CHAPTER 9

DESIGN AND CALCULATION

Seperated system is adopted in this scheme. The sewerage system would be laid at the edge of roads adjacent to the footpath. Some parts of existing system has still used for the drainage system by the storm water is drained to nearest main klongs. The drainage system would be placed under the footpath. By this way the traffic congestion is eliminated. A lot of money has to spend in these works consequently the area under consideration would be smaller. The area for this scheme, 33 km^2 is considered enough for the community needed which is shown in Figure 17. The septic tank has still utilized in the outside of sewerage area.

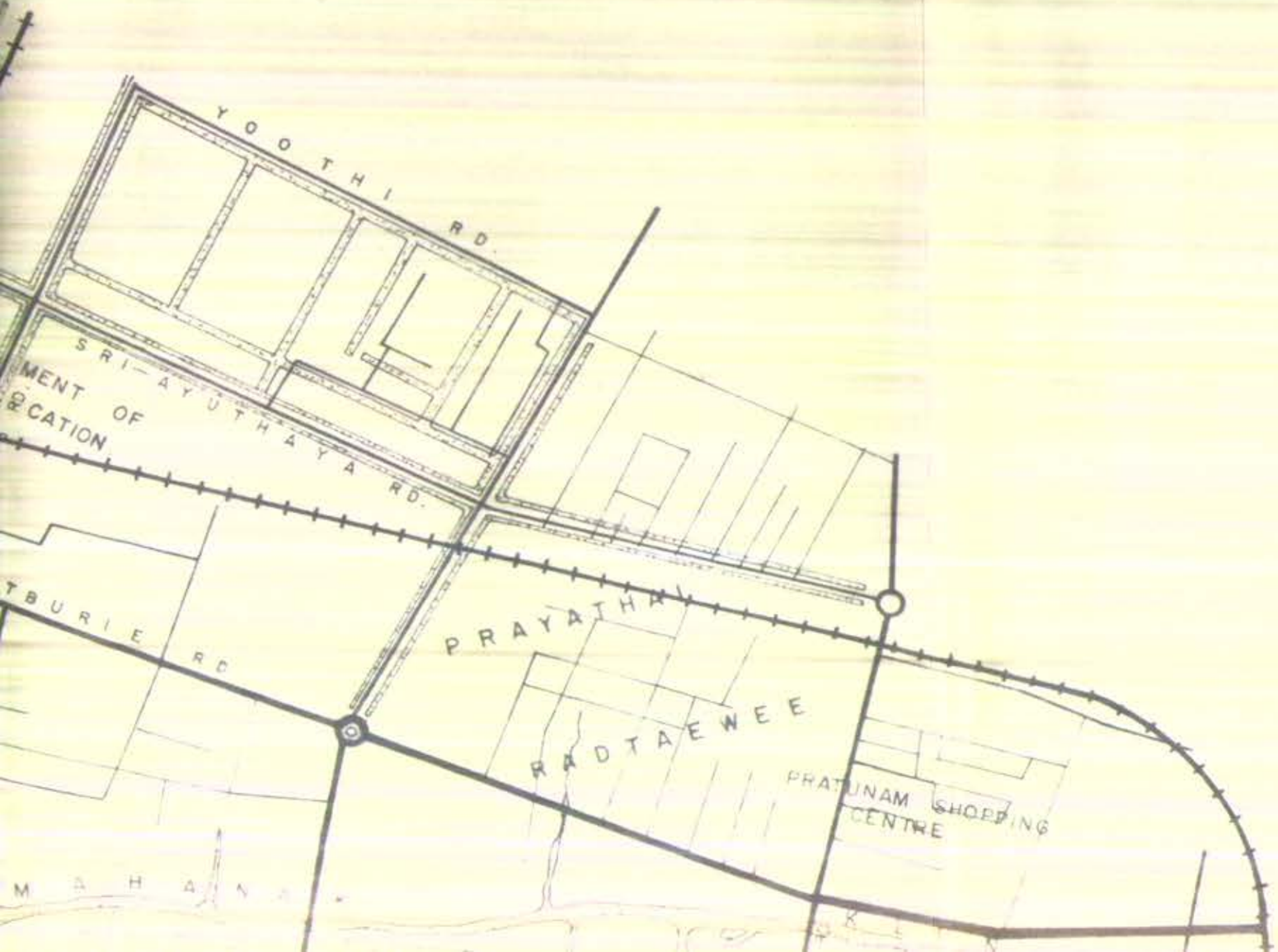
SANITARY SEWERS

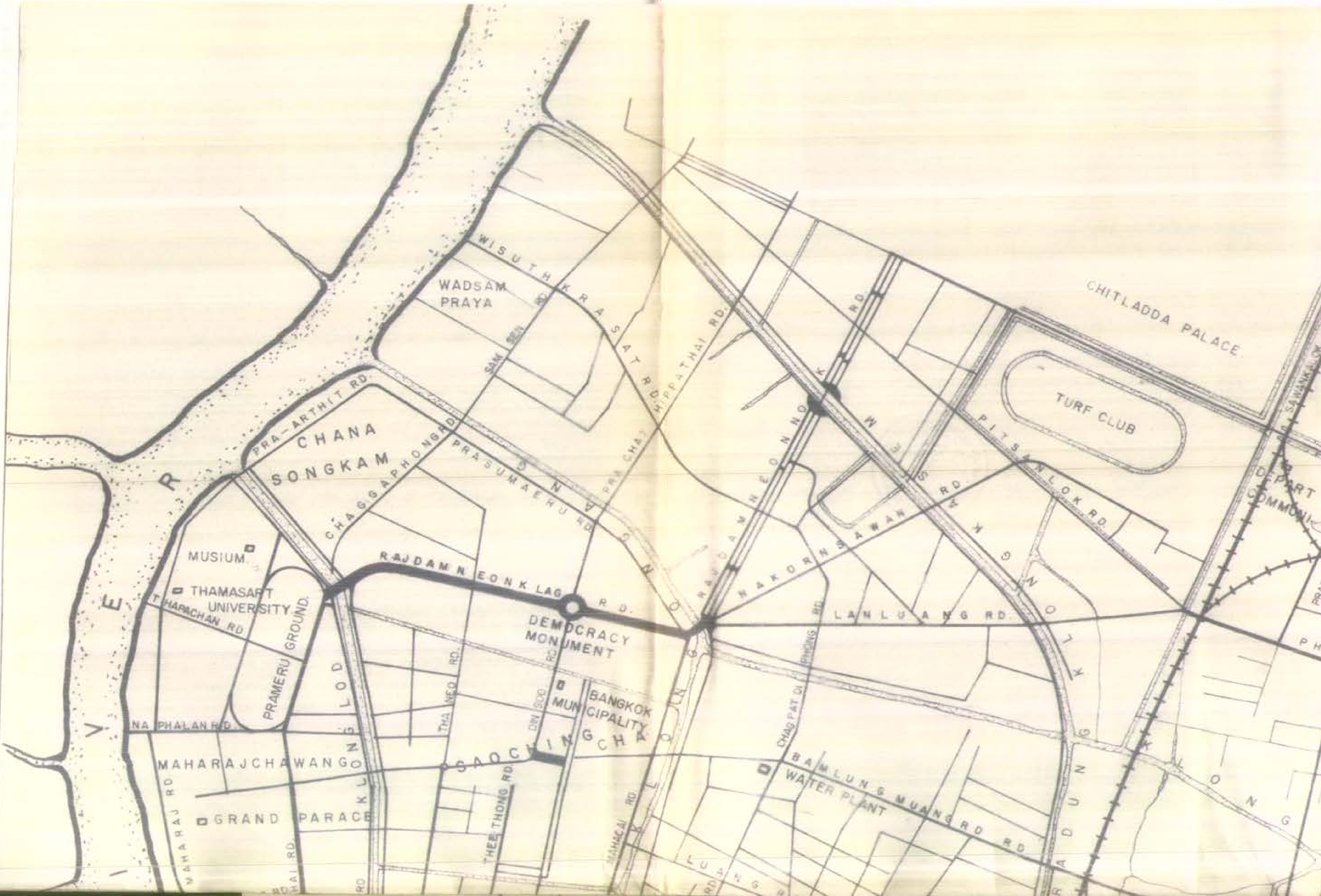
According to following the Litchfield concept that the population in the metropolitan area would hold in the limit of 4.5 million people. The Land Use prepared by Litchfield for 4.5 million people is brought for design in this scheme. Figure 18 shows the separated area of commercial, institution etc. Population intensity can be found from Table 4.

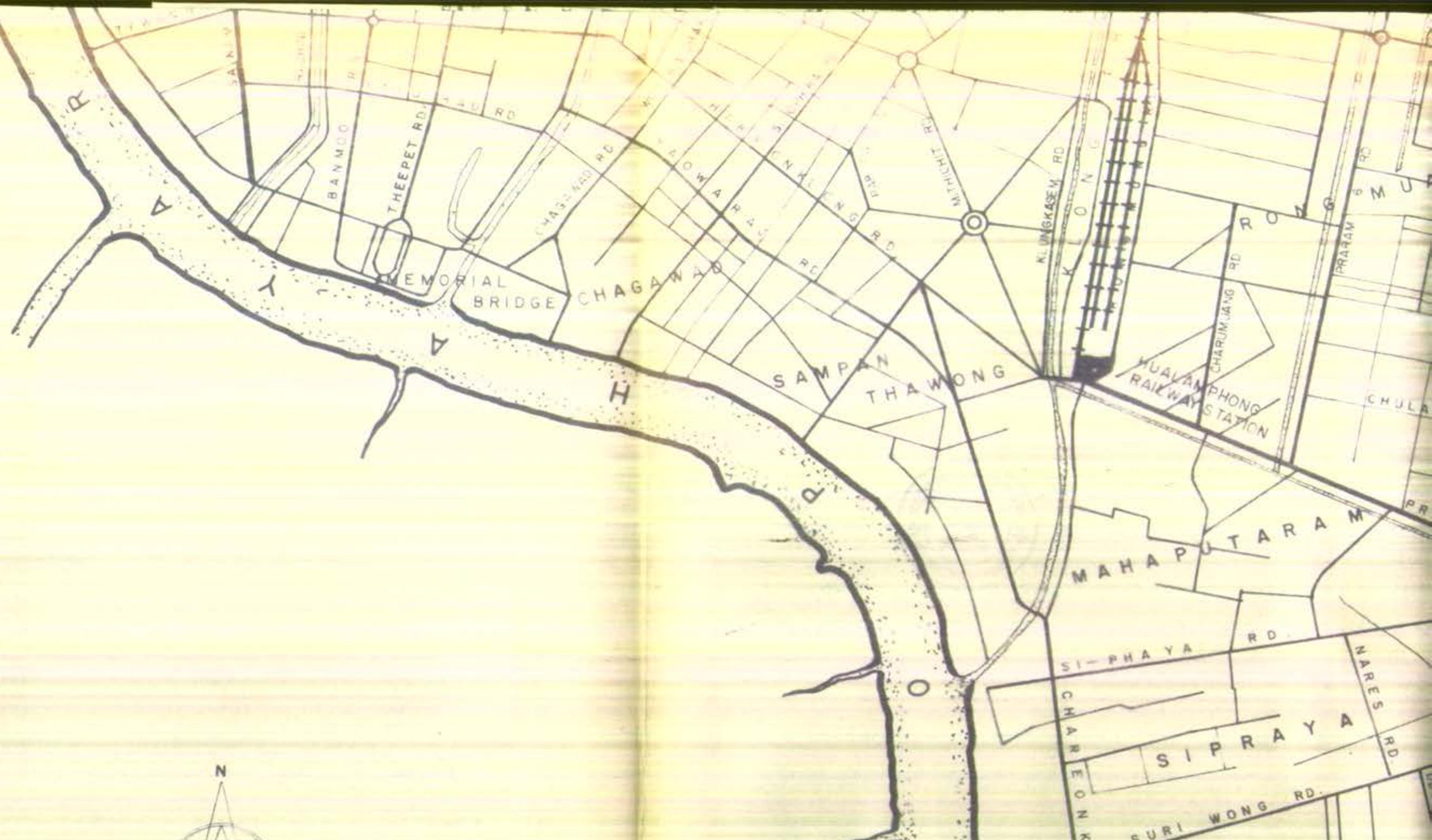
Site of Treatment Plant

It would be located at the end of Klong Chong Nonsi and near Chao Phraya River. This site considered very suitably which the reasons are as following:-

