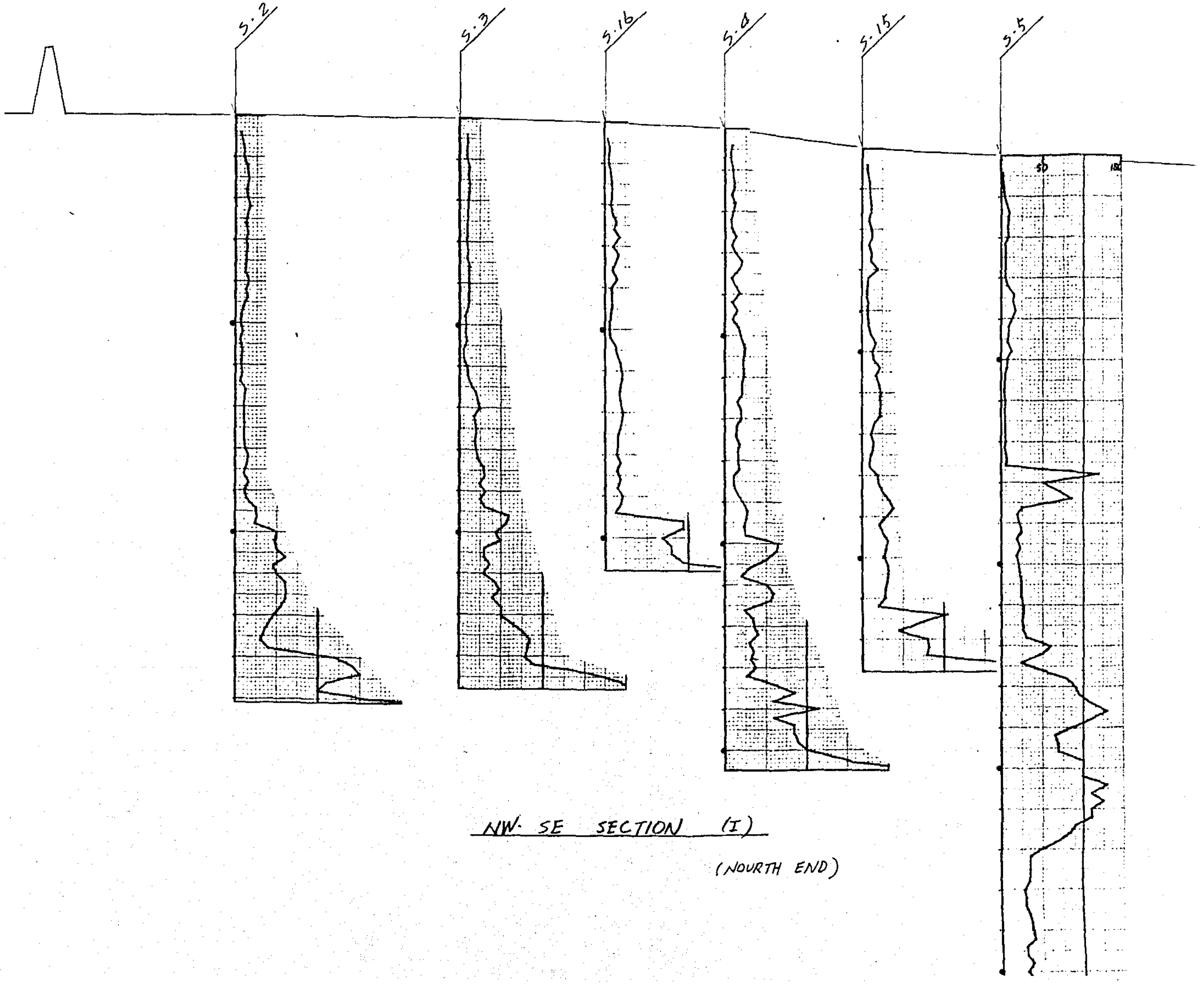
| DEPTH in meter | NUMBER OF BLOWS |
|---|---|
| 1.18 | 6/27 |
| 2.90 | 6/25 |
| 4.90 | 3/25 |
| 6.35 | 15/30 |
| 7.85 | 21/30 |
| 8.95 | 40/30 |
| 10.15 | 96/17 |
| 11.15 | 115/30 |
| 12.10 | 33/30 |
| 13.15 | 70/30 |
| 14.15 | 73/30 |
| 15.15 | 42/30 |
| 16.15 | 36/30 |
| 17.15 | 34/30 |
| 18.15 | 28/30 |
| 19.15 | 32/30 |



PERMEABILITY

| DEPTH in meter | GRAVITY K (cm/s 10^x) | PRESSURE Lugeon (L/m.min) |
|---|---|---|
| | | |

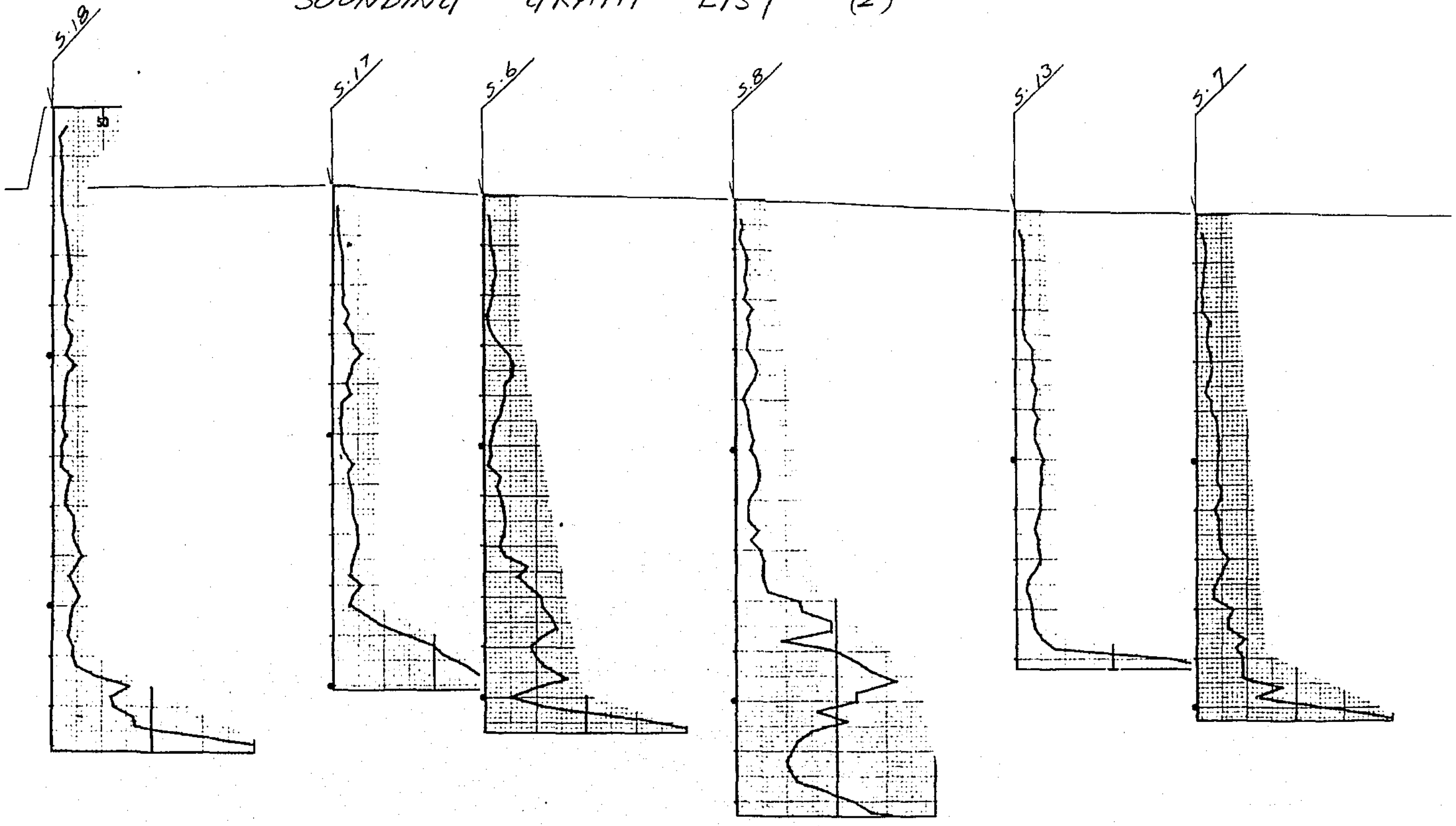
# SOUNDING GRAPH LIST (1)



NW· SE SECTION (I)

(NOURTH END)

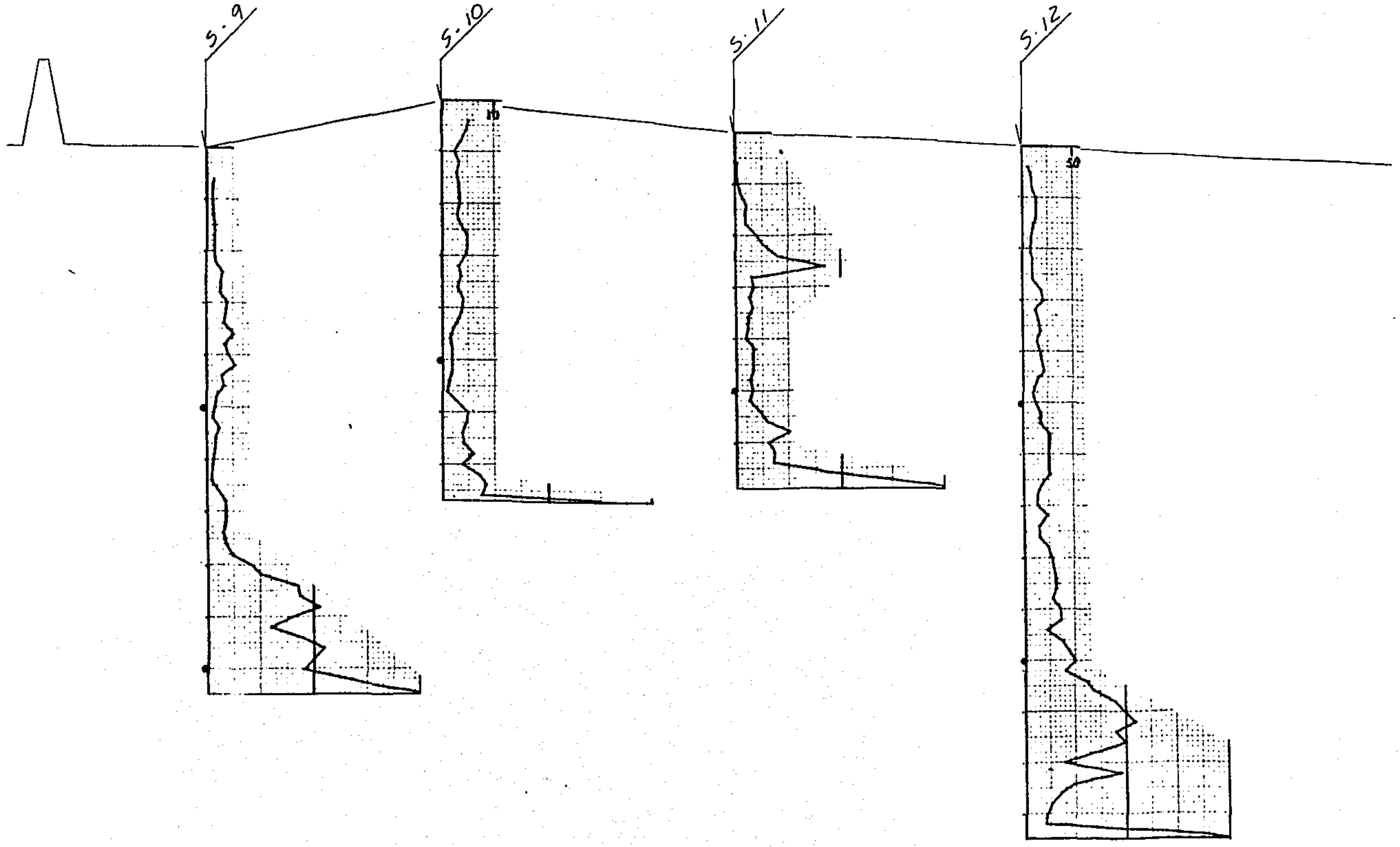
# SOUNDING GRAPH LIST (2)



NW - SE SECTION (II)

(CENTER)

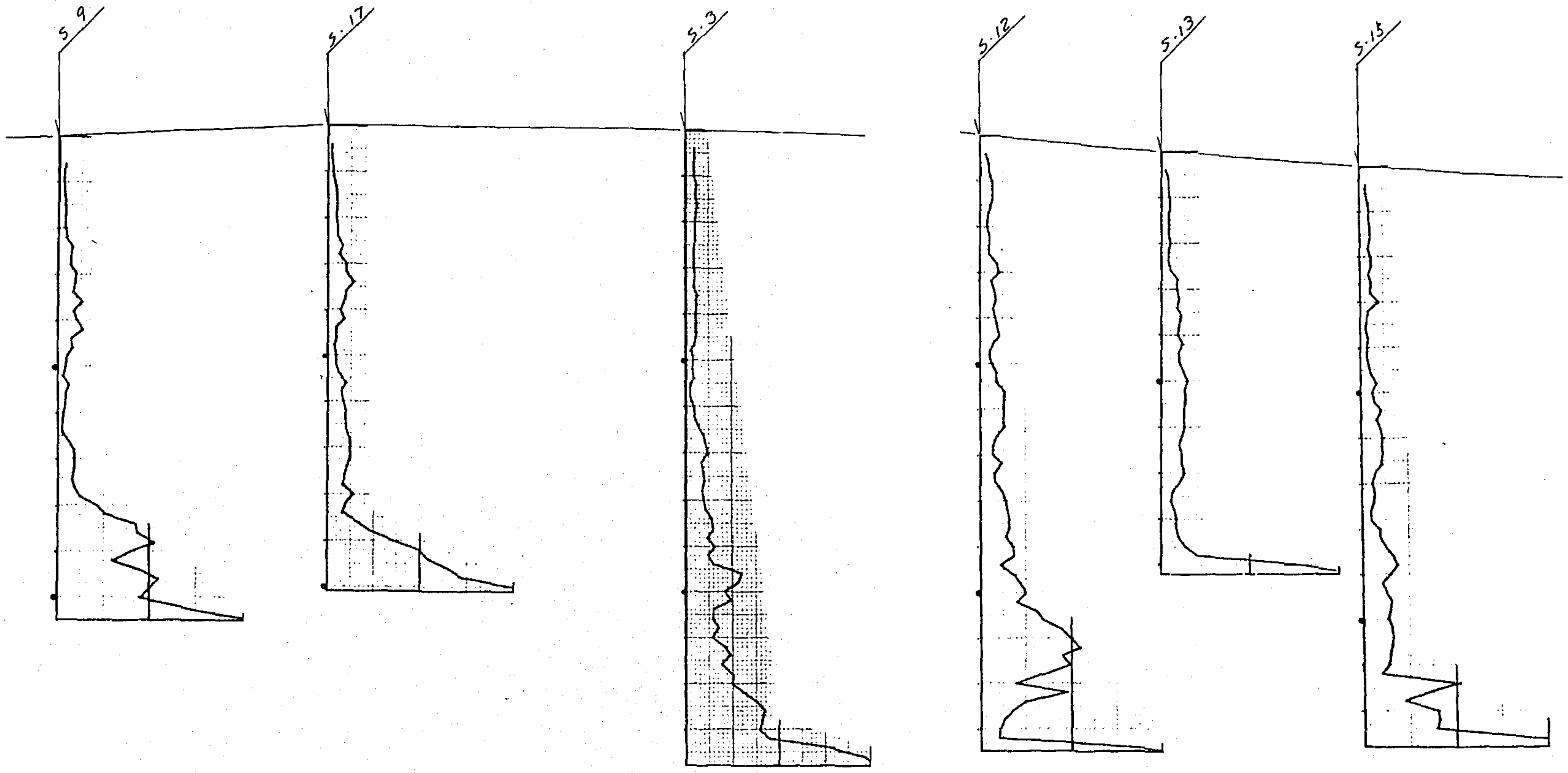
# SOUNDING GRAPH LIST (3)



NW-SE SECTION (III)

(SOUTH END)

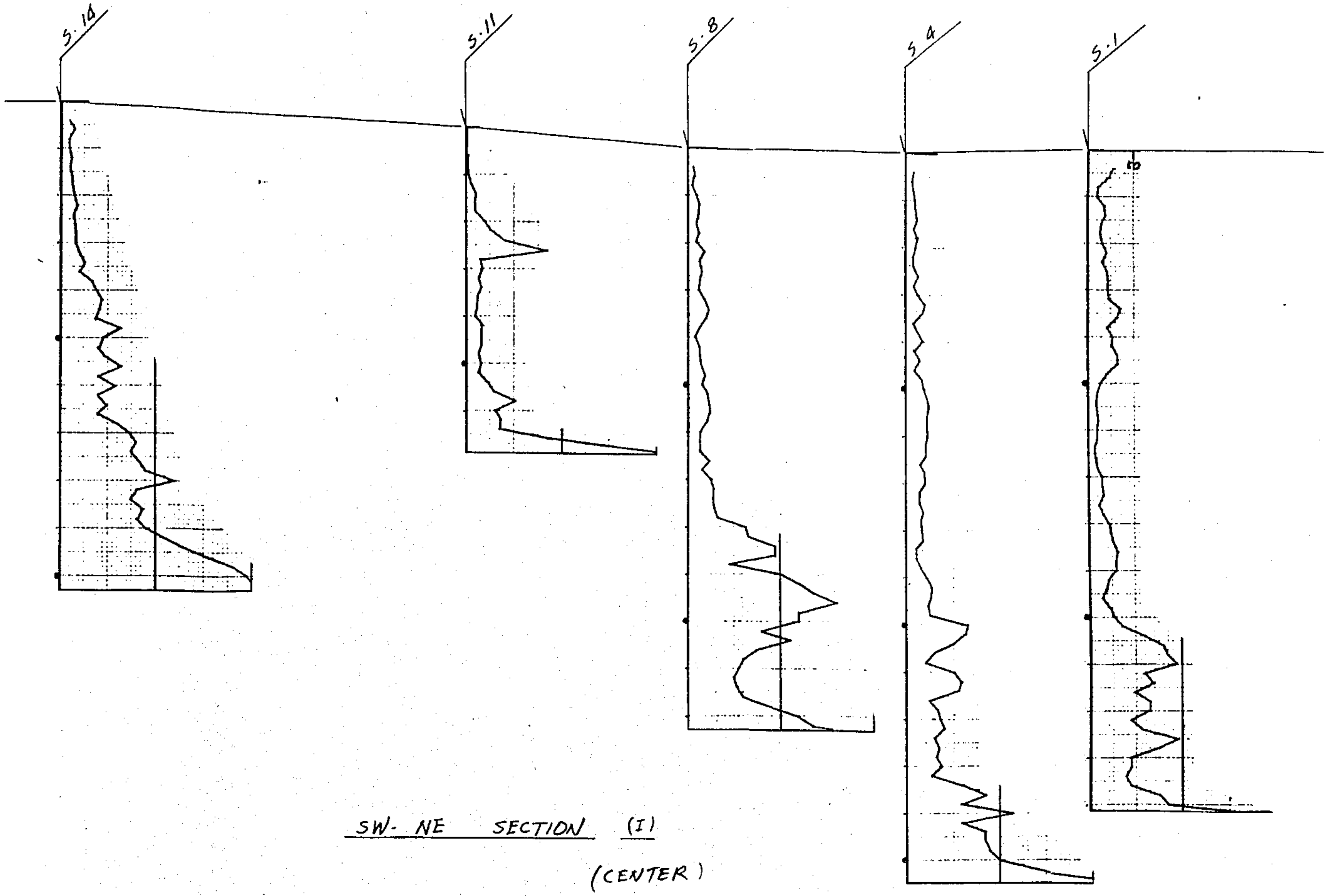
# SOUNDING GRAPH LIST (4)



SW - NE STCTION (II)

(EAST END & WEST END)

# SOUNDING GRAPH LIST (5)



SW- NE SECTION (I)

(CENTER)

# LABORATORY TEST DATA

PROJECT : LOW COST HOUSING
LOCATION : CENGKARENG.

| | Bor/ POINT No. | Depth m | $\gamma_s$ t/m³ | In - Situ test | | | $w_L$ % | $w_P$ % | $I_P$ % | $I_L$ | $w_S$ % | e | n % | Sr % | % finer by weight passing sieve No.200 | qu kg/cm² | St % | UU.~~CU~~.~~CD~~ Triaxial | | Consolidation. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $\gamma_m$ t/m³ | $\gamma_d$ t/m³ | w % | | | | | | | | | | | | C kg/cm² | φ ° | Cc | Pc kg/cm² |
| ① | B.1 | 2.00 - 2.70 | 2.65 | 1.75 | 1.21 | 44.5 | 52.3 | 29.1 | 23.2 | + 0.66 | - | 1.19 | 54 | 99 | 40 | * | - | 0.35 | 10.5 | 0.33 | 3.00 |
| ② | | 3.50 - 4.20 | 2.62 | 1.63 | 1.05 | 54.8 | 79.1 | 30.9 | 48.2 | + 0.50 | - | 1.49 | 60 | 96 | 74 | 0.875 | 2.2 | 0.35 | 11 | 0.43 | 2.00 |
| ③ | | 5.00 - 5.70 | 2.60 | 1.67 | 1.07 | 56.2 | 114.8 | 44.2 | 70.6 | + 0.17 | - | 1.43 | 59 | 100 | 98 | * | - | 0.40 | 10.5 | 0.30 | 3.35 |
| ④ | | 5.70 - 6.20 | 2.61 | 1.61 | 1.02 | 58.0 | 121.5 | 45.7 | 75.8 | + 0.16 | - | 1.56 | 61 | 97 | 100 | * | - | 0.15 | 17 | 0.39 | 3.80 |
| ⑤ | | 8.00 - 8.55 | 2.54 | 1.37 | 0.69 | 100.2 | 126.5 | 60.3 | 66.2 | + 0.60 | - | 2.71 | 73 | 94 | 99 | * | - | 1.60 | 10 | 1.62 | 4.25 |
| ⑥ | | 12.00 -12.60 | 2.51 | 1.61 | 1.04 | 54.5 | 108.1 | 42.9 | 65.2 | + 0.18 | - | 1.41 | 59 | 97 | 86 | * | - | 0.15 | 17 | 0.39 | 4.25 |
| ⑦ | B.2 | 2.00 - 2.70 | 2.65 | 1.75 | 1.25 | 39.9 | 48.3 | 24.3 | 24.0 | + 0.65 | - | 1.12 | 53 | 94 | 15 | * | - | 0.26 | 9 | 0.33 | 2.10 |
| ⑧ | | 3.50 - 4.20 | 2.63 | 1.57 | 1.01 | 55.5 | 56.7 | 26.5 | 30.2 | + 0.96 | - | 1.60 | 62 | 91 | 53 | 1.00 | - | 0.35 | 13 | 0.46 | 2.20 |
| ⑨ | | 4.20 - 4.70 | 2.55 | 1.46 | 0.78 | 87.0 | 117.7 | 45.5 | 72.2 | + 0.57 | - | 2.27 | 69 | 98 | 97 | 0.96 | 1.8 | 0.30 | 8 | 1.18 | 2.05 |
| ⑩ | | 5.50 - 6.20 | 2.57 | 1.73 | 1.26 | 38.2 | 62.4 | 23.0 | 39.4 | + 0.39 | - | 1.05 | 51 | 93 | 88 | 0.65 | 2.3 | 0.34 | 4.5 | 0.48 | 0.79 |
| ⑪ | | 7.00 - 7.70 | 2.60 | 1.43 | 0.83 | 72.6 | 80.2 | 39.8 | 40.4 | + 0.81 | - | 2.14 | 68 | 88 | 59 | 0.61 | - | 0.30 | 12 | 0.49 | 3.00 |
| ⑫ | | 8.50 - 8.80 | 2.61 | 1.52 | 0.83 | 82.9 | 108.6 | 50.7 | 51.9 | + 0.56 | - | 2.14 | 68 | 100 | 92 | * | - | 0.40 | 8 | 0.30 | 6.10 |

Note : * SAMPLE NOT ENOUGH TO BE TESTED

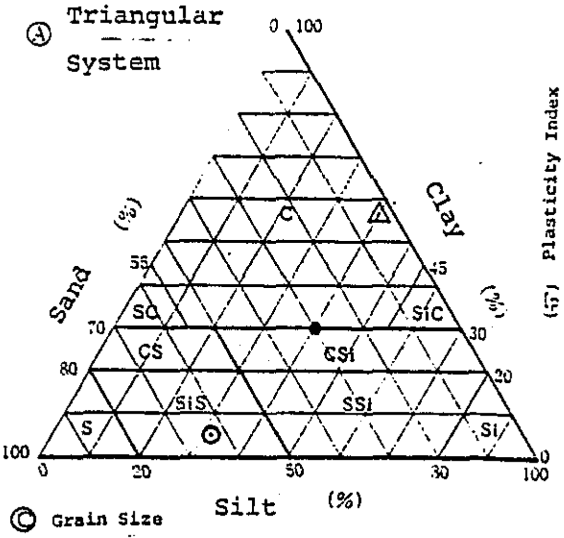
# SOIL CLASSIFICATION (2)

Location CENGKARENG SITE Testing Date

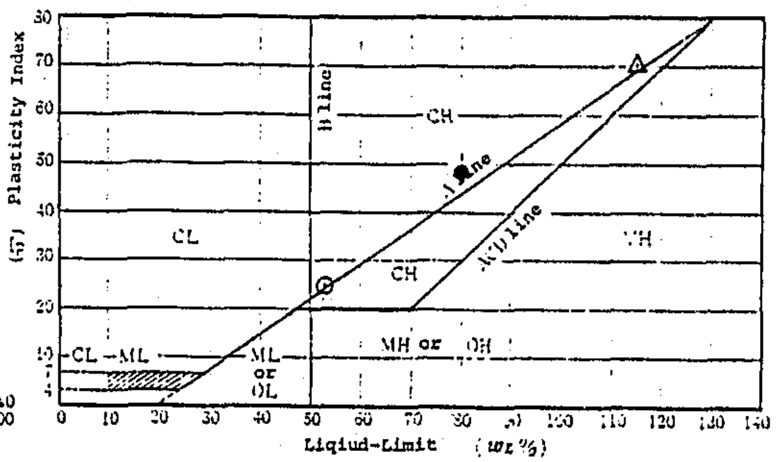
Point No B1 Tester

| Test No | Depth of Collection (m) | Specific Gravity | Field Moist Content (%) | Consistency |  |  |  | Gen. Classification | Classification by Triangular System |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | $w_L$ % | $w_P$ % | $I_P$ % | $w_s$ % |  |  |
| ⊙ ① | 2.00 ~ 2.70 | 2.65 | 44.5 | 52.3 | 29.1 | 23.2 |  | SC | SiS |
| ● ② | 3.50 ~ 4.20 | 2.62 | 54.8 | 79.1 | 30.9 | 48.2 |  | CH | CSi |
| △ ③ | 5.00 ~ 5.70 | 2.60 | 56.2 | 114.8 | 44.2 | 70.6 |  | CH | C |

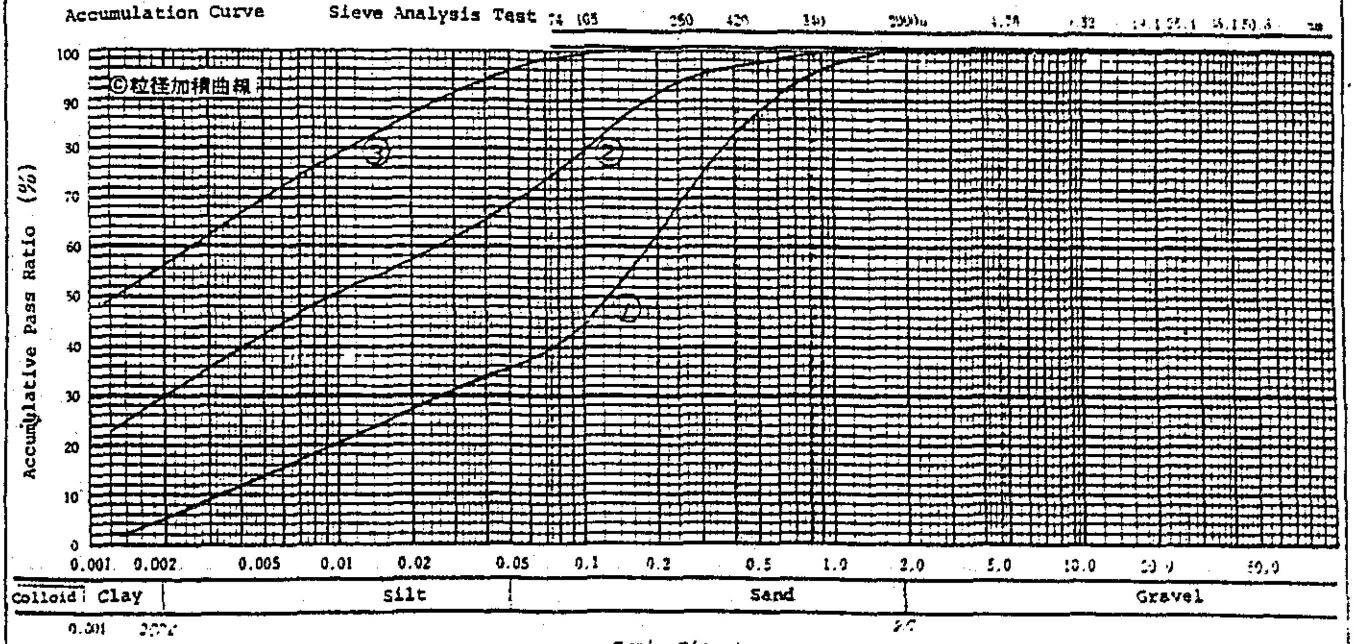
Ⓐ Triangular System



Ⓑ Plasticity Chart



Ⓒ Grain Size Accumulation Curve



| Sample No. | Depth of Collection (m) | 4760μ Sieve Ratio (%) | 74μ Sieve Ratio (%) | 5μ Sieve Ratio (%) | Gravel % | Sand % | Silt % | Clay % | Max. Dia. mm | 60% Dia. mm | 30% Dia. mm | 10% Dia. mm | Uniformity Coeffi. U c | Curvature Coeffi U'c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ① |  | 100 | 32 | 14. | 0 | 63 | 32. | 5 |  | 0.16 |  | 0.003 | 53.3 |  |
| ② |  | 100 | 75 | 43. | 0 | 30 | 40 | 30 |  | 0.024 |  |  |  |  |
| ③ |  | 100 | 98 | 70 | 0 | 3 | 40 | 57 |  | 0.0025 |  |  |  |  |

Note: · Uc = D60/D10 · U'c = (D30)² / D60·D10

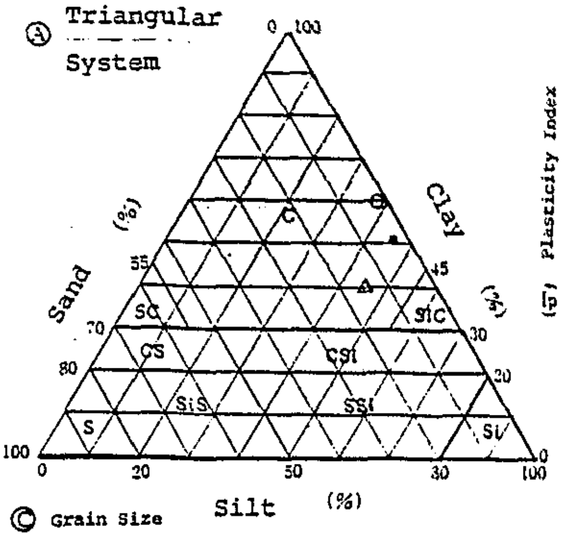
# SOIL CLASSIFICATION (b)

Location CENGKARENG SITE  Testing Date

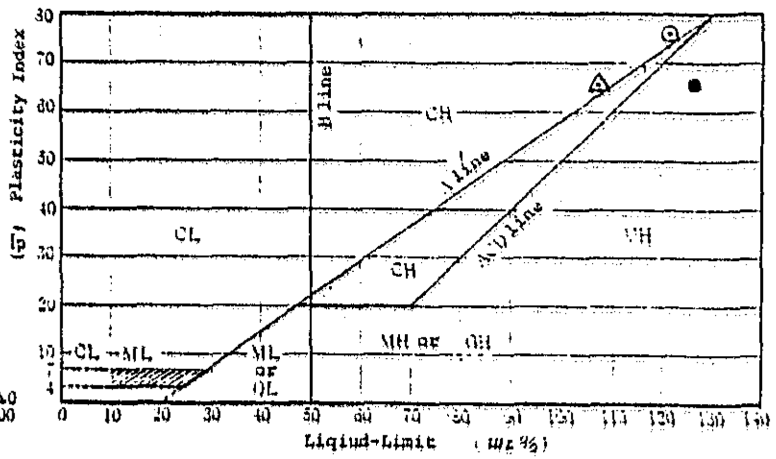
Point No B 1  Tester

| | Test No | Depth of Collection (m) | Specific Gravity | Field Moist Content (%) | Consistency | | | | Gen. Classification | Classification by Triangular System |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $w_L$ % | $w_P$ % | $I_P$ % | $w_s$ % | | |
| ⊙ | ④ | 5.70 ~ 6.20 | 2.61 | 58.0 | 121.5 | 45.7 | 75.8 | | CH | C |
| ● | ⑤ | 8.00 ~ 8.55 | 2.54 | 100.2 | 126.5 | 60.3 | 66.2 | | (VH) | C |
| △ | ⑥ | 12.00 ~ 12.60 | 2.51 | 54.5 | 108.1 | 42.9 | 65.2 | | CH | C |

Ⓐ Triangular System

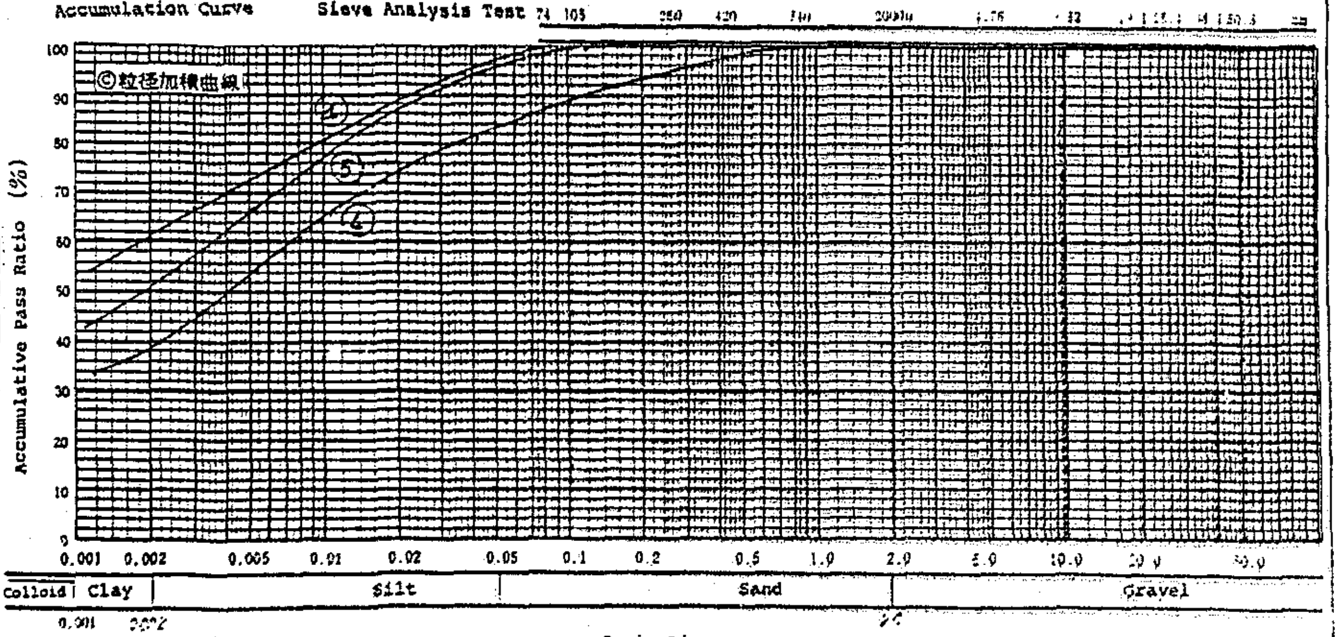


Ⓑ Plasticity Chart



Ⓒ Grain Size Accumulation Curve

Sieve Analysis Test



Grain Diameter (mm)

| Sample No. | Depth of Collection (m) | 4760μ Sieve Ratio (%) | 74μ Sieve Ratio (%) | 5μ Sieve Ratio (%) | Gravel % | Sand % | Silt % | Clay % | Max. Dia. mm | 60% Dia. mm | 30% Dia. mm | 10% Dia. mm | Uniformity Coeff. U'c | Curvature Coeff. U'c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (4) | | 100 | 99 | 72 | 0 | 2 | 38 | 60 | | 0.002 | | | | |
| (5 | | 100 | 98 | 66 | 0 | 3 | 46 | 51 | | 0.0035 | | | | |
| (6) | | 100 | 86 | 54 | 0 | 15 | 45 | 40 | | 0.0075 | | | | |

Notes; Uc = $D_{60}/D_{10}$    U'c = $D_{30}^2/D_{60} \cdot D_{10}$

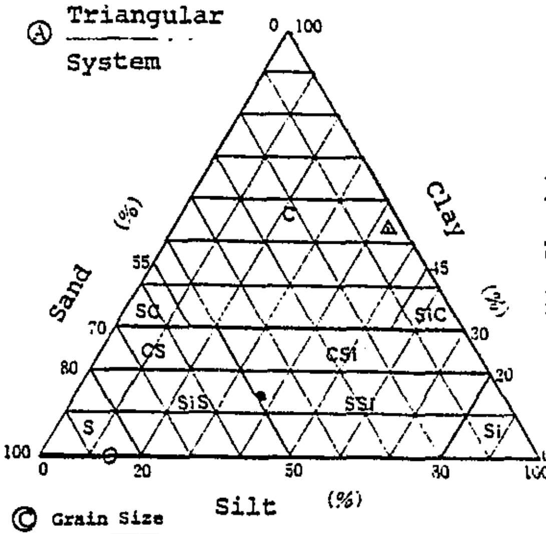
# SOIL CLASSIFICATION (C)