1. It is close to the community about 5.5 kilometres from the centre of the city.


Y O O T H I
R D .
S R I – A Y U T H A Y A R D .
M E N T O F
C A T I O N
T B U R I E R D
P R A Y A T H A I
R A D T A E N E E
P R A T U N A M S H O P P I N G
C E N T R E
M A H A N A K


CHITLADDA PALACE
TURF CLUB
WADSAM PRAYA
WISUTH KRASAT RD.
SAM SEN RD.
CHANA SONGKAM
PRA-ARTHIT RD.
CHAGGAPHONGRD.
PRASUMAERU RD.
RAJDAMNEON NOK RD.
NAKORNSAWAN RD.
PITSANLOK RD.
MUSIUM
THAMASART UNIVERSITY
THAPACHAN RD.
PRAMERU GROUND.
RAJDAMNEONK LAG RD.
DEMOCRACY MONUMENT
LANLUANG RD.
BANGKOK MUNICIPALITY
THA NEO RD.
DIN SOO RD.
NA PHALAN RD.
MAHARAJCHAWANG
SAOCHINGCHA
GRAND PARACE
MAHARAJ RD.
THEE THONG RD.
MAHACHAI RD.
CHAGGAPATDIPHONG RD.
BAMLUNGMUANG RD.
WATER PLANT



100 0 200 400
50 100 300 500

SEALE 1: 12,500

AREA UNDER CONSIDERATION FOR SEWERAGE AND DRAINAGE SYSTEM IN BANGKOK - THONBURI

PRATUMWAN
POLICE DEPARTMENT
ERAWAN HOTEL
PHEON CHIT RD.
CHULA SOI 12
HENRI DUNANT RD
SPORT CLUB
RAJ DAMRI RD
LUMPINI
WITHAYU RD
CHULALONGKORN UNIVERSITY
PHAYA THAI RD
CHULA SOI 14
WATER PLANT.
CHULA HOSPITAL
LUMPINEE PARK
SAP RD.
PATPHONG RD.
CONVAN RD
SALADANG SOI
LOM
SUAN HAMFK
TONGMA
NGARMDUPHI RD
SRIBAMPEN RD

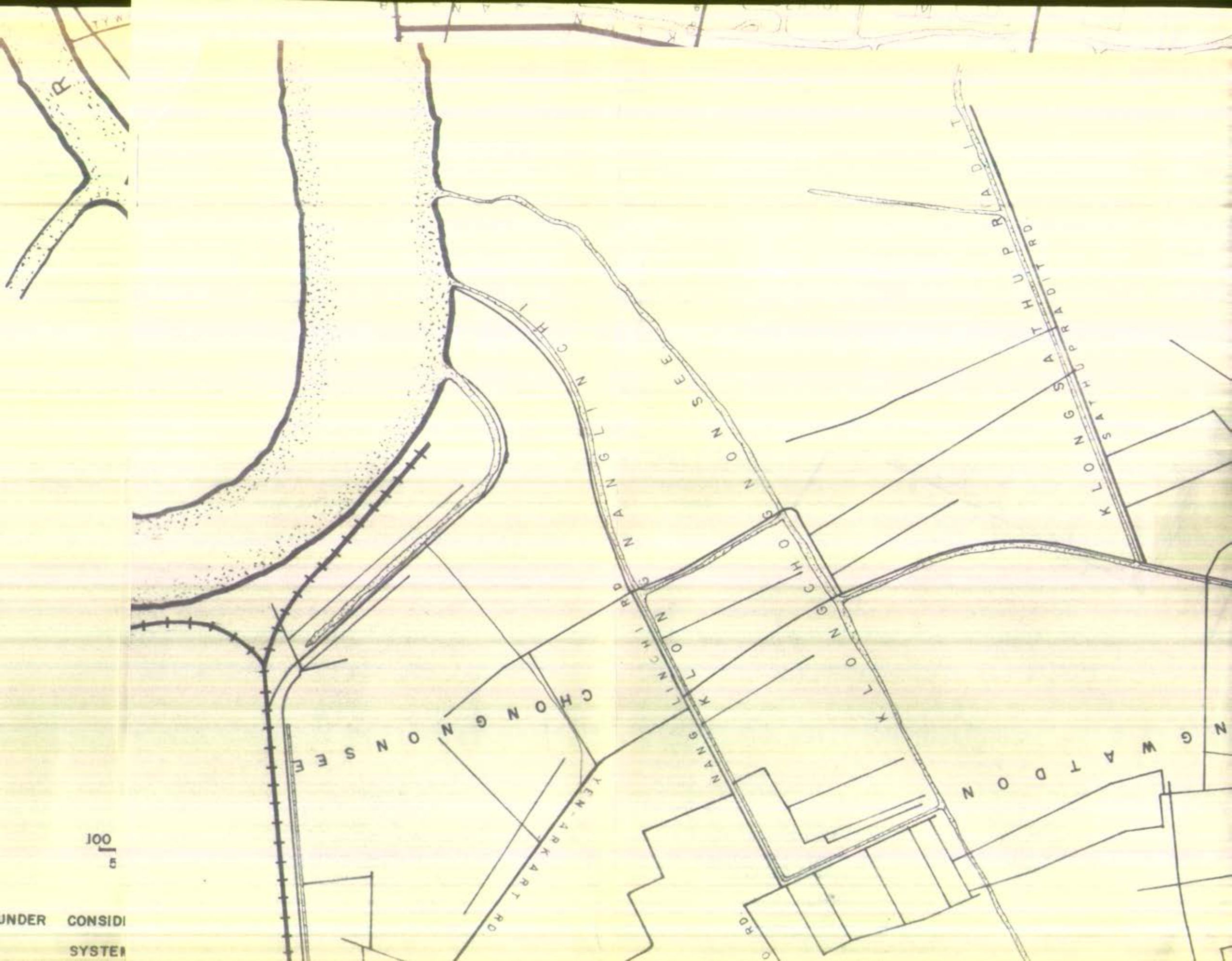
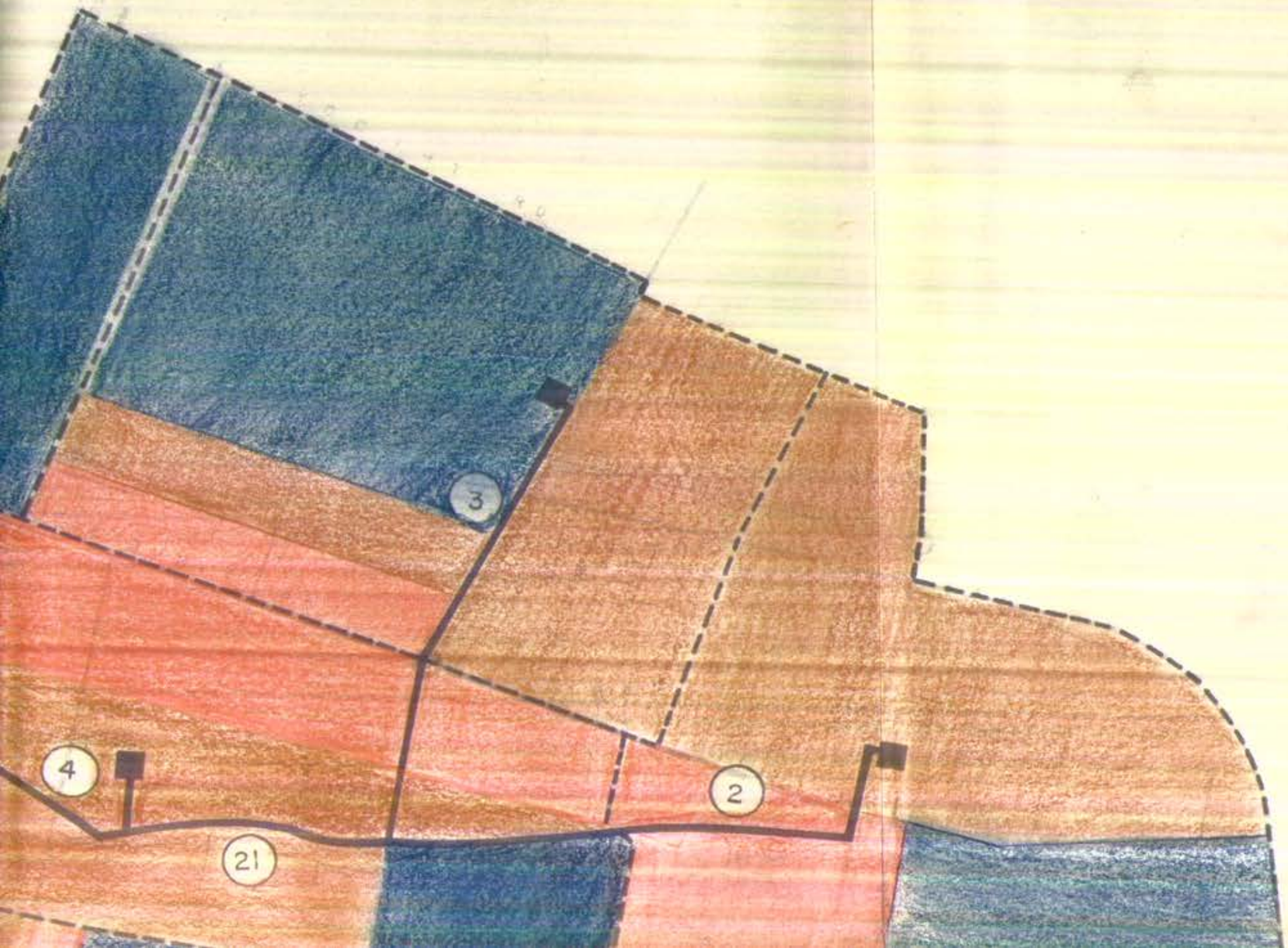
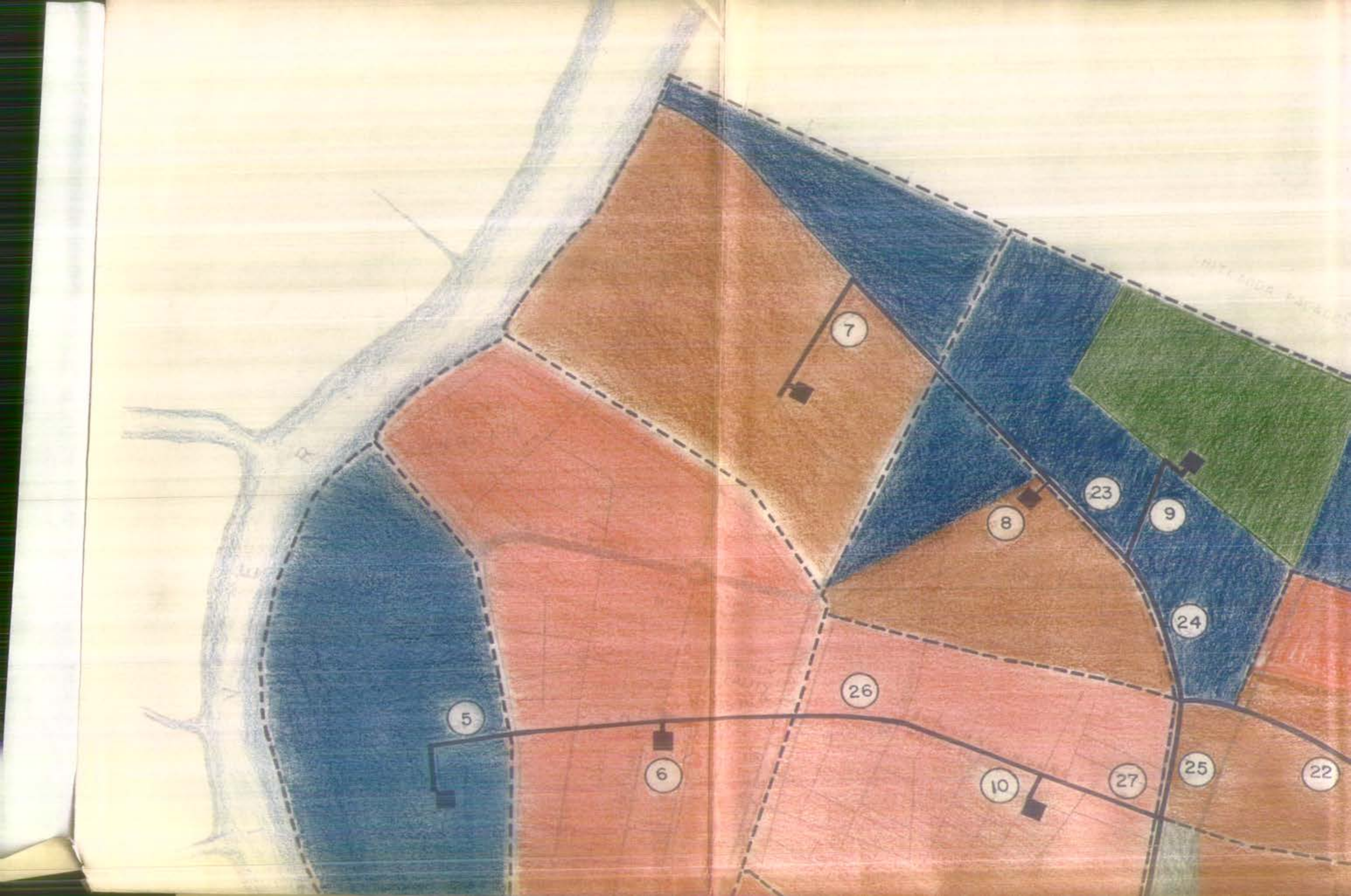

CHONGNONSEE
YEN-AKART RD
NANGLINCHI RD
SATHUPRADIT RD
KLONGTOEY
NGWATDON
100
5
UNDER CONSIDI
SYSTEI

FIGURE 17


3
4
2
21


7
23
9
8
24
26
5
6
10
27
25
22

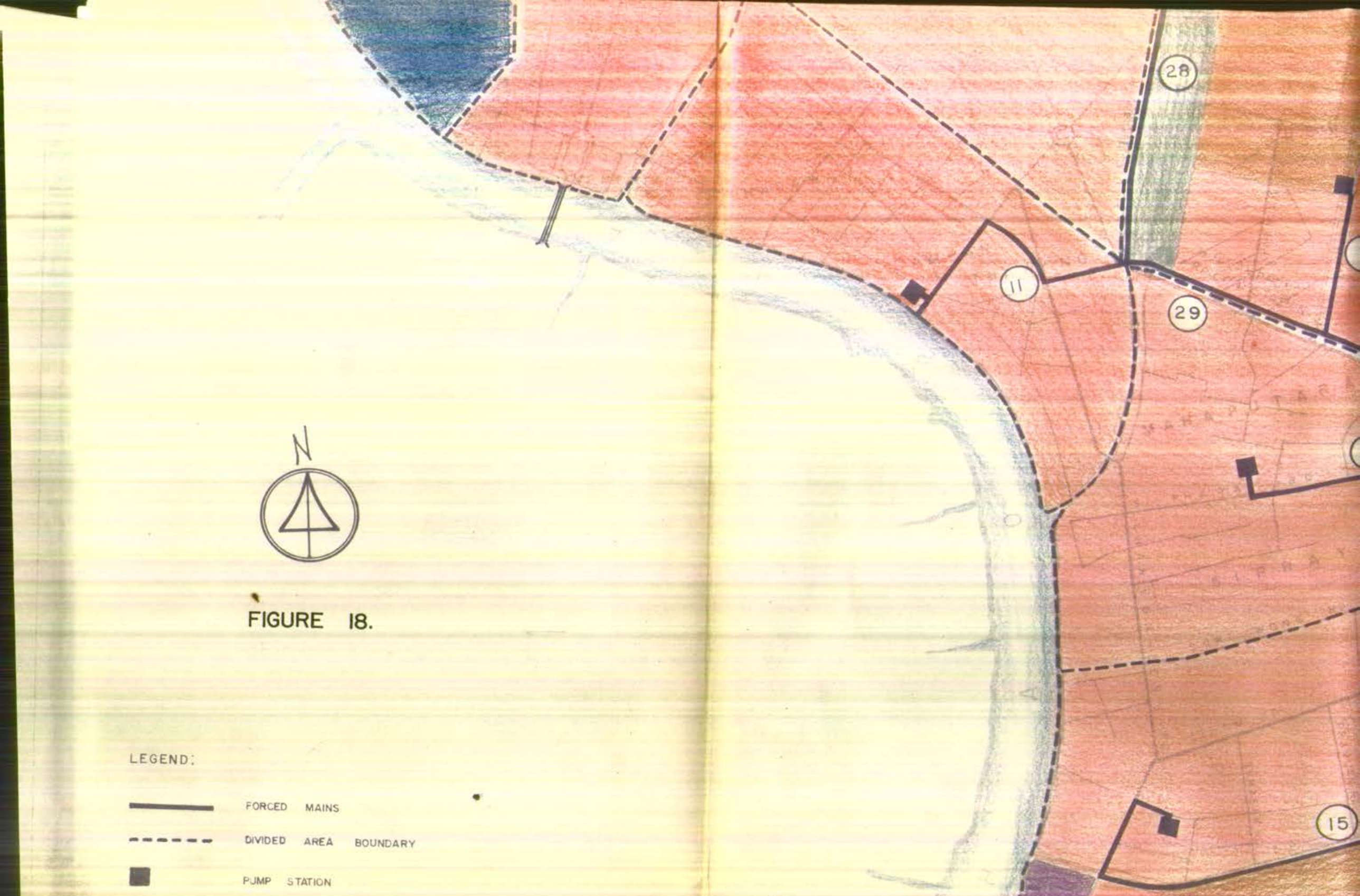


FIGURE 18.

LEGEND:

FORCED MAINS

DIVIDED AREA BOUNDARY

PUMP STATION


13
12
30
31
32
16
33
34
1

19

18

35

20

36

SEWAGE TREATMENT PLANT

(1) NUMBER OF FORCED MAINS

COMMERCIAL

INSTITUTIONAL

UTILITY

HIGH RESIDENTIAL

MEMIUM RESIDENTIAL

LOW RESIDENTIAL

17

LOCATIONS OF FORCDED MAINS

100 0 200 400
50 100 300 500
SCALE 1:12500

2. It gives minimum nuisance for that site is in the plantation area.

3. Due to selected area being in the plantation area so the land cost is rather cheap.

4. The saline water does not influence in dumping the treated sewage because it is far away from the sea. The distance from the community along the river is very far about 18 kilometres from Memorial Bridge.

Design Of Foreed Main

The general principle concept required to convey the waste water to selected sumps with pumps by gravity flow as possible as it can. The pump will convey the waste water into the forced main and continually bring it to treatment plant. It is very difficult to limit the boundary of divided areas. If the divided area is very large the sumps and sewers must be deep. On the other hand the small area required many pumps and the later is its difficult to select the site of various pump. The divided areas are shown in map is about 1.56. kilometre. The location of pumps was selected by going to see it and considering it would be possible to lay out. The forced main are usually laid at the main roads and at the edge of main klongs. Figure 18 is shown various pumps and forced main sewers.

1. Determine the Designed Domestic Sewage

average water consumption = 65 gapd

maximum daily flows = 2xaverage daily flow

= 2x65 = 130 gcpd

extreme maximum flows = 1½xmax. daily flow

= 1.5x130 = 195 gcpd

for industrial plus 15 % = 195x1.15 = 214 gcpd

Factors due to wrong connections of storm water, fluctuation of the population which do not follow the land use of city planning and other factors plus 20 %

= 214x1.20 = 269 gcpd

domestic sewage = 70 % of water consumption

= .70x269 = 188 gcpd

[2]infiltration plus 10 % = 188x1.10 = 207 gcpd

so that designed domestic sewage = 207 gcpd

approximately =.4.55xD.W.F.

How to Select the Area for Calculation

Selected area for the calculation that is shown in Figure 19 is very suitable to represent all of sewerage area because it includes commercial area, institutional area, residential area and utility. Moreover this service area is considerably saturated in the peroid of forecast. Lanes,

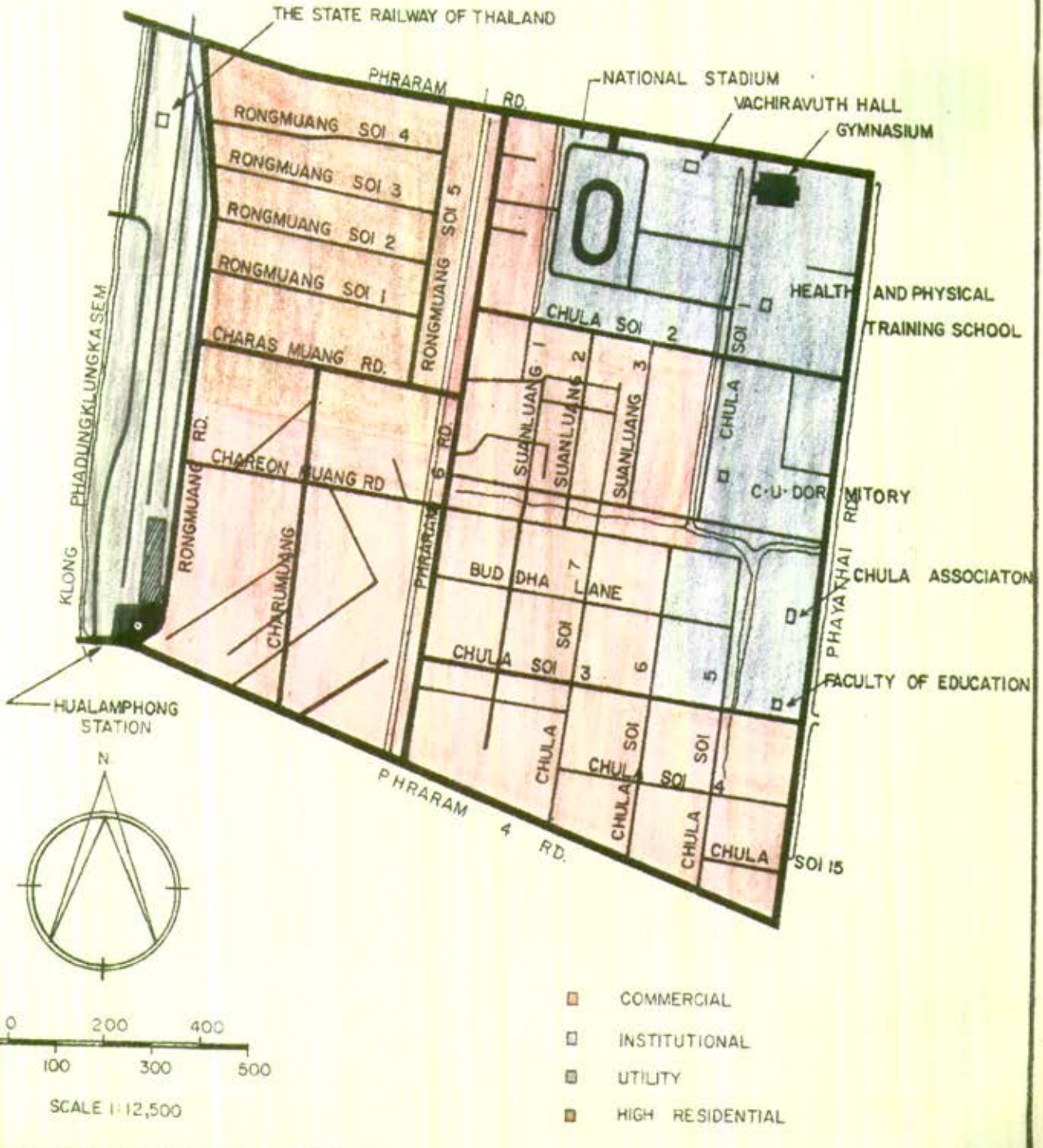
---

[1]Gordon M. Fair and John C. Geyer, Water Supply and Wastewater Disposal (New York: John Wiley & Sons, Inc., 1954), p. 426.

[2]Vichai Pakdeedindan, Report on Sewerage and Drainage Disposal in Bangkok (Engineering Division, Department of Town & Country Planning)

FIGURE 19

SELECTED AREA OF SAMPLE CALCULATIONS FOR SEWERAGE IN BANGKOK — THONBURI



roads and buildings are up to standard and the alignment of road seems to be under the planning by Bangkok Municipality for the similarity of their lengths such as the length of adjacent roads are nearly equal.