Location CENGKARENG SITE Testing Date

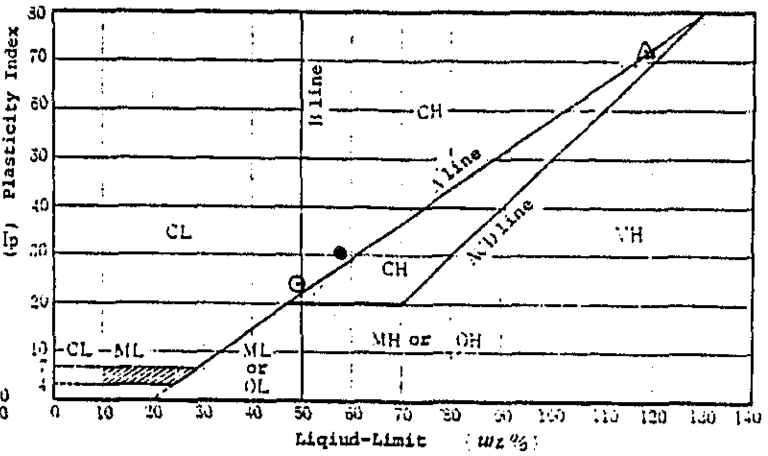
Point No B2 Tester

| | Test No | Depth of Collection (m) | Specific Gravity | Field Moist Content (%) | Consistency | | | | Gen. Classification | Classification by Triangular System |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $w_L$ % | $w_P$ % | $I_P$ % | $w_s$ % | | |
| ⊙ | ⑦ | 2.00 ~ 2.70 | 2.65 | 39.9 | 48.3 | 24.3 | 24.0 | | SC. | S |
| ● | ⑧ | 3.50 ~ 4.20 | 2.63 | 55.5 | 56.7 | 26.5 | 30.2 | | CH. | SSi |
| △ | ⑨ | 4.20 ~ 4.70 | 2.55 | 87.0 | 117.7 | 45.5 | 72.2 | | CH | C |

Ⓐ Triangular System

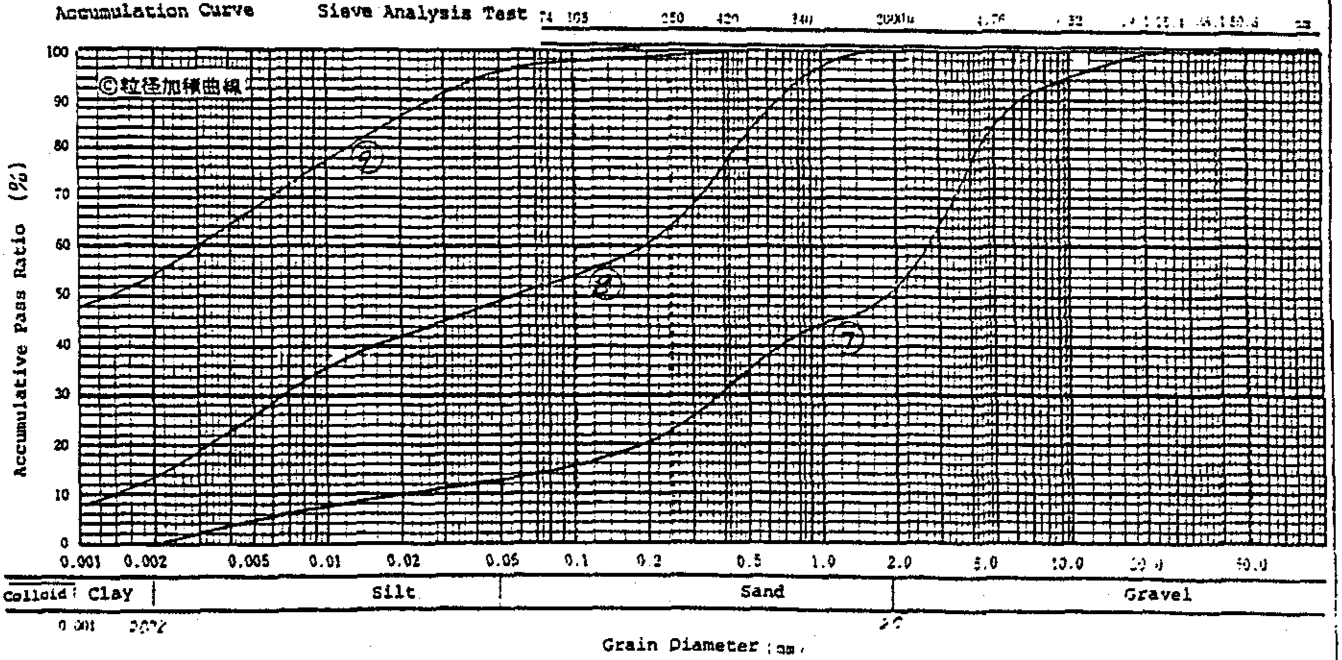


Ⓑ Plasticity Chart



Ⓒ Grain Size Accumulation Curve

Sieve Analysis Test



| Sample No. | Depth of Collection (m) | 4760μ Sieve Ratio (%) | 74μ Sieve Ratio (%) | 5μ Sieve Ratio (%) | Gravel % | Sand % | Silt % | Clay % | Max. Dia. mm | 60% Dia. mm | 30% Dia. mm | 10% Dia. mm | Uniformity Coeffi. U c | Curvature Coeffi. U'c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ⑦ | | 85 | 14. | 5 | 48. | 38. | 14. | 0 | | 2.80 | | 0.017 | 164.7 | |
| ⑧ | | 100. | 52 | 26 | 0 | 49. | 37. | 14 | | 0.20 | | 0.0014 | 142.9 | |
| ⑨ | | 100 | 97 | 67 | 0 | 4. | 42. | 54 | | 0.0031 | | | | |

Note: · $U_c = D_{60} / D_{10}$ · $U'_c = D_{30}^2 / D_{60} \cdot D_{10}$

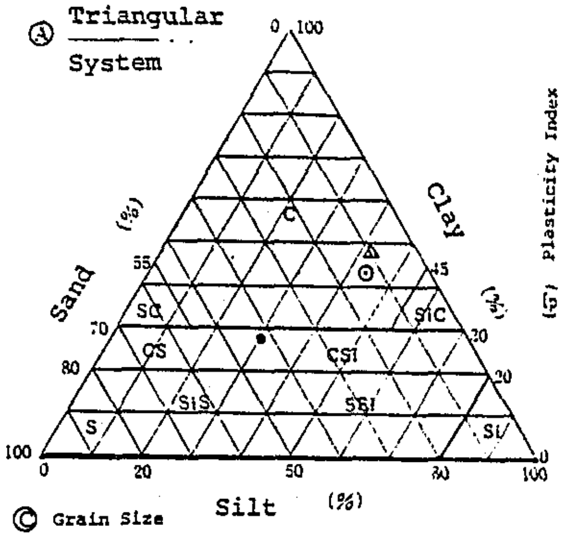
# SOIL CLASSIFICATION (d)

Location CENGKARENG SITE Testing Date

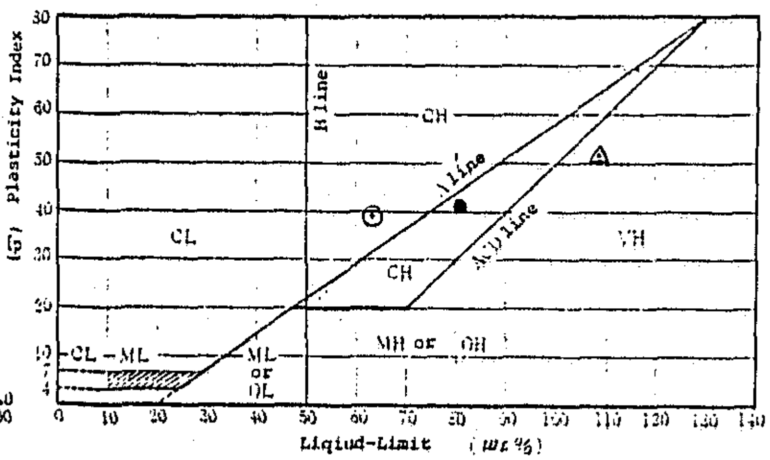
Point No B 2 Tester

| | Test No | Depth of Collection (m) | Specific Gravity | Field Moist Content (%) | Consistancy | | | | Gen. Classification | Classification by Triangular System |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | wL % | wP % | Ip % | ws % | | |
| ⊙ | ⑩ | 5.50 ~ 6.20 | 2.57 | 38.2 | 62.4 | 23.0 | 39.4 | | CH | C |
| ● | ⑪ | 7.00 ~ 7.70 | 2.60 | 72.6 | 80.2 | 39.8 | 40.4 | | CH | CSi |
| △ | ⑫ | 8.50 ~ 8.80 | 2.61 | 82.9 | 108.6 | 50.7 | 51.9 | | (VH) | C |

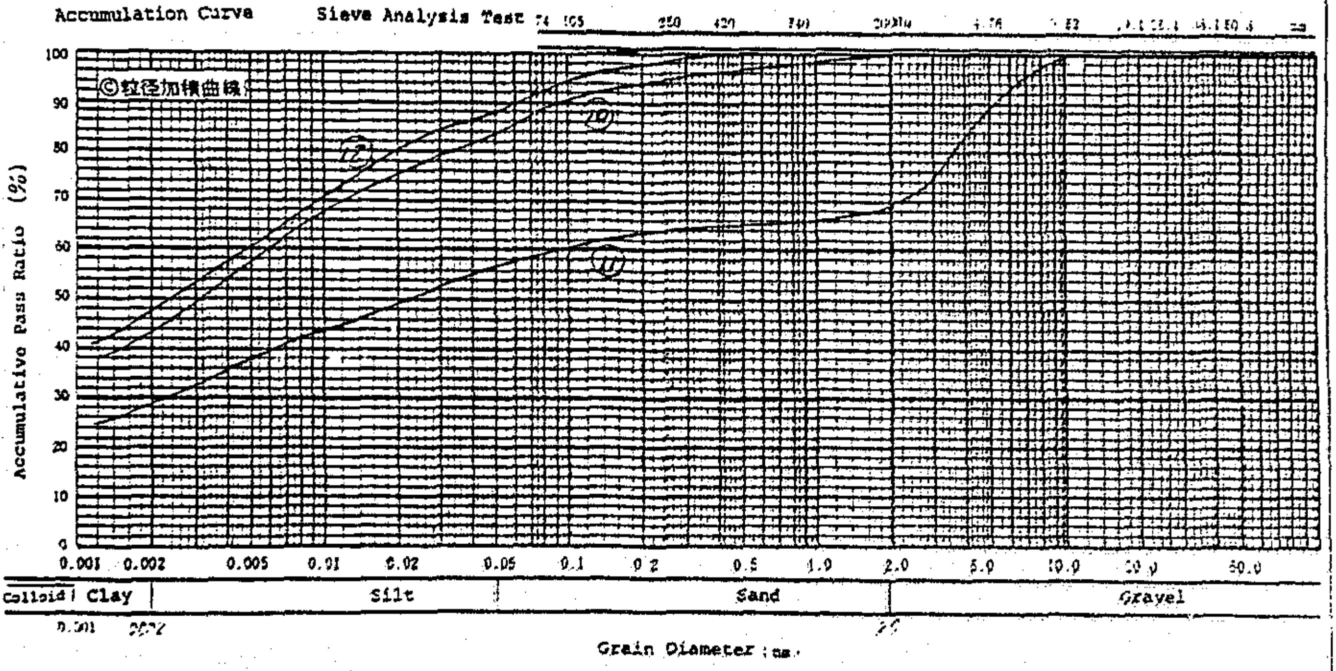
## Ⓐ Triangular System



## Ⓑ Plasticity Chart



## Ⓒ Grain Size Accumulation Curve



| Sample No. | Depth of Collection (m) | 4760μ Sieve Ratio (%) | 74μ Sieve Ratio (%) | 5μ Sieve Ratio (%) | Gravel % | Sand % | Silt % | Clay % | Max. Dia. mm | 60% Dia. mm | 30% Dia. mm | 10% Dia. mm | Uniformity Coeffi. U'c | Curvature Coeffi. U'c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ⑩ | | 100 | 88 | 57 | 0. | 14. | 43. | 43. | | 0.0058 | | | | |
| ⑪ | | 89 | 59 | 38 | 31. | 11. | 30. | 28. | | 0.1 | | | | |
| ⑫ | | 100. | 92 | 66 | 0 | 10 | 42. | 48. | | 0.0049 | | | | |

Note: $U'c = D_{60}/D_{10}$ $U'c = (D_{30})^2/D_{60} \cdot D_{10}$

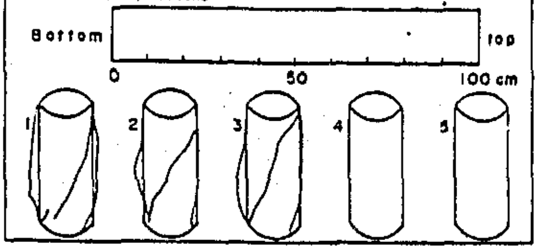
# TRIAXIAL COMPRESSION TEST

**PROJECT** : LOW COST HOUSING
**LOCATION** : CENGKARENG
**SAMPLE NO.** : B-1
**DEPTH IN METER** : 2.00 - 2.70
**DESCRIPTION OF SOIL** : CLAYEY SILT,brown coloured
**REMARKS** :

**JOB NO.** :
**DATE** : Nov.9,1979
**RECORDED BY** : Soe..
**CHECKED BY** :
**TESTING METHOD** : (UU) (CU) (CD)

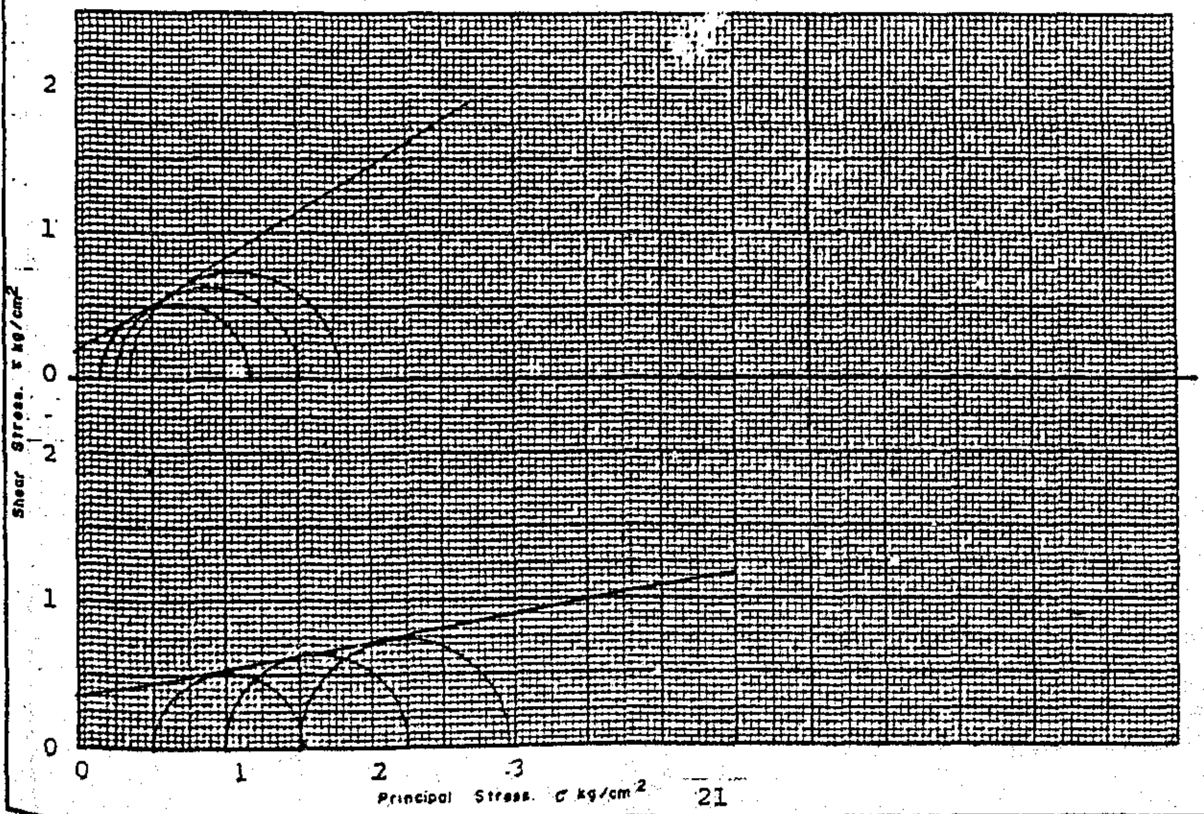
| Soil Specimen No. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Bulk Density. $\gamma_m$ g/cm$^3$ | 1.63 | 1.63 | 1.64 | | |
| Initial Moist Content. $w_1$ % | 40.9 | 41.3 | 41.0 | | |
| Final Moist Content. $w_2$ % | | | | | |
| Dry Density. $\gamma_d$ g/cm$^3$ | 1.16 | 1.15 | 1.16 | | |
| Initial Void Ratio. e. | 1.29 | 1.30 | 1.28 | | |
| Degree of Saturation. Sr. % | 84 | 84 | 85 | | |
| Lateral Pressure. $\sigma_3$ kg/cm$^2$ | 0.50 | 1.00 | 1.50 | | |
| Deviator Stress. $\sigma_1 - \sigma_3$ kg/cm$^2$ | 1.036 | 1.252 | 1.460 | | |
| Volume Change Ratio. % | - | - | - | | |
| Strain ε % | 9.0 | 10.5 | 11.0 | | |
| Pore Pressure U. kg/cm$^2$ | 0.35 | 0.75 | 1.15 | | |

**Position of Specimens**



| | |
|---|---|
| Specific Gravity of Soil. Gs. | 2.65 |

| Test | Results | |
|---|---|---|
| Cohesion C kg/cm$^2$ | $\bar{c}$ : | 0.20 |
| | c : | 0.35 |
| Angle of Internal Friction $\phi$° | $\bar{\phi}$ : | 32 |
| | $\phi$ : | 10.5 |



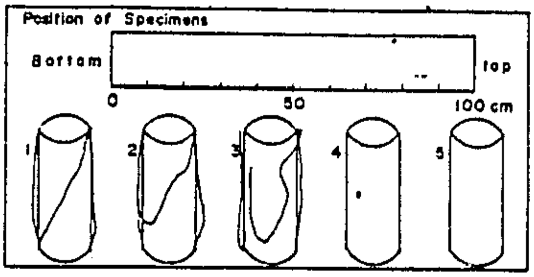
# TRIAXIAL COMPRESSION TEST

PROJECT : LOW COST HOUSING
LOCATION : CENGKARENG
SAMPLE NO. : B.2*
DEPTH IN METER : 2.00 - 2.70
DESCRIPTION OF SOIL : CLAYEY SAND, Brownish grey coloured
REMARKS :

JOB NO. :
DATE : NOV. 6, 1979
RECORDED BY : Soe
CHECKED BY :
TESTING METHOD: UU CU CD

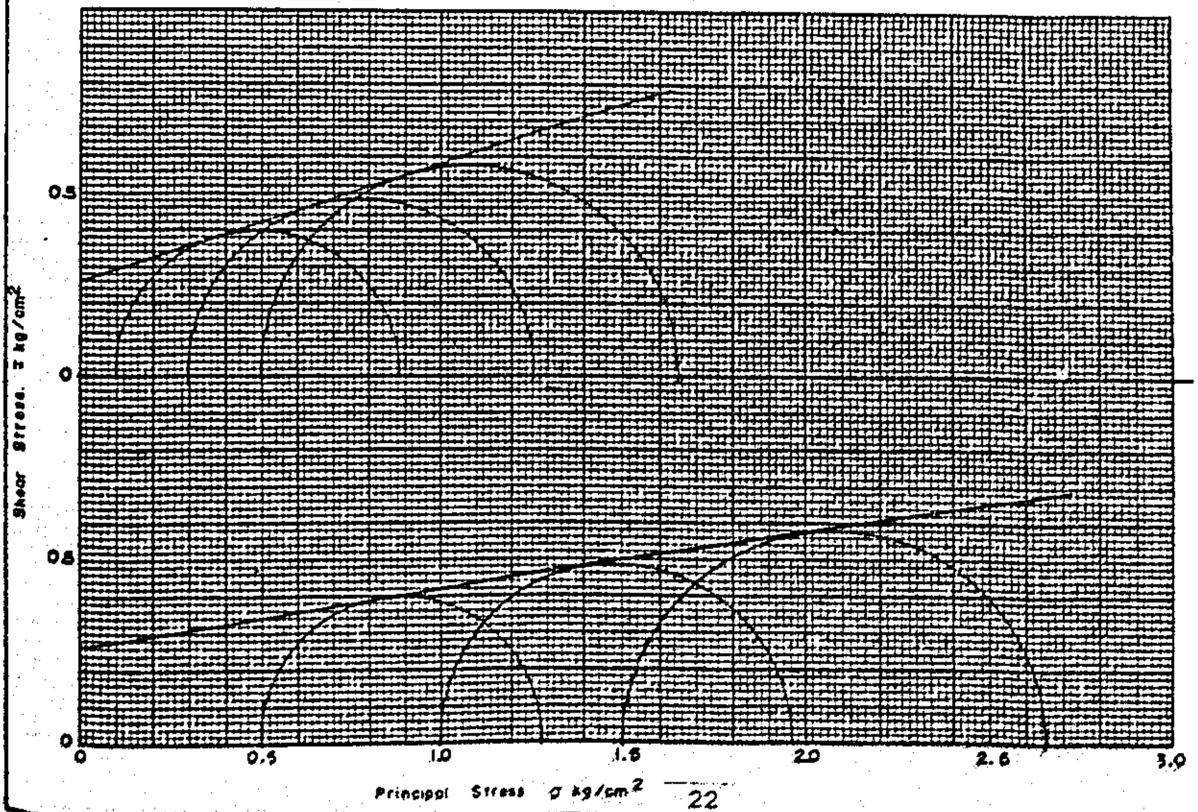
| Soil Specimen No. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Bulk Density. $\gamma_m$. g/cm$^3$ | 1.83 | 1.83 | 1.82 | | |
| Initial Moist Content. $w_1$ % | 39.5 | 39.8 | 39.8 | | |
| Final Moist Content. $w_2$ % | | | | | |
| Dry Density. $\gamma_d$. g/cm$^3$ | 1.31 | 1.31 | 1,30 | | |
| Initial Void Ratio. e. | 1.02 | 1.02 | 1.04 | | |
| Degree of Saturation. Sr. % | 100 | 100 | 100 | | |
| Lateral Pressure. $\sigma_3$ kg/cm$^2$ | 0.50 | 1,00 | 1.50 | | |
| Deviator Stress. $\sigma_1 - \sigma_3$ kg/cm$^2$ | 0,787 | 0.961 | 1.151 | | |
| Volume Change Ratio. % | - | - | - | | |
| Strain $\varepsilon$ % | 14,0 | 13,5 | 12,0 | | |
| Pore Pressure u. kg/cm$^2$ | 0,40 | 0,70 | 1,00 | | |

Position of Specimens



| | |
|---|---|
| Specific Gravity of Soil. Gs. | 2,65 |

| Test | Results |
|---|---|
| Cohesion C kg/cm$^2$ | $\bar{C}$ = 0,26<br>C = 0.26 |
| Angle of Internal Friction $\phi$° | $\bar{\phi}$ = 18<br>$\phi$ = 9 |



# CONSOLIDATION TEST

PROJECT : LOW COST HOUSING

LOCATION : CENGKARENG

BORING / POINT NO. : B.I

DEPTH IN METER : 2.00 — 2.70

DESCRIPTION OF SOIL : FEW GRAVEL SANDY SILT, greyish broun coloured.

REMARKS :

JOB NO. :

DATE :

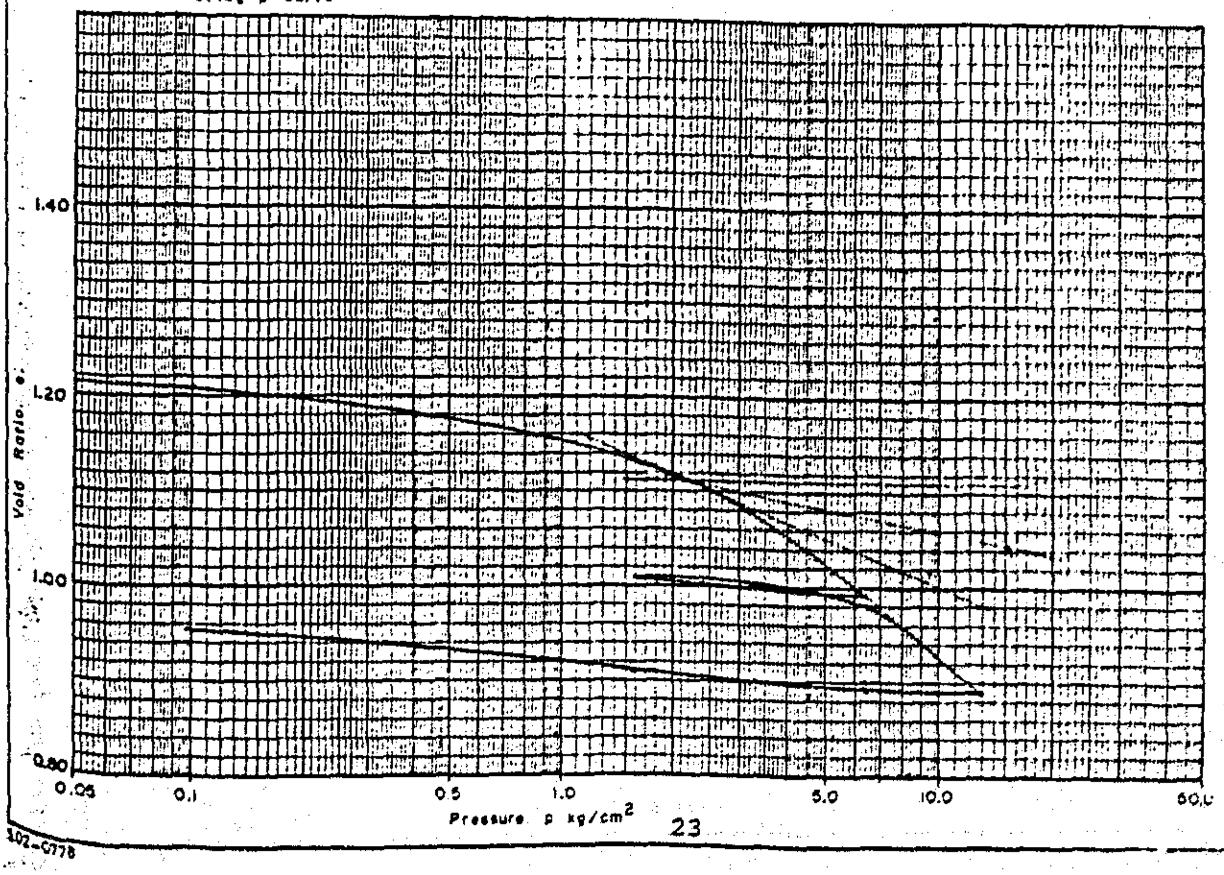
RECORDED BY :

CHECKED BY :

| | | |
|---|---|---|
| Water Content. w, % | Initial. | 45.1 |
| | Final. | 40.4 |
| Wet Density. $\gamma m$, g/cm$^3$ | Initial. | 1.73 |
| | Final. | 1.87 |
| Dry Density. $\gamma d$, g/cm$^3$ | Initial. | 1.20 |
| | Final. | 1.33 |
| Specific Gravity of Soil. Gs. | | 2.65 |
| Degree of Saturation Sr. % | Initial. | 98.1 |
| | Final. | 100 |
| Preloading Pc. kg/cm$^2$ | | 3.0 |
| Compression Index. Cc. | | 0.33 |

| Pressure p kg/cm$^2$ | Final Change R cm | Void Ratio e | $C_v$ cm$^2$/sec x $10^{-4}$ | | |
|---|---|---|---|---|---|
| 0.0 | | 1.22 | | | |
| 0.05 | | 1.21 | 15.67 | | |
| 0.1 | | 1.21 | 20.79 | | |
| 0.2 | | 1.20 | 10.78 | | |
| 0.4 | | 1.18 | 8.62 | | |
| 0.8 | | 1.14 | 10.44 | | |
| 1.6 | | 1.02 | 5.26 | | |
| 3.2 | | 1.08 | 6.33 | | |
| 6.4 | | 0.99 | 3.31 | | |
| 3.2 | | 1.00 | | | |
| 1.6 | | 1.01 | | | |
| 6.4 | | 0.98 | 7.94 | | |
| 12.8 | | 0.89 | 8.39 | | |
| 8.4 | | 0.89 | | | |
| 3.2 | | 0.90 | | | |
| 1.6 | | 0.91 | | | |
| 0.4 | | 0.93 | | | |
| 0.1 | | 0.95 | | | |
| 0.0 | | 0.99 | | | |
| | | | | | |
| | | | | | |

e. log p Curve



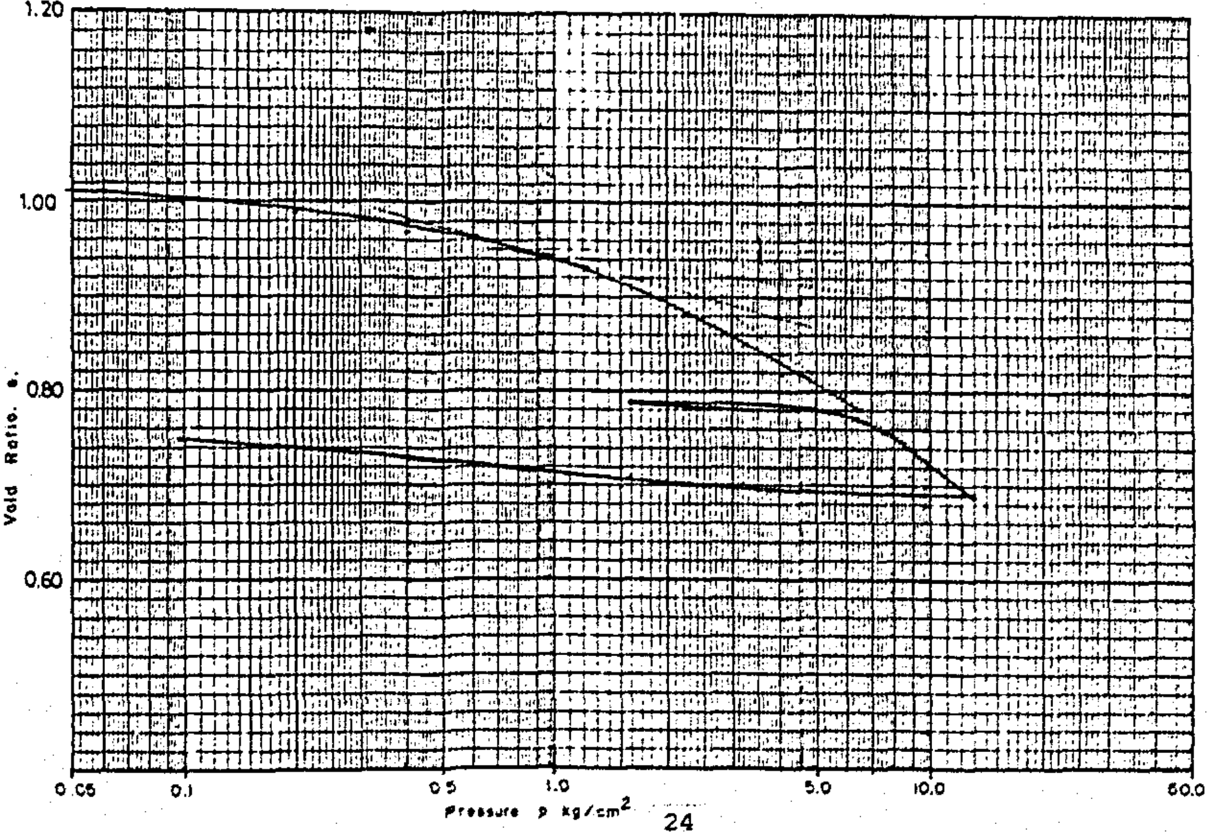
# CONSOLIDATION TEST

PROJECT. : LOW COST HOUSING
LOCATION : CENGKARENG
BORING / POINT NO. : B.2
DEPTH IN METER : 2.00 - 2.70
DESCRIPTION OF SOIL : SANDY SILT greyish brown coloured
REMARKS :

JOB NO. :
DATE : Nov. 1.1979
RECORDED BY : Nick
CHECKED BY : AR

| | | |
|---|---|---|
| Water Content. $w_t$ % | Initial. | 37.2 |
| | Final. | 32.5 |
| Wet Density. $\gamma m$, g/cm³ | Initial. | 1.80 |
| | Final. | 1.98 |
| Dry Density. $\gamma d$, g/cm³ | Initial. | 1.31 |
| | Final. | 1.50 |
| Specific Gravity of Soil. Gs. | | 2.65 |
| Degree of Saturation Sr. % | Initial. | 96.8 |
| | Final. | 100 |
| Preloading Pc. kg/cm² | | 2.10 |
| Compression Index. Cc. | | 0.33 |

| Pressure p kg/cm² | Final Change R cm | Void Ratio e | $C_v$. cm²/sec x $10^{-4}$ | | |
|---|---|---|---|---|---|
| 0.00 | | 1.02 | | | |
| 0.05 | | 1.01 | 6.66 | | |
| 0.1 | | 1.00 | 9.69 | | |
| 0.2 | | 0.99 | 24.03 | | |
| 0.4 | | 0.97 | 7.03 | | |
| 0.8 | | 0.95 | 8.30 | | |
| 1.6 | | 0.91 | 5.58 | | |
| 3.2 | | 0.85 | 5.32 | | |
| 6.4 | | 0.78 | 3.40 | | |
| 3.2 | | 0.78 | | | |
| 1.6 | | 0.79 | | | |
| 6.4 | | 0.77 | 5.43 | | |
| 12.8 | | 0.69 | 3 83 | | |
| 6.4 | | 0.69 | | | |
| 3.2 | | 0.70 | | | |
| 1.6 | | 0.71 | | | |
| 0.4 | | 0.73 | | | |
| 0.1 | | 0.75 | | | |
| 0.0 | | 0.77 | | | |
| | | | | | |
| | | | | | |



· REFERENCE

- ENGINEERING GEOLOGIC MAP OF JAKARTA-BOGOR AREA
  scale 1:50,000 (THE GEOLOGICAL SURVEY OF INDONESIA '69)

- PROYEK URBAN DEVELOPMENT STUDY JAKARTA
  (CIPTA KARYA '73)

- SOIL INVESTIGATION OF P.L.T.U MUARA KARANG
  (P.T.P.P. TAISEI INDONECIA CONSTRUCTION '78)

- SOIL INVESTGATION AT COPPER WIRE PLANT TANGGERANG
  (P.T.P.P. TAISEI INDONESIA CONSTRUCTION)

- JAKARTA MASTER PLAN 1965-1985
  (JAKARTA DKI '66)

- MASTERPLAN FOR DRAINAGE AND FLOOD CONTROL OF JAKARTA
  (NEDECO '73)

- PRELIMINARY STUDIES ON SEWERAGE SYSTEMS WITHIN CENGKARENG PROJECT-SITE
  (J.T.B '74)

- DEEP WELL DATA BETWEEN JAKARTA AND TANGGERANG
  (THE GEOLOGICAL SURVEY OF INDONESIA)

## 2. REPORT ON ECOLOGICAL PLANNING

1. Background to the Advent of Ecological Planning
2. The Process of Ecological planning
    - (1) The process of planning
    - (2) Utilization of ecological plannig
    - (3) The principles of ecological planning
3. Specific Environmental Planning
    - (1) The utilization of specific environmental planning
    - (2) Catchment system planning
    - (3) Rain drainage control planning
    - (4) Planning for securing the needed water volume
    - (5) Water pollution prevention planning
    - (6) Waste water treatment planning
    - (7) Topographical and soil conservation planning
    - (8) Vegetation planning
    - (9) Noise control planning

Supplement:

"Supplementary Explanation on the Principles of Ecological Planning"

## 1. BACKGROUND TO THE ADVENT OF ECOLOGICAL PLANNING

It is against the background of technological advancement that expressways, large-scale industrial complexes, jumbo jetplanes have come to be regarded as the symbol of an affluent society. As a result, the tendency to consider that "the greater, the better" has appeared as far as the scales of every undertaking is concerned. This way of thinking is based on the belief that natural resources are infinite and growth can be continued forever.

In our society, we have been building its system aimed at the expansion of productivity as we believed that this would lead to the realization of an affluent human life for every member of it. It has become gradually clear, however, that as production expands it is only those systems centering on inputting activities that enlarge, and as a consequence, all other areas come under increasingly greater pressure. Here the system has been built with the emphasis on the increase of production rather than on efficiency, and no attention has been paid to its effects on other systems.

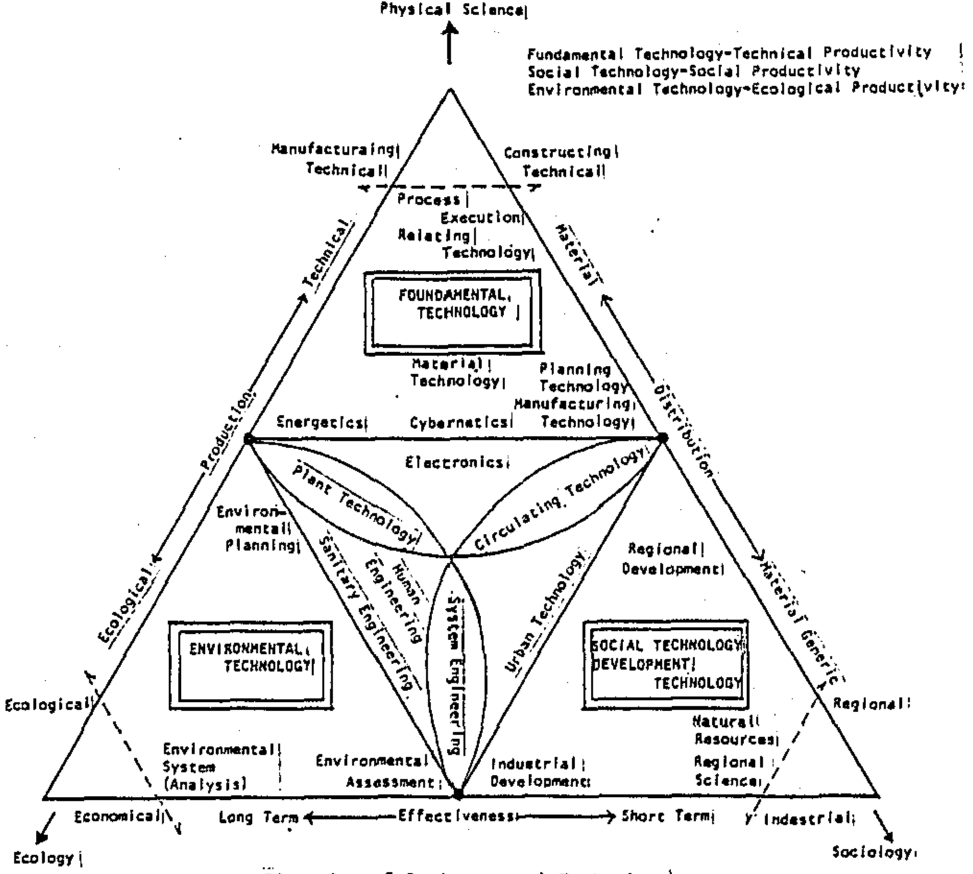
In an era of production-oriented technology, environmental disruption and the waste of natural resources including natural environment take place on such an extensive scale that unprecedented in our history. In terms of real efficienty, it is highly possible that society has advanced toward negative direction. Schumacher proposed the concept of "appropriate technology" based on the above reflection. This calls for the return to a system of appropriate scale, density, and artificiality taking their balance into consideration from the current system of mammoth scale, high density and excessive artificiality, i.e., unmanned device-controlled operation where further waste is involved in its maintenance and control.