[3]EXAMPLE OF CALCULATIONS FOR FORCE MAINS

Design of Sewer No.1

Location of Sewer	Phraram 6 road	
The length of sewer	= 500	metres
Service area: 1. Utility	= 146	rais
2. Institutional	= 287	"
3. Commercial	= 524	"
4. Residential	= 300	"
Total population	= (146x4+287x12+524 x46+300x50)	persons
	= 43124	"
Designed domestic sewage	= 207	gpd
Total domestic sewage	= 43124x207	"
	=,8,940,000	"

For sewer under pressure using Hazen-Williams Formula

$$v = 1.318\ Cr^{0.63}s^{0.54}$$

$$Q(mgd) = 0.279\ CD^{2.63}s^{0.54}$$

---

[3]Gordon M. Fair and John C. Geyer, Water Supply and Wastewater Disposal (New York: John Wiley & Sons, Inc., 1954). p. 305.

Q = rate of discharge in mgd.

D = diameter of conduits in ft.

v = average velocity of flow in fps.

s = hf/l = slope of hydraulic gradient, or loss of head, hf in ft in a conduit of length l in ft.

C = the Hazen-Williams coefficeint.

In disign used the value of [4]C = 130 for uncertain concrete conduits (asbestos cement). Assuming that the asbestos cement sewers can receive with high resistance even the velocity in the sewers is in range [5]8-10 fps (depend on the recomendation of sewer). Consequently design criteria of velocity must be in the range 8-10 ft per sec.

when Q = 8.94 gpd

try ϕ 16"

$Q = 0.279\ CD^{2.63}s^{0.54}$

$8.94 = 0.279 \times 130 \left(\frac{16}{12}\right)^{2.63} s^{0.54}$

$s^{0.54} = \frac{8.94}{0.279 \times 130 \times 2.12}$

$= .115$

$n = .018$

---

[4]ibid p. 306.

[5]ibid p. 62.

So that head loss in pipe 550 metres $= \frac{.018 \times 550}{1000}$

$= 9.90$ m.

$= .018 \times 550$

$v = 1.318\ Cr^{0.63} s^{0.54}$

$= 1.318 \times 130 \frac{(16)}{12 \times 4}^{0.63} (.018)^{0.54}$

$= 1.318 \times 130 \times .50 \times 115$

$= 9.85$ fps.

$= 2.99$ mps.

Illustrative computation for forced main are shown in Table 16,17,18.

[6] EXAMPLE OF CALCULATION IN SELECTED AREA

Design of Sewer $a_1 a_2$

Length of sewer = 150 metres

Service area (commercial) = 8.5 rais

Equivalent population of commercial area = person/rai

Total population = 8.5 x 46 = 391 persons

The designed domestic sewage = 207 gcpd

Total sewage which the sewer received = 391x207 gpd

$= \frac{391 \times 207}{7.48 \times 24 \times 60 \times 60}$ cfs

$= .125$

Manning's Formula

$$v = \frac{1.486\ r^{2/3} s^{1/2}}{n}$$

v = velocity

---

[6] Ibid p. 399.

TABLE 16 [illegible]

NO. OF SEWER	LOCATION OF SEWER	COMMERCIAL rai	INSTITUTIONAL rai	HIGH RESIDENTIAL rai	UTILITY rai	[illegible]	[illegible] mgd	[illegible] m	[illegible] in	[illegible] m	[illegible] mps
1	PHRARAM 6 RD.	524	287	300	146	43,124	8·96	550	16	9·90	2·98
2	KLONG MAHANAK	210	480	620	—	46,420	9·65	1400	18	14·70	2·46
3	PHRAYATHAI RD.	80	523	430	—	31,456	6·55	1200	15	15·60	2·50
4	KLONG MAHANAK	—	140	940	—	48,680	10·15	200	36	4·00	3·04
5	PHRAMERU GROUND	—	790	—	—	9,500	1·98	1050	10	10·50	1·68
6	SAO CHING CHA	1455	—	—	—	6,700	13·90	150	20	2·00	2·90
7	PHRACHATHIPOK RD.	—	277	792 m	—	22,330	4·64	1450	14	14·50	2·05
8	KRUNG KASEM RD.	—	143	307 m	—	9,120	1·90	150	8	4·05	2·47
9	KLONG PHADJNG – KRUNGKASEM RD.	—	549	—	455 r	8,061	1·68	550	8	12·10	2·22
10	SAO PHA RD.	1115	—	—	—	51,300	10·65	150	18	1·89	2·69
11	YAOWARAJ RD.	815	—	—	—	37,500	7·80	1100	16	14·30	2·54
12	KLONG PHASINGTO	—	1475	—	330 r	18,840	3·91	1200	12	18·00	2·34

REMARKS: m = medium residential.

l = low residential.

r = [illegible]

TABLE 17 ILLUSTRATIVE COMPUTATION FOR [illegible]

NO. OF SEWER	LOCATION OF SEWER	COMMERCIAL roi	INSTITUTIONAL roi	HIGH RESIDENTIAL roi	UTILITY roi	POPULATION	VOL. OF SEWAGE mgd	LENGTH m	SIZE in	HEAD LOSS m	VELOCITY mps
13	KLONG PHAISINGTO	150	605	—	250[r]	14,910	3·10	1100	12	11·00	1·93
14	SIPHRAYA RD	1035	—	—	—	47,600	9·90	1050	18	11·00	2·50
15	KLONG NORTH SAYHROM	1230	—	—	—	56,600	11·75	2100	20	20·00	2·46
16	KLONG CHONGNONSI	985	—	—	—	45,000	9·35	150	16	2·63	2·96
17	TOK DONKUSOL	—	—	752	—	31,600	6·55	1500	16	20·01	3·50
18	YEN ARKARD RD	—	—	1550[l]	—	18,600	3·87	1650	14	11·60	1·75
19	KLON CHONGNONSI	—	—	1130[m]	—	27,200	5·65	150	14	2·02	2·46
20	TOK CHAN RD	—	—	1240[m]	—	30,000	6·24	1150	14	19·00	2·69
21	KLONG MAHANAK	290	1003	1050	—	77,876	16·20	600	22	6·36	2·81
22	KLONG MAHANAK	290	1143	1990	—	126,556	26·35	1100	28	9·90	2·98
23	KLONG PHADUNG KRUNGKASEM	—	420	1099[m]	—	31,416	6·64	400	14	7·40	2·64
24	KLONG PHADUNG KRUNGKASEM	—	969	1099[m]	455[r]	39,824	8·22	550	15	11·00	2·76

REMARKS: m = medium residential,

l = low residential,

r = recreation.

TABLE 18 ILLUSTRATIVE COMPUTATIONS FOR FORCED MAINS

NO OF SEWER	LOCATION OF SEWER	COMMERCIAL rai	INSTITUTIONAL rai	HIGH RESIDENTIAL rai	UTILITY rai	POPULATION	VOL OF SEWAGE mgd	LENGTH m	SIZE in	HEAD LOSS m	VELOCITY mps
25	KLONG PHADUNG KRUNG KASEM	290	2112	1990 m 1099 m	455 r	186,101	34·57	500	30	4·6	3·18
26	BAMRUNGMUANG RD	1455	750	—	—	76,500	15·88	1100	22	11·5	2·78
27	BAMRUNGMUANG RD	2570	750	—	—	127,800	26·53	550	28	4·87	2·93
28	KLONG PHADUNG KRUNG KASEM	2360	2902	1990 m 1099 m	455 r	293,901	61·11	1250	42	3·25	2·99
29	PHRARAM 4 RD	3675	2902	1990 m 1099 m	455 r	331,401	68·91	700	42	4·55	3·17
30	PHRARAM 4 RD	4199	3189	2290 m 1099 m	146 r 455	374,525	77·87	900	48	4·03	2·77
31	KLONG CHONGNONSI	4349	5269	2290 m 1099 m	146 r 455	408,275	84·88	250	48	1·32	3·08
32	KLONG CHONGNONSI	5384	5269	2290 m 1099 m	146 r 455	455,905	94,78	700	48	4·54	3·28
33	KLONG CHONGNONSI	6369	5269	2290 m 1099 m	146 r 455	500,905	104·13	500	54	2·65	2·99
34	KLONG CHONGNONSI	7899	5269	2290 m 1099 m	146 r 455	557,505	115·88	1050	54	5·46	3·29
35	KLONG CHONGNONSI	7599	5269	2290 m 2229 m 1550 l	146 r 455	603,305	125·40	800	60	2·80	2·03
36	KLONG CHONGNONSI	7589	5269	2290 m 3469 m 1550 l	146 r 455	633,275	131·19	2500	60	10·90	3·03

REMARKS : m = medium residential.

l = low residential.

r = recreation

r = hydraulic radius

$= \frac{\text{area}}{\text{wetted perimeter}}$

n = Kutter coefficient of friction

For velcity flowing full would be full in the range of 2-3 fps, and the [7] minimum actual velocity would be 2 fps. Using the Kutter coefficient of friction is .015 fro fair interior surface of concrete sewer or asbestor cement sewer. $\not{\text{10}}^{\text{a}}$ -sewer is required for minimum sewers to protect clogging in sewers due to the garbage did not grind such as banana's leaf, paper, branches etc. and decreasing the slope in placing sewers.

For flowing full $v = \frac{1.486\, r^{2/3} s^{1/2}}{n}$

Try $d = \not{\text{10}}^{\text{a}}$, $s = .004$

$r = \frac{\pi}{4} d^2 \frac{\pi}{\pi} d = d/4$

$= \frac{10}{12} \times \frac{1}{4} = .208$

$n = .015$

$v = \frac{1.486(.208)^{.667}(.004)^{.5}}{.015}$ fps.

$= \frac{1.486 \times .351 \times .063}{.015}$ fps.

$= 2.19$ fps.

Q = v4(velocity x cross-sectional area)

---

[7] Joint Committee of the American Society of Civil Engineers and the Water Pollution Control Federation, Design and Construction of Sanitary and Storm Sewers (The American Society of Civil engineers and The Water Pollution Control Federation 1960), p. 135.

$$= 2.19 \times \frac{\pi}{4}\left(\frac{10}{12}\right)^2 = 1.195 \text{ ft}^3$$

$$\frac{q}{Q} = \frac{.125}{1.195} = .105$$

Q = discharge of flowing full

q = discharge of partial flow

From Figure 15-1, page 400 of the book "Water Supply and Waste Water Disposal" by MAIR and GEYER

$$\frac{d}{D} = .23, \frac{v}{V} = .67$$

d = depth in sewer of partial flow

v = velocity in sewer of partial flow

D = diameter of sewer

V = velocity of flowing full

$v = .67 \times 2.19 = 1.47$ approx. 1.5, Use dia. = ϕ10", slope = .004

Figure 20 shows the layout of sewers and direction of flow of sanitary sewers in selected area and illustrative computations for a system of sanitary sewers are shown in Table 19 to 27. Figure 21 showed the section and length of sanitary sewers and Figure 22 sewers added being omitted in calculation.

<u>STORM SEWERS</u>

The purpose of design for the drainage system requires main klongs using for holding basins and open channels. Main klongs are considered for using in design in this scheme namely Klong Lok, Klong Ong-Ang, Klong Phadungkrungkasem, Klong Sathorn and Klong Chong Nonsi. The main sewers which had been constructed instead of Klong Hua Lamphong is combined

FIGURE 20

SELECTED AREA OF SAMPLE CALCULATIONS FOR SEWERAGE IN BANGKOK – THONBURI

LAYOUT AND DIRECTION OF FLOW OF SANITARY SEWERS

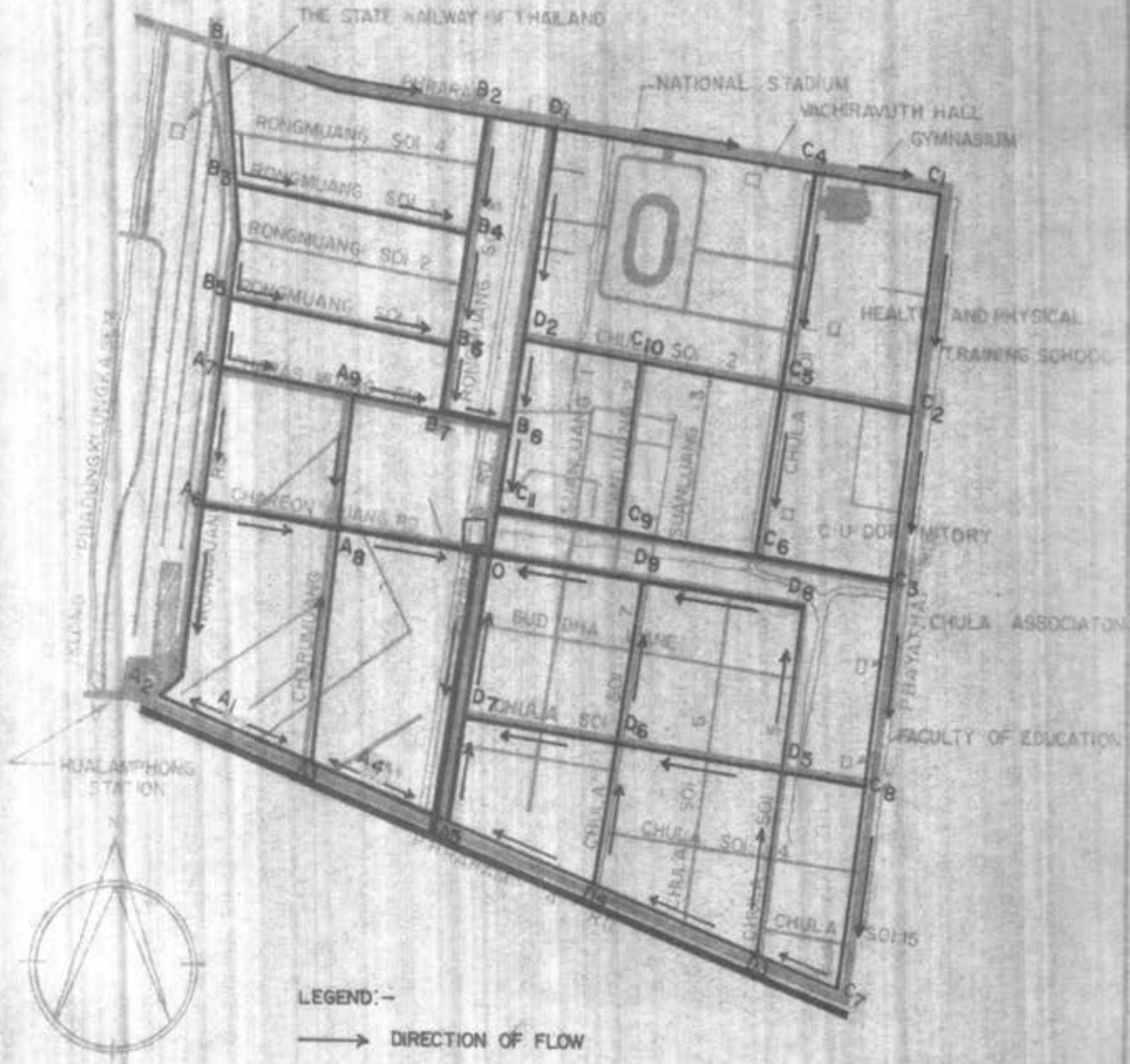


TABLE 19 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMER-CIAL	INSTITU-TIONAL	HIGH RE-SIDENTIAL	UTILITY	COMMER-CIAL	INSTITU-TIONAL	HIGH RE-SIDENTIAL	UTILITY	
A1A2, A1A3 A4A3, A4A5	PHRARAM 4 RD.	8.5	—	—	—	8.5	—	—	—	391
A2 A6	RONGMUANG RD.	8.5	—	—	—	34.1	—	—	42	1345
A6 A7	RONGMUANG RD.	—	—	13	50	—	—	13	50	850
A6 A8	CHAREON MUANG RD.	34.1	—	13	92	47.7	—	26.6	92	3910
A3 A8	CHARUMUANG RD.	17.0	—	—	—	71.0	—	—	—	3262

SEWER	VOLUME OF SEWAGE	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
					FULL	ACTUAL			UPPER END	LOWER END	
	cfs	in		cfs			in	m			
A1A2, A1A3 A4A3, A4A5	.125	10	.004	1.20	2.19	1.50	2.76	150	.75	1.35	1.05
A2 A6	.430	10	.0035	1.12	2.06	1.94	4.40	380	1.35	2.68	2.02
A6 A7	.270	10	.0035	1.12	2.06	1.72	3.40	250	.75	1.61	1.18
A6 A8	1.255	2-12	.0025	1.54	1.97	1.88	5.50	250	2.68	3.31	2.99
A3 A8	1.046	2-12	.0025	1.54	1.97	1.79	4.93	420	1.35	2.40	1.88

TABLE 20 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS.)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	
A9 A8	CHARUMUANG	—	—	13	—	—	—	13	—	650
A8 O	CHAREONMUANG RD.	118 7	—	39.6	92	132.7	—	58.6	92	8458
B1 B2 A7 B7	PHRARAM I RD. CHARAS MUANG RD.	—	—	30	—	—	—	30	—	1500
B1 B3										
B3 B5	LONGMUANG RD.	—	—	10	24	—	—	10	24	596
B3 B4	LONGMUANG SOI 3									
B4 B5	LONGMUANG SOI 1	—	—	10	24	—	—	34	24	2796

SEWER	LENGTH OF SEWER	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
					FULL	ACTUAL			UPPER END	LOWER END	
	m	in		cfs			in	m			
A9 A8	208	10	004	1.20	2.19	1.64	2.85	250	.75	1.75	1.25
A8 O	2 717	2—15	002	2.50	2.05	2.16	8.86	300	88	1.48	1.18
B1 B2	482	12	0025	1.54	1.97	1.65	4.08	550	88	1.48	1.49
B1 B3											
B3 B5	192	10	0035	1.13	2.07	1.57	2.80	250	.75	1.63	1.19
B3 B4											
B5 B6	950	2—12	.0025	1.54	1.97	1.70	4.45	470	1.63	2.80	2.22

TABLE 21 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	
B2 B4	RONGMUANG SOI 5	—	—	30	—	—	—	53	—	2650
B4 B6	RONGMUANG SOI 5	—	—	87	24	—	—	105	24	6346
B6 B7	RONGMUANG SOI 5	—	—	169	39	—	—	178	39	9460
B7 B8	CHARAS MUAMG RD.	—	—	178	39	—	—	185	39	9710
C1 C2	PHAYATHAI ROAD	—	33.7	—	—	—	33.7	—	—	404

SEWER	AVERAGE	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
					FULL	ACTUAL			UPPER END	LOWER END	
	ft	in		cfs			in	m			
B2 B4	85	15	002	2.50	2.05	1.74	6.3	220	2.18	2.62	2.40
B4 B6	2.04	18	.0015	3.52	2.00	2.08	9.9	200	2.80	3.10	2.95
B6 B7	3.04	21	0012	4.80	2.00	2.12	12.4	100	1.16	1.28	1.08
B7 B8	3.11	21	0012	4.80	2.00	2.12	12.4	100	1.16	1.28	1.22
C1 C2	.132	10	.004	1.20	2.19	1.50	2.3	400	0.75	2.35	1.55

TABLE 22 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	
C2 C3	PHAYATHAI RD	—	33.7	—	—	—	59.7	—	—	716
C4 C5	CHULA SOI 1	—	56.0	—	—	—	56.0	—	—	672
C5 C6	CHULA SOI 1	—	—	—	—	30	30	—	—	1740
C7 C8	PHAYATHAI RD.	18	—	—	—	18	—	—	—	830
C8 C3	PHAYATHAI RD.	18	—	—	—	18	18	—	—	902

SEWER	DESIGN PROFILE									
	VOLUME OF SEWAGE cfs	SIZE in	SLOPE	CAPACITY cfs	VELOCITY, fps FULL	VELOCITY, fps ACTUAL	DEPTH OF FLOW in	LENGTH m	INVERT ELEVATION UPPER END	INVERT ELEVATION LOWER END	AVERAGE OF CUT
C2 C3	232	10	0035	1.13	2.07	1.64	3.1	320	2.35	3.47	2.91
C4 C5	.218	10	004	1.20	2.19	1.64	2.9	400	.75	2.35	1.55
C5 C6	.556	10	.0035	1.13	2.07	2.07	5.0	320	.75	1.87	1.31
C7 C8	.266	10	.0035	1.13	2.07	1.70	3.3	400	.75	1.63	1.24
C8 C3	.295	10	0035	1.13	2.07	1.78	3.6	350	1.63	2.75	2.19

TABLE 23 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMER-CIAL	INSTITU-TIONAL	HIGH RE-SIDENTIAL	UTILITY	COMMER-CIAL	INSTITU-TIONAL	HIGH RE-SIDENTIAL	UTILITY	
C3 C6	SUANLUANG	18	77.7	—	—	18	110.7	—	—	2231
C6 C9	SUANGLUANG	48	196.7	—	—	53	196.7	—	—	4800
C10 C9	SUANGLUANG 2	36	—	—	—	36	—	—	—	1660
C9 C11	SUANGLUNG	89	196.7	—	—	94	196.7	—	—	6680
C1 C4	PRARAM I RD	—	30	—	—	—	30	—	—	360

SEWER	VOLUME OF SEWAGE	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
	cfs	in		cfs	FULL	ACTUAL	in	m	UPPER END	LOWER END	
C3 C6	0.715	15	.002	2.50	2.05	1.76	5.56	260	.88	1.40	1.14
C6 C9	1.535	18	.0015	3.52	2.00	1.94	8.35	280	1.40	1.82	1.61
C10 C9	0.530	12	.0025	1.54	1.97	1.79	4.92	320	.80	1.60	1.20
C9 C11	2.140	21	.0012	4.80	2.00	1.90	9.80	250	1.82	2.12	1.97
C1 C4	0.115	10	.004	1.20	2.19	1.40	2.20	240	.75	1.71	1.23

TABLE 24 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	
C4 D1	PHRARAM 1 RD.	—	30	—	—	5	69	—	—	1060
D1 D2	PHRARAM 6 RD.	5	69+56	—	—	7.4	96+56	—	—	2160 + 670
C2 C5	CHULA SOI 2	—	30	—	—	—	30	—	—	360
C5 C10	CHULA SOI 2	—	30	—	—	29	35	—	—	1752
C10 D2	CHULA SOI 2	29	35	—	—	52	35	—	—	2812

SEWER	VOLUME OF SEWAGE cfs	DESIGN PROFILE SIZE in	SLOPE	CAPACITY cfs	VELOCITY, fps FULL	VELOCITY, fps ACTUAL	DEPTH OF FLOW in	LENGTH m	INVERT ELEVATION UPPER END	INVERT ELEVATION LOWER END	AVERAGE OF CUT
C4 D2	.340	12	.0025	1.54	1.97	1.50	3.36	540	1.71	3.06	2.38
D1 D2	.692	15	.002	2.50	2.05	1.72	5.50	400	.88	1.68	1.28
C2 C5	0.115	10	.004	1.20	2.19	1.80	2.20	250	.75	1.75	1.25
C5 C10	.780	12	.0025	1.54	1.97	1.97	6.00	280	2.35	3.05	2.70
C10 D2	.902	15	.002	2.50	2.05	1.88	6.30	250	.88	1.38	1.13

TABLE 25 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	
D2B8	PHRARAM 6 RD.	59·4	104	—	—	60·9	104	—	—	4050
B8C11	PHRARAM 6 RD.	60·9	104	185	39	60·9	104	195	39	—
C7D3 C8D5	PHRARAM 4 RD.	6·0	5	—	—	6·0	5	—	—	336
D3D4	PHRARAM 4 RD.	6·0	5	—	—	27·0	5	—	—	1306
D4A5 D6D7	PHRARAM 4 RD. CHULA SOI 3	—	—	—	—	2·0	—	—	—	920

SEWER	VOLUME OF SEWAGE	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
					FULL	ACTUAL			UPPER END	LOWER END	
	cfs	in		cfs			in	m			
D2B8	1·300	18	·0015	3·520	2·00	1·86	5·16	170	1·68	1·94	1·81
B8C11	4·570	24	·001	6·250	2·00	2·14	15·00	170	1·94	2·11	2·03
C7D3 C8D5	0·108	10	·004	1·195	2·19	1·45	2·00	170	·75	1·43	1·09
D3D4	0·418	12	·0025	1·540	1·97	1·68	4·32	340	1·43	2·28	1·86
D4A5 D6D7	·295	10	·0035	1·13	2·07	1·78	3·6	320	·75	1·87	1·31