The system for the utilization of appropriate technology is already established in the advanced countries. Therefore, it is extremely difficult for these countries to reconstruct such system from a different assessment viewpoint. In the case of developing countries, however, the systematic introduction of the afore-mentioned technology is considered to be easier since the full-scale investment of national land infrastructure and social capital has not yet begun.

The purpose of this report is to propose a set of plans for the Cengkareng housing development in Jakarta, Republic of Indonesia, on the basis of the above principles of planning theory (hereinafter referred to as "ecological planning".) The planning ultimately aims at housing development, but for this fiscal year it will concentrate on land utilization which forms the basis of the housing development plan. Land utilization is closely related to natural environment. In particular, in the case where majority of the area to be developed consists of paddy fields and marshes, and its natural environment and system are excellent, the adoption of the method of ecological planning will be highly effective.

First of all, we would like to propose environmental engineering as the basis of ecological planning and the systematic utilization of appropriate technology.

Figure 1 shows the relative importance of "basic engineering" and "social engineering" so that the characteristics of "environmental engineering" are clarified. Of these three branches of engineering, "basic engineering" is based on physical science while "social engineering (production engineering)" is based on sociology and "environmental engineering" on ecology. Moreover, the fundamental criteria of assessment are technological productivity, sociological productivity and ecological productivity. When the three sides of the triangle are used as the assessment axes of production, utility and distribution, environmental engineering is in the direction of ecological productivity with regard to productivity; it has long-term utility and is neutrally positioned with regard to distribution. As can be seen from the above elucidation of its relative importance, the ecological planning proposed in this report aims not only at the preservation of the ecological system and the environment but also at the positive utilization of ecological characteristics and its incorporation in our plans.

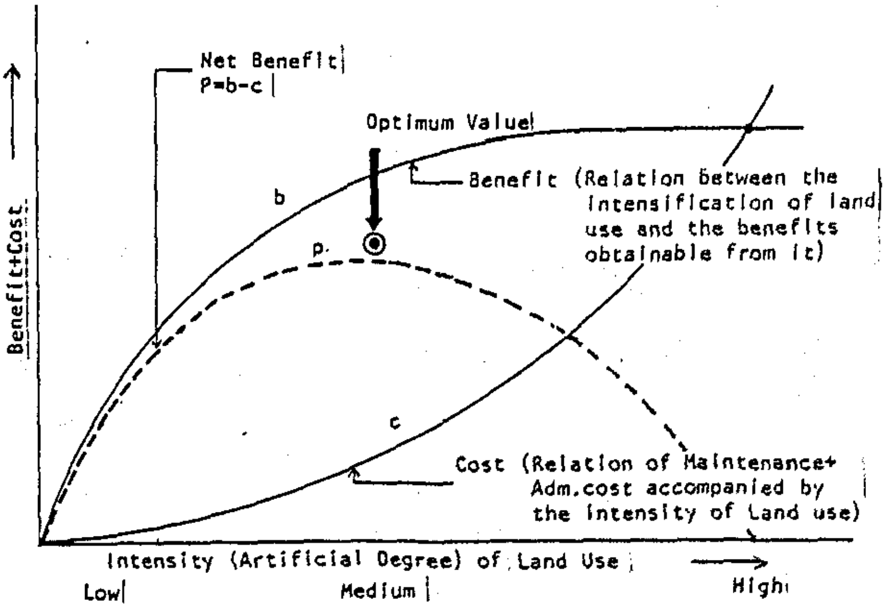


Situation of Environmental Technology

Next, we wish to explain in concrete terms the relative significance of ecological planning and its functions with reference to the relationship between land utilization plan which forms the core of this report and the above-described environmental engineering.

In the conventional method of land utilization planning, the approach to siting is made mostly from the standpoints of economic rationality and land reformation based on civil engineering. As a result, development has been carried out often neglecting various actions of nature and soil characteristics. In the end this will proves ineffective since flood disasters, ground subsidence and ecological imbalance will occur and maintenance and control costs will increase. Therefore, it is becoming increasingly important to draw up a land utilization plan which is compatible with various actions of nature and land characteristics.

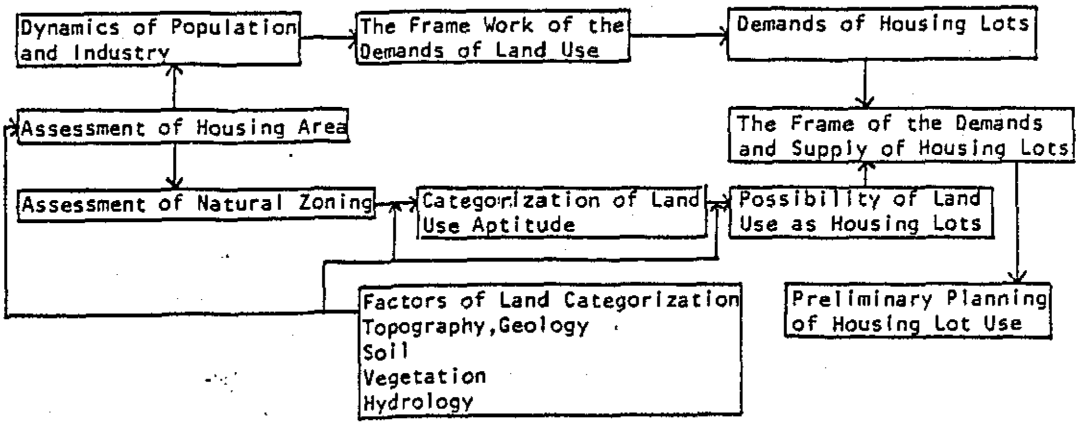
To explain the above in greater detail, we would like to describe the relationship between the benefits which we can derive from land utilization and the costs needed for its maintenance as well as the changes brought about by its transition from natural status to artificial status. This is to say that, in nature, very complicated mechanism and various factors are at work to maintain ecological balance. Whenever this balance is disturbed, a feedback mechanism will start functioning automatically so that the balance is restored. But in the ecological system where excessive artificial changes are made, such mechanism does not work. In many cases of land utilization, increasingly frequent human interventions and higher costs are required to maintain ecological stability in parallel with the degree of artificial changes made to simplify the ecological system. A model of this relationship is shown in Figure 2.



Relation of Maintenance, Administration Cost Accompanied by the Intensity of Land Use

The enduring ecological system can be maintained by relying on the interrelationship of various ecological factors which are intentionally-conserved in the moderately controlled land utilization planning. The intensionally-conserved ecological system -- i.e., various ecological factors which are not artificially controlled -- can exist without man's help. It is necessary to analyze and plan for ecological stability by finding the common principles and conditions of adjustment needed for the maintenance of the enduring ecological system.

Figure 3 presents a housing land utilization plan based on the assessment of land use appropriateness which takes into account the above-mentioned awareness of problem areas and facts. As shown in the figure, the appropriate land utilization which is determined by the assessment of various environmental conditions accounts for the supply of land. On the other hand, the demand for land arising from social and economic needs is adjusted to it. In the conventional land utilization planning, it can be considered that the lower half of Figure 3 has been neglected and it was only the upper half that has been included in plans.



Work Flow of Housing Lots Planning Considering the Natural Environment

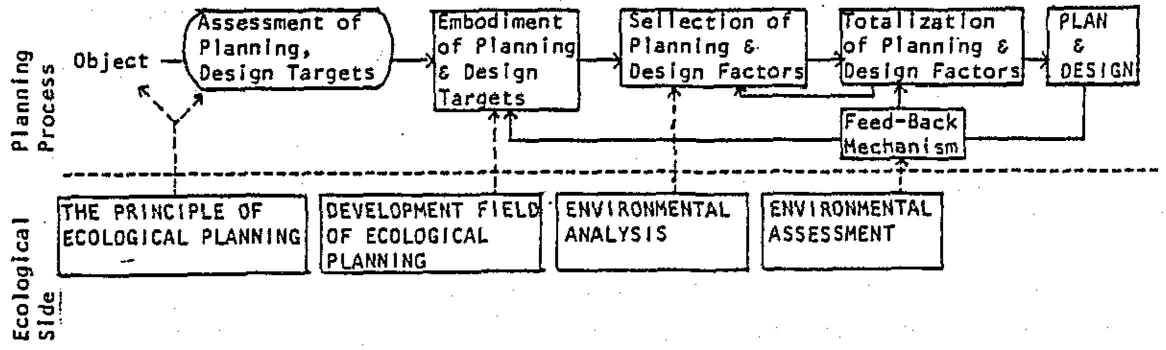
Now, we would like to describe briefly the assessment process of the appropriateness of land use. First, as the starting point, it is necessary to define the area to be assessed in relation to the assessment of the appropriateness of land use. In many cases, relatively wide areas such as basin and bay areas are selected taking into consideration the uniformity of natural conditions and the completeness of ecosystem. The next step calls for the subdivision of the assessment area into natural zones on the basis of topographical classification. Topography is considered important because various factors such as morphology, formative era, formative resiliency and constituent substances are organically linked. In other words, it is possible to gather multi-faceted information on land characteristics as topography is not limited to morphology.

This subdivision of natural zones is considered to be made in response to various actions of nature in the assessment area. By adding information on vegetation, geology, etc., to this, land characteristics will become even clearer and the assessment of land use appropriateness can be conducted by further deviding these sub units.

## 2. THE PROCESS OF ECOLOGICAL PLANNING

### (1) The process of planning

Planning can be defined as the "process which is, in general, needed for the creation of plants, structures and processes with the application of knowledge, technique and mind. Ecological planning can be found in the context of this process.
Figure 4 shows an outline of the planning principles and intentions of ecological planning incorporated in general planning process.
The goals of the plan are set and planning and design (hereinafter referred to only as "planning") objectives are established.
In the past, land use plans have been prepared on the basis of the demand for land, but it is necessary to take into account the availability of land, i.e., land supply on the basis of environmental characteristics. Therefore, it is necessary to give consideration to a set of principles along with the demand situation based on the accumulation of ecological studies.



Thereafter it will be necessary to give concrete shape to the objectives of the plan to develop it into the form of specific plans. This is the process of moving to the stage of subsystems such as waste water treatment plan and water pollution prevention plan from the abstract stage of ecological planning.

For the further development of these specific plans various planning factors must be selected. The finding and selection of these factors need to be conducted by analyzing the environment of the area to be developed from the viewpoint of ecological planning.

At the final stage, these factors are synthesized and a land use plan is drawn up, but this will call for an environmental assessment to check whether the plan is in conformity with the initial objectives and to assess its impact on the neighborhood environment.

Now we would like to take up the ecological factors of the planning process, i.e., "the principles of ecological planning," "the utilization of ecological planning", "the analysis of the environment" and "the environmental assessment". Here "the analysis of the environment" and "environmental assessment" will be omitted since they are treated elsewhere in this report.

## (2) Utilization of ecological planning

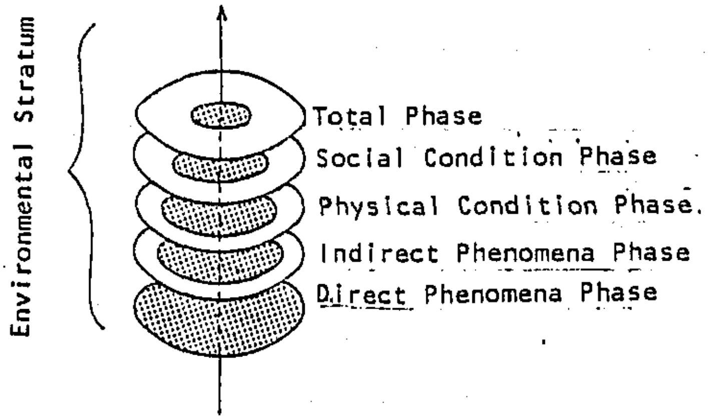
Needless to say, the utilization of ecological planning is related to the objectives of the plan. Therefore, first of all, we would like to examine in what areas ecological planning can be utilized in line with its aims of the solution of environmental problems and the more active and effective utilization of ecological characteristics. These areas can be roughly divided into 5 phases of (a) to (e) as given in Figure 5.

### (a) Direct phenomenon phase

Direct phenomenon is the type of phenomenon which we can come to grips with directly and it is the one most commonly recognized. Treatment technology deals with this phenomenon and, in many cases, it is handled by the specialists in sanitary engineering and those concerned with hygienic activities. In recent years, however, there has been a marked increase in the number of engineers, especially pollution control engineers, involved in this area.

### (b) Indirect phenomenon phase

Indirect phenomenon represents the characteristics of the social functions of direct phenomenon and it consists of the assessment of economic values and social impact. Pollution control engineering deals with this phenomenon and, in most cases, those who are specializing in system engineering and social engineering are active in this field.



Development Field of Ecological Planning

(c) Physical restriction phase

Physical restriction means the type of phenomenon which is related to the assessment of and restriction on the functions and impact of direct and indirect phenomena of environmental disruption on the basis of physical environemmtal conditions.
To be more specific, it is dictated by the characteristics of environmental disruption and the tolerance level of the natural environment. Specialists in ecology and environmental engineering are working this area.

(d) Social restriction phase

Social restriction is the phenomenon which shows social restrictions on the direct and indirect phenomena of environmental disruption. While the phase (c) shows physical environmental load, the phase (d) has bearing on the restrictions arising from social tolerance level. The extent to which social capital is developed corresponds to this phenomenon and it is studied by some sociologists and economists who are concerned about environmental problems.

(e) Comprehensive approach phase

The comprehensive approach phase deals with the problems which present the microcosm of today's society, i.e., urban problems, depopulation, overpopulation and so forth. Comprehensive approach is required to deal with this phase and at the present stage it is covered by the mass media and commentators.

Next, we would like to turn to the utilization of ecological planning in housing plan, namely, in the area of specific plans. For this purpose, the list of specific plans related to housing land development plan has been prepared as given in Table 1. It includes the description of each specific plan and items which is considered to have impact on the environment. Along with these items, environmental protection goals are set forth with specific environment protection plans aimed to achieve these goals.

Table 1 Specific Plans for the Environment in Housing Plans

| Specific plans related to housing | Specific plan description | Environmental assessment | Environmental protection goals | Specific environmental planning |
|---|---|---|---|---|
| Land utilization plan | Setting of land utilization ratio | Reformation of average natural factors | Examination of protection measures according to natural factors of plan | Vegetation plan. Succession plan |
| | | Reformation of runoff ratio | Increase in permeability, examination of runoff prevention measures | Rain drainage control plan |
| Population density | Setting of population density | Increase in supply processing amount | Securing needed amount. Provision of treatment facilities | Supply processing facility plan |
| | | Increase in traffic volume | Road planning in response to generation of traffic volume. Improved provision of trans portation means | Traffic plan |
| | | Increase in the need for the facilities related to citizens' daily life | Establishment in response to needed number of facilities | Facility plan<br>Park and greenery plan |
| | Population density distribution plan | Regional characteristics | Environmental formation in response to regional characteristics | Residential plan.<br>Facility plan |
| Housing supply plan | Setting of single-family and tenement house types | Definition of income structure by the class of residents | Single-family and condominium arrangement in response to environ mental conditions. Promotion of harmonious arrangement of condominium-type housing | Residential arrangement plan |
| Housing arrangement plan | Building arrangement | Topsoil treatment, ground surface occupancy | Ground surface runoff prevention, establishment of ground surface runoff routes | Rain drainage control plan |
| | Open space arrangement | Topsoil treatment, ground surface reformation | Increase in underground permeability ratio | Greenery plan |
| Facility plan | Setting of facility system | Establishment of people's meeting facilities and definitionof their types, increase in transportation services. | Environmental formation in response to spaces set as plan objectives. Securing of transportation means | Facility arrangement plan.<br>Traffic plan |
| | Facility arrangement plan | Facility characteristics and land occupancy | Land reformation and natural factors preservation measures | Disaster prevention plan |
| Park and greenery plan | Park provision plan | Artificializing of natural forests and involvement of human factors | Conversion to alternative vegetation, clarification of preservation areas | Deforestation.<br>Vegetation plan.<br>Succession plan |
| | Greenery provision plan | Artificializing of natural forests, appearance of unstable greenery zones | Conversion to alternative vegeta tion, conservation of potential natural vegetation. Stabilization of greenery zones | Vegetation plan.<br>Greenery stability measures<br>(forest boundary, etc.) |
| Transportation system plan | Road network arrangement plan | Gradient balance by the removing and/or filling of soil | Seeking greater compatibility of topography with roads, balance of land preparation | Plan for effective arrange ment of road network.<br>Land preparation plan |
| | | Ground surface occupancy and pave ment, disruption of ecological system | Securing of ground surface drainage networks, preservation according to conditions of neighborhood land development | Water drainage plan |

|  |  |  |  |  |
|---|---|---|---|---|
|  |  | Generation of automobile traffic volume, exhaust gas and noise | Road structure in response to generation of traffic volume | Road width composition plan.<br>Traffic dynamics plan |
|  | Bus transportation plan | Increase in traffic volume and individual traffic service needs | Traffic planning in response to population mobility | Intraregional traffic plan |
|  | Mass transit system plan (railroad) | Land preparation, construction of tunnels and bridges | Topography and compatibility improvement | Land preparation plan |
|  |  | Ground surface occupancy, disruption of ecosystem |  |  |
|  |  | Generation of noise and vibration | Noise and vibration control and prevention measures |  |
| Land reformation plan | Land preparation plan | Transformation of topographical structure, i.e., removal and/or filling of soil | Preservation of soil movement balance and topographical structure | Soil volume conversion plan |
|  | Soil volume conversion plan | Topsoil treatment, soil becoming unstable | Minimization of processed land ratio, increase in topsoil conservation ratio | Topsoil conservation |
|  | Topsoil conservation | Lack of land structure stability |  | Ground surface treatment plan |
|  | Ground surface treatment plan | Increase in runoff ratio and topsoil treatment ratio, ground surface artificializing | Stabilization of ground surface drainage networks, structural stabilization by protection engineering | Soil reformation plan, Disaster prevention and security plan |
|  | Soil improvement plan | Groundwater system reformation, soil degradation | Conservation of underground water system, structural stabilization, securing well-balance superior soil | Disaster prevention and security plan |
| Disaster prevention and security plan | Rain drainage control plan | Securing of adjustment area space | Effective utilization of valley topography, development of reservoir spaces which can be used effectively. | Water utilization plan. Waste water treatment plan |
|  | Slope structure stability plan | Gradient adjustment, water system reformation due to soil improvement | Establishment of construction boundaries. Slope stabilization by vegetation protection | Vegetation plan. Ground surface treatment plan |
|  | Disaster prevention and shelter plan | Securing of disaster shelters and routes to shelters |  | Park and greenery plan |
| Supply processing | Supply plan | Ground surface occupancy of networks, analysis of ecosystem by topsoil treatment | Seeking reduction in processing ratio and occupancy ratio in response to road network | Road plan |
|  | Processing plan | Establishment of treatment facilities | Selection of land with minor influence on wide area processing and human environment | Location appropriateness diagnosis |
|  |  | Water or air pollution due to waste water | Establishment of effluent standards and treatment method | Disaster prevention and security plan |
| Annual construction | Annual plan for land preparation and road and housing construction | Soil movement, vibration, noise and afflux | Give consideration to balance of annual planning and alienating conditions of living |  |

### (3) The principles of ecological planning

The dominant principles of ecosystem form the basis of an environmental planning and they provide the viewpoint of environmental analysis. These principles have been found mostly in the study of ecology and they have been sufficiently substantiated.
Thus they can be regarded as the rules of ecosystem. Here we will limit our description to the conclusions of these principles.
Their contents and linkage with the environmental planning are explained in the Supplement.

#### i) Every living organism is linked with other living organisms

A very intricate system of networks is established among various living organisms, biological populations, species and individual living organisms as well as between these organisms and their physical and chemical environments.

#### ii) All substances eventually go somewhere

All substances and energy entering into ecosystem are either accumulated or eventually go somewhere. Materials and energy are transformed from one form to another, but they never perish nor are destroyed.

#### iii) Nothing can be obtained without paying a price

The ecosystem of the earth is a closely interlinked unity and nothing increases nor decreases in it. The system as a whole never changes.

#### iv) The lowering of utilization efficiency and depletion of resources

When resources, with the exception of time and diversity, are utilized exceeding a certain level of utilization, the per unit increase of their utilization effect diminishes.
(In economics, this phenomenon is called the "law of diminishing marginal utilities.") In ecosystem, the increase in resource utilization exceeding the maximum level becomes detrimental accompanied by toxity in many cases. Thus, the probability of the system to disintegrate increases.

v) Space, time and diversity are resources

Due to the lack of the recognition that space, time and diversity are also resources along with materials and energy, many problems for mankind have appeared and they are increasing.

vi) Stability supported by diversity

In the fully-developed ecosystem, biological diversification progresses in parallel with the physical stability of the environment. On the other hand, biological population stabilizes in keeping with progress in diversification.

vii) A mature system takes advantage of immature systems

A mature ecosystem exploits immature ecosystems. In greater number of cases, this can be seen as immature ecosystems being exploited by its more mature and highly systematized partner.

## 3. SPECIFIC ENVIRONMENTAL PLANNING

### (1) The utilization of specific environmental planning

We would like to propose specific plans for the environment in the housing planning on the basis of the orientation of ecological planning in Cengkareng. Since detailed survey on the environment has not been conducted during this fiscal year as mentioned earlier, our presentation will be limited to the outline of these plans at this stage.

In Table 1, we have shown housing and specific environmental plans. We will describe here the items, contents, criteria and methods of environmental protection on the basis of environmental factors such as hydrology and topography. In sections (2) - (9), we will attempt to make further clarification according to specific environments given in Table 1 while paying attention to the environmental characteristics of Cengkareng.

Table 2

(1) Outline of Environmental Protection Measures

| Environment | Protection items | Descriptions | Criteria | Protection methods |
|---|---|---|---|---|
| Hydrology | Catchment system conservation ratio | Indicates level of present catchment system conservation. Level of structural changes in hydrologic system | | Conservation of topographical structure |
| | Discharge destination safety standards | Securing safety of down stream destination of water discharged from planned area | Based on water utilization status and water quality standards | Control of discharged water |
| | Runoff coefficient | Numerical values indicating rain runoff levels according to work conditions | Seeks preservation of present status | Low building-to-land ratio and greater height by low work ratio |
| | Surface flow - water quality standards | *Safety of water quality* | Environmental standards (river) related to living environment shall apply in this criterion | Seeks improved provision of treatment facilities and effective utilization and recycling of treated water |
| | Underground water - water quality standards | Safety of water quality | River environmental standards shall apply | Seeks perfection of observation methods and improvement of tracking methods of pollution sources |
| | Lakes, reservoirs - water quality standards | Safety of water quality | Based on lake environmental standards | Seeks perfection of observation methods and improvement of tracking methods of pollution sources |
| | River capacity | Capacity to contain runoff water safely at time of heavy rainfall | Maximum load capacity of each river will be set based on catchment system and plan for control reservoirs | River improvement and improved provision of service and waste water conduits |
| | Streamflow | Constant water volume each catchment system can bear and contain | Volume of each system is set in accordance with water utilization potentials | |
| | Water utilization potentials | Water utilization status and its quantitative distribution status | | Construction of reservoirs, etc. |
| | Temperatures (surface flow, underground water, lake, etc.) | | Present water temperatures are taken as standards | Investigation of causes of temperature rise |
| | Underground water system conservation ratio | Prevents disruption of underground water system network caused by land preparation. *Especially related to slope working* | | Seeks topographically advantageous overall plan and protection of underground water systems when works are undertaken |
| | Underground water volume, | Securing conditions to prevent disruption of ecosystem of ground surface plants, etc. | Highest priority is given to securing of present water volume | Preservation of impervious layers |
| | Reservoir capacity | Planned capacity of rain control reservoirs and reservoir capacity for water utilization (in preparation for water shortage) | Maximum value of peak water flow at time of heavy rainfall will be set | Provision of terminal reservoirs |

Table 2

(1) Outline of Environmental Protection Measures

| Environment | Protection items | Descriptions | Criteria | Protection methods |
|---|---|---|---|---|
| Topography | Topographical structure transformation level | Level of present topographical structure conservation.<br>Structural change in hydrologic system | | Preservation of branching structures of hydrologic systems |
| | Working area ratio | Securing of conservation areas | Approx. 25% | Low density and greater height |
| | Topographical stability | Securing of stability in topographical detail | | Improved provision of detail work methods such as works on the side and end areas of slopes and forest boundaries |
| | Land potential utilization | Extraction and analysis of land potentials and level of such potential utilization | | Methods in response to contents of potentials |
| | Slope work ratio | Work level check after setting slope zones in accordance with gradient | Work will not be conducted on steep slopes | Zoning of steep slopes using topographical analysis chart |
| Soil | Strata transformation level | Level of strata transformation by land preparation works | | Seeks fewer changes in items related mostly to water systems such as impervious layers |
| | Land utilization level | Seeks higher utilization of land generated by land preparation works | | Examination of soil quality in accordance with land preparation depth chart and geological cross-section chart |
| | Soil stability level (land resistance) | Seeks structural stability of land | | Improvement of inferior grounds |
| | Soil stability level (earthquake resistance) | Seeks structural stability against earthquake | Areas within 20° gradient | Slopes less than 20° gradient will be designated as safe grounds |
| | Topsoil preservation ratio | Conservation of superior topsoil | | Setting of preservation areas and preservation depths |
| | Land preparation balance and filling in | Seeks balance of removal land preparation | Balance with no removal and filling difference is to be desired. | |
| | Land preparation work depth | Status of land removal depth | | Utilize present topography to the greatest extent possible |
| | Preparation area ratio | Ratio of removal and filling in land preparation | | Seeks setting of topographical reformation plan utilizing present topography |

THE OBJECTS OF ENVIRONMENTAL PRESERVATION

| Category | Preserving Item | Contents of Preserving Item | Criteria of Preservation | Preserving Method |
|---|---|---|---|---|
| Soil | Condition of soil movement | | 0-amount is desirable | Minimize the topographical *reform and backfill* the soil caused by land development to valley |
| Air | Airduct balance | Prevention of abnormal wind | | Wind channel test |
| | Wind force Standard | Setting of stable wind force as outer environment | | |
| | Air quality standard | Setting of environmental standard value about air pollution | (*)<br>$SO_2$; Average daily value of hourly value is less than 0.04 ppm and hourly value is less than 0.1ppm.<br>Suspended Solid Staff(*); average daily value of hourly value is less than $0.10^{mg}/m^3$ and hourly value is less than $0.2^{mg}/m^3$ | |
| | Air temperature hike | Problem of heat discharge in urban area | | Setting of heat discahrge standard value, and the method of heat treatment.<br>Study of sun shadow curve |
| Air Pollution | Standard of discharge treatment | Controle of exhaust gas from factory | | Study of discharge treatment method corresponding to the environmental standard |
| | Total amount controle standard | Setting of total discharge amount in the area. | | |
| | Anger limit of pollution | Limit value of poluttion | | |
| Water Pollution | Standard of discharge treatment | Controle of exhaust water from factory | | *Set corresponding* to the environmental standard |
| | Total amount controle standard | Setting of total discharge amount in the area | | |
| | Water quality *standard* | | | |

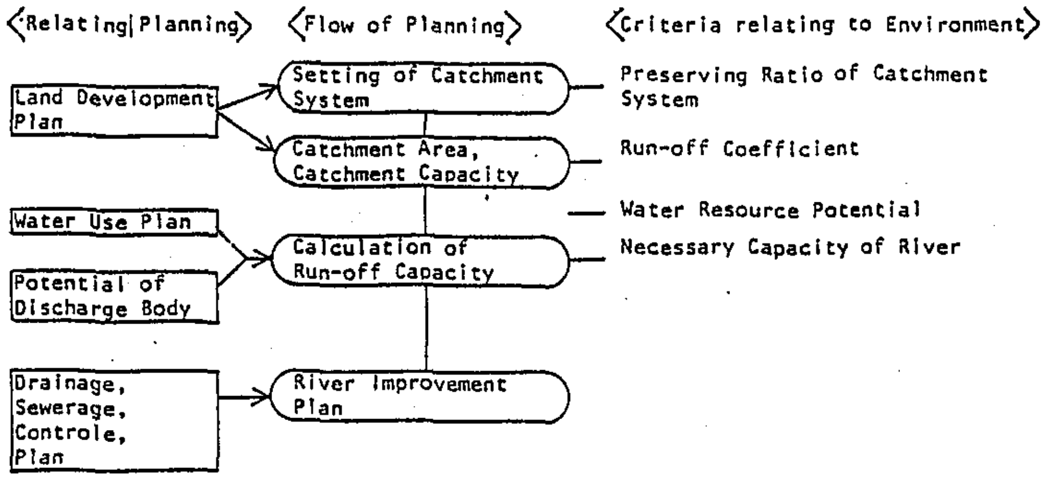
| | | | | |
|---|---|---|---|---|
| Soil Pollution. | Standard of heavy metal contents | | | Environmental standard relating to human health |
| | PCB.agricultural chemicals standard | | | |
| | Sonic environment value standard | | (*)<br>Day time; less than 50 phone<br>Morning+ Evening ; less than 45 phone<br>Night ; less than 40 phone | Standard value by areal classification model Housing area standard |
| | Noise source regulation standard | Controle of noise source | | Sound insulating regulation |
| Vegetation | *Preservation* ratio of existing vegitation | *Degree of the* preservation of existing vegitation | | Minimize the land reform and preserve vegetation |
| | Natural degree | Degree of natural condition of vegetation | | Try to restore to the existing condition |
| | Planting Ratio | Vegetation | | Setting of the amount of planting corresponding to felling and preserving amount |
| | Vegetation Ratio | Vegetation area ratio at the completion phase | | Preserving Ratio+ Vegetation Ratio |

(*) Further Study Needed.

(2) Catchment system planning

i) Flow chart of the plan.

Flow Chart of Planning



ii) Objectives: Establishment of water flow systems within the area covered under the plan and preparation of a plan seeking their quantitative balance.

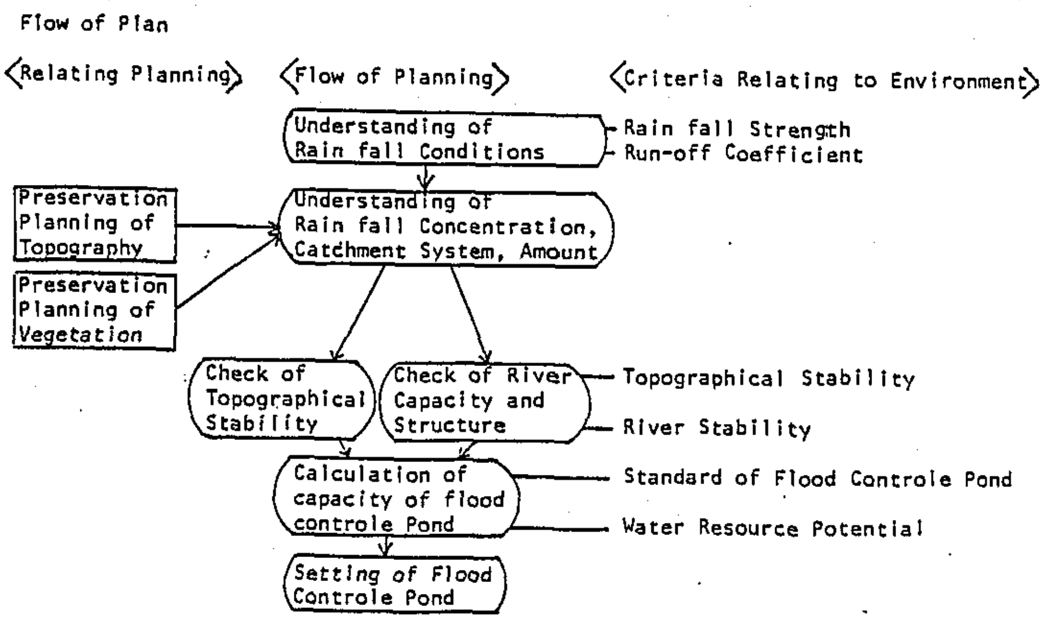
iii) Relation to other plans: The plan seeks to establish a framework as the foundation for the hydraulic preservation plan. Also, this will be able to serve as the framework of housing land planning as the basis of rain drainage systems and household waste water drainage systems. The basis of the plan is related to topographical reformations and, in this context, the plan has a close relationship with topographical preservation planning.

iv) Environment-related criteria:

| | |
|---|---|
| Cathcment system: | The plan functions as a cartographical framework |
| Discharge destination: | Relation to the areas not covered by the plan |
| Catchment area: | Measured on the basis of areas surrounded by topographical watersheds included in the system as its quantitative factors. |

(3) Rain drainage control planning

i) Flow chart of the plan



ii) Objectives: Measures are necessary to seek securing of rain drainage systems at the time of heavy rainfalls while minimizing its impact on the areas not covered by the plan. In other words, the plan will provide for the establishment of a system where the difference in water drainage between before and after construction is temporarily stored.

iii) Relation to other plans: The basic approach to the rain drainage control planning in the hydraulic preservation planning is to hold water flow conditions approximately at the present levels as well as to plan for safety at the time of flood in the area.

iv) Environment-related criteria:

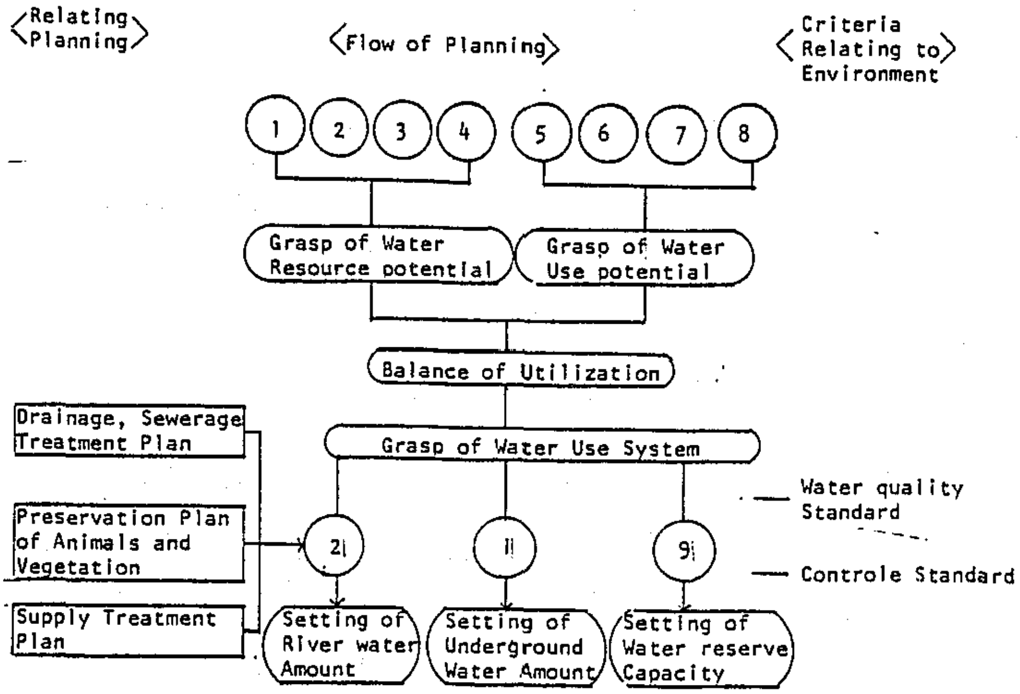
| | |
|---|---|
| Catchment system: | The plan will follow and grasp cartographically the status of rain concentration. |
| Catchment area: | Consideration will have to be given to the runoff coefficient to grasp rain concentration volume. |

Rainfall intensity: Rain concentration levels and intensity will be examined on the basis of meteorological probabilities.

River capacity: The goals for river improvement will be indicated by comparing rain drainage volume with river capacity.

## (4) Planning for securing the needed water volume

### i) Flow chart of the plan



1 Underground Water sub-system
2 Surface Water sub-system
3 Climatic Conditions
4 Extensive Area Water Distribution
5 Industrial Water Use
6 Living Water Use
7 Necessary Water for natural feature
8 Landscape
9 Ditention Water sub-system

ii) Objectives: The plan aims at securing sufficient level of underground water volume to prevent ground subsidence and the withering of vegetation. For this purpose, the needed water volume will be secured in rivers or in reservoirs constructed in preparation for water shortage while paying attention to the status of water utilization in the areas within and without the sphere of the plan.

iii) Relation to other plans: The plan seeks to maintain the quantitative balance of water in the hydraulic preservation plan. This is to maintain the potentials of water resources existing in the area.

iv) Environment-related criteria:

River water volume: Securing of the needed water volume on the basis of the quantitative balance of water utilization.

Storage capacity: Securing of the needed agricultural water volume in preparation for water shortage.

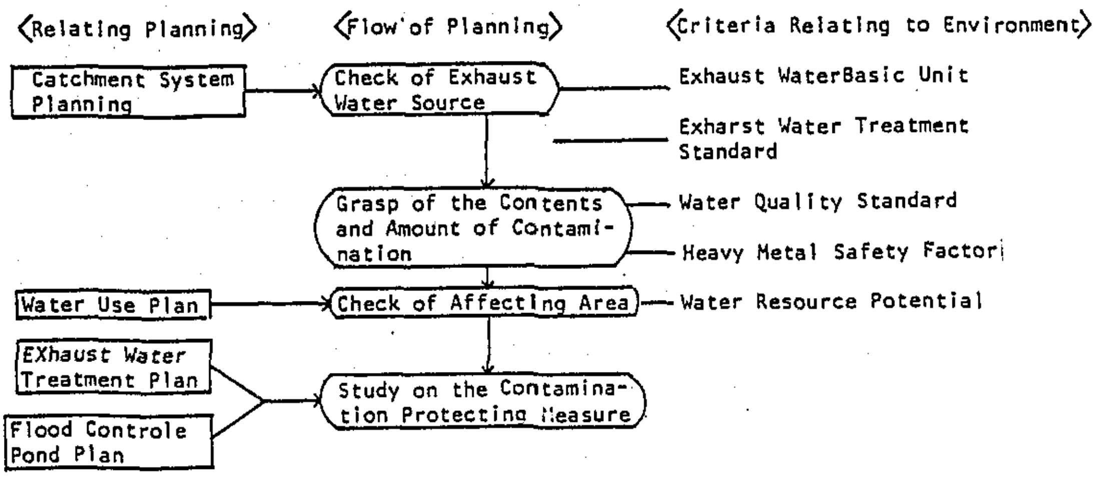
Strata (impervious layers): Underground structure aimed at the securing of underground water volume.

Soil: Balance between underground water systems and soil conditions.

### (5) Water pollution prevention planning

i) Flow chart of the plan

Flow of Planning



ii) Objectives: The plan aims at maintaining the water quality of rivers, swamps, marshes, lakes, etc. in the area and preventing water pollution while giving consideration to the impact on the areas not covered by this plan.

iii) Relation to other plans: The purpose of this plan is to confirm the safety of the human body vis-à-vis flowing water or backwater while taking into account the preservation of scenery in which water plays a pivotal role. This plan has a close bearing on the waste water treatment planning.

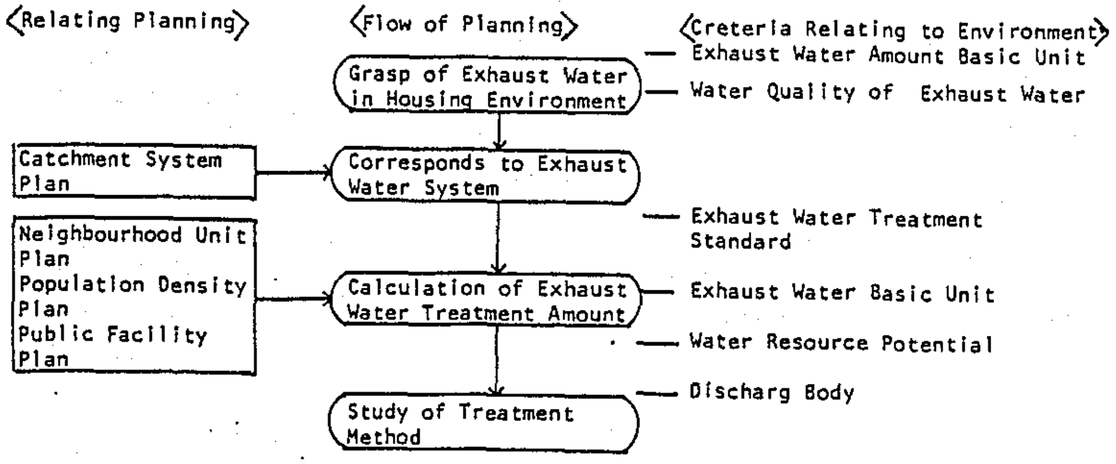
iv) Environment-related criteria:

| | |
|---|---|
| Catchment system: | The plan will be used as the basis for the measurement of pollution routes. |
| Pollution source: | Plotting of pollution source locations. |
| Pollution factor: | Description of the contents of pollution and quantitative levels thereof. |

(6) Waste water treatment planning

i) Flow chart of the plan

6 Flow of Planning



ii) Objectives: The plan will establish waste water drainage systems within the area and seek the stabilization of water quality and environmental conditions. For this purpose, water treatment methods will be established in accordance with the location of the waste water drainage systems.

iii) Relation to other plans: This is to study the method of maintaining and securing water quality standards in the hydraulic preservation planning. Such a method will seek the preservation of ecosystem in overall hydraulic systems and consideration must be given to the establishment of a treatment method which utilizes natural ecosystem to the greatest extent possible.

iv) Environment-related criteria:

| | |
|---|---|
| Discharge volume original unit: | The unit volume of water discharge in the environment having residential areas. This unit will function as the basis for treatment. |
| Natural decontamination formula: | The utilization method and volume of natural decontamination capability. |
| Effluent treatment measures: | A set of clarifications concerning the treatment capabilities of various facilities. |
| Discharge water quality: | Discharge water quality in the environment having residential areas. |

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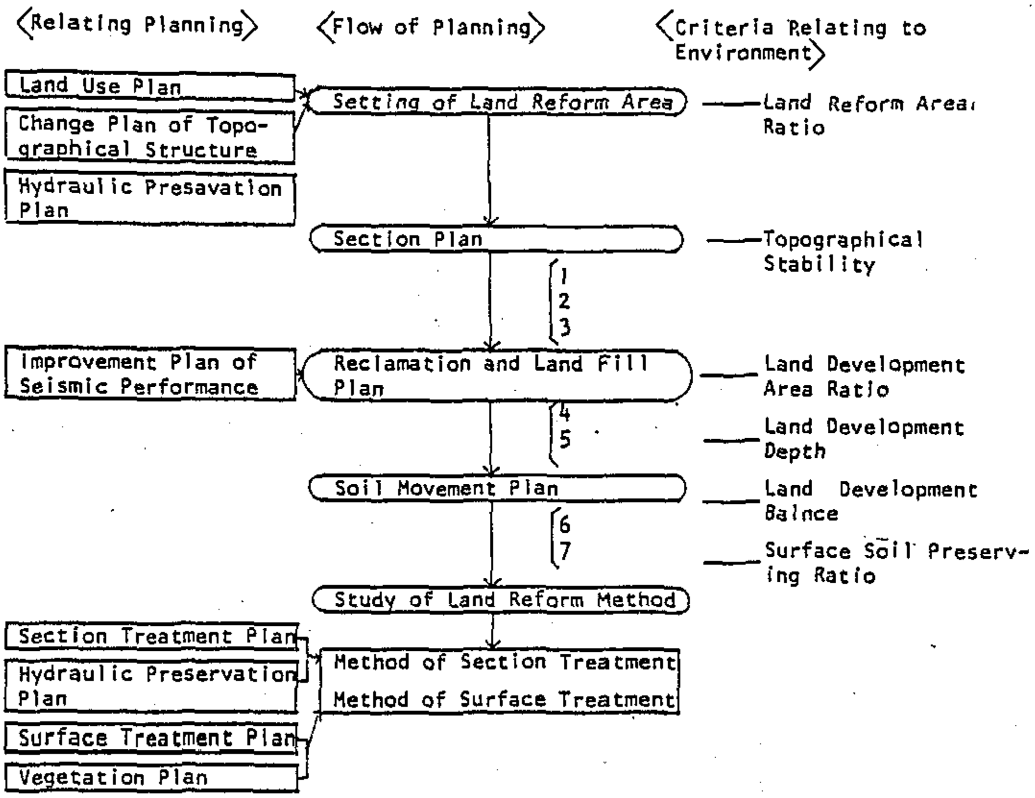
(7) Topographical and soil conservation planning
(Land reclamation and filling plan, soil movement plan, ground surface treatment plan)

i) Flow chart of the plan


Flow of Planning

1 Stabilization of Land Reform Area
2 Stabilization of Preserving Area
3 Stabilization of Boundary Area
4 Land Reform Amount, Land Development
5 Balance of Depth
6 Balance of Soil Amount
7 Preservation of Surface Soil

ii) Objectives: The plan deals with the movement and treatment of soil resulting from construction. Basically it forms the foundation of topographical stability.

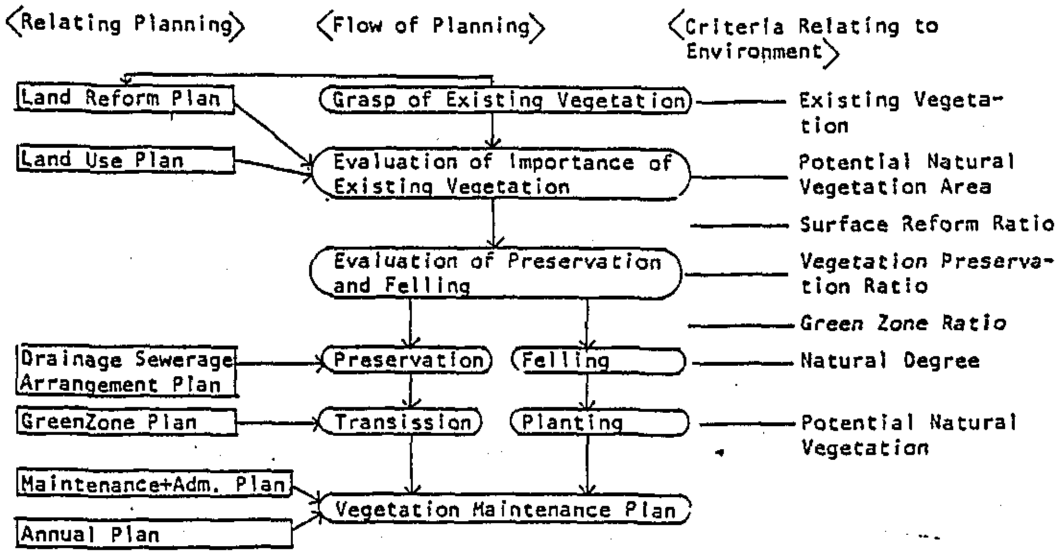
iii) Relation to other plans: Soil movement and treatment are the main factors of land conservation planning, and this plan is closedly related to reclamation planning.

iv) Environment-related criteria:

## (8) Vegetation planning

### i) Flow chart of the plan

Flow of Planning



ii) Objectives: It is necessary to draw up a plan to utilize presently existing vegetation and seek coordination with other plans. Vegetation planning consists of three plans, i.e., deforestation plan, landscaping plan and succession plan.

iii) Relation to other plans: Vegetation plan includes the factors of growth in environmental protection planning. The utilization of the presently existing species of vegetation, the cultivation of vegetation and the succession aimed at the conversion to superior vegetation are mainstays of this planning. It is closely related to various plans for topography, water, etc. since nature conservation and plant cultivation are handled in this planning.

iv) Environment-related criteria

| | |
|---|---|
| Present vegetation: | Presently existing vegetation -- its specie composition forms the basis of this planning. |
| Potential natural vegetation: | This represent the type of vegetation logically conceivable in a location when all artificial interventions are ceased and is important for the plant cultivation plan and succession plan. |

Greenery occupancy ratio: This indicates the area covered by vegetation and is an important factor as a greenery indicator along with the levels of greenery occupancy and population.

(9) Noise control planning

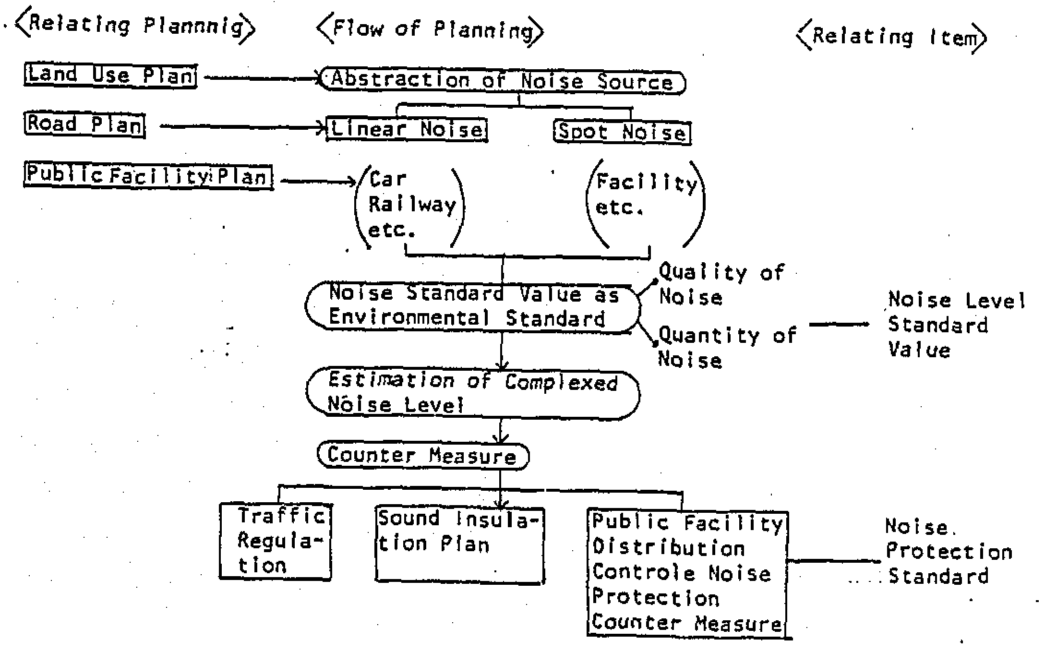
(With special reference to the international airport planned for construction)

i) The plan aims at the improvement of the noise environment and realization of a pleasant living environment.

ii) Noise sources are roughly divided into traffic noises and equipment-originated noises. The former is linear noise sources and the latter represents insular noise sources. Restriction on noise sources and sound insulationg plan hold the major places in the noise prevention planning. Improvement of the environment has to be made through the combination of these two methods.

iii) Noise sources: Traffic noise presents the most serious problem in this plan. This is caused by automobiles, railroads, and, in special cases, by airplanes and Shinkansen (super express railway system) and this is related to the nature of the noise generated.

iv) Flow chart of the plan



SUPPLEMENT:

## "Supplementary Explanation on the Principles (i) - (vii) of Ecological Planning"

### Principle (i)

Through the long history of the earth, survival from natural selection has been possible because stabilization function had been programmed in ecosystem from the beginning. There is always a danger that we may overrun the point of this equilibrium and go to the extent that the system becomes irretrievable. The resisting force of this equilibrium point to outside pressure is usually high in tendem with the degree of complexity of ecosystem.
In most cases, ecosystems have extremely complicated interrelationships and their resisting force is much higher than the simple ones. The occurrence of environmental pollution bears witness to the facts that ecological linkage is disrupted, ecosystems are made artificially simple and, as a result, they have become susceptible to outer forces. It is necessary for the ecological planning to take advantage of these interrelationships and conduct careful planning and designing taking into consideration the points of diversity about which we will describe elsewhere in this explanation.

### Principle (ii)

Explanation on the grounds of the establishment of this principle will not be necessary since it derives from the first law of thermodynamics. If this principle is expressed in terms of ecology, it means that the existence of the materials explained by the concept of "waste materials" is no longer possible in the natural world.
In nature, the substances discharged from one living organism as waste is taken by other living organism as food. As mentioned earlier, there is nothing in this world that "perishes." Materials or energy only move from place to another in a different form while giving influence on the life sustaining process of the living organism. One of the environmental problems we are confronted today is that great quantity of materials are taken from the earth and they are discharged into the environment after being changed into new forms.

Principle (iii)

This principle is first established in economics and it demonstrates that also in ecology all incomes are obtained in return for some losses or expenses. The ecosystem of the earth is an interlinked unity and nothing increases or decreases in it. The system as a whole never changes.

Whatever taken from it by man's activity must be returned to it. Such payment of prices cannot be avoided even if it is delayed in some cases. Various problems of today's environmental disruption are a warning that this payment is longtime overdue.

Principle (iv)

This principle which sets forth the existence of the utilization efficiency of resources has been obtained empirically. In any given process, there is a ceiling for the ratio of energy use in order to maintain the process. Moreover, when energy use reaches the marginal point in any process by increasing the level of resource utilization, higher effect becomes impossible to obtain no matter how resource use is increased. The most important lesson that we can learn from this principle is that the optimum level of resource utilization efficiency may exist. At the resource utilization level under or above the optimum level, resource efficiency values in relation to ecosystem are always lower than the optimum level values. This means that there is an optimum level of resource utilization for each living organism in the biological population. Viewed from another angle, this attests to the fact that there is the optimum number of living organisms for resource utilization at a given stage of the environment. This is the reason why the size of a biological population in an environment in the constant status has a tendency to fluctuate over a certain set of values rather than to increase or decrease gradually over a long period of time.

Principle (v)

In many countries, it is not recognized that space is an important resource for mankind. Space itself as a resource is never affected by any other resources existing in it, but it is important to note that there are limits to its expanse. Particularly it should be noted that in the area where there is a large population, valuable spaces are being diminished. This can actually be seen in the cases of deteriorating the functions of superior farm agricultural land due to the sprawling phenomenon in the areas surrounding metropolitan areas and the increasingly higher cost and longer hour for transportation due to haphazard land utilization.

Next we will turn to the question of time. We tend to neglect the importance of time as a valuable resource. In other words, the probability of a phenomenon to take place depends on the leeway of available time. We are optimistic to expect that fast breeders and nuclear fusion reactors will be in wide use before the depletion of fossil fuels. However, it takes a very long time to develop and put such a large-scale project to practical use. The establishment of a plan is necessary before the depletion of fossil fuels. One approach to this goal is to hasten the completion of the big projects. The other is to save the annual consumption of fossil fuels and create leeway in terms of time. Therefore, it can be clearly seen that time is a relative and alternative concept.

As for diversity, the diversity of nature all over the world is rapidly diminished at present by mankind. Man is overlooking the fact that diversity is an important resource to increase stability and this has given rise to various problems. Stability is increased by the diversification of risk. For example, by the conversion of forest to farmland, scenery becomes uniform and by changing natural community to one-crop area, the majority of fauna and flora is eliminated. As a result, the diversity of community patterns and species disappear.

Principle (vi)

This principle can be explained by the phenomenon where the variety of insects decreases and the population per species increases when a single crop is planted over a wide area. As a consequence, the probability that a certain species increases to the density that it threat the maintenance of ecological balance in the area. This is because other species spread over a wide area in a short time and with a small amount of energy.

This principle applies not only in the natural world but also in the artificially created urban areas. When the economy of a city is closedly related to the performance of a big company which operate seeking the economies of scale, serious stagnation will occur when the company's market diminishes or is lost. Such phenomenon is not limited to the lack of diversity in industry. When there is a distortion in the distribution of age groups, i.e. disproportionately large numbers of young people and small number of adults, a situation similar to the above arises. An extremely large number of young people lead to the heavy tax burden on each tax payer and capital outflows and the city will become highly unstable.

This diversity - stability principle is fairly comprehensive one and can be divided into a number of principles about which we will describe later. This is mainly due to the characteristics of diversity, namely - specific diversity, habitat diversity and community diversity. The most important point of this principle is that the systemic stability or the capability in resisting unfavorable conditions and preventing destruction is low in a young system while a mature system has high capability and stability. In the matured system, highly sensitive and complex adaptation and control system develop in response to biological and social environments. These various adjustment functions are an extremely complex feedback control system which assures constancy and stability. In such controlling of nature, we must direct special attention to the question how we can skillfully unify a system which is in the process of development and has a high productivity with a mature system which has a high stability.

As shown in Table II - 1, this relationship was proposed by Odum as a model presenting ecological succession.

In the application of this diversity - stability principle, it is important to clarify the question of how we should diversity the artificial ecosystems under man's control in order to maintain them without damaging harvest or market while seeking effective measures for production stability. For this purpose, the possibility of the zoning of the environment should be examined so that the growth stage can be maintained in an areas while upholding the stability stage in the other areas of the same region.

Principle (vii)

A mature ecosystem, nutritional stage, or population obtains energy, biological amount and diversity from those which are relatively immature. In other words, energy, materials, and diversity move to a complex or more highly diversified ecosystem.

This principle is also valid in social phenomenon. As young people leave their villages and towns and move to urban areas, the distribution of population by age group changes also along with the degree of diversity. Developing countries and financially-poor local governments entail a relatively large sum of expenditures to conduct fundamental education and train doctors and scientists. Nevertheless, these doctors and scientists eventually move to urban areas where they can get higher remuneration for their skill and where economic and social activities are more active to satisfy their lifestyle.
In other words, they move to the city which is more highly diversified. It is in such a way that people with talent, technology and basic education move toward the system which has higher diversity.

As seen in the above example, even if it appears that it is in the interest of developing countries and provincial regions to conduct economic transactions with advance countries or region-to-region trade, it is advanced countries and cities that reap far greater socioeconomic profits.

Ecological Transition Model;

The tendencies expected in the development of ecological system

| Property of Ecological System | Development Phase | Maturity Phase |
|---|---|---|
| **Energy Metabolism of Crowd** | | |
| 1. Crude Production/ Crowd Respiration (P/R ratio) | $>1$ or $<1$ | $\sim 1$ |
| 2. Crude Production/ Existing Amount of Biological Being (P/B ratio) | high | low |
| 3. Maintaining Amount of Biological Being/ Unit Energy Flow (B/E ratio) | low | high |
| 4. Pure Crowd Production (the yield) | high | low |
| 5. Food Circulation Links | Linear and Advantageous to Hervivorous | Mesh Work and Advantageous to Detoritus |
| **Structure of Crowd** | | |
| 6. Total Organic Body Amount | small | large |
| 7. Inorganic Nourishment | Non-biological origine | Biological origine |
| 8. Variety of Species-Element of Kinds | low | high |
| 9. -do- -Element of Uniformity of Individual Number | low | high |
| 10. Bio-Chemical Variety | low | high |
| 11. Degree of Stratification and Spacial Heterogenity (Variety of Pattern) | low | high |
| **Life History** | | |
| 12. Size of Niche | wide | narrow |
| 13. Size of Biological Being | small | large |
| 14. Life Circulation | Short and simple | Long and complexed |
| **Circulation of Nourishment** | | |
| 15. Circulation of Inorganic Body | open | closed |
| 16. Exchanging speed of Nourishment among Biological Being and Environment | fast | slow |
| 17. Role of Ditoritus in the Reproduction of Nourishment | not important | important |
| **Sellection Pressure** | | |
| 18. Growth Model | Quick growth is advantageous | Advantageous for feed-back controle |
| 19. Production | ("r sellection") amount | ("k sellection") amount |
| **Constancy Total** | | |
| 20. Internal Co-existence | Not developed | Developed |
| 21. Keeping of Nourishment | poor | poor |
| 22. Stability | bad | good |
| 23. Entropy | high | low |
| 24. Information | low | high |

Source : E.P. odum (1969)

# 3. REPORT ON TOPOGRAPHY AND DRAINAGE

## Contents

Contents (cont'd)

## A. Jakarta: Topography and Drainage

### Jakarta, Topography

1. Jakarta was found in the 16th Century at the mouth of the Ciliwung river on the flat plain in the northcoast of Java. Although drainage and flood control in the city of Jakarta and its surroundings have been a problem from the beginning, with an increase of population and densely built-up areas the urgency of the problem has inevitably grown.

2. Geomorphologically, three zones in the Jakarta area could be distinguished in direct connection with the present drainage and flood control, reaching from the watershed line in the mountains south of Jakarta to the Java sea:

- the mountainous area south of Bogor and above the 150m-contour line, crowned by the Volcanoes Salak (2,200m) and Gede (2,960m);
- the upper coastal region between the contour lines of 150m and 5m, dissected by many rivers having eroded deep and clearly defined valleys; and
- the coastal plain below the 5m-contour line; in this area which is in general very flat and swampy, the rivers and drains are much less clearly defined and have often shifted their courses; the coastline has moved northwards in the historic times due to sediment deposits;* some old beach ridges and natural river levees occur in the plain; the width of this coastal plain varies between 6 and 10km. Under this situation in the coastal plain, soft clays with high plasticity, low strength property, a high water table and low permeability has been developed.

* ... reported by 75m in one month after the eruption of Mt. Salak in 1699.

### Jakarta, Present Drainage and Flood Control

3. The existing system for drainage and flood control in Jakarta has grown with the city development. The rapid extension of the capital in the last three decades, however, has not been accomplished by a comprehensive enlargement of the above system. And also, most of the existing rivers and drains have become shallowed by siltation process as well as by habitual dumpings of solid waste and garbage directly into them, in combination with inadequate maintenance and dredgings.

4. The most important element of the existing flood control system is the Western Banjir Canal constructed in 1920, starting with the regulation structure (Manggari weir) in the Ciliwung river and joining the Angke river near its mouth through the Terusan Banjir. Other elements are numerous drainage canals. (See Figures 2 and 3.)

5. The present problems of drainage and flood control of the greater Jakarta are three-fold:

1) to drain off the rainfall on the urban area;

2) to prevent the run-off from the hills to the south to flood the city area; and

3) to prevent, in the dry season, stagnation of the water in the open canals in the city.

6. In February 1965, a special task force, as later called "Proyek Pengendalian Banjir Jakarta Raya" (P.B.J.R.) in the Ministry of Public Works and Electric Power was established by the Presidential decree to assist the Municipality of Jakarta with the solution of these problems within the framework of the Development Plan for Greater Jakarta which is envisaged for the years 1985 and 2000.

## Masterplan for Drainage and Flood Control of Jakarta

7. After severe floods in February 1970, a technical assistance was requested from and supplied by the Netherland Government. In November 1972, the P.B.J.R. in cooperation with the Dutch consultants, NEDECO submitted a preliminary masterplan including various alternatives for several of the measures for drainage and flood control.

On April 27, 1973 after several discussions with the government agencies concerned, a decision on the main principles of the plan was taken by H.E. the Governor of Jakarta, and agreement on the incorporation of the plan into the Development Plan for the City was worked out in the ensuring months.

To this end, a final report "Masterplan for Drainage and Flood Control* of Jakarta" was submitted by the P.B.J.R. and the NEDECO in December 1973.

* ... (1) "Flood Control" is defined as diversion of floods in the rivers to prevent them from entering the city area, while "Drainage" is to evacuate the run-off during heavy rainstorms on the city area itself inside the protection of the flood diversion canals.

## Western Banjir Canal Scheme

8. The Masterplan in December 1973 explains that the existing Western Banjir Canal where it turns north is to be extended further to the west in order to encompass a large part of the low-lying extensions of the city on that side, and to collect the floods of the rivers coming down from the hills. Alignment of the Western Banjir Canal extension is dictated by its branching-off point from the existing Canal and the possibility of joining the Angke river at Pesing near the railway from Jakarta to Tanggerang, in which the shortest possible alignment in between these points was worked out

with the Municipal Department of Town Planning. The suburb of Cengkareng, furthest to the west along the coast is not encompassed. (See Figures 2 and 3.)

Hydrological information as involved in the Masterplan are summarized below:

| River | Catchment Area | | -do- Accumulated | | Design Flood<br>Q2 | Q25 | Q100 |
|---|---|---|---|---|---|---|---|
| | (sq.km) | (%) | (sq.km) | (%) | (cu.m/s) | | |
| Ciliwung | 347 | 41 | 347 | 41 | | | |
| Cideng | 8 | 1 | 355 | 42 | | | |
| Krukut | 98 | 11 | 453 | 53 | | | |
| Grogol | 13 | 2 | 466 | 55 | | | |
| Secretaris | 8 | 1 | 474 | 56 | 150 | 270 | 370 |
| Pesaggrahan | 110 | 13 | 584 | 69 | | | |
| Angke | 263 | 31 | 847 | 100 | 190 | 400 | 525 |
| Total | 847 | 100 | - | - | | | |

(See also Figure 4.)

## Polders and Land Fill

9. The Masterplan Report indicates that the Jakarta urban area, situated approx. below the level of 2.0m+p.p. (Priok Peil - Mean Low Water Level established in 1925) near the coast should be completely filled up or be properly equipped with pumped drainage.

The land fill would take much time to be realized and would be particularly difficult in the areas which are already built-up often through congested traffic to selected dumping sites. And also, the fact that the soil in the lowest areas consists mostly of soft marine clay which would consolidate considerably under the load of land fill, and that some subsidence of survey benchmarks dating back to 1925 in relation to p.p. has been confirmed, requires very large quantities of the fill.

On the other hand, pumped drainage of areas, protected by polder dikes does not affect the existing structures, although these would be some problems as to higher operation cost for continuous pumpings as well as difficulties in proper operations in view of mechanics, electricity and hydrology.

## B. Cengkareng Area: Topography and Drainage

### Extent of the Cengkareng Area

1. The Area, in which the proposed housing area is located, is situated west of Jakarta, lying between the Java sea and the Mookervaart river.* According to the Masterplan for the Development of Jakarta City (1965 to 1985), the Cengkareng Area will be developed into an urban area, just like the near by Grogol and Jelambar areas. A new international airport is scheduled to be complete in its construction in 1982 near the bounding of Jakarta and Java Barat. This Area is limited to the west by a road and a green belt. (See Figures 1 and 5.)

* ... A report on Cengkareng drainage system by the P.B.J.R. and the NEDECO in 1976 indicates that the capacity of the Mookervaart river which serves as a collecting drain as well as an emergency outlet for the Cisedane river, should be approx. 50 cu.m. per sec., however, the maximum flow from the Cisedane is usually limited to 15 cu.m per sec. Relatively low water levels in the Mookervaart river at all times were examined by the P.B. J.R. and the NEDECO in 1976, as follows:

| | | Water Level | Road |
|---|---|---|---|
| Location | River Bed | -Q25- | Jakarta-Tanggerang |
| | | (p.p.-m) | |
| A | -2.06 | +3.98 | +2.45 |
| B | -2.14 | +4.34 | +2.48 |
| C | -0.96 | +4.43 | +2.79 |

(See Figure 5)

### Topography

2. The predominantly rural area at present consists of (1) a few small villages with small-scaled industries mainly situated along the road (Jakarta to Tanggerang), old beach ridges and natural river levees, (2) paddy fields, and (3) low-lying swampy areas.

The Cengkareng Area can be topographically designated into two:

1) The vast low areas (approx. p.p.+1.0 to +2.0m) alongside the coast are flooded by the Java sea during high water (see Figure 8). Fish ponds have been developed adjacent to the sea.

2) The southern part slopes from south to north or east with land elevations from p.p.+6.0 to 2.5m, where the former beach ridges parallel to the existing coastline can be distinguished.

## Drainage and Irrigation

3. The existing drainage system in the Area could be largely divided into three sections: (1) to the Java sea (subarea A1), (2) to the Angke river (subarea A2) and (3) to the Mookervaart river (subareas 3 and 4). (See Figure 1.) It can be considered that the existing system of gravity drainage would be sufficient in view of the present rural needs except for the inundation problems of some low-lying swampy areas.

4. Paddy fields in the Area is currently receiving irrigation water from the Prosida Subproject Cisedane under the J.P.V. Prop Java Barat. The intake is at Bendungan Pasar Barn, Tanggerang in the Cisedane river. Water is delivered through the Cisedane Timor Irrigation Canal (see Figure 1).

## Cengkareng Urban Drainage Scheme

5. The drainage and flood control problem of the Cengkareng Area is not dismissed in the Masterplan for Drainage and Flood Control of Jakarta (1973) for three reasons:

- the Area can be treated separately from the area protected by the Western Banjir Canal Scheme,
- the Area could drain directly to the Java sea and is properly protected from the external floods by high banks along the rivers of Angke and Mookervaart.
- no relevant data of future urbanization in the Area were not available in 1973.

6. With the presentation of urbanization scheme in the Area, it has been possible to work out a detailed scheme for main and drainage drains. In February 1976, "Explanatory Note on the Design of the Cengkareng Drainage System"* was submitted by the P.B.J.R. and the NEDECO. (See Figure 5.)

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* ... ANNEX VIII to Final Report Phase II, Jakarta Drainage and Flood Control Project

## C. Proposed Housing Area: Topography and Drainage

### Location

1. The Cengkareng low-cost housing area under discussion is located within the drainage catchment of A2 (approx. 1,130 Ha), as shown in Figure 1. This catchment area is bounded on the west by the road (Jl. Kamal Raya) to Cengkareng Belakang and Kayu Besar, on the north by the road to Kampung Kapuk, and on the east and south by the border of flood limit of the Angke river. Strictly speaking, this area is contained to the west and north by an embankment which supports a raised irrigation canal called "Cisedane Timur Irrigation Canal". The northern boundary follows the edge of an old beach ridge and the ground beyond is generally about 1.5m lower than the prevailing site level.

2. As a matter of fact, the area belongs to the rainfall catchment of the Angke river as shown in Figures 1, 2 and 3. This small catchment with an area of about 11.3 sq.km is compared with a larger one in the upstream catchment of the Angke river (373 sq.km at "A" in Figure 2) which geomorphologically belongs to the upper coastal region and mountainous area. It can be considered that the Cengkareng area is quite different from the majority of rainfall catchment in the Angke river in terms of hydrology and environment.

### Existing Rural Drainage System

3. This area at present drains towards the east through a rural drainage canal called "Kali Kapuk Muara" which follows to the Angke river (see Figure 1). The rural canal, over much of its length obstructed and overgrown with regetation, passes first through paddy fields and later through urban areas given for some housing development with a large-scaled pig and chicken rearing.

The canal size varies from 3m wide by 1m deep at the beginning, viz. western edge ("x" is Figure 1) to 5m wide by 1.5m deep being 500m apart from the Angke river. The final 500m is concrete-lined and 10m wide by 3m deep.

4. The field survey reveals that a conduit pipe under the road (Jl. Kamal Raya) at "x" in Figure 1 connects the both drainage canals in the catchments "A2" and "A3". This pipe with a diameter of 1.2m was provided around 1960. A local farmer explained that during the wet season, water level in the "A2" drainage canal is lower than the "A3" drainage canal and inundation in the larger swampy area along the canal in "A3" catchment would be about 1m deep.

5. The present rural drainage canal is situated along the lowest parts of the catchment area, as is explained in Figure 7. There appear the swampy areas along the canal and also the road (Jl. Kamal Raya). Due to construction of the Cisedane Timur Irrigation Canal, the natural drainage of parts in the western end of this catchment which is involved in the proposed housing area has been interrupted, and in these areas the surface water stays for long duration.

## Flood and Inundation

6. During the field survey, an effort was made to collect the historical data with respect to inundation and flood drainage covering the proposed housing site from the various government agencies concerned; however, this was not available.

Interviews with chiefs in District Offices at Cengkareng and Kapuk explain:

- The offices have not been requested to record the inundations because of no damage.

- As a matter of fact, there are temporary inundations over the paddy field due to every rainfall and a fact that the Angke river even now is unsuitable as a main drain because the water level is high during floods being affected by the sea level.

- There has not been inundation over the present rural villages and main roads.

- There is rather long inundation over the swampy area; however, because of no product in this area, the inundation data is not available.

- The maximum inundation with depth of about 0.5m over the paddy field has been observed once in every three or four years. Since the paddy is tolerable with this inundation, no damage has been recorded.

7. The above-mentioned information are interpreted that as far as the proposed housing site is concerned (1) the present drainage system would properly function in terms of rural needs except for the swampy areas, and (2) difference of the elevations between the rural residential area and the paddy field would be more than 0.5m. As a matter of fact, a temporary storage of the rainwater over the paddy fields has contributed to rather favorable function of the present rural drainage system.

## D. The Cengkareng Drainage System

### General

1. Reference is made to "Explanatory Note on the Design of the Cengkareng Drainage System", ANNEX VIII to Final Report Phase II, Jakarta Drainage and Flood Control Project by the P.B.J.R. and the NEDECO in February 1976, from which important information for design of the urban drainage system relating to the proposed housing site have been excerpted with additional considerations and views.

> * ... It has been confirmed by the Mission that the P.B.J.R. has no particular or important comment on this Report and also has asked for suggestions useful to refine the present proposal from the Cengkareng low-cost housing project.

2. In the capital city of Jakarta, the residential areas, industrial zones, business regions, recreational sites and traffic arteries should be in general free from flooding; in other words, the minor inundations of short durations should occur on an average only once in one or two years in stochastic terms.

It is said that for the Jakarta city area above the elevation of p.p. +5.0m, this demand could easily be met with the construction of a proper drainage system. On the other hand, the area situated approx. below the level of p.p. +2.0m should either be completely filled up or be equipped with pump drainage. As a matter of fact, relatively large parts of Jakarta are situated at such low level in relation to the Java sea that the minimum drainage requirement could not be met and free drainage during high tide is impossible.

### Alignment of the Main Drains

3. The alignment of the proposed urban drains has been made on the following considerations:

1) Drains should be situated in the lowest parts of the rainfall catchment areas which eventually coincide with the existing rural drainage system;

2) The drains should fit well in the town plan. It is kept in mind that the urban road plan should be adapted to the optional lay-out of the main drainage in view of economy in the construction and subsequent maintenance cost, and not the drainage system to the road plan. Violation of this principle may lend to artificial and expensive solutions for urban drainage in the area, even to demolition of newly built buildings or dwellings; and

3) Canals should be as short and straight as possible to keep the maximum water levels as low as possible and moreover to ease maintenance.

4. A basic scheme for main drains and secondary drains as worked out is introduced in Figure 5 for the entire Cengkareng Area and in Figure 6 for the proposed housing site, although detailed information is not yet available about the plan of new town. It is, however, emphasized that although minor changes may be introduced into the drainage scheme, the alignment of main drains should be considered as final to semi-final. Where possible, location of the secondary drains should be made alongside future roads.

5. In compliance with the design principle 3) as mentioned above, an outlet of the existing rural drain in the catchment "A2" at the Angke river as is in Figure 1 has been changed to directly the Java sea as specified in Figure 5. The Report proves that direct drainage to the Java sea would entail lower water levels in the area than that to the Angke river, part of the future Western Banjir Canal. This is properly revealed by comparison of the channel length to the Java sea between (1) the course through the Angke river and (2) that of the proposed main drain "2" in the Cengkareng drainage system.

6. In addition, two basic rules which will have to be observed are described in the Report:

- The two main drains Nos. 1 and 2 as shown in Figure 5 should be provided with one joint, single outlet to the Java sea in terms of sufficient sediment-transportation capacity of drains and outlet as well as the maximum reduction of sedimentation and maintenance cost.

- The outlet will have to be dredged regularly so that the design water level for Q-25 discharge at the mouth will remain at p.p. +1.0m. *

* ... (1) Masterplan Report for Drainage and Flood control of Jakarta explains that the water level at the mouth is determined by sea level which is introduced in Figure 8. It is said that the tidal movement in the Java sea at Jakarta is mainly a single day tide with one high water and one low tide a day. It has been observed at the present Western Banjir Canal that the peak discharges last through hours; therefore, it is assumed that the Q-100 discharge may coincide with High High Water Level at p.p.+1.25m. In addition, the general observation that sand-banks are formed at the mouth of rivers and canals, has induced an assumption that the discharge from the Western Banjir Canal into the sea will pass over this bank as a kind of weir with its crest at p.p. ±0 equivalent to Lower Low Water Level in the Java sea and with an assumed length of 1.6 times the width of the Canal at level p.p. +0. Under this assumption, water level of the Q-100 discharge at p.p.+1.85m is given immediately upstream of the sand-bank, as explained in Figure 4.

(2) Moreover, the Report indicates that it would be exaggerated to employ the highest level during spring tide in case of drainage, but because the evacuation of the maximum discharges may require several hours in the present calculation, Mean High Water Level at p.p.+0.90m in the Java sea has been employed. It is assumed that taking into account the probable effect by the sand-bank, the water level for the Q-25 discharge at p.p.+1.0m is given immediately upstream of the sand bars at the outlet of the Cengkareng main drains.

Without regular dredging, the water level at the main drain may rise to p.p.+1.5m, resulting in an important rise of the design water level for the Q-25 discharge in the secondary and roadside drains to the main drain entailing an extension of the necessary land-filling in the Cengkareng Area.

## Return Period of the Design Rainfall for Urban Drainage

7. The Masterplan Report (1973) delineates:

- The micro-drainage system1) in the Jakarta urban area is designed with a capacity sufficient for the maximum rainfall which could be anticipated to occur once in every year or every two years.

  1) ... drainage system within the housing site incl. internal drain, roadside drain, gutter, ditch and so forth, which carries the run-off to the macro-drainage system. This system will be provided by the PEKUMNAS.

- The macro-drainage system2) is designed with a capacity sufficient for the maximum rainfall with a return period of 25 years.

  2) ... includes the main drains and secondary drains as shown in Figure 5, which will be constructed by the Ministry of Public Works. In the proposed housing area, the secondary drains "2-3" and "2-2-2-2" have been incorporated into a plan.

- The Western Banjir Canal is designed on the floods with a return period of 100 years.