TABLE 26 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	COMMERCIAL	INSTITUTIONAL	HIGH RESIDENTIAL	UTILITY	
D3D5	CHULA SOI 5	39	—	—	—	39	—	—	—	1792
D5D8	CHULA SOI 5	—	—	—	—	18	15	—	—	1010
D8D9	CHAREON MUANG RD	18	15	—	—	36	15	—	—	1840
D9 0	CHAREON MUANG RD	72	15	—	—	90	15	—	—	4320
A5D7	PHRARAM 6 RD	20	—	—	—	39	—	—	—	1790

REACH	LENGTH OF DRAINAGE	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
					FULL	ACTUAL			UPPER END	LOWER END	
		in		cfs			in	m			
D3D5	·575	2 — 10	·0035	1·13	2·07	1·78	3·6	370	·75	2·05	1·40
D5D8	·324	2 — 10	·0035	1·13	2·07	1·50	2·6	300	·75	1·80	1·28
D8D9	·590	12	·0025	1·54	1·97	1·83	5·15	300	1·80	2·55	2·18
D9 0	1·40	18	·0015	3·52	2·00	1·90	6·0	300	2·55	2·94	2·80
A5D7	·574	12	0025	1·54	1·97	1·82	5·15	220	1·87	2·42	2·15

TABLE 27 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF SANITARY SEWERS

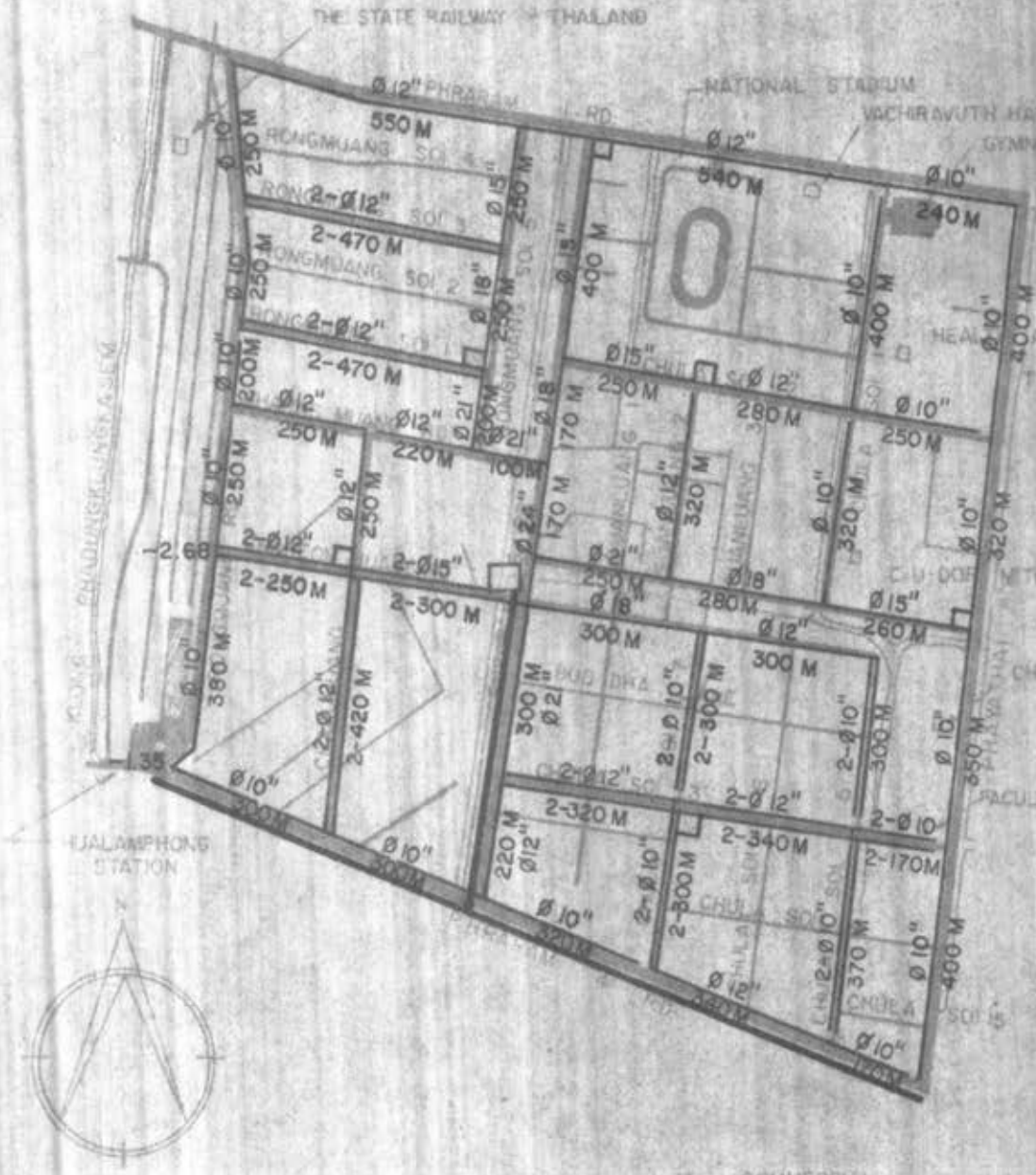
SEWER	LOCATION OF SEWER	ADJACENT AREA (RAIS)				TOTAL TRIBUTARY AREA (RAIS)				POPULATION
		COMMER-CIAL	INSTITU-TIONAL	HIGH RE-SIDENTIAL	UTILITY	COMMER-CIAL	INSTITU-TIONAL	HIGH RE-SIDENTIAL	UTILITY	
D7 O	PHRARAM 6 RD.	159	5	—	—	194	5	—	—	9060
CII O	PHRARAM 6 RD.	154.9	300.7	195	39	154.9	300.7	195	39	20736
D5D6	CHULA SOI 3	6+39	5	—	—	48+39	5	—	—	4060
D6D7	CHULA SOI 3	120	5	—	—	160	5	—	—	—

SEWER	VOLUME OF SEWAGE	DESIGN PROFILE								
		SIZE	SLOPE	CAPACITY	VELOCITY, fps		DEPTH OF FLOW	LENGTH	INVERT ELEVATION		AVERAGE OF CUT
	cfs	in		cfs	FULL	ACTUAL	in	m	UPPER END	LOWER END	
D7 O	2.88	21	.0012	4.80	2.0	2.10	12.3	300	2.42	2.78	2.60
CII O	6 65	24	.0009	8.0	2.02	2.27	18.6	70	2.11	2.17	2.13
D5D6	1. 30	2-12	.0025	1.54	1.97	1.89	5.7	340	2.05	2.90	2.48
D6D7	2 38	2-15	.002	2.50	2.05	1.97	7.2	340	.75	1.43	1.09

FIGURE 21

SELECTED AREA OF SAMPLE CALCULATIONS FOR SEWERAGE IN BANGKOK - THONBURI

SECTION AND LENGTH OF SANITARY SEWER



I COMMERCIAL

INSTITUTION

UTILITY

HIGH

Ø 10" – 500 m

Ø 10" – 490 m

Ø 10" – 490 m

Ø 10" – 470 m

Ø 10" – 470 m

Ø 10" – 460 m

Ø10" – 460 m

Ø 10" – 460 m

Ø10" – 460 m

Ø 10" – 160 m

Ø 10" – 250 m

Ø12" – 250 m

Ø10" – 250 m

Ø12" – 250 m

Ø 10" – 200 m

Ø 10" – 320 m

Ø 15" – 300 m

Ø 21" – 100 m

Ø12" – 120 m

Ø15" – 140 m

Ø18" – 140 m

Ø12" – 560 m

Ø21" – 160 m

Ø21" – 240 m

Ø12" – 560 m

Ø15" – 200 m

Ø15" – 200 m

Ø18" – 240 m

Ø21" – 160 m

Ø12" – 140 m

Ø12" – 140 m

Ø12" – 560 m

Ø15" – 200 m

Ø10" – 200 m

Ø10" – 200 m

Ø15" – 160 m

Ø15" – 160 m

Ø10" – 240 m

Ø10" – 240 m

Ø10" – 240 m

Ø10" – 240 m

Ø10" – 160 m

Ø10" 160 m

Ø10" – 160 m

Ø10" – 160 m

Ø10" – 160 m

Ø10" – 160 m

Ø10" – 180 m

Ø10" – 180 m

Ø12" – 560 m

Ø10" – 240 m

Ø10" – 400 m

Ø10" – 400 m

Ø12" – 400 m

Ø12" – 400 m

Ø10" – 240 m

Ø10" – 240 m

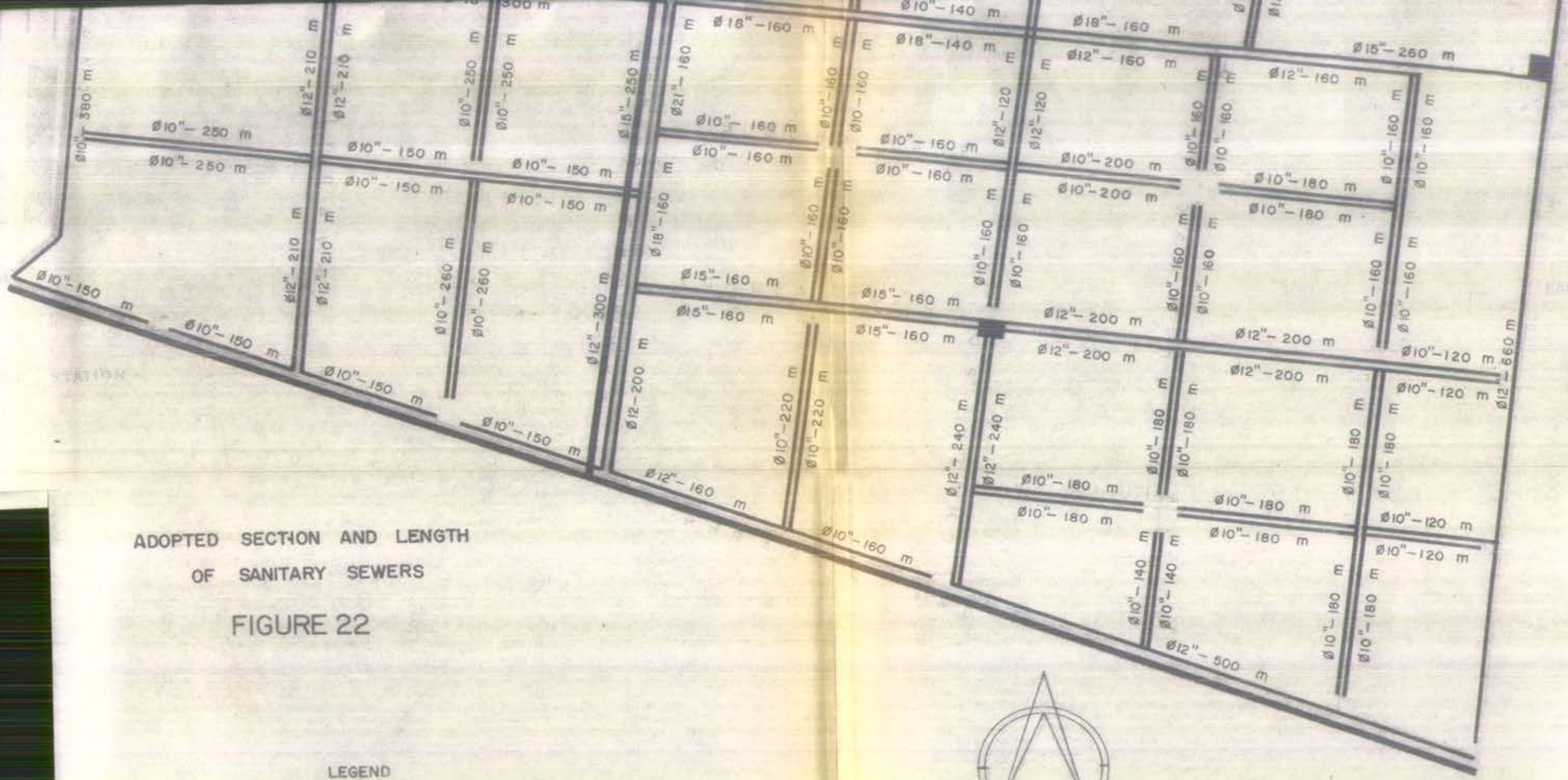
Ø12" – 800 m

Ø10" – 200 m

Ø10" – 200 m

Ø10" – 240 m

Ø10" – 240 m



ADOPTED SECTION AND LENGTH
OF SANITARY SEWERS

FIGURE 22

LEGEND

PUMP STATION

SEWER

FORCED MAIN

SCALE 1:4,000

in design for this drainage work also. These main Klongs are selected because of their widths are very large and the necessity to keep them for water transport. Moreover some Klongs have the retaining wall to protect the bank. Gates and pump are provided at the end of klongs to take storm water out during rainy hours. It necessitates to find out Klongs whether they can receive the storm water or not.