## Water Levels in the Drains

8. The water level in the macro-drainage system, viz. in the secondary drains over the proposed housing area during the design rainfall T=2 (return period:2 years) should be lower than the lowest parts drained by the micro-drainage system of the area. With the following assumptions, the water level in the secondary drains should be as much as 0.4 to 1.0m lower than that lowest part:

- Number of the secondary drains in the macro-drainage system should be restricted for practical reasons. At many places in the existing system and in the new urban areas of Jakarta, the average distance would be about 1,000m. Then, it is assumed that the lowest parts are located at a distance of 500m along the micro-drainage systems to the secondary drains.

- During the rainfall T=2, the micro-drainage system may be filled to capacity.

- Slope of the micro-drainage system would be 1:1,000 to 1:3,000.

- Head-loss at crossing structures such as culverts and bridges would be 0.25 to 0.5m.

9. During the rainfall T=25, the water level in the macro-drainage system may reach the ground surface level along the drains; while minor inundations in the micro-drainage system would then occur, however, this would be of short duration taking into account a fact that heavy rainfall is generally concentrated in the afternoon and evening with 60 to 80 percent falling from 14:00 till 21:00 hour.

General speaking, the surface drainage system as mentioned above could prevent large-scaled inundations of long duration during all rainstorms except some and extreme storms which would have a probable frequency of occurring with a return period of more than 25 years.

## Preliminary Design of the Macro-Drainage System

10. Design of the main and secondary drains* has been made employing (1) the rainfall with a return period of 25 years and (2) the assumption that design water level may reach the present land level along the drains. As a matter of fact, slope of the water level in the drains has been selected relating to the present ground levels with certain limits. When design water levels rise above the present ground level, land-filling should be carried out. In the Report, no consideration has been made of the micro-drainage system.

* ... The macro-drainage system in Jakarta is of the open type which has an advantage of much larger storage capacity for tropical rain and run-off intensities and sudden discharge increases, than closed conduit under ground would have.

11. For the proposed Cengkareng low-cost housing site, direct concern is given to such main and secondary drains as "2", "2b", "2-2", "2-3", "2-2-2" and "2-2-2-2" which are shown in Figure 6. The subsequent longitudinal profiles of such drains and important cross-sections at "AX", "BJ", "BK", "BO" and "BK" as quoted from the Report are compiled in Figures 8, 9 and 10, together with the related hydraulic information.

As is in Figure 10, a considerable amount of the landfill is needed for the secondary drain "2-3" which contributes to surface gravity drainage for the majority of the proposed housing site, while the minor landfill is seen along the secondary drain "2-2-2-2" in Figure 9. Under this situation, water level at "BI" has been a matter of additional concern:

| Location | "BI" | | "AX" (mouth) |
|---|---|---|---|
| Distance of Drain | | ←— 4,600m —→ | |
| Water Level at Q-25 | +2,258m | ←—1/3,657—→ | +1,000m |
| Water Level at Q-2 | +1,448m | ←—1/10,268—→ | +1,000m |

### Review of the Design

12. If the hydraulic slope between the two takes 1:5,000, the Q-25 water level at BI would be estimated at p.p.+1.92m being lower by 0.34m as compared with the Report, and then this lowering could be transmitted to the secondary drain "2-3". Table 1 indicates height of the landfill at the specified cross-sections which are obtained from Figure 10. By lowering the water level at BI by 0.34m, the majority of landfill along the secondary drain would be eliminated except for the upstream part.

This consideration should further be reviewed in view of sufficient sediment-transportation capacity of the drains from "BI" to "AX" and other important factors. This should be out of the present study and be made by the P.B.J.R. and the NEDECO in future.

13. It can be believed that the location and hydraulic properties along the secondary drains "2-3" and "2-2-2-2" which are mainly within the subject housing area are discussed within this study and the subsequent proposal should proceed to the P.B.J.R. under the Ministry of Public Works for review.

This has been shortly done taking modification of hydraulic slope for the Q-25 discharge along the drain "2-3" when the water level at "BI" is fixed at p.p.+2,258m. Reference is made to Table 1, in which two gentle slopes in the revised case (1): 1/4,000 and the revised case (2): 1/5,000 are discussed in terms of height of the required landfill, although the slope of approx. 1/2,500 is taken by the P.B.J.R. and the NEDECO in their Report.

Degree of the decrease in the height of landfill has been of great interest; to this end, it would be more appropriate to take the hydraulic slope of 1:4,000 at the Q-25 discharge taking into account deterioration of the hydraulic properties in the slope of 1:5,000.

14. Further reference is made to Figures 11 and 12, in which the cross-sections* at "BJ" and "BK" in the two cases of the revised slope are examined by using the Q-25 discharges as are given in the Report. More particularly, Figure 11 describes those in both cases taking the elevation of drain bed as given in the Report with expansion of the canal width, and Figure 12 shows the cross-sections in case of 1:4,000 taking modification of both the elevation and width of drain. As a result, the cross-sections as revealed in a case of the Revised (1), Alternative (2) would be more applicable in terms of the various hydraulic aspects along the secondary drain "2-3".

* ... The side slopes of 2 horizontal to 1 vertical in the terminal stretch near the sea and 1.5 horizontal to 1 vertical in the upstream part along the drains are proposed in the Report, on the basis of degree of such soil properties as soft marine clays with high plasticity, low strength properties, a high watertable and low permeability as well as also in order to obtain a permanent grass cover on the slopes for protection against erosion. Although the main and secondary drains are unlined, the major drains in the micro-drainage system will be of open construction except where culverts are provided to pass under the roads, and be concrete-lined with trapezoidal cross-section and side slope of 1 to 3 to minimize the maintenance costs.

15. The Report indicates that water levels based upon the rainfall T=2 have also been compiled in the longitudinal profiles (see Figures 8, 9 and 10). The water levels for the Q-2 discharge which have not been calculated in detail*, should be low enough to enable the micro-drainage system to function at full capacity.

* ... It is considered that assumption of the permanent flow at peak discharges might have been incorporated on the pre-feasibility basis in the Report, and this is not accurate enough being overestimated.

## Land Filling or Poldering in the Lower Parts

16. The Report discusses a problem of the lower land which is located north of the proposed Cengkareng housing site as surrounded by the main drains "1" and "2" and the road at Kamping Kapuk, as is seen in Figures 6 and 8. In the Report, a proposal of the landfill for this area is tentatively made without design of detailed drainage system, with a remark that a choice between such two possibilities as landfill and poldering can be made as soon as the destination of this area has been fixed.

17. Each case would pose its individual problems, and generally valid answer could not be given with any detailed consideration. A practical solution will be determined by (1) destination of this area, whether there are already many buildings in the area or whether there is time for landfill by pumping in sand from the Java sea or bringing in soil from elsewhere, (2) comparison of the cost for continuous pumping in the future and costly investments for landfilling prior to building, (3) influence of the local solution on the whole drainage system in the engineering and socio-economic terms, and (4) many other aspects which should be considered in each case.

It can be considered that the landfill, where possible, should take place; while for the lowest areas of a considerable extent which are seen in particular in Eastern Jakarta, poldering and pumped drainage would be chosen as the quickest solution.

18. In case of a polder solution, the area is enclosed by dikes which prevents rain water from entering from the outside, and evacuation of the rainfall on the poldered area is effected by pumping. Since the peak discharges occur only during a shore period, important saving on the installed pump capacity could be achieved by providing a buffer-storage reservoir through more detailed studies by using the computer. Usually, pump capacity would be somewhere between 10 and 20 liters per second per Ha. The reservoir should be excavated deep enough to prevent the plant growth even at low water level. Care should be taken to prevent the floating garbage and polluted water from being spilled into the reservoir.

## Flushing Operations

19. Flushing of the open drains particularly in the dry season and during dry spells will form an essential part of the operation of the drainage system, as long as (1) the solid waste and garbage disposal system is not drastically improved and (2) effective measures are not taken to prevent garbage from being dumped into the drains.

By regular replacement of the water in the drains, the environment and health hazards of stagnant water can be prevented. This will be particularly necessary as far as there is no complete sewerage system for the removal of liquid waste.

20. The Report emphasizes that the water required for the flushing operations could be obtained through the existing Cisedane Timur Irrigation Canal from the Cisedane river at Bendungan Pasar Baru Tanggerang, since the necessary amount of flushing water would be equal in terms of Ha to the present need for irrigation.

## E. Recent Modification in the Western Banjir Canal Scheme

### Difficulties in Improvement of the Angke River

1. The proposed extension of the existing Western Banjir Canal joins up with the Angke river at Pesing after about 8 km of new canal (see Figure 2), and the debouches into the Java sea after another 6 km of the existing Angke river course. Over the last stretch, the Angke river should be widened and straightened, and embankments should be provided on both sides.

The Masterplan Report explains that the horizontal alignment through this course is a balanced compromise between expropriation difficulties and costs on the one hand, and length of canal, slope and costs of cut and fill on the other hand which arrived at after many deliberations between the P.B.J.R. and the Municipal Department of Town Planning, Jakarta.

2. It was mentioned that a considerable effort had been devoted to procure the required land along the Angke river in the much congested area since 1973; however, it had been impossible to carry out the improvement of the Angke river in line with the original plan as introduced above.

In March 1979, a decision on relocation for the terminal part of the proposed Western Banjir Canal was taken by H.E. the Governor of Jakarta, and alignment of a new Canal was shifted to the west of the existing Angke river, although the documents concerned were not available. Location of this new Canal is outlined in Figure 7.

### Cengkareng Drain (or Western Banjir Canal)

3. The P.B.J.R. expressed two different proposals on relocation of the terminal part for extension of the existing Western Banjir Canal in October 1979 when the Mission visited:

- Mere shifting away from the Angke river to a new site without any change of the entire scope under the Western Banjir Canal Scheme; and
- Subdivision of the Western Banjir Canal Scheme into two: (1) that of the rivers of Ciliwung, Cideng, Krukut, Grogol and Sekretaris which is drained through the existing Angke river (56 percent of the total catchment area) and (2) that of the rivers of Pesaggrahan and Angke which is discharged into the Java sea through a new Canal, viz. the "Cengkareng Drain" (44 percent of the total catchment area).

The latter scheme "Cengkareng Drain" is briefed in a publication "PENJELASAN SINGKAT PENANGGULANGAN MASALAH BANJIR"* (in Indonesian) by the Ministry of Public Works in 1979.

* ... "Brief Explanation on Measures of the Flood Control and Drainage in D.K.I. Jakarta" in English.

4. Figure 3 illustrates the flood control and drainage system in west of Jakarta in a form of block diagram with respect to the Cengkareng housing site, which includes those of the existing and of several proposals. The Mission considers that of the above-mentioned two proposals, the latter, viz. "Cengkareng Drain Scheme" would be more realistic.

## Implementation Schedule of the Cengkareng Drain

5. The Municipal Government of Jakarta informed the Mission of the following:

- At present, acquisition of the land necessary for the Cengkareng Drain (width: ±100m, length: 8km) is in process under the Municipal Government of Jakarta, and also is scheduled to complete in 1980.
- Construction of the Cengkareng Drain is anticipated to start in 1980/81.

On the other hand, the P.B.J.R. mentioned in October 1979 that the Dutch Consultant, NEDECO would arrive at Jakarta in November 1979 to assist in undertaking of a detailed study and subsequent detailed design for the Cengkareng Drain Scheme and others.

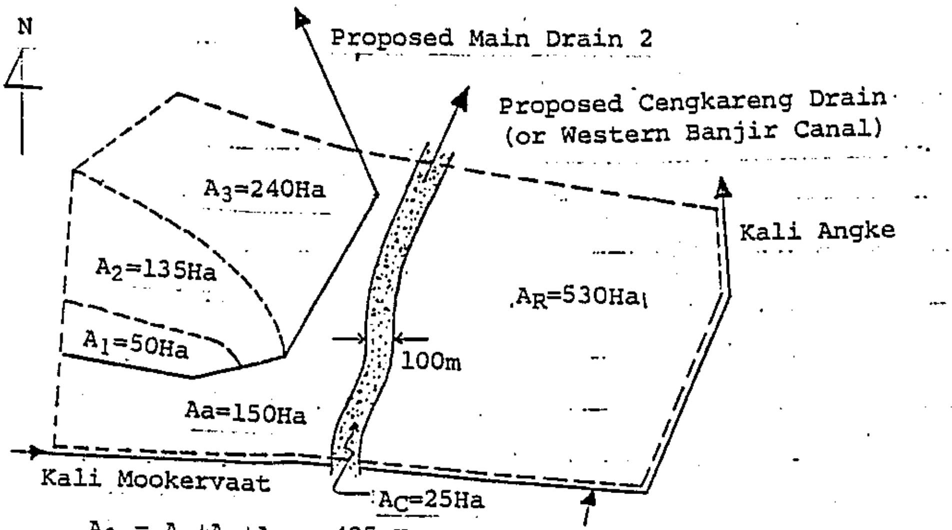
6. Details of the Cengkareng Drain in terms of longitudinal profile and cross-sections have not been received to date. To get the preliminary information and knowledge on the scope of this Drain, reference has been made to the Western Banjir Canal as indicated in the Masterplan Report (1973) (see Figure 4). Although the design flood discharge in the Cengkareng Drain is smaller than that of the Western Banjir Canal, the hydraulic gradient of the water level over the terminal part as regulated by a sand-bar at the drain mouth would be very close to that of the Western Banjir Canal Scheme.

7. As is clearly shown in Figure 7, the proposed Cengkareng Drain will divide the rainfall catchment (1,130 Ha) of "A2" in Figure 1 into two:

The existing drain called "Kali Kapuk Muara" will be interrupted by the Drain. The catchment area (530 Ha) east of the Drain would be somewhat improved in view of the drainage, while that west of the Drain (575 Ha) will be completely suffered from the inundations of long duration, although there may be a plan of crossing the Drain in or form of the inverted syphon towards the existing drain which would be sometimes or bottle neck for proper drainage.

## Relation of the Cengkareng Drain to the Cengkareng Drainage System

8. Attention is made to location of the main drain "2" proposed in the Cengkareng drainage system. As is explained in Figure 7, a plan of the secondary drains "2a", "2-1" and "2-2-1" should be excluded, and a large part of the rainfall catchment within the territory of these drains will be directed to the Angke river as it is at present or shortly discharged into the Cengkareng Drain.



$A_0 = A_1+A_2+A_3 = 425$ Ha

$A_L = Ao+Aa = 575$ Ha ... West of Drain

$At = A_L+A_C+A_R = 575+25+530 = 1{,}130$ Ha
(50.9%+2.2%+46.9%=100.0%)

9. It appears that the secondary drains "2b", "2-2" and "2-2-2" run parallel with the Cengkareng Drain with more favorable environment in terms of drainage. Generally speaking, layout of the drainage system on the west side of these drains in principle needs not to change; however, the following can be considered:

- The rainfall catchment area of the main drain "2" under the Cengkareng drainage system as previously proposed will be decreased to its half. In view of this, discussion may be raised of the effectiveness to connect this directly with the Java sea. This also may be concerned with development of the "Proposed Land Fill Area" as specified in Figure 6.
- Direct release of the drainage discharges into the proposed Cengkareng Drain at "BD" in Figure 7 in a form of gravity will be a matter of concern because of rather short distance towards the Java sea resulting in favorable drainage conditions. Although there would be functional discrepancy between the Cengkareng Drain as "flood control" and the Cengkareng drainage system as "drainage", attention is paid to a probably great difference of the time of concentration for the flood flows from the rivers of Pesanggrahan and Angke and for the peak discharges from the Cengkareng drainage system:

The above-mentioned considerations could not be discussed in more detail within this study, because study of both the Cengkareng Drain and Cengkareng drainage system should belong to the territory of the P.B.J.R. and the NEDECO.

## Timing for the Implementation of the Projects Concerned

10. It is needless to say that timing of the Cengkareng Drain and drainage system should be some years before the Development Plan for Greater Jakarta, in which the Cengkareng low-cost housing project is involved, is implemented. Although construction schedule to complete the Cengkareng Drain and drainage system is not specified in detail, it will take supposedly at least three to four years.

11. Generally speaking, the Cengkareng Drainage System as proposed in 1976 with the exception of the drainage east of the Cengkareng Drain is first implemented to complete for its full function, and then the Cengkareng Drain over the existing drain (Kali Kapuk Muara) should be constructed, in order not to interrupt the drainage from west of the Cengkareng Drain which involves that of the proposed housing site.

In case that a plan for the direct release of the drainage flow into the Cengkareng Drain at "BD" in Figure 7 as mentioned above is employed, rather complicated procedures in construction would take place during its final course in the dry months taking into account proper drainage in the west of the Cengkareng Drain.

12. It might be considered that implementation of the proposed Cengkareng Drain and Drainage System will take a long gestation period with many unforeseen factors, resulting in great delay for implementation of the Cengkareng housing project.

In this paragraph, a brief discussion is made of the drainage problem which may occur when the housing project is implemented before completion of the Cengkareng Drain and Drainage System.

1) It is rather easy to plan and construct the urban drains within the housing site such as the secondary drains "2-3" and "2-2-2-2" as shown in Figure 7; however, without any improvement of the subsequent rural drainage canal (Kali Kapuk Muara), it is quite impossible to achieve proper drainage over the proposed housing site, and also the drainage situation downstream of the site will be severely deteriorated.

2) To avoid the worse situation in the downstream, it would a critical plan that a part of the urban drainage discharge from the proposed housing site is confined to a buffer-reservoir (Waduk) to be provided within the site. Simple assumption would be given taking into account difference of the run-off coefficients between the urban (0.7) and the rural, viz. paddy field (supposed at 0.4):

   - Present discharge at the outlet:

$$Q_P = C_1 \cdot I \cdot A = 0.4 * I * A$$

where $Q_P$ = Present peak discharge
$C_1$ = Run-off coefficient (0.4)
$I$ = Rainfall intensity
$A$ = Paddy field drained

   - Future discharge at the outlet:

$$Q_F = C_2 \cdot I \cdot A \ - C_3 \cdot I \cdot A_2 = 0.7 * I * A_1$$

where $Q_F$ = Future peak discharge
$C_2$ = 0.7
$C_3$ = 0 (from the buffer-storage)
$A_1$ = Housing area drained
$A_2$ = Water retention area

When $Q_F$ is equal to $Q_P$, $A_1 = 1.33\ A_2$,
$A_2 = 0.75\ A_1$ or $A_1 = 0.57\ A$ & $A_2 = 0.43A$

This means that 43 percent of the total area, probably over-estimated might be kept as the flood reservoir located closely to the drainage outlet. This reservoir should be excavated deep enough to prevent an excess outflow from this drainage basis. It is, therefore, understood that this plan would not be feasible in every corner.

3) This is to improve and upgrade an entire scope of the existing rural drain at the PERMUNAS cost. There would be a problem as to higher water level in the Angke river as mentioned

previously as well as additionally rather longer distance to the Java sea. It is assumed that drainage conditions over the proposed housing site esp. its lower-lying land near the main drain would be rather poor when compared with that of the Cengkareng Drainage System.

13. In conclusion, it could be suggested that implementation of the proposed Cengkareng low-cost housing project should be carried out in the most favorable drainage environment over the area after construction of the flood control and drainage works as mentioned above in line with the Development Plan for Greater Jakarta.

## F. Computations for Drainage

### Maximum Rainfall

1. The data available in the Masterplan Report by the P.B.J.R. and the NEDECO in 1973 have been used for this study in line with the instruction obtained in the P.B.J.R.

2. Average yearly rainfall varies from 2,000mm near the coast to 4,000mm in the mountains. The greater part (approx. 80 percent) of the yearly rainfall takes place during the wet season (generally from November 1 till May 31) with predominantly north-western winds, in which January is generally the wettest month with about 25 percent of the annual precipitation. The five months of the dry season with predominantly north-eastern winds are characterized by long dry spells, with the month of August on an average receiving the minimum monthly rainfall (±3.5% of the yearly total).

The rainfall is characterized by high intensities and low occurrence probability. The very high rainfall intensities during thunderstorms often are sharply localized. It has been observed that rainfall is generally concentrated in the afternoon and evening, with 60 to 80 percent falling from 14:00 till 21:00 hour.

3. The daily rainfalls, recorded at 7:00 a.m. at 38 stations in the Jakarta catchment area during 15 years or more are available. Cengkareng (26a) as shown in Figure 2 has a series of the records relatively short as compared with those of Jakarta Observatory (27); therefore, for the coastal plain, Jakarta Observatory data (floating limit) have been chosen in view of a fact that the maximum rainfalls are very similar each other.

Maximum Daily and 24-Hour Rainfall

(Unit:mm)

| Return period (T yrs.) | Jakarta Observatory (No.27) 1864-1961 (98 yrs.) | Cengkareng (No.26a) 1918-1970 (26 yrs.) | Pasar Minggu (No.33) 1909-1964 (50 yrs.) | Tanjung Priok (No.26) 1900-1962 (53 yrs.) |
|---|---|---|---|---|
| Daily Rainfall (recorded at 7:00a.m.) ... Fixed limit | | | | |
| 2 | 102.2 | 106.1 | 96.7 | 116.7 |
| 5 | 136.0 | 143.0 | 123.3 | 158.7 |
| 10 | 159.7 | 167.0 | 140.9 | 186.5 |
| 20 | 181.7 | 190.8 | 157.7 | 213.2 |
| 25 | 188.7 | 198.2 | 163.1 | 221.7 |
| 50 | 210.2 | 221.1 | 179.6 | 247.7 |
| 100 | 231.5 | 243.8 | 195.9 | 273.6 |

| Return period (T yrs.) | Jakarta Observatory (No.27) 1864-1961 (98 yrs.) | Cengkareng (No.26a) 1918-1970 (26 yrs.) | Pasar Minggu (No.33) 1909-1964 (50 yrs.) | Tanjung Priok (No.26) 1900-1962 (53 yrs.) |
|---|---|---|---|---|
| | 24-Hour Rainfall ... Floating limit | | | |
| 2 | 111.5 | 115.8 | 105.5 | 127.3 |
| 5 | 151.8 | 158.7 | 136.9 | 176.2 |
| 10 | 178.5 | 186.7 | 157.5 | 208.5 |
| 20 | 204.0 | 214.3 | 177.1 | 239.4 |
| 25 | 212.3 | 223.0 | 183.5 | 249.4 |
| 50 | 237.1 | 249.4 | 202.6 | 279.4 |
| 100 | 261.8 | 275.7 | 221.6 | 309.4 |

In the coastal area, the rainfalls at Tanjung Priok (26) are consistently higher than the Jakarta Observatory, and for Pasar Minggu (33) they are lower. The decrease from the coast to the south does not continue. From Depok (36) 30km from the coast further to the south, the daily rainfall increases again with the rising land levels.

4. The maximum rainfalls in periods shorter and longer than one day at Jakarta Observatory (27) as analyzed in the Masterplan Report are introduced:

Maximum Rainfalls in the Coastal Plain

(Unit: mm)

| Return period (T yrs.) | | Consecutive Days | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 Hour | 1 | 2 | 3 | 5 | 10 | 15 |
| 2 | 61.0 | 112 | 143 | 170 | 210 | 297 | 357 |
| 5 | 72.9 | 152 | 199 | 241 | 304 | 425 | 509 |
| 10 | 81.0 | 179 | 235 | 290 | 367 | 508 | 610 |
| 20 | 89.0 | 204 | 269 | 335 | 425 | 586 | 702 |
| 25 | 91.0 | 212 | 280 | 350 | 445 | 613 | 734 |
| 50 | 98.6 | 237 | 313 | 390 | 500 | 686 | 821 |
| 100 | 106.0 | 262 | 346 | 435 | 557 | 765 | 915 |

5. The rainfall mass-curves and the rainfall intensity curves as obtained based upon the rainfall analysis are compiled in Figures 13 and 14 respectively.

6. The rainfall intensities as mentioned above represent those at a station rainfall. When applying these spot rainfalls to the rainfall catchment area, care should be taken of the fact that the rainfall intensity decreases with the distance from the center of the storm and the center of the storm need not be situated over the station because the rainfall is highly localized.

The areal rainfall reduction factor to discuss this effect has not been taken into account in this study, because the study area is rather small.

## The Rational Method

7. The run-off discharges are derived from the rainfall using the so-called "Rational Method" and assuming the highest intensities to occur at the beginning of the storm, viz. "Early Rainfall Pattern".

The "rational method" which has been popular for the design of drainage system in urban areas and airports, represents the relation between rainfall and peak run-off with the assumption that the maximum rate of flow owing to a certain rainfall intensity over a drainage area is produced by that rainfall which is maintained for a time equal to the period of concentration of flow at the point under consideration.

8. The time of concentration is defined as the time which would be required for the surface run-off from the remotest part of the drainage area to reach the point under consideration, generally depending upon the slopes and characters of surfaces.

Where the drainage area served by an inlet is entirely paved, the time of concentration is assumed to vary from about 5 to 10 minutes as the length of flow to the inlet varies from 30 to about 150m.

For turfed area, the time is usually considered to vary from about 10 minutes for lengths of flow less than 30m to about 30 minutes for 120 to 150m.

For bare ground, the time would be taken somewhere between the values for paved and turfed, decreasing with the expected smoothness of the surface.

9. The Final Report Phase II, Jakarta Drainage and Flood Control Project, ANNEX VIII indicates that the design Q-25 and -2 discharges for the Cengkareng Drainage System have been computed in accordance with the rational method by using the nomogram presented in the Second Progress Report Phase II (Chapter 6.3), and the run-off coefficient for the Cengkareng has been fixed 0.7 and a retention factor $\delta$=2 has been used.

The Mission could not get this nomogram in October 1979 during the field operations, because of non-availability of it in the P.B. J.R.

10. No exact measurements on run-off coefficients have been made in Jakarta. Generally, the percentage of the rainfall which contributes to the immediate run-off depends upon initial soil moisture, infiltration, depression storage, slopes in the area, etc. The following coefficients, therefore, are only approximated averages:

Moderately built-up areas : 70%
Densely built-up areas : 80%
Open areas : 60%

## Hydraulic Design

11. In general, the following minimum slopes have been employed for design calculations:

Main Drain : 1/5,000 to 1/3,300
Secondary Drain : 1/3,300 to 1/2,500
Smaller Drain in the Macro-Drainage System: 1/2,500 to 1/2,000
Main Drain in the Micro-Drainage System : 1/2,000 to 1/1,000

Smaller slopes result in smaller velocities and consequently in requirement of larger drains occupying more space. With the above specified slopes, velocity during the rainfall T=2 and 25 would be of the order of 0.8m per second and over 1m per second respectively. This could then wash out the garbage and fine silt and mud materials in the drains.

12. The drains have been sized by using the Manning's formula with the roughness coefficient (n) of:

- Concrete lined : 0.016
- Earth : 0.025

13. Hydraulic behaviors of the drainage flows through the drains are very complicated due to the fact that (1) a drainage system is filled by the micro-drains at many points along its course, and (2) the concentration time at the outlet of the micro-drains is short in comparison with the time which is needed for all the accumulated and superimposed peak discharges to pass through the long open main drain towards the Java sea.

Approximate calculation based upon the permanent and uniform flow of the maximum discharges is not accurate and then may be overestimated; however, this method is much easier to analyze and solve than the unsteady flow*, hence, this has been applied to this study on pre-feasibility level.

* ... The velocity varies either in magnitude or in direction with respect to time.

A complete computation of water levels, discharges and velocities for the unsteady flow through the drainage system can be realized by application of the principles of continuity, momentum and energy with an aid of the electronic computer.

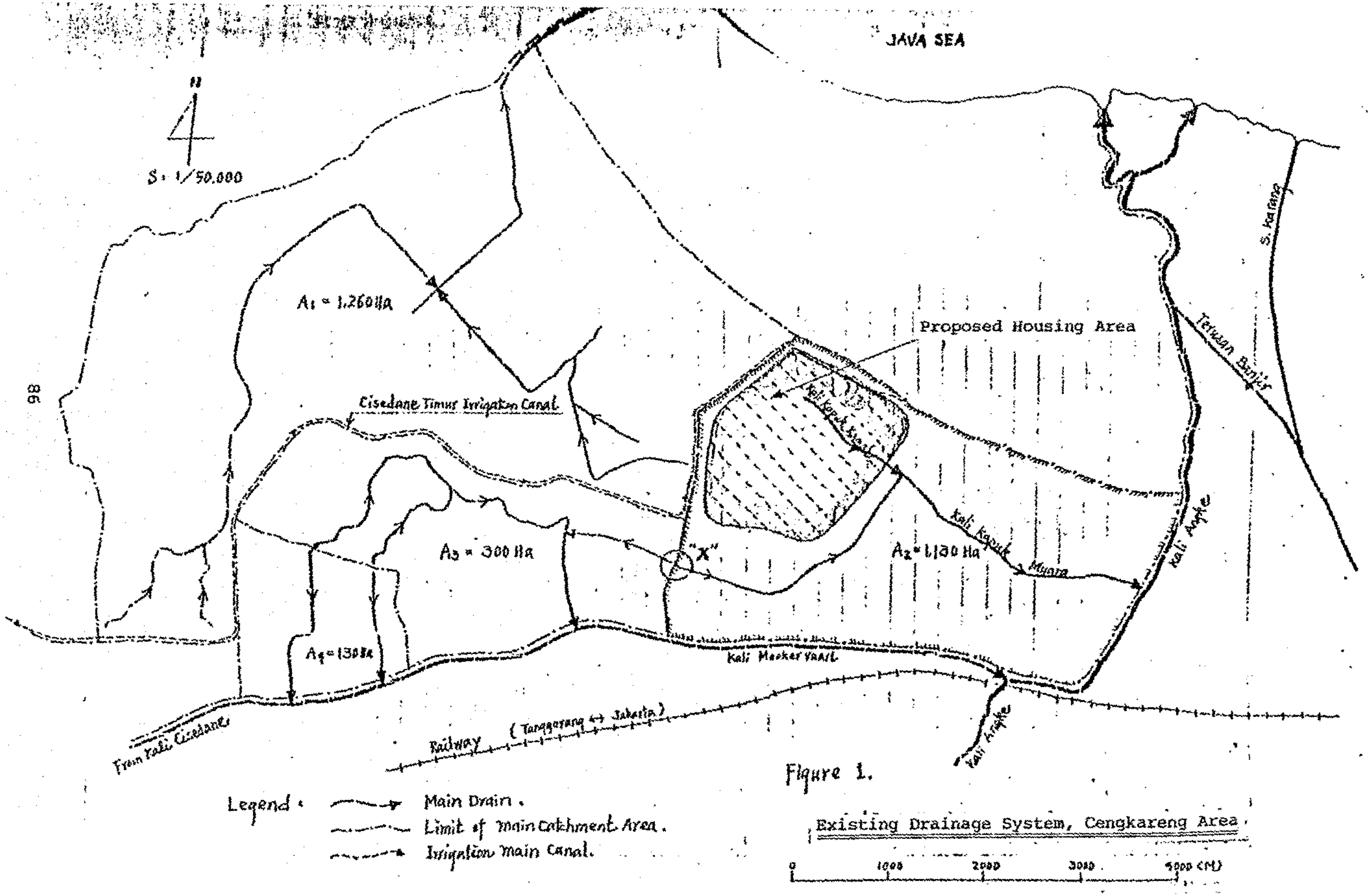


Figure 1.

Existing Drainage System, Cengkareng Area

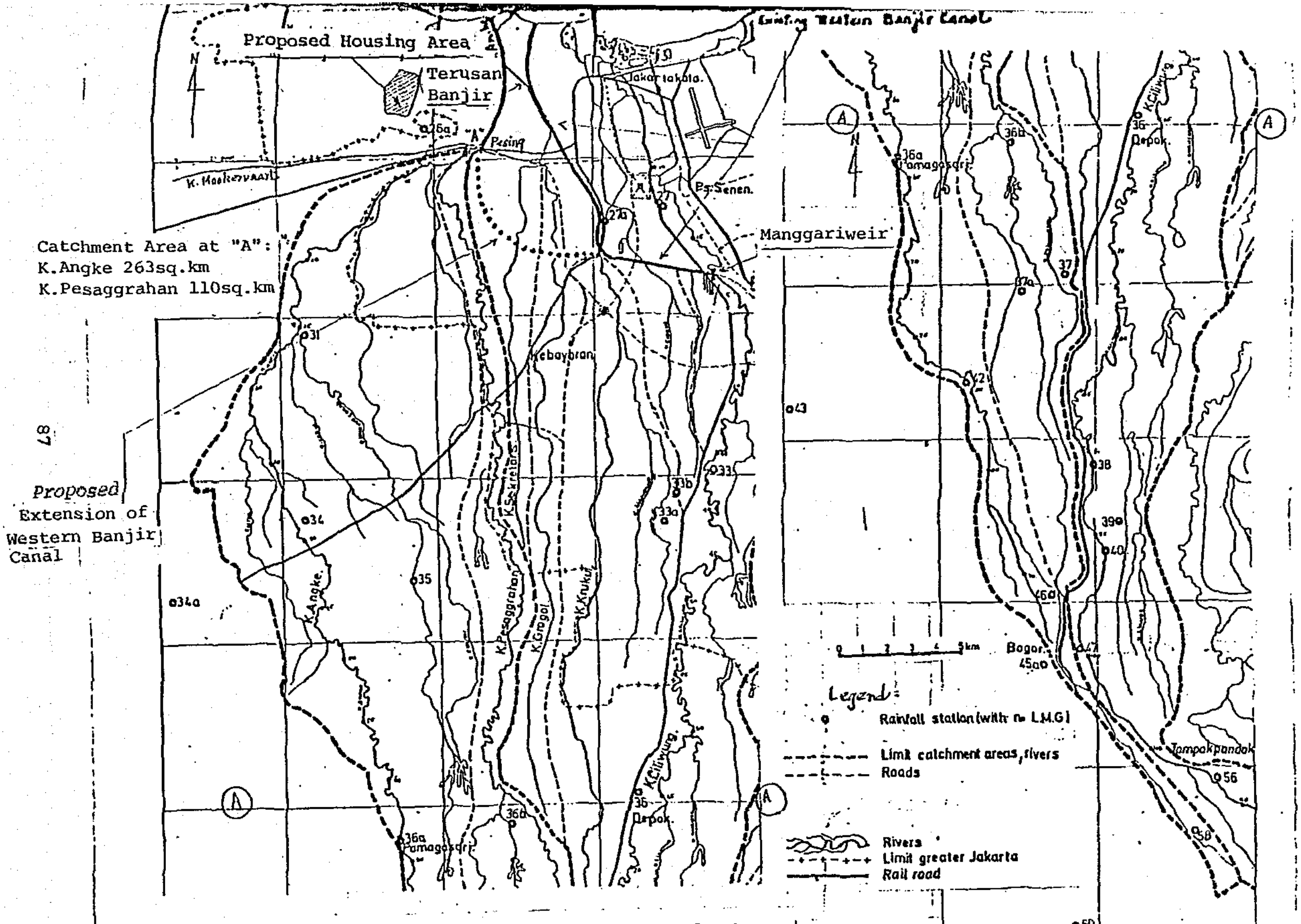
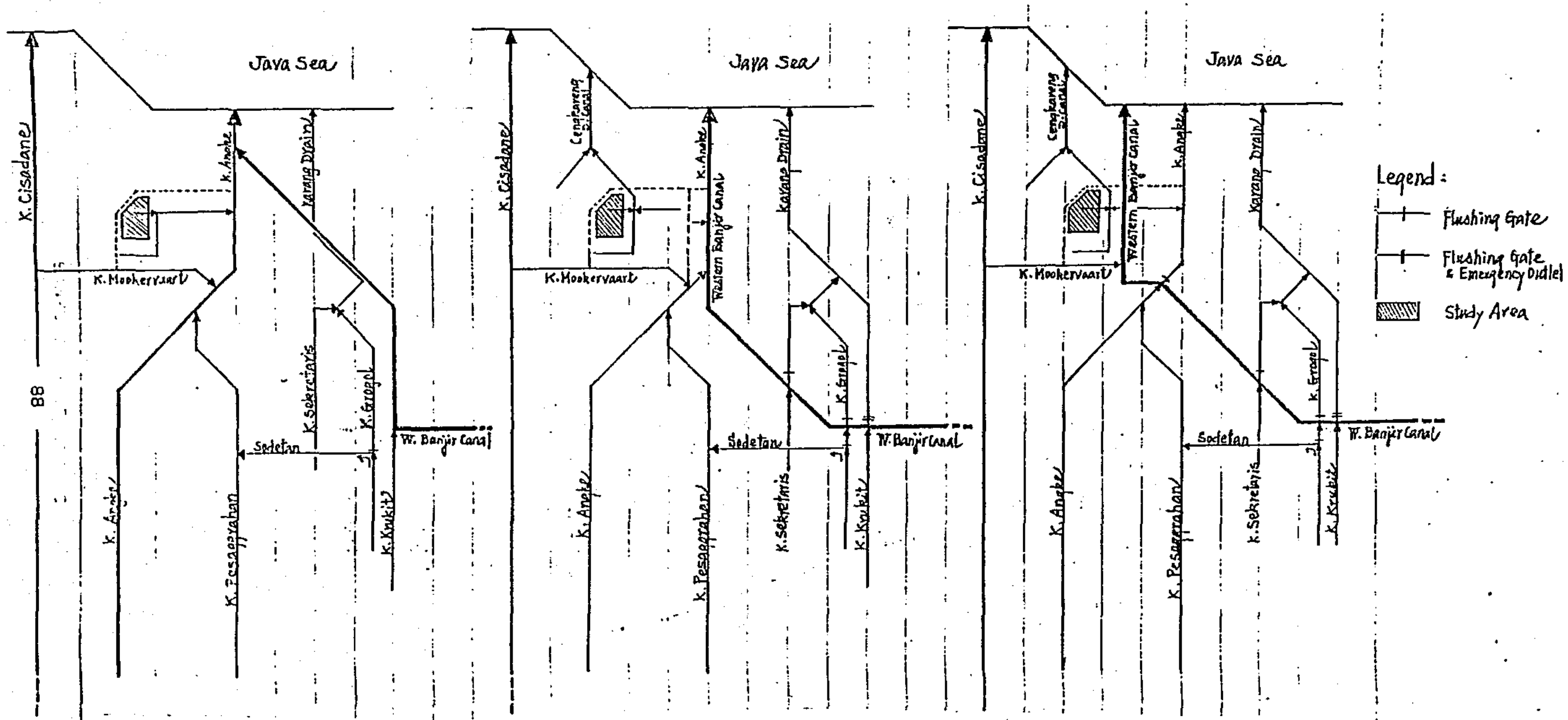


Figure 2. River Catchments, West of Jakarta



① Existing

② Proposed: NEDECO MASTERPLAN, 1973
NEDECO CENGKARENG, 1976

③ Proposed: PPBJ, 1979 (1)