The Intensity of First Storm

The "rational method" is applied in this scheme. "Experience has shown that to yield satisfactory results may be obtained when properly applied. More than 90 % of the engineering offices throughout the United States that replied to questionaires on storm-sewer design practice and indicated the use of the rational method with satisfactory results for urban drainage area. Though the basic principles of the rational method are applicable to large drainage areas, but from the report of practice point of view, generally limits its use to urban area of less than 5 sq. miles".[6]

$Q = CiA$

Q = maximum rate of runoff in cfs.

C = runoff coefficient

i = the average rainfall intensity in in/hr

A = the drainage area in acre

---

[6] Ibid pp. 31-32.

Assume the first storm is in the area of 3 sq. miles and the average runoff coefficient throughout the area is 0.5 From Figure 5 the intensity for 20 minute duration is 3.27 inches.

Q = .5x3.27x640x3		cfs
= 3140		"
or = 1,410,000		gal per min

THE VOLUME OF MAIN KLONGS

Figure 23 shows the various klongs in area under consideration and the crosssectional area of Klong Lod, Klong Ong-Ang, Klong Phradungkrungkasem, Klong Sathorn are shown in Figure 24.

KLONG LOD

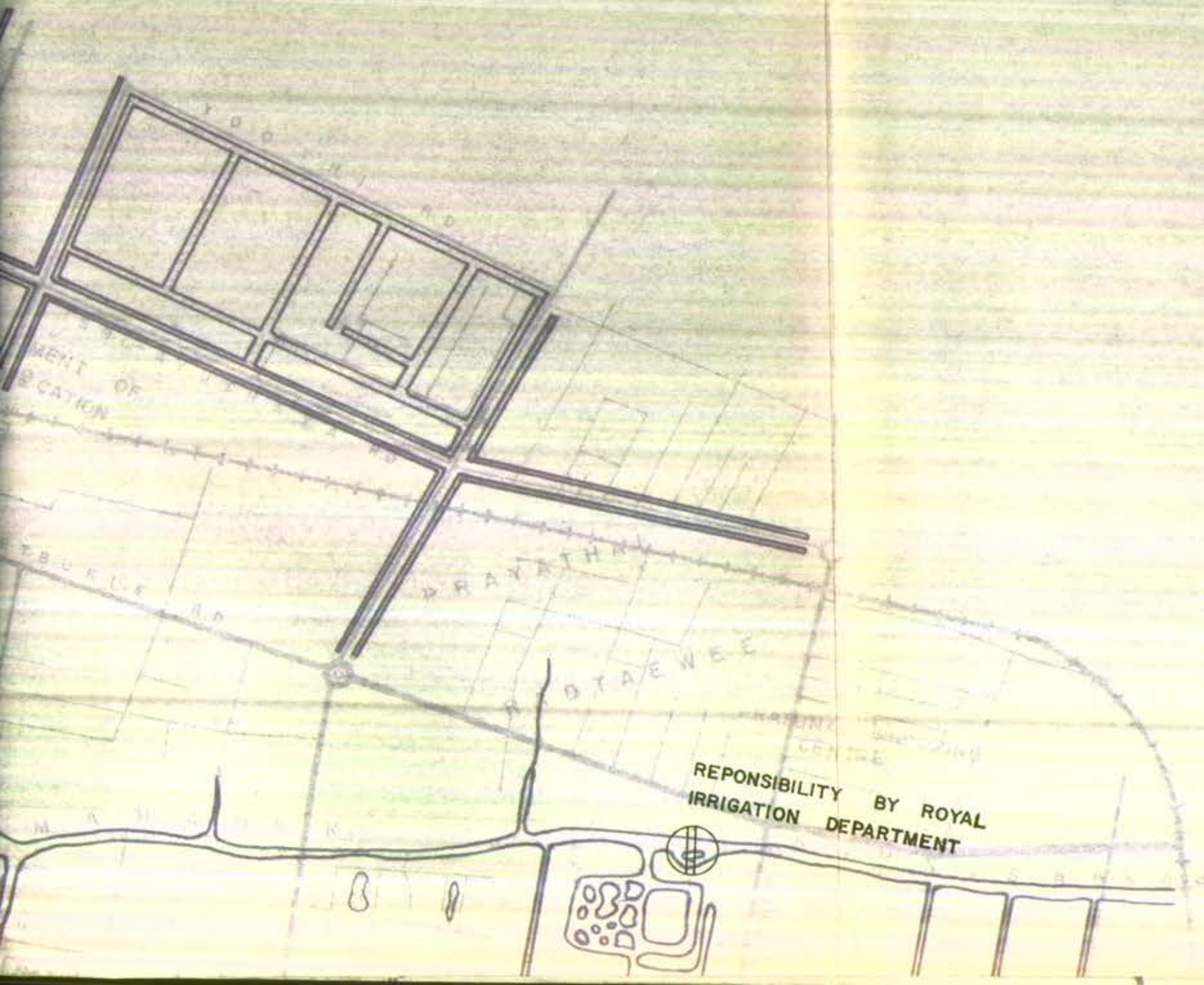
The length	= 2350	metres
Cross-sectional area	= (18x1-2½x1x1)+18x.70	m^2
	= 29.6	m^2
Volume	= 69600	m^3
	= 69600x35.3 = 2,460,000	ft^3

KLONG ONG-ANG

The length	= 3400	metres
Crosssectional area	= (12x1-2x½x1x1)+12x.70	m^2
	= 11+8.4 = 19.4	m^2
Volume	= 3400x19.4 = 67000	m^3
	= 2,380,000	ft^3

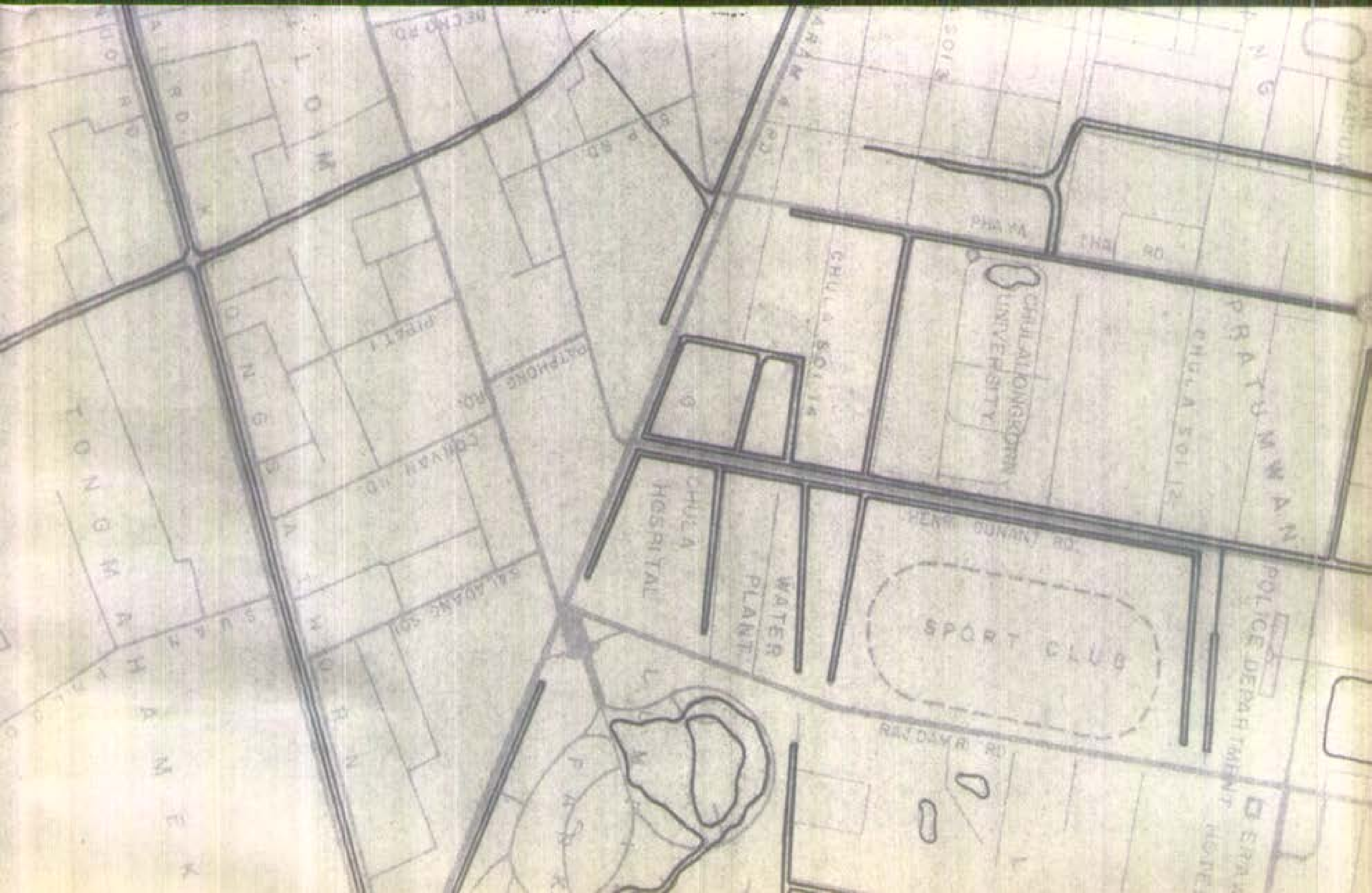
KLONG PHADUNGDRUNGDASEM

The length	= 5350	metres


REPONSIBILITY BY ROYAL
IRRIGATION DEPARTMENT


WADSAN PRAYA
CHANA SONGKAM
MUSIUM
THAMASART UNIVERSITY
PRAMERU GROUND
DEMOCRACY MONUMENT
BANGKOK MUNICIPALITY
MAHARAJCHAWANGO
GRAND PARADE
SAMSEN
CHITLADDA PALACE
TURF CLUB
SAMSEN WATER PLANT