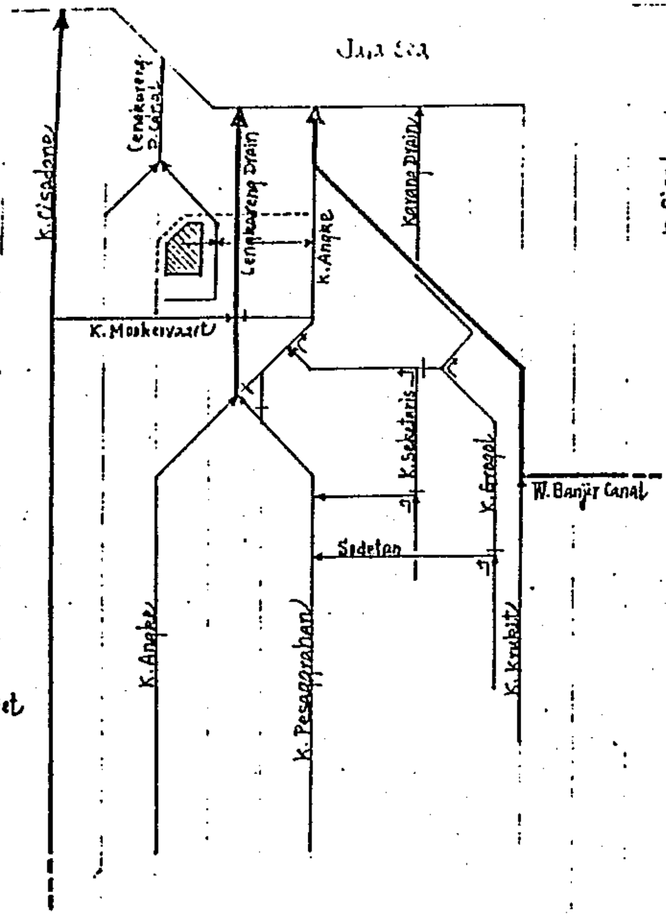
Figure 3. Flood Control and Drainage System in the Western Jakarta

**Legend :**

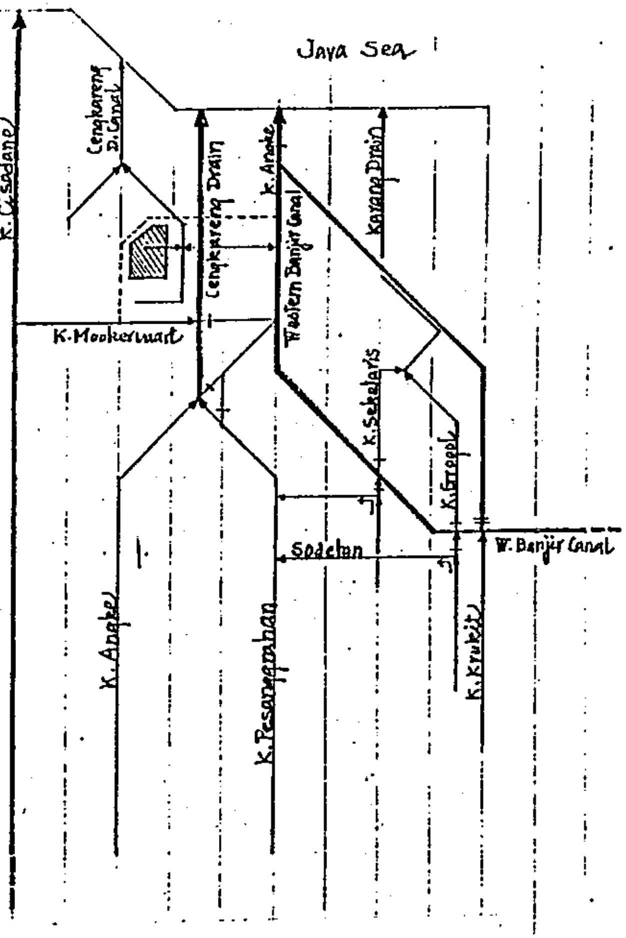
—┼— Flushing Gate

—╫— Flushing Gate & Emergency Outlet

▨ Study Area



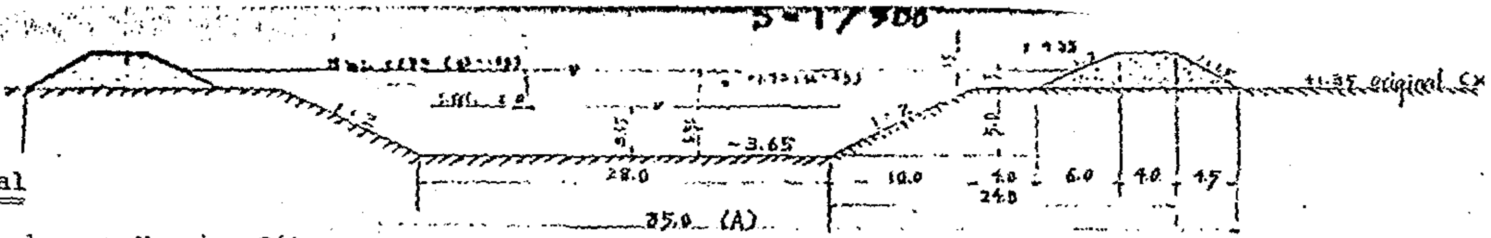
④ Proposed: PPBJ, 1979 (2)
Alternative I



⑤ Proposed: PPBJ, 1979 (2)
Alternative II

(cont'd)

Figure 4. Western Banjir Canal

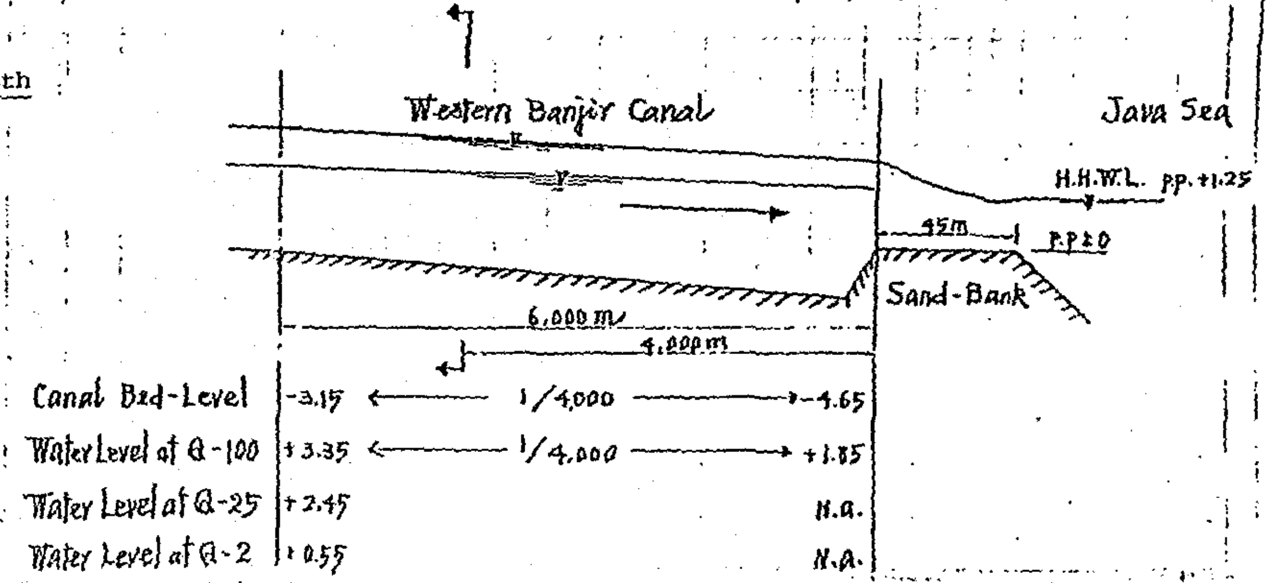


(1) Cross-Section near the Cengkareng Housing Site (4.0km upstream of the Canal mouth)

| X<br>(P.P.-m) | A<br>(m) | Excavation 1/<br>(cu.m/km) | Embankment 2/<br>(cu.m/km) | 1/ - 2/<br>(cu.m/km) |
|---|---|---|---|---|
| 1.35 | 85.10 | 190,000 | 55,500 | 134,500 |
| 1.50 | 84.55 | 197,250 | 51,230 | 146,020 |
| 2.00 | 83.05 | 222,050 | 38,130 | 183,920 |
| 2.50 | 81.55 | 247,850 | 26,780 | 221,070 |
| 3.00 | 80.05 | 292,650 | 17,180 | 275,470 |
| 3.50 | 78.55 | 302,450 | 9,330 | 293,120 |
| 4.00 | 77.05 | 331,250 | 3,230 | 328,020 |

Q-100 = 525 cu.m/s
Q-25 = 400 cu.m/s
Q-2 = 190 cu.m/s

(2) Hydraulics in the Canal Mouth



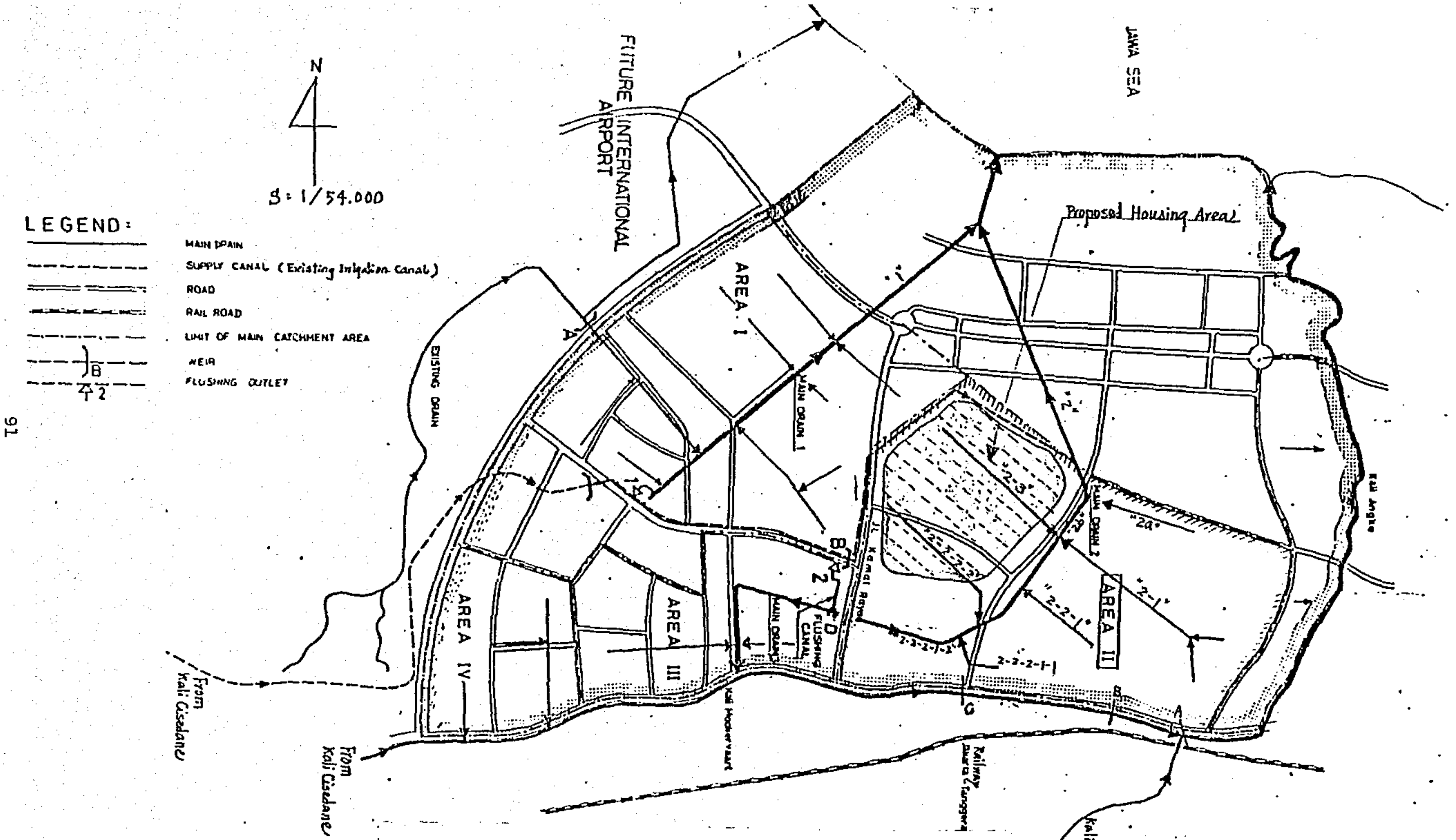


Figure 5. Proposed Cengkareng Drainage System (Summary)

(Data: NEDECO, 1976)

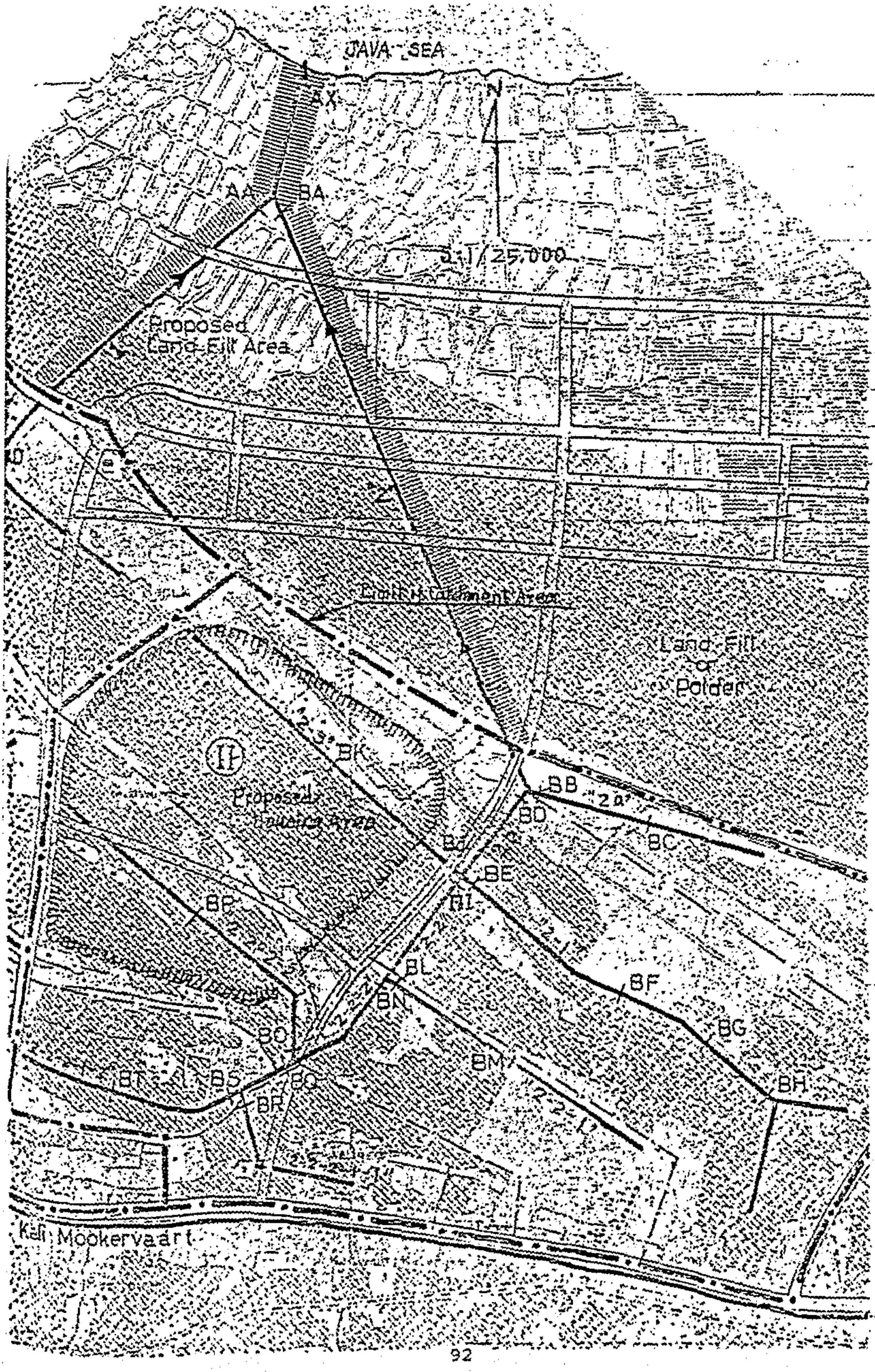


Figure 6. Proposed Cengkareng Drainage System - Main Drain "2"

(Data Source: NEDECO, 1976)

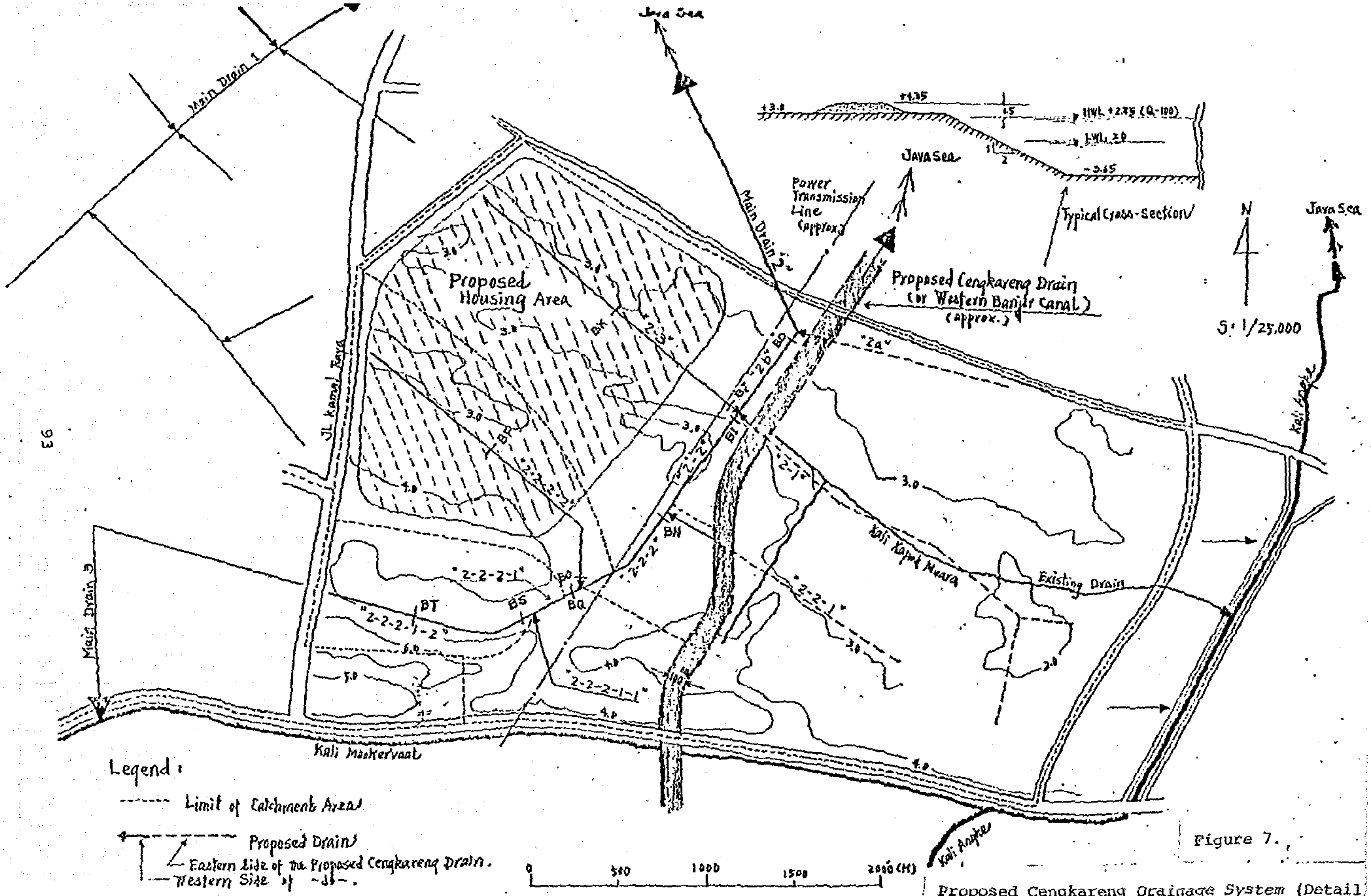
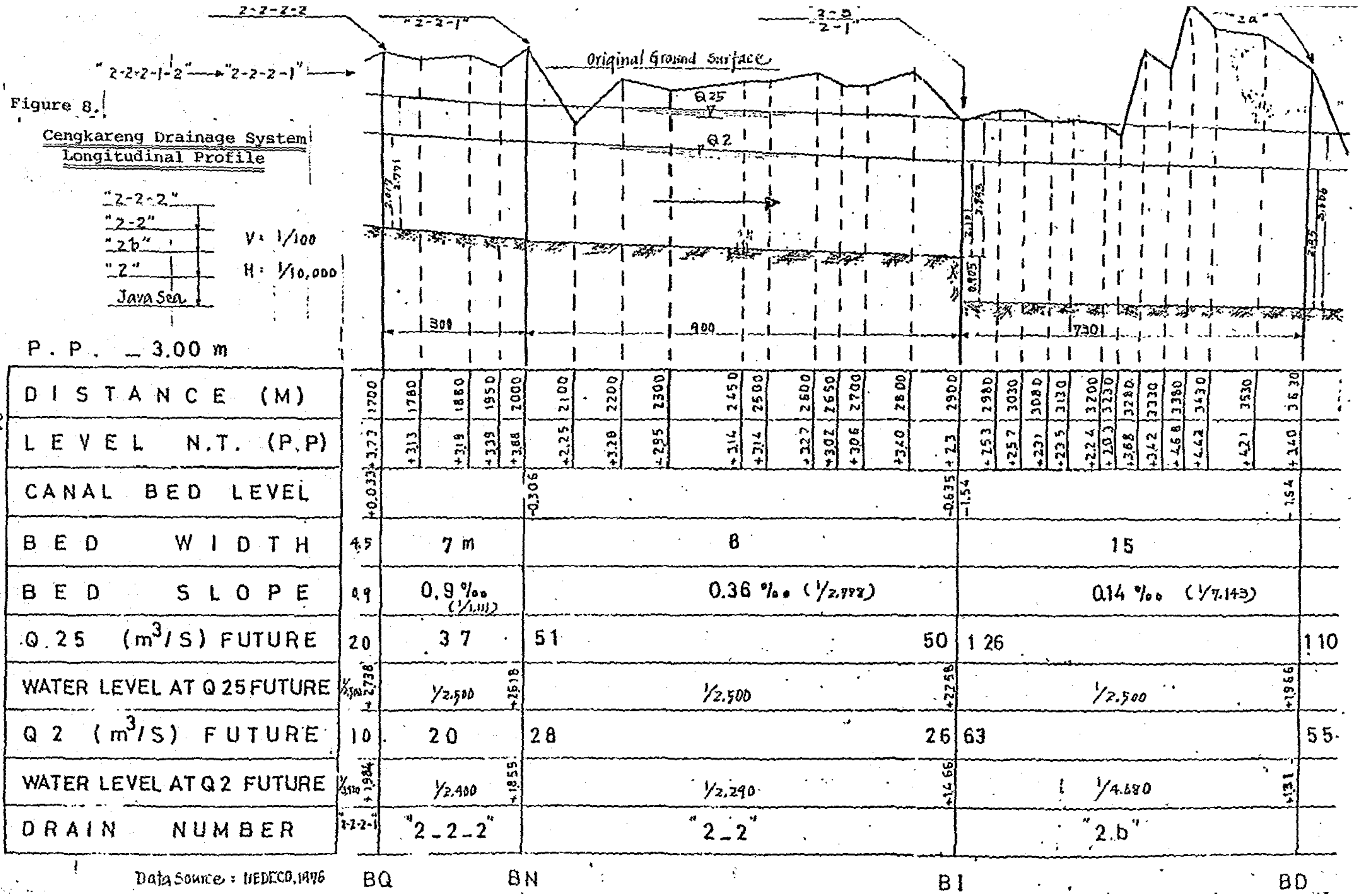


Figure 7.

Proposed Cengkareng Drainage System (Detail)

Figure 8.

Cengkareng Drainage System Longitudinal Profile



Data Source : NEDECO,1976

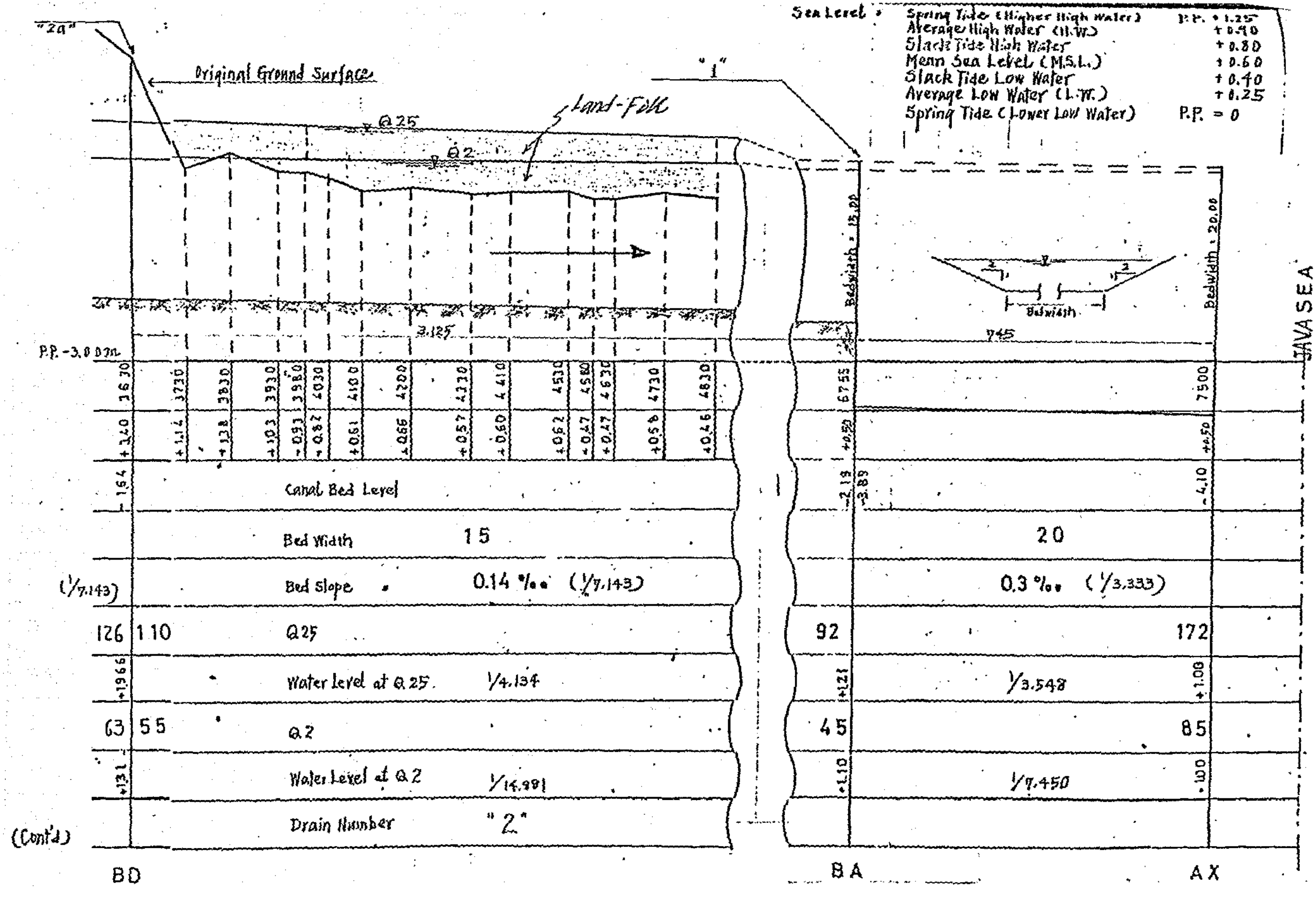
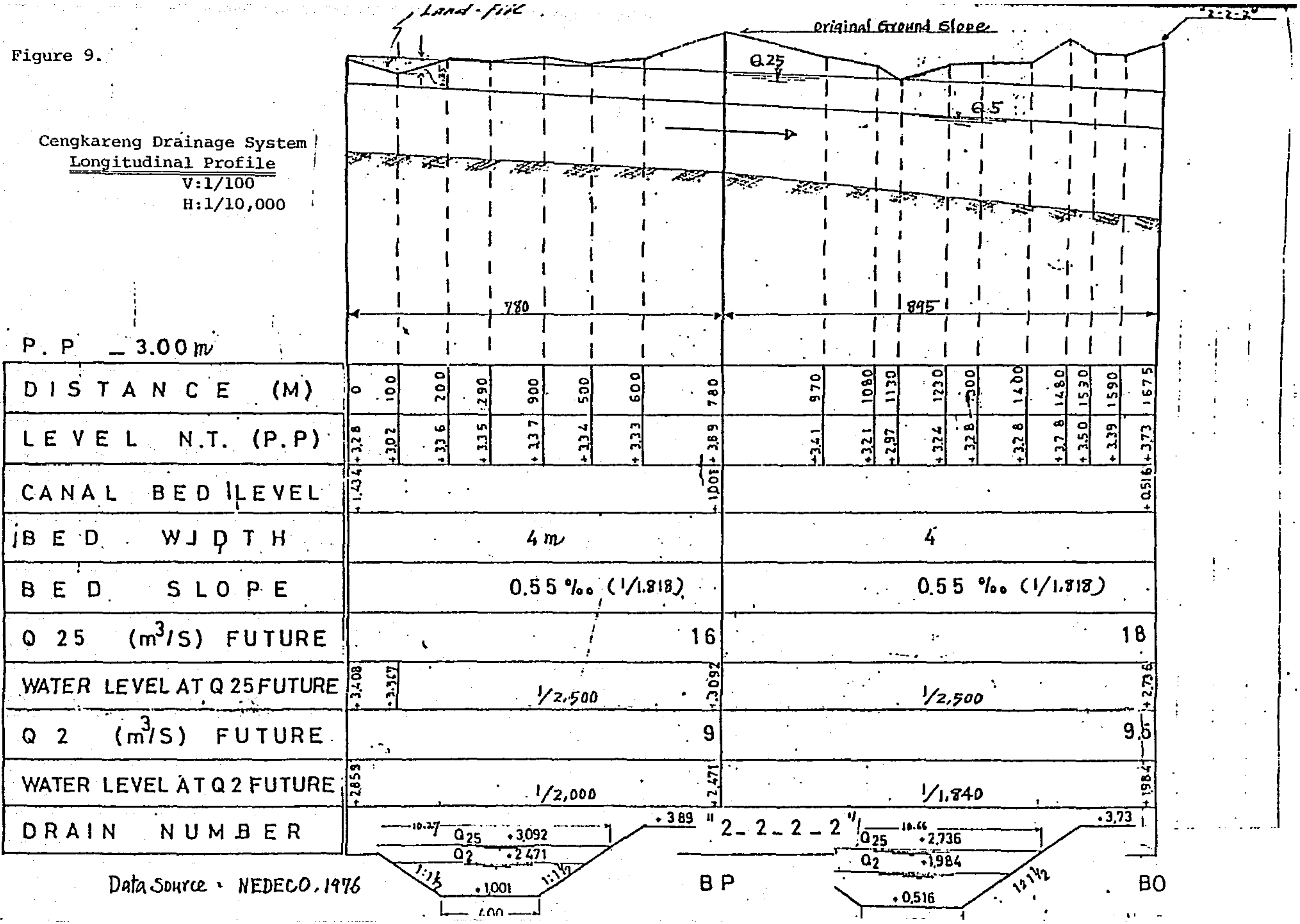
"2a"
Original Ground Surface
"1"
Land-Fall
Q 25
Q 2
3.125
745
Bedwidth = 15.00
Bedwidth = 20.00
Bedwidth
2
1
JAVA SEA
Sea Level =
Spring Tide (Higher High Water) P.P. + 1.25
Average High Water (H.W.) + 0.90
Slack Tide High Water + 0.80
Mean Sea Level (M.S.L.) + 0.60
Slack Tide Low Water + 0.40
Average Low Water (L.W.) + 0.25
Spring Tide (Lower Low Water) P.P. = 0
P.P. -3.00 m
3630
3730
3830
3930
3980
4030
4100
4200
4330
4410
4530
4580
4630
4730
4830
6755
7500
+ 1.40
+ 1.14
+ 1.38
+ 1.03
- 0.93
+ 0.87
+ 0.61
+ 0.66
+ 0.57
+ 0.60
+ 0.62
+ 0.47
+ 0.47
+ 0.58
+ 0.46
+ 0.50
+ 0.50
- 1.64
- 2.19
- 3.89
- 4.10
Canal Bed Level
Bed Width
15
20
Bed Slope
0.14 ‰ (1/7,143)
0.3 ‰ (1/3,333)
(1/7,143)
Q25
126
110
92
172
Water level at Q 25
+ 1.966
1/4,134
+ 1.21
1/3,548
+ 1.00
Q 2
63
55
45
85
Water Level at Q 2
+ 1.31
1/14,981
+ 1.10
1/7,450
+ 1.00
Drain Number
"2"
(Cont'd)
BD
BA
AX

Figure 9.

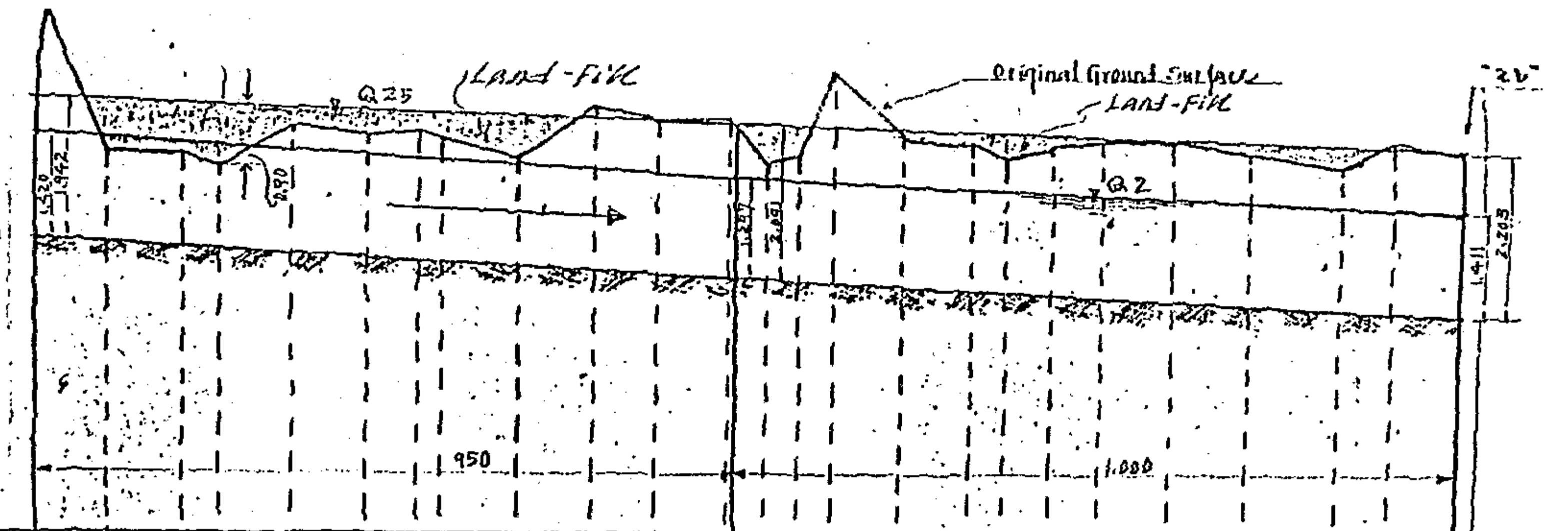
Cengkareng Drainage System
Longitudinal Profile
V:1/100
H:1/10,000



Data Source · NEDECO, 1976

Figure 10.

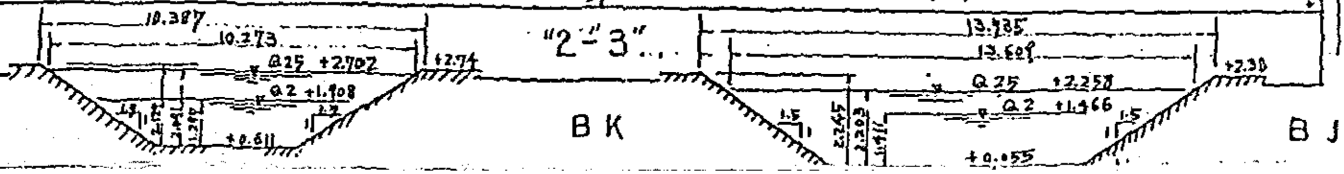
Cengkareng Drainage System
Longitudinal Profile
V:1/100
H:1/10,000



P.P. -3.00

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE (M) | 0 | 100 | 200 | 250 | 350 | 450 | 520 | 550 | 650 | 750 | 840 | 940 | 990 | 1030 | 1080 | 1175 | 1270 | 1320 | 1380 | 1450 | 1550 | 1650 | 1780 | 1850 | 1950 |
| LEVEL N.T. (P.P) | +4.45 | +2.26 | +2.23 | +2.08 | +2.66 | +2.52 | +2.54 | +2.44 | +2.22 | +2.95 | +2.74 | +2.74 | +2.14 | +2.28 | +3.60 | +2.57 | +2.41 | +2.26 | +2.40 | +2.44 | +2.45 | +2.34 | +2.11 | +2.49 | +2.30 |

| | | | | | |
|---|---|---|---|---|---|
| CANAL BED LEVEL | +1.139 | | +0.611 | | +0.055 |
| BED WIDTH | | 4 m | | 7 | |
| BED SLOPE | | 0.56 ‰ (1/1,785) | | 0.56 ‰ (1/1,785) | |
| Q 25 ($m^3$/S) FUTURE | | 16 | | 28 | |
| WATER LEVEL AT Q 25 FUTURE | +3.082 | +2.982<br>1/2.500 | +2.702 | 1/2.252 | +2.258 |
| Q 2 ($m^3$/S) FUTURE | | 9 | | 15 | |
| WATER LEVEL AT Q 2 FUTURE | +2.559 | 1/1.459 | +1.908 | 1/2,262 | +1.466 |
| DRAIN NUMBER : | | | "2"–"3"... | | |



Data Source : NEDECO, 1976

Table 1. Longitudinal Profile in Drain "2-3"

| Station | Original Ground Level | NEDECO. 1976 | | | | Revised (1) | | | | Revised (2) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Water Level | | B - A *1 | | Water Level | | C - A *1 | | Water Level | | D - A *1 | |
| | | Q25 | Q2 | Q25 | Q2 | Q25 | Q2 | Q25 | Q2 | Q25 | Q2 | Q25 | Q2 |
| (Distance.m) | (PP.+m) | (PP.+m) | | (m) | | (pp.+m) | | (m) | | (pp.+m) | | (m) | |
| | -A- | -B- | | | | -C- | | | | -D- | | | |
| End.(+1,950) | 2.30 | 2.258 | 1.466 | -0.04 | -0.83 | 2.258 | 1.466 | -0.04 | -0.83 | 2.258 | 1.466 | -0.04 | -0.83 |
| + 1,780 | 2.11 | 2.331 | 1.541 | 0.22 | -0.57 | 2.301 | | 0.19 | | 2.292 | | 0.18 | |
| + 1,650 | 2.34 | 2.391 | 1.599 | 0.06 | -0.74 | 2.233 | | -0.01 | | | | | |
| + 1,450 | 2.44 | 1/2,252.3<br>2.480 | 1/2,262.4<br>1.687 | 0.04 | -0.75 | 2.383 | | -0.06 | | | | | |
| + 1,380 | 2.40 | 2.511 | 1.718 | 0.11 | -0.68 | 2.401 | | 0 | | | | | |
| + 1,320 | 2.26 | 2.538 | 1.744 | 0.28 | -0.52 | 2.416 | | 0.16 | | 2.384 | | 0.12 | |
| + 1,175 | 2.57 | 2.602 | 1.809 | 0.03 | -0.76 | 2.452 | | -0.12 | | 2.413 | | -0.16 | |
| + 990 | 2.14 | 2.698 | 1.904 | 0.56 | -0.24 | 2.498 | | 0.36 | | 2.450 | | 0.31 | |
| + 950 | 2.74 | 2.702 | 1.908 | -0.04 | -0.83 | 1/4,000<br>2.516 | | -0.22 | | 1/5,000<br>2.458 | | -0.29 | |
| + 650 | 2.22 | 2.822 | 2.114 | 0.60 | -0.11 | 2.583 | | 0.36 | | 2.518 | | 0.30 | |
| + 450 | 2.52 | 2.902 | 2.251 | 0.38 | -0.27 | 2,633 | | 0.11 | | 2.558 | | 0.04 | |
| + 350 | 2.66 | 1/2,500<br>2.942 | 2.319 | 0.28 | -0.44 | 2.658 | | 0 | | | | | |
| + 250 | 2.08 | 2.982 | 1/1,459.3<br>2.388 | 0.90 | 0.31 | 2,683 | | 0.60 | | 2.598 | | 0.52 | |
| + 200 | 2.23 | 3.002 | 2.422 | 0.77 | 0.19 | 2.696 | | 0.47 | | 2.608 | | 0.38 | |
| + 100 | 2.26 | 3.042 | 2.490 | 0.78 | 0.23 | 2,721 | | 0.46 | | 2,628 | | 0.37 | |
| 0 | 4.45 | 3.082 | 2.559 | -1.37 | -1.89 | 2.746 | | -1.80 | | 2.648 | | | |

*1 ----- (000) shows need of the land filling-up, while (-00) indicates that the water level is lower than the original ground surface.

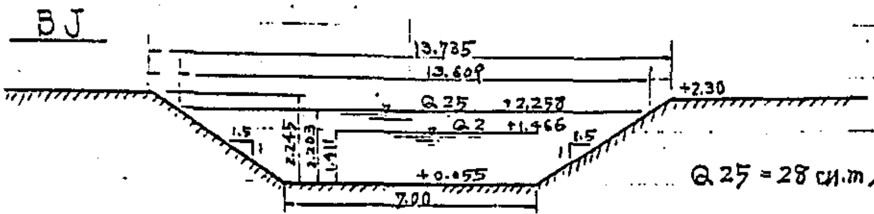
Figure 11.

## Cross-Sections in Drain "2-3"

### (1) NEDECO, 1976

S: 1/200

BJ



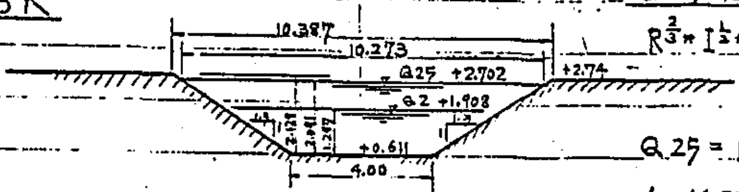
Q 25 = 28 cu.m/sec , V = 1.23 m/sec

A = 22.70 sq.m , P = 14.93 m , R = 1.52 m

I = 1/2,252 , n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.6324$

BK



Bed Slope = (0.611 - 0.055)/1,000 = 1/1,798

Q 25 = 16 cu.m/sec , V = 1.07 m/sec

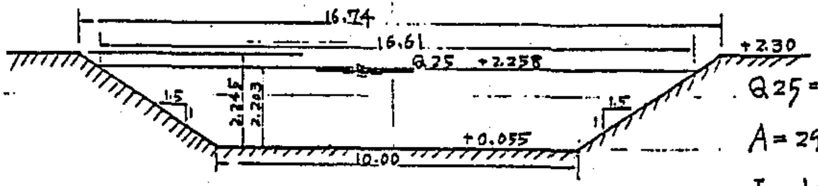
A = 14.92 sq.m , P = 11.52 m , R = 1.30 m

I = 1/2,500 , n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.3554$

### (2) Revised (1)

BJ



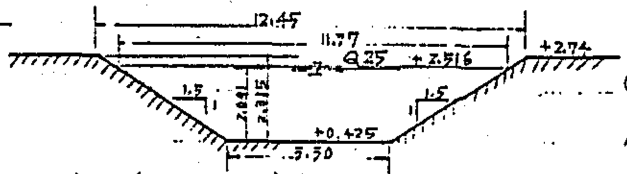
Q25 = 28 cu.m/sec , V = 0.96 m/sec

A = 29.31 sq.m , P = 17.93 m , R = 1.63 m

I = 1/4,000 , m = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.6418$

BK



Bed Slope = (0.425 - 0.055)/1,000 = 1/2,702

Q25 = 16 cu.m/sec , V = 0.89 m/sec

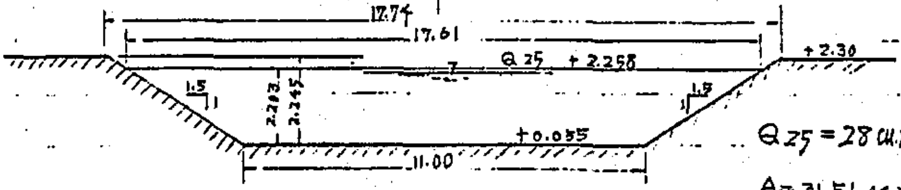
A = 18.06 sq.m , P = 13.03 m , R = 1.39 m

I = 1/4,000 , n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.3549$

### (3) Revised (2)

BJ



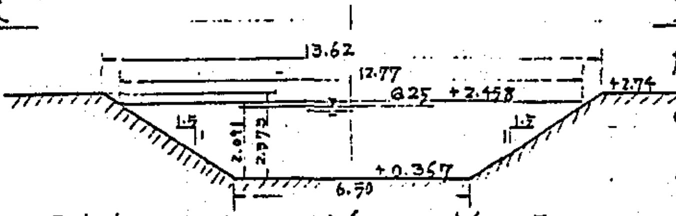
Q 25 = 28 cu.m/sec , V = 0.89 m/sec

A = 31.51 sq.m , P = 18.93 m , R = 1.66 m

I = 1/5,000 , n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.6259$

BK



Bed Slope = (0.367 - 0.055)/1,000 = 1/3,205

Q 25 = 16 cu.m/sec , V = 0.79 m/sec

A = 20.15 sq.m , P = 14.03 m , R = 1.44 m

I = 1/5,000 , n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.3627$

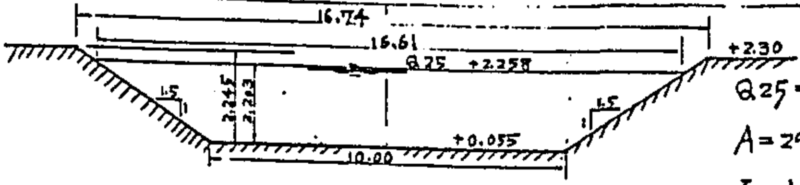
Figure 12.

## Cross-Sections in Drain "2-3", Revised (1).

### (1) Revised (1), Original

BJ

$S = 1/200$



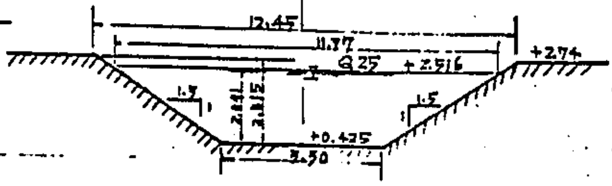
Q25 = 28 cu.m/sec, V = 0.96 m/sec

A = 29.31 sq.m. P = 17.93 m, R = 1.63 m

I = 1/4,000, n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.6418$

BK



Q25 = 16 cu.m/sec, V = 0.89 m/sec

A = 18.06 sq.m. P = 13.03 m, R = 1.39 m

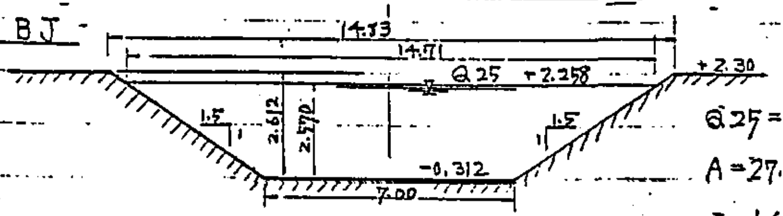
I = 1/4,000, n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.3549$

Bed slope = (0.425-0.055)/1,000 = 1/2,703

### (2) Revised (1), Alternative (1)

BJ



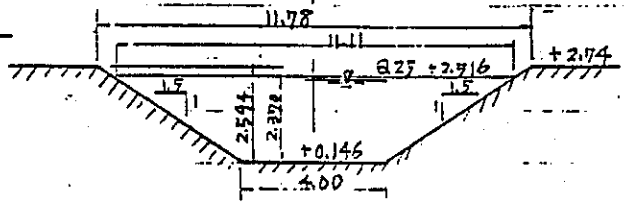
Q25 = 28 cu.m/sec, V = 1.00 m/sec

A = 27.90 sq.m, P = 16.25 m, R = 1.72 m

I = 1/4,000, n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.6025$

BK



Q25 = 16 cu.m/sec, V = 0.89 m/sec

A = 17.90 sq.m, P = 12.53 m, R = 1.43 m

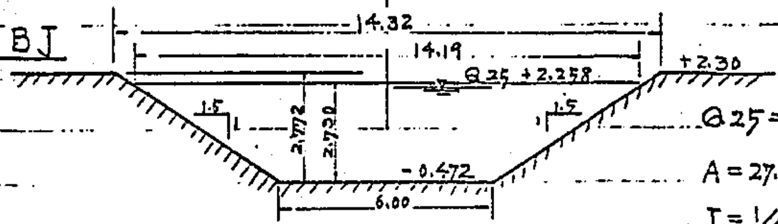
I = 1/4,000, n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.3590$

Bed Slope = (0.146+0.312)/1,000 = 1/2,183

### (3) Revised (1), Alternative (2)

BJ



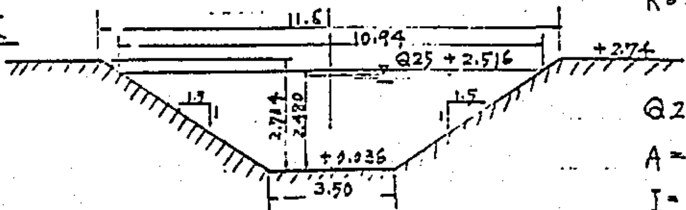
Q25 = 28 cu.m/sec, V = 1.02 m/sec

A = 27.57 sq.m, P = 15.82 m, R = 1.74 m

I = 1/4,000, n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.6305$

BK



Q25 = 16 cu.m/sec, V = 0.90 m/sec

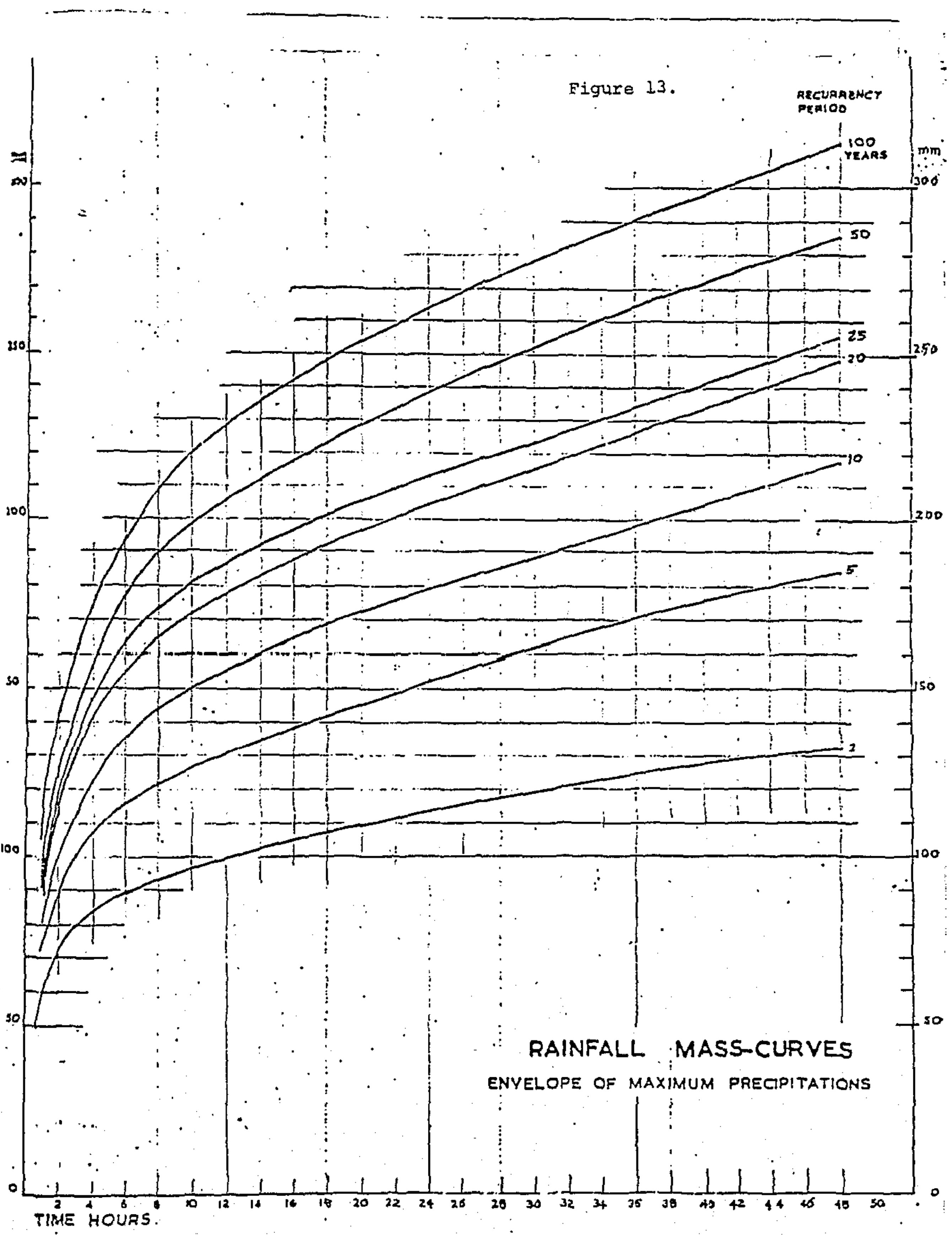
A = 17.91 sq.m, P = 12.42 m, R = 1.44 m

I = 1/4,000, n = 0.0225

$R^{\frac{2}{3}} * I^{\frac{1}{2}} * A = 0.3615$

Bed Slope = (0.036+0.472)/1,000 = 1/1,969

Figure 13.



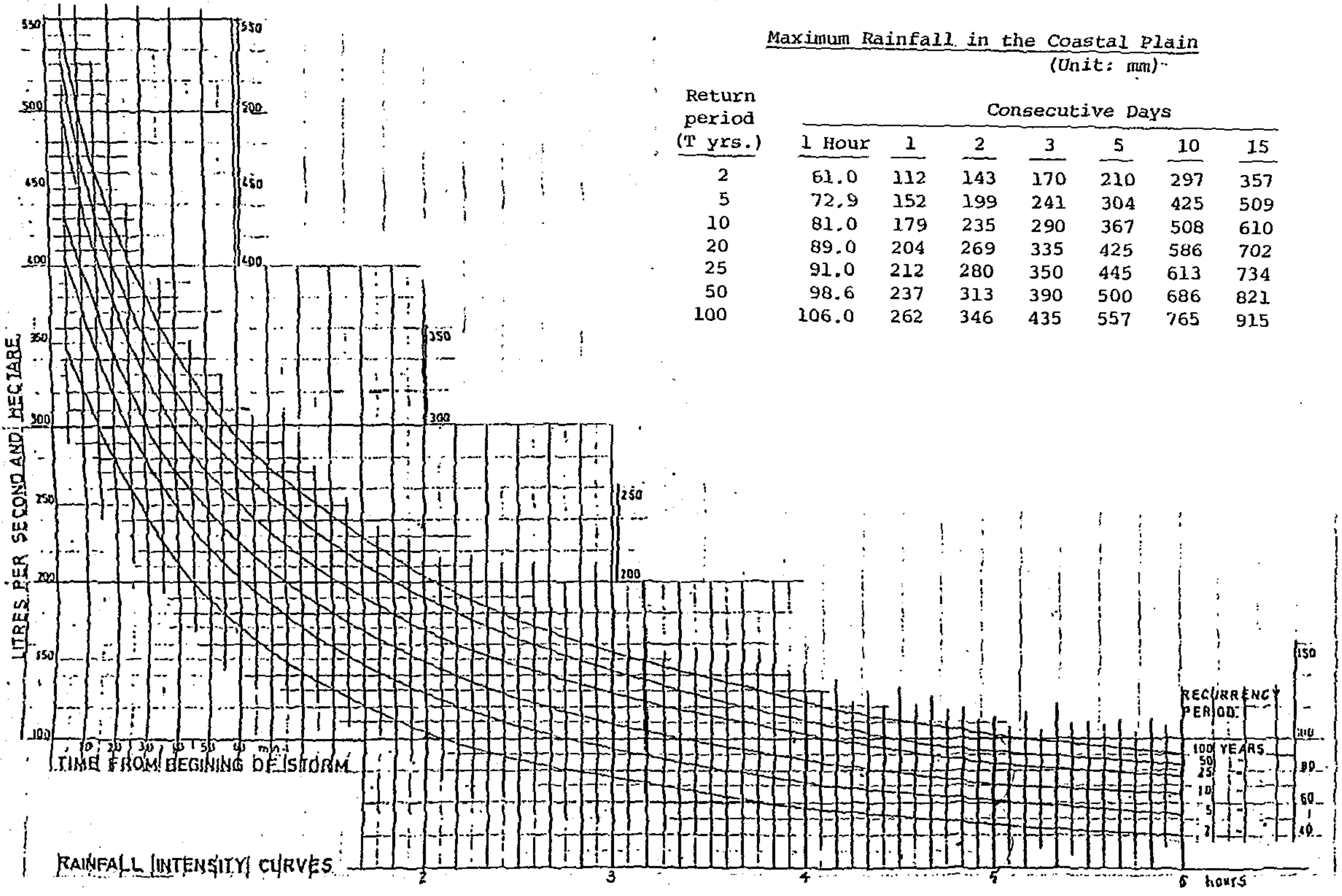
RAINFALL MASS-CURVES

ENVELOPE OF MAXIMUM PRECIPITATIONS

Figure 14.

Maximum Rainfall in the Coastal Plain
(Unit: mm)

| Return period (T yrs.) | | Consecutive Days | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 Hour | 1 | 2 | 3 | 5 | 10 | 15 |
| 2 | 61.0 | 112 | 143 | 170 | 210 | 297 | 357 |
| 5 | 72.9 | 152 | 199 | 241 | 304 | 425 | 509 |
| 10 | 81.0 | 179 | 235 | 290 | 367 | 508 | 610 |
| 20 | 89.0 | 204 | 269 | 335 | 425 | 586 | 702 |
| 25 | 91.0 | 212 | 280 | 350 | 445 | 613 | 734 |
| 50 | 98.6 | 237 | 313 | 390 | 500 | 686 | 821 |
| 100 | 106.0 | 262 | 346 | 435 | 557 | 765 | 915 |



## 4. COST DATA

1. Labor
2. Materials
3. Unit Cost
4. Element List
5. Cost List for Housing Units

| Item | Unit | Cost (RP) | Remarks |
|---|---|---|---|
| 1. Labor | day | | |
| 1 Foreman | | 2,100 | |
| 2. Skilled Labor | | 1,750 | |
| 3. Unskilled Labor | | 1,200 | |
| 4. Carpenter | | 1,800 | |
| 5. Painter, Mason, Tinsmith | | 1,600 | |
| 6. Plumber | | 1,500 | |
| 2. Materials | | | |
| 1. River Stone | | | |
| .Crushed Stone | $m^3$ | 6,250 | |
| Round Stone | $m^3$ | 6,500 | |
| 2. Sand | | | |
| Bedding Sand | $m^3$ | 3,700 | |
| Mortar Sand | $m^3$ | 4,350 | |
| Concrete Sand | $m^3$ | 4,800 | |
| 3. Lime | $m^3$ | 7,250 | |
| 4. Red Brick Powder | $m^3$ | 6,750 | |
| 5. Portland Cement | bag | 1,600 | 40kg/bag |
| 6. Brick | pc. | 15 | Batu bata |
| 7. Bataco | pc. | 80 | |
| 8. Concrete Block | pc. | 160 | |
| 9. Roofing Tile | pc. | 75 | Kodok |
| 10. Wood | | | |
| Kamper | $m^3$ | 115,000 | Class II |
| Borneo | $m^3$ | 70,000 | " II, III |
| Meranti | $m^3$ | 65,000 | " IV |
| Terentang | $m^3$ | 26,000 | " IV |
| 11. Steel Bar | kg | 280 | |
| 12. Steel Pipe | kg | 350 | for a Handrail |
| 13. Wire | kg | 450 | |

| Item | Uint | Cost (Rp) | Remarks |
|---|---|---|---|
| 14. Oil Paint | | | |
| Under Coating | $m^2$ | 213 | |
| Final Coating | $m^2$ | 394 | |
| 15. Tar Paint | $m^2$ | 100 | 2 Times |
| 16. Glass (W/Naco) | $m^2$ | 7,500 | |
| 17. Naco Window | step | 400 | |
| 18. Lock (Kunci Pintu) | pc | 1,500 | |
| 19. Door Hinge | pc | 400 | |
| 20. Corrugated Asbestos Cement Sheet | pc | 4,070 | 2,100X1,050X4$^{mm}$ |
| 21. Particle Board | $m^2$ | 3,500 | t:18$^{mm}$ |
| 22. Asbestos Cement Board | $m^2$ | 2,700 | t: 5$^{mm}$ |
| 23. Cement Fiber Board | $m^2$ | 1,440 | t:25$^{mm}$ |
| | $m^2$ | 2,880 | t:50$^{mm}$ |
| 24. Pipe | | | |
| PVC 1/2" | m | 385 | |
| 1 | m | 670 | |
| 2 | m | 2,155 | |
| 3 | m | 4,250 | |
| 4 | m | 6,590 | |
| 6 | m | 13,060 | |
| 8 | m | 19,880 | |
| 10 | m | 28,980 | |
| 12 | m | 41,110 | |
| ACP 3" | m | 2,480 | |
| 4 | m | 3,700 | |
| 6 | m | 5,465 | |
| 8 | m | 9,840 | |
| 10 | m | 14,415 | |
| 12 | m | 18,430 | |
| 14 | m | 24,560 | |
| 16 | m | 31,510 | |
| 18 | m | 39,195 | |
| 20 | m | 46,550 | |
| 24 | m | 65,700 | |

| Item | | Unit | Cost (Rp) | Remarks |
|---|---|---|---|---|
| GIP | 1/2" | m | 970 | |
| | 1 | m | 1,930 | |
| | 2 | m | 3,240 | |
| | 3 | m | 5,410 | |
| | 4 | m | 7,785 | |
| | 6 | m | 13,080 | |
| | 8 | m | 23,870 | |
| Concrete Pipe | 4" | m | 1,100 | |
| | 6 | m | 1,300 | |
| | 8 | m | 1,600 | |
| | 10 | m | 2,400 | |
| | 12 | m | 2,900 | |
| | 16 | m | 4,500 | |
| | 20 | m | 6,000 | |
| | 24 | m | 9,120 | |
| | 30 | m | 21,450 | |
| | 40 | m | 29,150 | |
| Ductile Cast Iron Pipe | 6" | m | 16,275 | |
| | 8 | m | 19,750 | |
| | 10 | m | 26,250 | |
| | 12 | m | 42,400 | |

| Item | Unit | Cost (Rp) | Remarks |
|---|---|---|---|
| 3. Unit Cost | | | |
| 1. Earth Work | | | |
| Excavation | $m^3$ | 1,050 | |
| Back filling | $m^3$ | 300 | |
| Soil Disposal | $m^3$ | 400 | Transported within 25M. |
| Sand filling | $m^3$ | 4,600 | |
| Compaction | $m^2$ | 300 | |
| 2. Reinforced Concrete Work | | | |
| Concrete 175kg/cm | $m^3$ | 25,000 | 1:2:3 |
| 500kg/cm | $m^3$ | 32,500 | |
| Steel Bar | kg | 500 | |
| 3. Form Work Forming Material; Terentang Class IV. w/Support Materials | | | |
| Foundation | $m^2$ | 2,100 | |
| Wall | $m^2$ | 3,000 | |
| Column | $m^2$ | 3,300 | |
| Beam | $m^2$ | 3,000 | |
| Floor | $m^2$ | 4,200 | |
| Pile | $m^2$ | 3,000 | |
| 4. Wooden Work | | | |
| General | $m^3$ | 86,300 | Meranti ClassIII |
| W/Wolman Preservation | $m^3$ | 92,800 | -do- |
| Truss | $m^3$ | 120,000 | Borneo |
| 5. Plaster Work | | | |
| Floor Mortar (1:5) | $m^2$ | 700 | t:30$^{mm}$ |
| Exterior Wall Mortar(1:5) | $m^2$ | 800 | t:25$^{mm}$ |
| Water Proof Mortar(1:3) | $m^2$ | 1,050 | |
| Exterior Wall Plaster | $m^2$ | 600 | t:15$^{mm}$ |
| Coking | m | 700 | |
| 6. Paint Work | | | |
| Oil Paint | $m^2$ | 1,000 | 3 Times |
| Tar Paint | $m^2$ | 230 | 2 Times |

| Item | Unit | Cost (Rp) | Remarks |
|---|---|---|---|
| 7.Masonry Work | | | |
| Bataco | m$^2$ | 2,000 | t:100$^{mm}$ |
| Bataco W/Vertical Reinforcement | m$^2$ | 2,750 | 9$\phi$ @ 400$^{mm}$ |
| Concrete Block | m$^2$ | 3,000 | t:100$^{mm}$ |
| Concrete Block W/Vertical Reinforcement | m$^2$ | 3,750 | 9$\phi$ @ 400$^{mm}$ |
| Brick Exposure (full Brick) | m$^2$ | 4,000 | Tangerang Class II |
| " (half brick) | m$^2$ | 2,000 | -do- |
| 8.Roof Work | | | |
| Plain Tile | m$^2$ | 2,300 | |
| Ridge Tile | m | 1,500 | |
| 9.Wall Board Work | | | |
| Cement Fiber Board | m$^2$ | 2,440 | t:25$^{mm}$ |
| | m$^2$ | 3,880 | t:50$^{mm}$ |
| Asbestos Cement Board | m$^2$ | 3,700 | t: 5$^{mm}$ |
| Particle Board | m$^2$ | 4,500 | t:18$^{mm}$ |
| Bamboo Mat | m$^2$ | 600 | |
| 10.Plumbing | | | |
| W/Fitting, Valve, Anchor, Pipe laying, Fixing, Excavation(1Meter), Backfilling, Sand bedding and Compaction | | | |
| PVC 1/2" | m | 1,470 | |
| 1 | m | 1,865 | |
| 2 | m | 3,690 | |
| 3 | m | 6,240 | |
| 4 | m | 9,170 | |
| 6 | m | 17,175 | |
| ACP 4" | m | 8,875 | |
| 6 | m | 12,275 | |
| 8 | m | 20,110 | |
| 10 | m | 28,275 | |
| 12 | m | 35,515 | |
| 14 | m | 46,410 | |
| 16 | m | 58,770 | |
| 18 | m | 72,455 | |
| 20 | m | 85,680 | |
| 24 | m | 119,210 | |

| Item | Unit | Cost (RP) | Rematks |
|---|---|---|---|
| Concrete | | | |
| Pipe 4" | m | 5,100 | |
| 6 | m | 6,030 | |
| 8 | m | 7,155 | |
| 10 | m | 9,270 | |
| 12 | m | 10,825 | |
| 16 | m | 15,405 | |
| 20 | m | 20,285 | |
| 24 | m | 27,845 | |

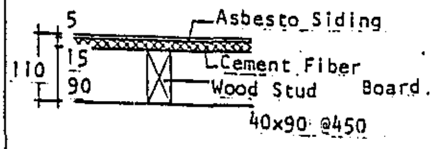
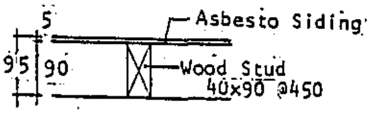
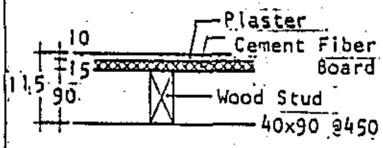
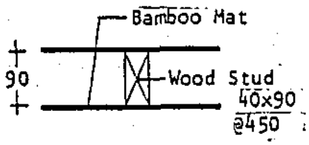
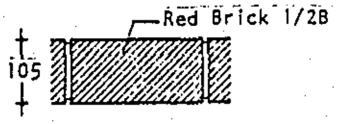
*Depth ratio for excavation rate

| | |
|---|---|
| 0 ~ 1 M : | 1.0 |
| 1 ~ 2 | 1.3 |
| 2 ~ 3 | 1.8 |
| 3 ~ 4 | 2.1 |
| 4 ~ 5 | 2.5 |
| 5 ~ 6 | 3.5 |
| 6 ~ 7 | 5.2 |

11 Other Works

| | | |
|---|---|---|
| Handrail (Steel) | kg | 720 |
| Pile Driving (Concrete) | m | 2,700 |

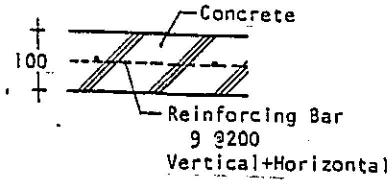
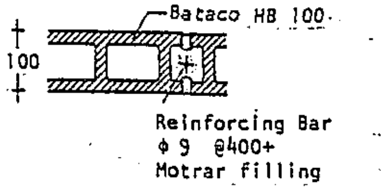
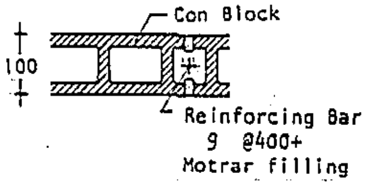
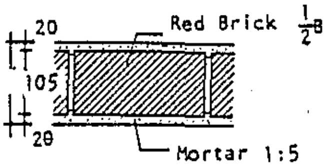
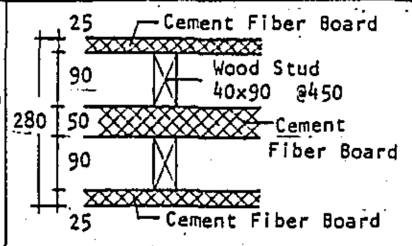
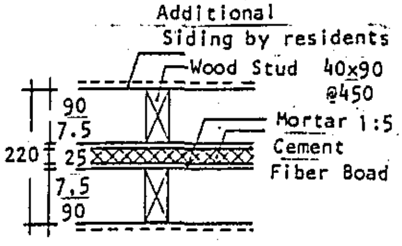
## EXTERIOR WALL & PARTITION WALL

| No. | Component | Unit Price Rp/M² | Performance | | | Note |
|---|---|---|---|---|---|---|
| | | | Weight Kg/M² | Sound Insulation dB (1000 Hz) | Fire Proofing | |
| P 1 |  | 6,700 | 27 | | (~F.P) | Asbesto Siding 6mm +Cement Fiber Board 25mm=F.P (japanese code) |
| P 2 |  | 5,000 | 18 | (28) | | |
| P 3 |  | 4,000 | 28 | | (~F.P) | Plaster 15mm+ F.C.B.15mm+metal Stud =F.P (japanese code)<br>plaster 15mm+ F.C.B.15mm+Wood Stud =F.P. (japanese permit) |
| P 4 |  | 2,500 | 10 | (10) | | |
| |  | 2,000 | 190 | | F.R 1hr. | Tangerang Class II |

( );Expected Value

ELEMENT LIST

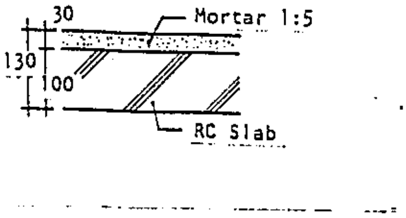
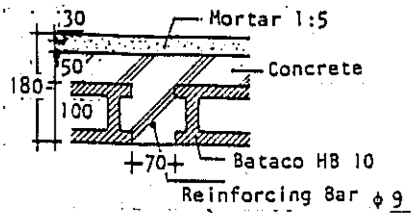
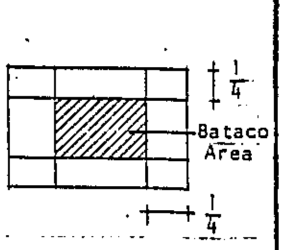
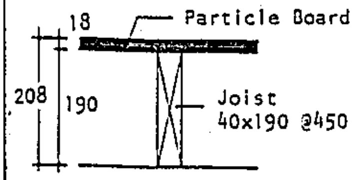
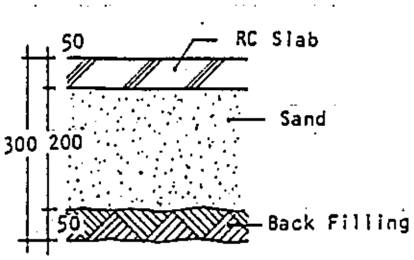
## WALL BETWEEN TWO UNITS

| No. | Component | Unit Price Rp/M² | Performance | | | Note |
|---|---|---|---|---|---|---|
| | | | Weight Kg/M² | Sound Insulation dB (1000 Hz) | Fire Proofing | |
| W 1 |  | 11,500 | 240 | (-45) | F.R 2hr. | |
| W 2 |  | 2,000<br>(2,750) | 130<br>150 | | | without reinforciment<br>with reinforcement |
| W 3 |  | 3,000<br>(3,750) | 110<br>130 | (-40)<br>(-40) | F.R 1hr. | without reinforcement<br>with reinforcement |
| W 4 |  | 2,000 | 270 | (49) | F.R 1hr. | Tangerang ClassII |
| W 5 |  | 10,140 | 72 | (-45) | (F.P) | |
| W 6 |  | 4,400 | 57 | (38) | (F.P) | if the center board is standing independently =F.R.1hr. |

( );Expected Value

## ELEMENT LIST

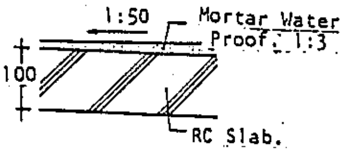
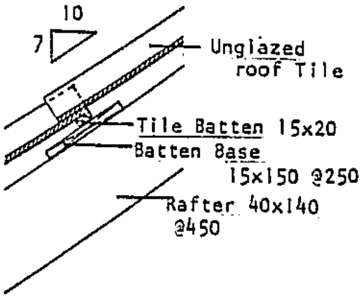
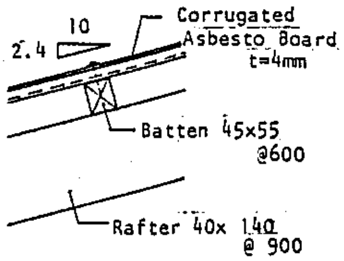
## FLOOR

| No. | Component | Unit Price Rp/M² | Performance | | | Note |
|---|---|---|---|---|---|---|
| | | | Weight Kg/M² | Sound Insulation dB (1000 Hz) | Fire Proofing | |
| F 1 |  | 11,000 | 300 | (-45) | F.R<br>2hr. | |
| F 2 |  | 11,900 | 400 | (-45) | |  |
| F 3 |  | 6,800 | 29.5 | (27) | | |
| F 4 |  | 2,750 | 535 | | | |
| | | | | | | |

( );Expected Value

## ELEMENT LIST

## ROOF

| No. | Component | Unit Price $Rp/M^2$ | Performance | | | Note |
|---|---|---|---|---|---|---|
| | | | Weight $Kg/M^2$ | Sound Insulation dB (1000 Hz) | Fire Proofing | |
| R 1 |  | 11,350 | 300 | (~45) | F.R 2hr. | |
| R 2 |  | 5,250 | 77 | | F.P* | *if the back side of eave is F.P. |
| R 3 |  | 6,800 | 16 | (20) | F.P* | *if the back side of eave is F.P |
| | | | | | | |

( );Expected Value

## 5. Cost List for Housing Units

D-20 (BATACO) ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X10$^3$RP ) | COST (X10$^3$ RP) | SUB TOTAL (X10$^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 23.80<br>(21.00<br>2.80 | m$^2$<br>m$^2$<br>m$^2$ | 2.75<br>7.45<br>2.75 | 65.45<br>164.15) | 218.96<br>(317.66) | |
| | 2F floor | - | - | - | - | | |
| | RC Belt Cource | - | - | - | - | | |
| | (Wall between Houses) | | | | | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 23.80 | m$^2$ | 6.45 | 153.51 | | |
| | Stair | - | - | - | - | | |
| Wall | Wall between Houses | 24.47 | m$^2$ | 2.80 | 48.94 | 233.68 | |
| | Outerwall | 29.37 | m$^2$ | 2.00 | 58.74 | | |
| | WC/M Wall | 12.60 | m$^2$ | 2.00 | 25.20 | | |
| | Door+Partition Wall | - | - | - | - | | |
| | Window+Door | 10.08 | m$^2$ | 10.00 | 100.80 | | |
| Miscellaneous Work | Rodge Tile | 8.40 | m | 1.50 | 12.60 | 77.03 | |
| | Eaves Fascia+ Back Eave Siding | 9.80 | m | 1.70 | 16.66 | | |
| | Gutter | 11.90 | m | 1.00 | 11.90 | | |
| | Unit Wall Mortar | 24.47 | m$^2$ | 1.20 | 29.36 | | |
| | Waterproof Mortar | 6.20 | m$^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 544.97 (643.67) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 599.97 (698.67) | |
| Overhead | | | | | | 60.00 ( 69.88) | |
| Grand Total | | | | | | 659.97 (768.54) | |

| | |
|---|---|
| Cost/Net Floor Area(10$^3$RP/M$^2$) [Slab on Grade Case] | 27.72 |
| Cost/Net Floor Area(10$^3$RP/M$^2$) [Raised Slab Case] | 32.29 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); in case of raised slab in 1 F.

D-20 (WOOD)

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X10³RP ) | COST (X10³RP) | SUB TOTAL (X10³RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 23.80 | m² | 2,75 | 65.45 | 218.96<br>(317.66) | |
| | | (21.00 | m² | 7.45 | | | |
| | 2F floor | 2.80 | m² | 2.75 | 164.15) | | |
| | RC Belt Cource | - | - | - | - | | |
| | (Wall between Houses) | - | - | - | - | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 23.80 | m² | 6.45 | 153.51 | | |
| | Stair | - | - | - | - | | |
| Wall | Wall between Houses | 24.47 | m² | 6.46 | 158.08 | 419.18 | |
| | Outerwall | 29.37 | m² | 4.60 | 135.10 | | |
| | WC/M Wall | 12.60 | m² | 2.00 | 25.20 | | |
| | Door+Partition Wall | - | - | - | - | | |
| | Window+Door | 10.08 | m² | 10.00 | 100.80 | | |
| Miscellaneous Work | Rodge Tile | 8.40 | m | 1.50 | 12.60 | 77.03 | |
| | Eaves Fascia+ Back Eave Siding | 9.80 | m | 1.70 | 16.66 | | |
| | Gutter | 11.90 | m | 1.00 | 11.90 | | |
| | Unit Wall Mortar | 24.47 | m² | 1.20 | 29.36 | | |
| | Waterproof Mortar | 6.20 | m² | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 730.47 (829.17) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 785.47 (884.17) | |
| Overhead | | | | | | 78.55 ( 88.42) | |
| Grand Total | | | | | | 864.02 (972.59) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/M²) [Slab on Grade Case] | 36.30 |
| Cost/Net Floor Area($10^3$RP/M²) [Raised Slab Case] | 40.87 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); in case of raised slab in 1 F.

D-36 (BATACO) ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP) | COST ($X10^3$RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 37.25 | $m^2$ | 2.75 | 102.44<br>(175.08) | 342.70<br>(415.33) | |
| | 2F floor | - | - | - | - | | |
| | RC Belt Cource | - | - | - | - | | |
| | (Wall between Houses) | | | | | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 37.25 | $m^2$ | 6.45 | 240.26 | | |
| | Stair | - | - | - | - | | |
| Wall | Wall between Houses | 20.87 | $m^2$ | 2.00 | 41.74 | 300.87 | |
| | Outerwall | 39.26 | $m^2$ | 2.00 | 78.54 | | |
| | WC/M Wall | 11.73 | $m^2$ | 2.00 | 23.45 | | |
| | Door+Partition Wall | 18.18 | $m^2$ | 3.00 | 54.54 | | |
| | Window+Door | 10.26 | $m^2$ | 10.00 | 102.60 | | |
| Miscellaneous Work | Rodge Tile | 6.24 | m | 1.50 | 9.36 | 69.11 | |
| | Eaves Fascia+ Back Eave Siding | 12.48 | m | 1.70 | 21.22 | | |
| | Gutter | 17.38 | m | 1.00 | 17.38 | | |
| | Unit Wall Mortar | 12.20 | $m^2$ | 1.20 | 14.64 | | |
| | Waterproof Mortar | 6.20 | $m^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 727.98 (800.61) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 782.98 (855.61) | |
| Overhead | | | | | | 78.30 ( 85.56) | |
| Grand Total | | | | | | 861.28 (941.17) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/$M^2$) [Slab on Grade Case] | 23.12 |
| Cost/Net Floor Area($10^3$RP/$M^2$) [Raised Slab Case] | 25.27 |

* Earth work, Soil improvement, Slol replacement, Insecticidation and Foundation Cost are not included.
( ); In case of raised slab in 1 F.

D-36 (WOOD) ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP ) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 37.25 | $m^2$ | 2.75 | 102.44<br>(175.08) | 342.70<br>(415.33) | |
| | 2F floor | - | - | - | - | | |
| | RC Belt Cource<br>(Wall between Houses) | - | - | - | - | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 37.25 | $m^2$ | 6.45 | 240.26 | | |
| | Stair | - | - | - | - | | |
| Wall | Wall between Houses | 20.87 | $m^2$ | 6.46 | 134.79 | 495.98 | |
| | Outerwall | 39.26 | $m^2$ | 4.60 | 180.60 | | |
| | WC/M Wall | 11.73 | $m^2$ | 2.00 | 23.45 | | |
| | Door+Partition Wall | 18.18 | $m^2$ | 3.00 | 54.54 | | |
| | Window+Door | 10.26 | $m^2$ | 10.00 | 102.60 | | |
| Miscellaneous Work | Rodge Tile | 6.24 | m | 1.50 | 9.36 | 69.11 | |
| | Eaves Fascia+<br>Back Eave Siding | 12.48 | m | 1.70 | 21.22 | | |
| | Gutter | 17.38 | m | 1.00 | 17.38 | | |
| | Unit Wall Mortar | 12.20 | $m^2$ | 1.20 | 14.64 | | |
| | Waterproof Mortar | 6.20 | $m^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 923.09 (995.72) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 978.09 (1,050.72) | |
| Overhead | | | | | | 97.81 ( 105.07) | |
| Grand Total | | | | | | 1,075.90 (1,155.79) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/$M^2$) [Slab on Grade Case] | 28.88 |
| Cost/Net Floor Area($10^3$RP/$M^2$) [Raised Slab Case] | 31.03 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); in case of raised slab in 1 F.

DM-24 (BATACO)

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP ) | COST ($X10^3$RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| | 1F floor | 13.14 | m$^2$ | 2.75 | 36.14<br>(97.90) | | |
| Floor | 2F floor | 10.80 | m$^2$ | 7.45 | 80.46 | | |
| | RC Belt Cource | | | | | | |
| Roof | (Wall between Houses) | 3.60 | m$^2$ | 3.79 | 13.65 | 320.13<br>(381.89) | |
| | (Outer Wall) | 19.20 | m | 3.34 | 64.13 | | |
| | Roof | 13.14 | m$^2$ | 6.45 | 84.75 | | |
| | Stair | | | | 41.00 | | |
| | Wall between Houses | 9.99 | m$^2$ | 2.00 | 19.98 | | |
| | Outerwall | 27.0 | m$^2$ | 2.00 | 54.00 | | |
| Wall | WC/M Wall | 13.84 | m$^2$ | 2.00 | 27.68 | 244.15 | |
| | Door+Partition Wall | 4.56 | m$^2$ | 3.00 | 13.68 | | |
| | Window+Door | 12.93 | m$^2$ | 10.00 | 129.30 | | |
| | Rodge Tile | 3.00 | m | 1.50 | 4.50 | | |
| | Eaves Fascia+ Back Eave Siding | 7.30 | m | 1.70 | 12.41 | | |
| Miscellaneous Work | Gutter | 17.20 | m | 1.00 | 17.20 | | |
| | Unit Wall Mortar | - | - | - | - | 40.62 | |
| | Waterproof Mortar | 6.20 | m$^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| | Water Closet | | | | | | |
| Equipment | Water Tub | | | | | 15.30 | |
| | Kitchin Sink | | | | | | |
| Building Total | | | | | | 620.20 (681.96) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 675.20 (736.96) | |
| Overhead | | | | | | 67.52 ( 73.70) | |
| Grand Total | | | | | | 742.72 (810.66) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/M$^2$) [Slab on Grade Case] | 31.02 |
| Cost/Net Floor Area($10^3$RP/M$^2$) [Raised Slab Case] | 33.86 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); in case of raised slab in 1 F.

DM-24 (WOOD)

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP ) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 13.14 | m$^2$ | 2.75 | 36.14<br>(97.90) | 242.35<br>(304.11) | |
| | 2F floor<br>RC Belt Cource | 7.45 | m$^2$ | 7.45 | 80.46 | | |
| | (Wall between Houses) | - | - | - | - | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 13.14 | m$^2$ | 6.45 | 84.75 | | |
| | Stair | | | | 41.00 | | |
| Wall | Wall between Houses | 9.99 | m$^2$ | 6.46 | 64.50 | 358.87 | |
| | Outerwall | 27.00 | m$^2$ | 4.60 | 124.20 | | |
| | WC/M Wall | 13.60 | m$^2$ | 2.00 | 27.19 | | |
| | Door+Partition Wall | 4.56 | m$^2$ | 3.00 | 13.68 | | |
| | Window+Door | 12.93 | m$^2$ | 10.00 | 129.30 | | |
| Miscellaneous Work | Rodge Tile | 3.00 | m | 1.50 | 4.50 | 55.02 | |
| | Eaves Fascia+ Back Eave Siding | 7.30 | m | 1.70 | 12.41 | | |
| | Gutter | 17.20 | m | 1.00 | 17.20 | | |
| | Unit Wall Mortar | 12.00 | m$^2$ | 1.20 | 14.40 | | |
| | Waterproof Mortar | 6.20 | m$^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 671.54 (733.30) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 726.54 (788.30) | |
| Overhead | | | | | | 72.65 ( 78.83) | |
| Grand Total | | | | | | 799.19 (867.13) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/M$^2$) [Slab on Grade Case] | 33.38 |
| Cost/Net Floor Area($10^3$RP/M$^2$) [Raised Slab Case] | 36.22 |

* Earth work, Soil improvement, Slol replacement, Insecticidation and Foundation Cost are not Included.
( ); in case of raised slab in I F.

DM-36 (BATACO)

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X$10^3$RP ) | COST (X$10^3$ RP) | SUB TOTAL (X$10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 17.28 | $m^2$ | 2.75 | 47.52<br>(139.97) | 438.31<br>(530.76) | |
| | 2F floor | 17.28 | $m^2$ | 8.10 | 139.97 | | |
| | RC Belt Cource (Wall between Houses) | 4.80 | $m^2$ | 3.79 | 18.20 | | |
| | (Outer Wall) | 24.00 | $m^2$ | 3.34 | 80.16 | | |
| | Roof | 17.28 | $m^2$ | 6.45 | 111.46 | | |
| | Stair | | | | 41.00 | | |
| Wall | Wall between Houses | 14.05 | $m^2$ | 2.00 | 28.10 | 306.37 | |
| | Outerwall | 37.58 | $m^2$ | 2.00 | 75.16 | | |
| | WC/M Wall | 14.08 | $m^2$ | 2.00 | 28.16 | | |
| | Door+Partition Wall | 15.95 | $m^2$ | 3.00 | 47.85 | | |
| | Window+Door | 12.71 | $m^2$ | 10.00 | 127.10 | | |
| Miscellaneous Work | Rodge Tile | 3.6 | m | 1.50 | 5.40 | 41.24 | |
| | Eaves Fascia+ Back Eave Siding | 7.20 | m | 1.70 | 12.24 | | |
| | Gutter | 17.10 | m | 1.00 | 17.10 | | |
| | Unit Wall Mortar | - | - | - | - | | |
| | Waterproof Mortar | 6.20 | $m^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 801.22 (893.67) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 856.22(948.67) | |
| Overhead | | | | | | 85.62( 94.87) | |
| Grand Total | | | | | | 941.84(1,043.54) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/$M^2$) [Slab on Grade Case] | 27.25 |
| Cost/Net Floor Area($10^3$RP/$M^2$) [Raised Slab Case] | 30.20 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); in case of raised slab in 1 F.

DM-36 (WOOD) ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F Floor | 17.28 | $m^2$ | 2.75 | 47.52<br>(139.97) | 339.95<br>(432.40) | |
| | 2F Floor | 17.28 | $m^2$ | 8.10 | 139.97 | | |
| | RC Belt Cource | | | | | | |
| | (Wall between Houses) | - | - | - | - | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 17.28 | $m^2$ | 6.45 | 111.46 | | |
| | Stair | | | | 41.00 | | |
| Wall | Wall between Houses | 14.05 | $m^2$ | 6.46 | 90.76 | 466.74 | |
| | Outerwall | 37.58 | $m^2$ | 4.60 | 172.87 | | |
| | WC/M Wall | 14.08 | $m^2$ | 2.00 | 28.16 | | |
| | Door+Partition Wall | 15.95 | $m^2$ | 3.00 | 47.85 | | |
| | Window+Door | 12.71 | $m^2$ | 10.00 | 127.10 | | |
| Miscellaneous Work | Rodge Tile | 3.6 | m | 1.50 | 5.40 | 61.65 | |
| | Eaves Fascia+ Back Eave Siding | 7.2 | m | 1.70 | 12.24 | | |
| | Gutter | 17.10 | m | 1.00 | 17.10 | | |
| | Unit Wall Mortar | 17.00 | $m^2$ | 1.20 | 20.40 | | |
| | Waterproof Mortar | 6.20 | $m^2$ | 1.05 | 6.51 | | |
| | Outerwall Plaster | - | - | - | - | | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 883.64 (976.09) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | - | |
| Sub Total | | | | | | 938.64 (1,031.09) | |
| Overhead | | | | | | 93.86 ( 103.11) | |
| Grand Total | | | | | | 1,032.50 (1,134.20) | |

| | |
|---|---|
| Cost/Net Floor Area($10^3$RP/$M^2$) [Slab on Grade Case] | 29.88 |
| Cost/Net Floor Area($10^3$RP/$M^2$) [Raised Slab Case] | 32.82 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); in case of raised slab in 1 F.

M-45A

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X10³RP ) | COST (X10³ RP) | SUB TOTAL (X10³RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Floor<br>Roof | 1F floor | 25.02 | m² | 2.75 | 68.81<br>(202.67) | 473.66<br>(607.52) | |
| | 2F floor | 22.68 | m² | 8.10 | 183.21 | | |
| | RC Belt Cource | | | | | | |
| | (Wall between Houses) | - | - | - | - | | |
| | (Outer Wall) | - | - | - | - | | |
| | Roof | 25.02 | m² | 7.20 | 180.14 | | |
| | Stair | | | | 41.00 | | |
| Wall | Wall between Houses | 30.87 | m² | 6.46 | 199.40 | 583.38 | asbesto siding 5mm |
| | Outerwall | 12.35<br>23.01 | m²<br>m² | 4.84<br>5.63 | 59.76<br>129.55 | | |
| | WC/M Wall | 13.60 | m² | 2.00 | 27.19 | | |
| | Door+Partition Wall | 11.53 | m² | 3.00 | 34.58 | | |
| | Window+Door | 13.29 | m² | 10.00 | 132.90 | | |
| Miscellaneous Work | Rodge Tile | 8.10 | m | 1.50 | 12.15 | 81.54 | |
| | Eaves Fascia+ Back Eave Siding | 8.50 | m | 1.70 | 14.45 | | asbesto 5mm |
| | Gutter | 18.50 | m | 1.00 | 18.50 | | |
| | Unit Wall Mortar | 17.73 | m² | 1.20 | 21.28 | | only outside |
| | Waterproof Mortar | 6.20 | m² | 1.05 | 6.51 | | |
| | Outerwall Plaster | 12.35 | m² | 0.70 | 8.65 | | only end walls |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | | | | | 15.30 | |
| Building Total | | | | | | 1,153.88 (1,287.74) | |
| Plumbing | | | | | | 45.00 | |
| Temporary Work | | | | | | 10.00 | |
| Surroundings Work | | | | | | 37.70 | |
| Sub Total | | | | | | 1,246.58 (1,380.44) | |
| Overhead | | | | | | 124.66 ( 138.04) | |
| Grand Total | | | | | | 1,371.24 (1,518.48) | |

| | |
|---|---|
| Cost/Net Floor Area(10³RP/M²) [Slab on Grade Case] | 28.75 |
| Cost/Net Floor Area(10³RP/M²) [Raised Slab Case] | 31.83 |

* Earth work, Soil improvement, Siol replacement, Insecticidation and Foundation Cost are not included.
( ); In case of raised slab in 1 F.

FG36-A 24 units/4F

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP ) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 31.5 | 2575.61 | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 2130.19 | | |
| | Staircase | | | | 321.68 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 149.70 | 149.70 | |
| Partition Work | Door+Partition Wall | | | | 66.10 | 66.10 | |
| BATACO Work | Wall between Houses<br>+End Wall<br>WC/M Wall | 26.37 | $m^2$ | 2.0 | 52.74 | 52.74 | |
| Mortar Plaster Work | Inside Floor Mortar | 35.10 | $m^2$ | 0.7 | 24.57 | 60.96 | |
| | Waterproof Mortar | 21.05 | $m^2$ | 1.05 | 22.10 | | |
| | Outerwall Plaster | 23.81 | $m^2$ | 0.60 | 14.29 | | |
| Miscellaneous Work | Roof | 13.68 | $m^2$ | 7.0 | 95.73 | 213.33 | |
| | Handrail | | | | 55.80 | | |
| | Wooden Louver | | | | 2.67 | | |
| | Stair Finnish | | | | 50.73 | | |
| | Gutter | 2.8 | m | 3.0 | 8.40 | | |
| Equipment | Water Closet | 1 | Pc | | 15.30 | 15.30 | |
| | Water Tub | 1 | Pc | | | | |
| | Kitchin Sink | 1 | Pc | | | | |
| Building Total | | | | | | 3,133.74 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.00 | |
| Sub Total | | | | | | 3,204.35 | |
| Overhead | | | | | | 320.44 | |
| Grand Total | | | | | | 3,524.79 | |
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | 65.38 | Cost/Net Floor Area($10^3$RP/$M^2$) | 83.68 | | | | |

Gross Floor Area 53.91 $m^2$

Net floor Area 42.12 $m^2$

FG-36B 24units/4F ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 31.50 | 2597.68 | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 2152.25 | | |
| | Staircase | | | | 321.68 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 169.65 | 169.65 | |
| Partition Work | Door+Partition Wall | | | | 73.97 | 73.97 | |
| BATACO Work | Wall between Houses +End Wall WC/M Wall | 29.19 | $m^2$ | 2.0 | 58.38 | 58.38 | |
| Mortar Plaster Work | Inside Floor Mortar | 35.10 | $m^2$ | 0.7 | 24.57 | 60.96 | |
| | Waterproof Mortar | 21.05 | $m^2$ | 1.05 | 22.10 | | |
| | Outerwall Plaster | 23.81 | $m^2$ | 0.60 | 14.29 | | |
| Miscellaneous Work | Roof | 13.68 | $m^2$ | 7.0 | 95.73 | 213.33 | |
| | Handrail | | | | 55.80 | | |
| | Wooden Louver | | | | 2.67 | | |
| | Stair Finnish | | | | 50.73 | | |
| | Gutter | 2.8 | m | 3.0 | 8.40 | | |
| Equipment | Water Closet | 1 | PC | | | 15.30 | |
| | Water Tub | 1 | PC | | | | |
| | Kitchin Sink | 1 | PC | | | | |
| Building Total | | | | | | 3,189.27 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.0 | |
| Sub Total | | | | | | 3,259.88 | |
| Overhead | | | | | | 325.99 | |
| Grand Total | | | | | | 3,585.87 | |

| | | | |
|---|---|---|---|
| Cost/Gross Floor Area ($10^3$ Rp/$M^2$) | 66.52 | Cost/Net Floor Area ($10^3$RP/$M^2$) | 85.13 |

Gross Floor Area 53.91 $m^2$

Net Floor Area 42.12 $m^2$

FG - 36C 24 units/4F ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE $(X10^3RP)$ | COST $(X10^3RP)$ | SUB TOTAL $(X10^3RP)$ | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 31.5 | 2558.52 | |
| | Pile Driving | | | | 65.25 | | |
| | Foundation+ Structure | | | | 2140.09 | | |
| | Staircase | | | | 321.68 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 165.87 | 165.87 | |
| Partition Work | Door+Partition Wall | | | | 77.12 | 77.12 | |
| BATACO Work | Wall between Houses +End Wall<br>WC/M Wall | 23.22 | $m^2$ | 2.0 | 46.44 | 46.44 | |
| Mortar Plaster Work | Inside Floor Mortar | 35.10 | $m^2$ | 0.7 | 24.57 | 60.96 | |
| | Waterproof Mortar | 21.05 | $m^2$ | 1.05 | 22.10 | | |
| | Outerwall Plaster | 23.81 | $m^2$ | 0.60 | 14.29 | | |
| Miscellaneous Work | Roof | 13.68 | $m^2$ | 7.0 | 95.73 | 213.33 | |
| | Handrail | | | | 55.80 | | |
| | Wooden Louver | | | | 2.67 | | |
| | Stair Finnish | | | | 50.73 | | |
| | Gutter | 2.8 | m | 3.0 | 8.40 | | |
| Equipment | Water Closet | 1 | PC | | | 15.30 | |
| | Water Tub | 1 | PC | | | | |
| | Kitchin Sink | 1 | PC | | | | |
| Building Total | | | | | | 3,137.54 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.0 | |
| Sub Total | | | | | | 3,208.15 | |
| Overhead | | | | | | 320.82 | |
| Grand Total | | | | | | 3,528.99 | |

| | | | |
|---|---|---|---|
| Cost/Gross Floor Area $(10^3 Rp/M^2)$ | 65.46 | Cost/Net Floor Area $(10^3RP/M^2)$ | 83.78 |

Gross Floor Area 53.91 $m^2$
Net Floor Area 42.12 $m^2$

FG-36A' 24 units/4F

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP) | COST ($X10^3$RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 31.50 | 2494.21 | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 2048.78 | | |
| | Staircase | | | | 321.68 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 149.70 | 149.70 | |
| Partition Work | Door+Partition Wall | | | | 66.10 | 66.10 | |
| Wall Work | Wall between Houses +End Wall | 13.24 | $m^2$ | 10.2 | 135.05 | 200.38 | W5<br>Wood stud+ FCB t=15 both side |
| | WC/M Wall | 12.81 | $m^2$ | 5.1 | 65.33 | | |
| Mortar Plaster Work | Inside Floor Mortar | 35.10 | $m^2$ | 0.7 | 24.57 | 60.36 | |
| | Waterproof Mortar | 21.05 | $m^2$ | 1.05 | 22.10 | | |
| | Outerwall Plaster | 23.81 | $m^2$ | 0.60 | 14.29 | | |
| Miscellaneous Work | Roof | 13.68 | $m^2$ | 7.0 | 95.73 | 213.33 | |
| | Handrail | | | | 55.80 | | |
| | Wooden Louver | | | | 2.67 | | |
| | Stair Finnish | | | | 50.73 | | |
| | Gutter | 2.8 | m | 3.0 | 8.40 | | |
| Equipment | Water Closet | 1 | PC | | 15.30 | 15.30 | |
| | Water Tub | 1 | PC | | | | |
| | Kitchin Sink | 1 | PC | | | | |
| Building Total | | | | | | 3,199.98 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.00 | |
| Sub Total | | | | | | 3,270.59 | |
| Overhead | | | | | | 327.06 | |
| Grand Total | | | | | | 3,597.65 | |

| | | | |
|---|---|---|---|
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | 66.73 | Cost/Net Floor Area($10^3$RP/$M^2$) | 85.41 |

| | |
|---|---|
| Gross Floor Area | 53.91 $m^2$ |
| Net Floor Area | 42.12 $m^2$ |

FG45-A 24 units/4F

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP ) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 37.8 | 3007.98 | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 2556.23 | | |
| | Staircase | | | | 321.7 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 149.70 | 149.70 | |
| Partition Work | Door+Partition Wall | | | | 94.60 | 94.60 | |
| BATACO Work | Wall between Houses +End Wall WC/M Wall | 31.12 | $m^2$ | 2.0 | 62.24 | 62.24 | |
| Mortar Plaster Work | Inside Floor Mortar | 42.66 | $m^2$ | 0.7 | 29.86 | 71.39 | |
| | Waterproof Mortar | 23.48 | $m^2$ | 1.05 | 24.65 | | |
| | Outerwall Plaster | 28.13 | $m^2$ | 0.6 | 16.88 | | |
| Miscellaneous Work | Roof | 16.17 | $m^2$ | 7.0 | 113.21 | 271.12 | |
| | Handrail | | | | 83.7 | | |
| | Wooden Louver | | | | 6.68 | | |
| | Stair Finnish | | | | 50.73 | | |
| | Gutter | 5.6 | m | 3.0 | 16.80 | | |
| Equipment | Water Closet | 1 | Pc | | 15.30 | 15.30 | |
| | Water Tub | 1 | Pc | | | | |
| | Kitchin Sink | 1 | Pc | | | | |
| Building Total | | | | | | 3,672.33 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.00 | |
| Sub Total | | | | | | 3,742.94 | |
| Overhead | | | | | | 374.29 | |
| Grand Total | | | | | | 4,117.23 | |
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | 64.43 | | Cost/Net Floor Area($10^3$RP/$M^2$) | | | 79.01 | |

Gross Floor Area 63.90 $m^2$

Net Floor Area 52.11 $m^2$

FG-45R 30 units/5F

( COST/HOUSING UNIT ) - Additional cost per attic unit

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X10$^3$RP ) | COST (X10$^3$RP) | SUB TOTAL (X10$^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Wall between Houses +End Wall | 44.55 | $m^2$ | 16.40 | 730.62 | | |
| | Sub Beam | 16.20 | m | 10.90 | 176.58 | 1084.57 | |
| | Staircase | | | | 177,37 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 160,50 | 160.50 | |
| Partition Work | Door+Partition Wall | 16.25 | $m^2$ | 6.0 | 97.47 | 97.47 | |
| Roof Work | Roof | 78.03 | $m^2$ | 4.6 | 358.92 | 399.34 | Incl. rafter+ |
| | Ridge+valley Tile | 9.8 | m- | 1.5 | 14.70 | | |
| | Purlin | 0.298 | $m^3$ | 86.3 | 25.72 | | Batten |
| BATACO Work | WC/M Wall | 28.12 | $m^2$ | 2.0 | 56.24 | 56.24 | |
| Mortar Plaster Work | Inside Floor Mortar | 39.29 | $m^2$ | 0.70 | 27.50 | 71.43 | |
| | Waterproof Mortar | 35.81 | $m^2$ | 1.05 | 1.05 | | |
| | Outerwall Plaster | 10.55 | $m^2$ | 0.6 | 0.6 | | |
| Miscellan-eous Work | Staircase Roof | 4.25 | $m^2$ | 7.0 | 33.26 | | |
| | Gable+Eaves Fascia | 34.57 | m | 1.0 | 34.57 | | |
| | Stair Finnish | | | | 50.73 | | |
| Equipment | Water Closet | 1 | PC | | | 15.30 | |
| | Water Tub | 1 | PC | | | | |
| | Kitchin Sink | 1 | PC | | | | |
| Building Total | | | | | | 2003.41 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | - | |
| Sub Total | | | | | | 2064.02 | |
| Overhead | | | | | | 206.40 | |
| Grand Total | | | | | | 2270.42 | |
| Cost/Gross Floor Area(10$^3$ Rp/M$^2$) | 35.53 | Cost/Net Floor Area(10$^3$RP/M$^2$) | | | | 39.92 | |

Gross Floor Area 63.90 $m^2$
Net Floor Area 56.88 $m^2$

FS36-A 24 units/4F ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3RP$) | COST ($X10^3 RP$) | SUB TOTAL ($X10^3RP$) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 26.46 | 2487.09 | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 1789.36 | | |
| | Staircase | | | | 579.02 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 149.70 | 149.70 | |
| Partition Work | Door+Partition Wall | | | | 66.10 | 66.10 | |
| BATACO Work | Wall between Houses +End Wall WC/M Wall | 26.37 | $m^2$ | 2.0 | 52.74 | 52.74 | |
| Mortar Plaster Work | Inside Floor Mortar | 35.10 | $m^2$ | 0.7 | 24.57 | 54.39 | |
| | Waterproof Mortar | 13.22 | $m^2$ | 1.05 | 13.88 | | |
| | Outerwall Plaster | 26.56 | $m^2$ | 0.60 | 15.94 | | |
| Miscellaneous Work | Roof | 12.19 | $m^2$ | 7.0 | 85.33 | 203.01 | |
| | Handrail | | | | 13.95 | | |
| | Wooden Louver | | | | 4.01 | | |
| | Stair Finnish | | | | 91.32 | | |
| | Gutter | | | | 8.40 | | |
| Equipment | Water Closet | 1 | PC | | 15.30 | 15.30 | |
| | Water Tub | 1 | PC | | | | |
| | Kitchin Sink | 1 | PC | | | | |
| Building Total | | | | | | 3,028.33 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.0 | |
| Sub Total | | | | | | 3,098.94 | |
| Overhead | | | | | | 309.89 | |
| Grand Total | | | | | | 3,408.83 | |
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | | 71.53 | | Cost/Net Floor Area($10^3$RP/$M^2$) | | | 80.93 |

Gross Floor Area 47.66 $m^2$

Net Floor Area 42.12 $m^2$

FS' 36-A 24 units/4F

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3$RP ) | COST ($X10^3$ RP) | SUB TOTAL ($X10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 30.29 | 2244.68 | |
| | Pile Driving | | | | 91.13 | | |
| | Foundation+ Structure | | | | 2048.26 | | |
| | Staircase | | | | 75.0 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 205.80 | 205.80 | |
| Partition Work | Door+Partition Wall | | | | 95.76 | 95.76 | |
| BATACO Work | Wall between Houses +End Wall WC/M Wall | 22.90 | $m^2$ | 2.0 | 45.79 | 45.79 | |
| Mortar Plaster Work | Inside Floor Mortar | 35.37 | $m^2$ | 0.7 | 24.76 | 69.47 | |
| | Waterproof Mortar | 22.71 | $m^2$ | 1.05 | 23.85 | | |
| | Outerwall Plaster | 34.77 | $m^2$ | 0.6 | 20.86 | | |
| Miscellaneous Work | Roof | 12.06 | $m^2$ | 7.7 | 92.86 | 159.05 | |
| | Handrail | | | | 50.84 | | |
| | Wooden Louver | | | | 9.01 | | |
| | Stair Finnish | | | | 2.94 | | |
| | Gutter | 2.8 | m | 3.0 | 8.40 | | |
| Equipment | Water Closet | 1 | PC | | 15.30 | 15.30 | |
| | Water Tub | 1 | PC | | | | |
| | Kitchin Sink | 1 | PC | | | | |
| Building Total | | | | | | 2,835.85 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.0 | |
| Sub Total | | | | | | 2,906.46 | |
| Overhead | | | | | | 290.65 | |
| Grand Total | | | | | | 3,197.11 | |
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | | 66.28 | | Cost/Net Floor Area($10^3$RP/$M^2$) | | | 74.51 |

Gross Floor Area 48.24 $m^2$
Net Floor Area 42.91 $m^2$

FS'36-A 32 units/4F ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X10$^3$RP ) | COST (X10$^3$RP) | SUB TOTAL (X10$^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work<br>Pile Driving<br>Foundation+ Structure<br>Staircase | | | | 30.29<br>91.13<br>2048.26<br>75.0 | 2,244.68 | Calculated in the light of FG 36-A Type |
| Side Wall Work | Window+Door +Brick exposure Wall | 20.58 | m$^2$ | 10.0 | 205.80 | 205.80 | |
| Partition Work | Door+Partition Wall | 15.96 | m$^2$ | 6.0 | 95.76 | 95.76 | |
| BATACO Work | Wall between Houses<br>+End Wall<br>WC/M Wall | 22.48 | m$^2$ | 2.0 | 44.95 | 44.95 | |
| Mortar Plaster Work | Inside Floor Mortar<br>Waterproof Mortar<br>Outerwall Plaster | 35.37<br>22.71<br>33.09 | m$^2$<br>m$^2$<br>m$^2$ | 0.7<br>1.05<br>0.6 | 24.76<br>23.85<br>19.85 | 68.46 | |
| Miscellaneous Work | Roof<br>Handrail<br>Wooden Louver<br>Stair Finnish<br>Gutter | 12.06<br><br><br><br>2.8 | m$^2$<br><br><br><br>m | 7.7<br><br><br><br>3.0 | 92.86<br>50.84<br>4.01<br>2.94<br>8.40 | 159.05 | |
| Equipment | Water Closet<br>Water Tub<br>Kitchin Sink | 1<br>1<br>1 | pc.<br>pc.<br>pc. | | 15.30 | 15.30 | |
| Building Total | | | | | | 2,834.00 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.00 | |
| Sub Total | | | | | | 2,904.61 | |
| Overhead | | | | | | 290.46 | |
| Grand Total | | | | | | 3195.07 | |

| | | | |
|---|---|---|---|
| Cost/Gross Floor Area(10$^3$ Rp/M$^2$) | 66.23 | Cost/Net Floor Area(10$^3$RP/M$^2$) | 74.46 |

Gross Floor A. 48.24 m$^2$

Net Floor Area 42.91 m$^2$

FS'45-A 32 units/4F ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE (X$10^3$RP ) | COST (X$10^3$ RP) | SUB TOTAL (X$10^3$RP) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 35.91 | 2,539.33 | |
| | Pile Driving | | | | 91.13 | | |
| | Foundation+ Structure | | | | 2428.42 | | |
| | Staircase | | | | 75.0 | | |
| Side Wall Work | Window+Door +Brick exposure Wall | | | | 205.80 | 205.80 | |
| Partition Work | Door+Partition Wall | 23.56 | $m^2$ | 6.0 | 141.36 | 141.36 | |
| BATACO Work | Wall between Houses +End Wall WC/M Wall | 28.88 | $m^2$ | 2.0 | 57.77 | 57.77 | |
| Mortar Plaster Work | Inside Floor Mortar | 42.39 | $m^2$ | 0.7 | 29.67 | 75.14 | |
| | Waterproof Mortar | 24.40 | $m^2$ | 1.05 | 25.62 | | |
| | Outerwall Plaster | 33.09 | $m^2$ | 0.6 | 19.85 | | |
| Miscellaneous Work | Roof | 14.24 | $m^2$ | 7.0 | 99.66 | 174.25 | |
| | Handrail | | | | 50.84 | | |
| | Wooden Louver | | | | 4.01 | | |
| | Stair Finnish | | | | 2.94 | | |
| | Gutter | 5.6 | m | 3.0 | 16.80 | | |
| Equipment | Water Closet | 1 | Pc | | 15.30 | 15.30 | |
| | Water Tub | 1 | Pc | | | | |
| | Kitchin Sink | 1 | Pc | | | | |
| Building Total | | | | | | 3,300.08 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.00 | |
| Sub Total | | | | | | 3,370.69 | |
| Overhead | | | | | | 337.07 | |
| Grand Total | | | | | | 3,707.76 | |
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | | 65.11 | | Cost/Net Floor Area($10^3$RP/$M^2$) | | 70.06 | |

Gross Floor Area 56.95 $m^2$

Net Floor Area 52.92 $m^2$

FM45-A 24 units/4F

( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE $(X10^3 RP)$ | COST $(X10^3 RP)$ | SUB TOTAL $(X10^3 RP)$ | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 33.39 | 2497.06 | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 2094.09 | | |
| | Staircase | | | | 277.33 | | |
| Side Wall Work | Window+Door | 13.94 | $m^2$ | 10 | 139.40 | 250.52 | |
| | +Brick exposure Wall | 16.59 | $m^2$ | 6.7 | 111.12 | | |
| Partition Work | Door+Partition Wall | 12.35 | $m^2$ | 3.0 | 37.05 | 37.05 | |
| BATACO Work | Wall between Houses<br>+End Wall<br>WC/M Wall | 45.1 | $m^2$ | 2.0 | 90.20 | 90.20 | |
| Mortar Plaster Work | Inside Floor Mortar | 12.30 | $m^2$ | 0.7 | 8.61 | 32.11 | |
| | Waterproof Mortar | 18.58 | $m^2$ | 1.05 | 19.51 | | |
| | Outerwall Plaster | 6.65 | $m^2$ | 0.6 | 3.99 | | |
| Floor Work | Wooden Floor | 22.56 | $m^2$ | 6.8 | 153.37 | 194.37 | |
| | Inside Stairs | | | | 41.0 | | |
| Miscellaneous Work | Roof | 14.39 | $m^2$ | 7.0 | 100.72 | 216.79 | |
| | Handrail | | | | 48.36 | | |
| | Wooden Louver | | | | 13.79 | | |
| | Stair Finnish | | | | 38.05 | | |
| | Gutter | 2.8 | m | 3.0 | 8.4 | | |
| | Alcove Ceiling | 3.06 | $m^2$ | 2.44 | 7.47 | | |
| Equipment | Water Closet | 1 | Pc | | 15.30 | 15.30 | |
| | Water Tub | 1 | Pc | | | | |
| | Kitchin Sink | 1 | Pc | | | | |
| Building Total | | | | | | 3,333.40 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.00 | |
| Sub Total | | | | | | 3,404.01 | |
| Overhead | | | | | | 340.4 | |
| Grand Total | | | | | | 3,744.41 | |

| | | | |
|---|---|---|---|
| Cost/Gross Floor Area$(10^3 Rp/M^2)$ | 65.12 | Cost/Net Floor Area$(10^3 RP/M^2)$ | 77.77 |

Gross Floor Area 57.50 $m^2$

Net Floor Area 48.15 $m^2$

FM45- A 24unit/4F ( COST/HOUSING UNIT )

| SECTION | ITEMS | VOLUME | UNIT | UNIT PRICE ($X10^3RP$) | COST ($X10^3RP$) | SUB TOTAL ($X10^3RP$) | NOTE |
|---|---|---|---|---|---|---|---|
| Structural Work | Earth Work | | | | 33.39 | | |
| | Pile Driving | | | | 92.25 | | |
| | Foundation+ Structure | | | | 1833.57 | 2236.54 | |
| | Staircase | | | | 277.33 | | |
| Side Wall Work | Window+Door | 13.94 | $m^2$ | 10.0 | 139.40 | | |
| | +Brick exposure Wall | 16.59 | $m^2$ | 6.7 | 111.12 | 250.52 | |
| Partition Work | Door+Partition Wall | 12.35 | $m^2$ | 3.0 | 37.05 | 37.05 | |
| Wall Work | Wall between Houses +End Wall | 34.24 | $m^2$ | 10.2 | 349.25 | 404.64 | W5 Wood stud +FCB t=15 both side |
| | WC/M Wall | 10.86 | $m^2$ | 5.1 | 55.39 | | |
| Mortar Plaster Work | Inside Floor Mortar | 12.30 | $m^2$ | 0.7 | 8.61 | | |
| | Waterproof Mortar | 18.58 | $m^2$ | 1.05 | 19.51 | 32.11 | |
| | Outerwall Plaster | 6. 65 | $m^2$ | 0.6 | 3.99 | | |
| Floor Work | Wooden Floor | 22.56 | $m^2$ | 6.8 | 153.37 | 194.37 | |
| | Inside Stair | | | | 41.0 | | |
| Miscellaneous Work | Roof | 14.39 | $m^2$ | 7.0 | 100.72 | | |
| | Handrail | | | | 48.36 | | |
| | Wooden Louver | | | | 13.79 | 216.79 | |
| | Stair Finnish | | | | 38.05 | | |
| | Gutter | 2.8 | m | 3.0 | 8.4 | | |
| | Alcove Ceiling | 3.06 | $m^2$ | 2.44 | 7.47 | | |
| Equipment | Water Closet | 1 | pc | | | | |
| | Water Tub | 1 | pc | | 15.30 | 15.30 | |
| | Kitchin Sink | 1 | pc | | | | |
| Building Total | | | | | | 3,387.32 | |
| Plumbing | | | | | | 60.61 | |
| Temporary Work | | | | | | 10.0 | |
| Sub Total | | | | | | 3,457.93 | |
| Overhead | | | | | | 345.79 | |
| Grand Total | | | | | | 3,803.72 | |
| Cost/Gross Floor Area($10^3$ Rp/$M^2$) | | 66.15 | Cost/Net Floor Area($10^3$RP/$M^2$) | | | 79.0 | |

Gross F.A 57.50 $m^2$

Net F.A 48.15 $m^2$