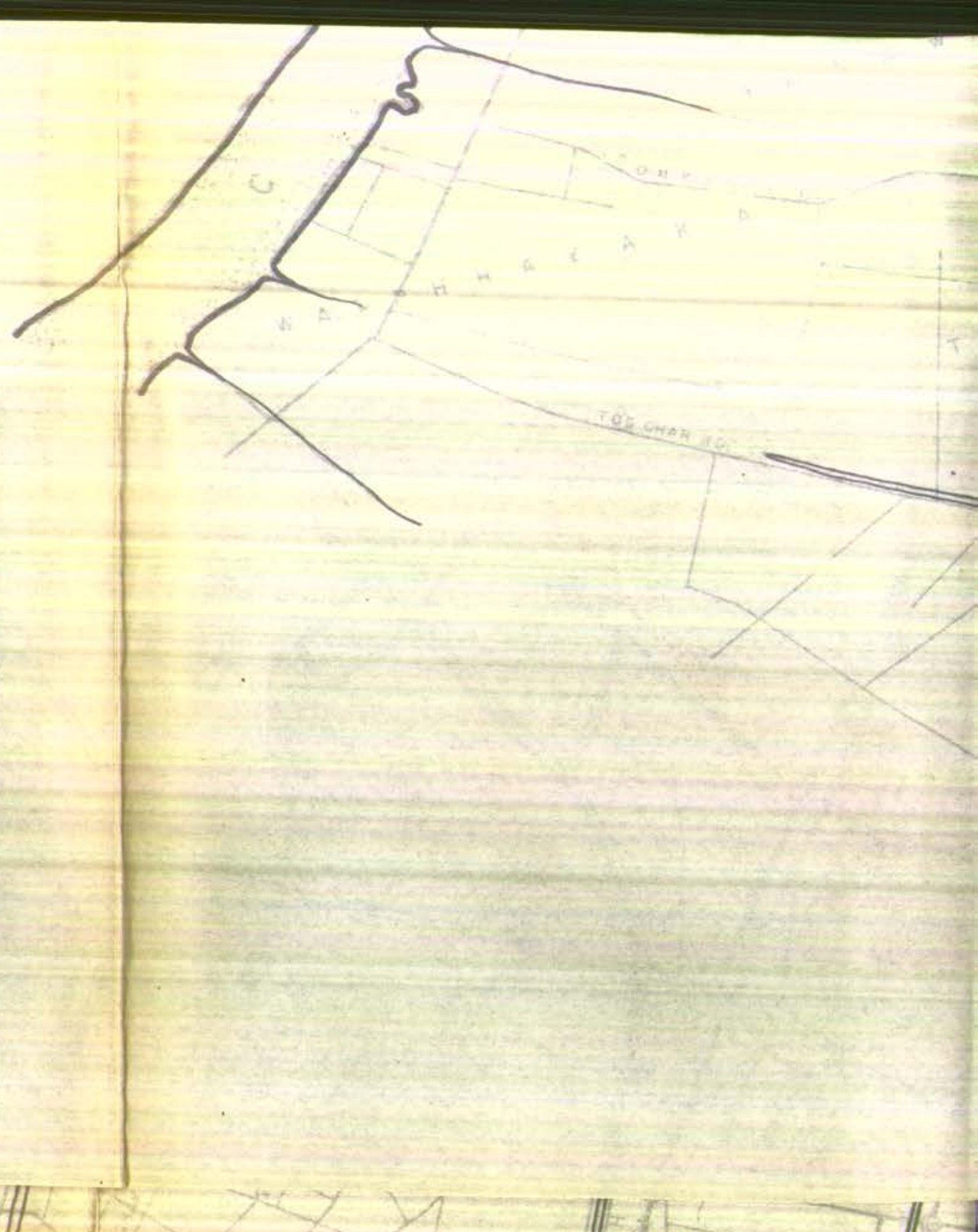

SAMPAN THAWONG
HUAI KHWANG RAILWAY STATION
MAHAPUTARAM
SI-PHAYA RD.
CHAREONKRUNG RD.
SIPRAYA
NARES RD.
SURI WONG RD.
SILOM RD.
SURASAK RD.
PRAMUAN RD.
SAN RD.
THON
CHAO PHRAYA


PHAYA THAI RD
CHULALONGKORN UNIVERSITY
PRATUMWAN
CHULA SOI 14
CHULA SOI 12
HENRI DUNANT RD
CHULA HOSPITAL
WATER PLANT
SPORT CLUB
POLICE DEPARTMENT
RAJDAMRI RD
PATPONG RD
CONVENT RD

LOCATION OF VARIOUS MAIN KLONGS

LOCK GATES AND PUMPS

FIGURE 23

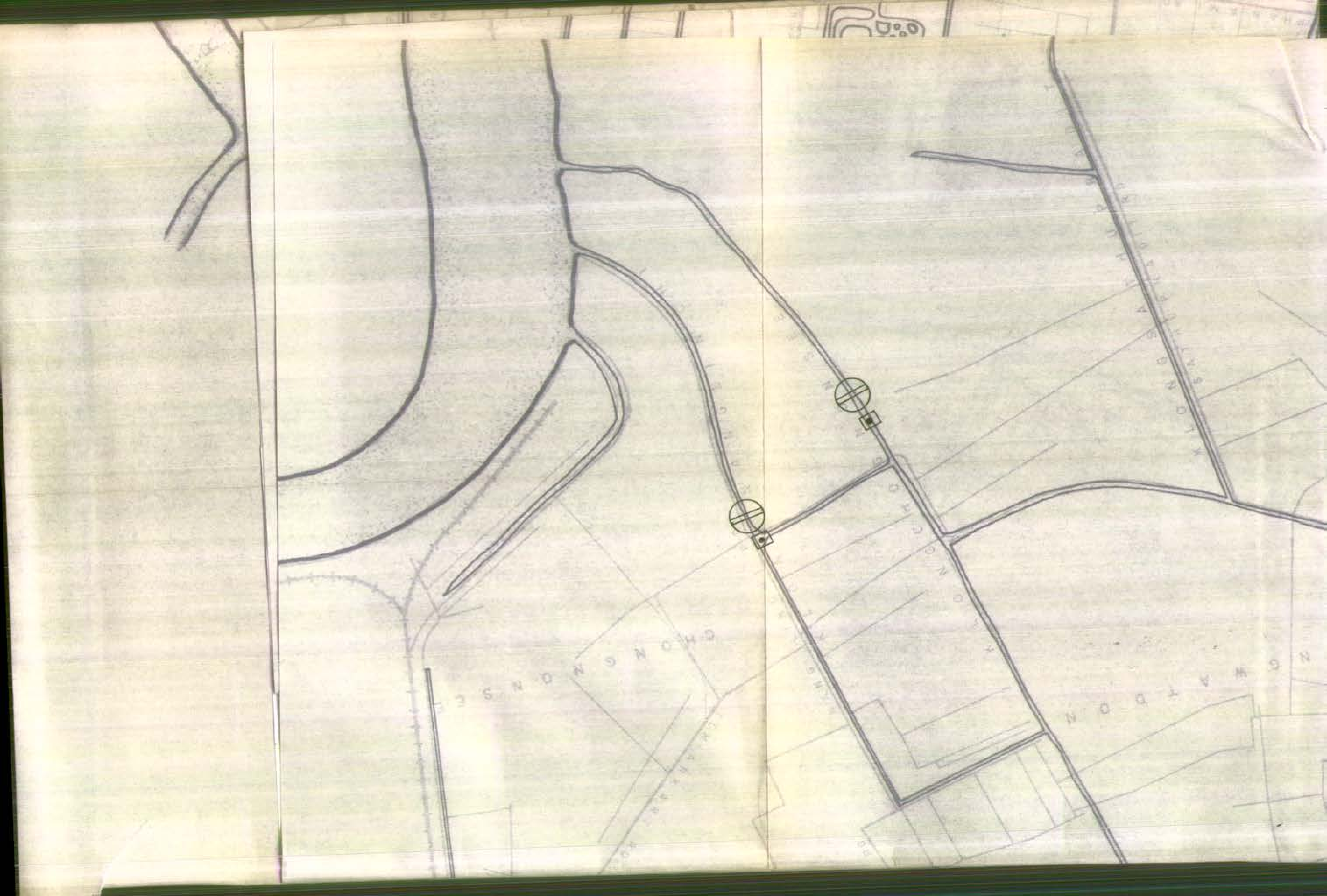


LEGEND

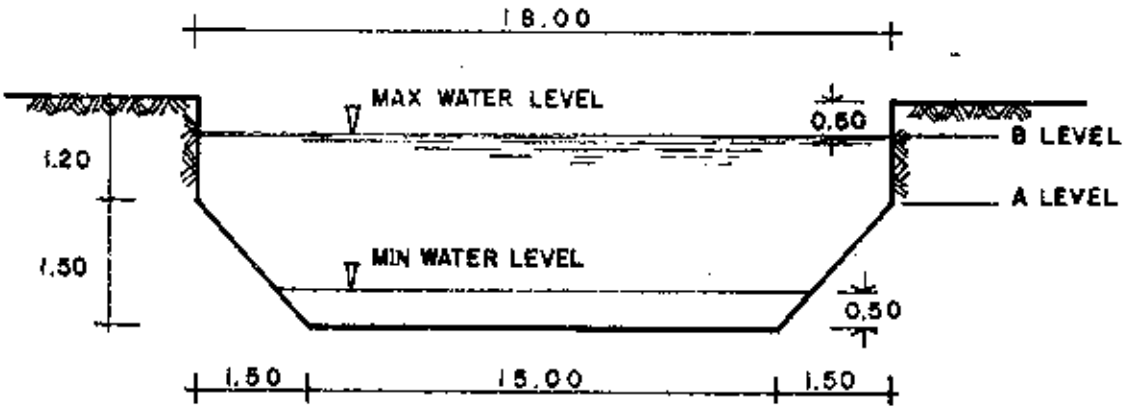
KLONG

LOCK GATE

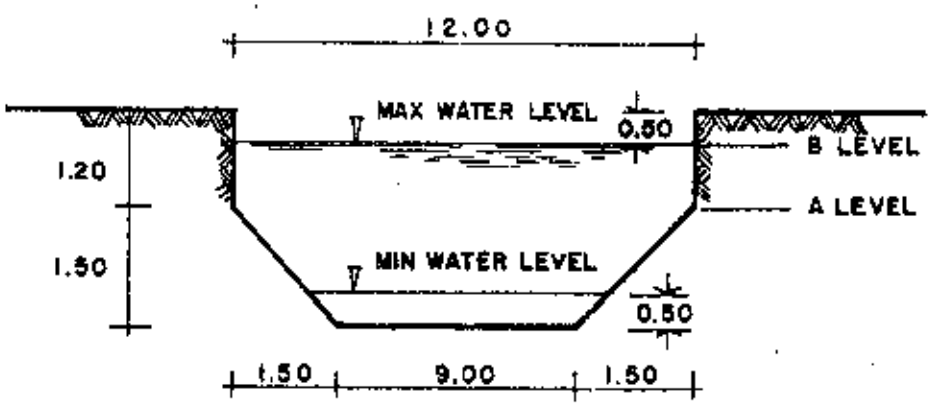
PUMP



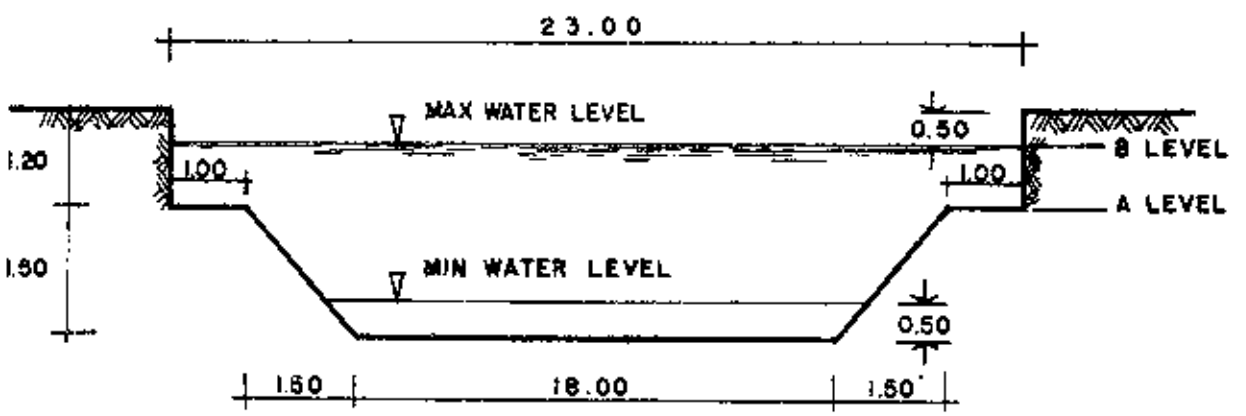
CROSSECTIONAL AREA OF 3 MAIN KLONGS



KLONG LOD



KLONG ONG-ANG & KLONG SATHORN



KLONG PHADUNGKRUNG KASEM

FIGURE 24

Cross-sectional area = $(21x1-2x\frac{1}{2}x1x1)$

= 20+16.1 = 36.1 m^2

Volume = 5350x36.1 = 193,000 m^3

= 193,000x35.5 ft^3

= 6,810,000 ft^3

KLONG SATHORN

The length = 3500 metres

Crossectional area = $(12x1-2x\frac{1}{2}x1x1)+12x7$ m^2

= 11+8.4 = 19.4 m^2

Volume = 3500x19.4 = 68000 m^3

= 2,410,000 ft^3

Volume of main klongs in Bangkok That cove first storm area

Klong Lod	2,460,000	ft^3
Klong Ong-Ang	2,380,000	"
Klong Phadungkrungkasem	6,810,000	"
Total volume	= 11,650,000	ft^3

If using the pumps during the storm peroid at the end of klongs it assumes that these main klongs would store the storm water about 1 hour.

Total volume/$_{hr}$ = 11,650,000 $ft^3/_{hr}$

= $\frac{11,650,000x7.48}{60}$ gal per min

= 1,460,000 1,410,000

[9]SAMPLE ON CALCULATION FOR STORM SEWERS

Layout of sewers and direction of flow shows in Figure 25. The location of lock gates and pumps for drainage system are shown in Figure 23. The sample area select for storm drain is at the same place of sewerage work.

Design of Sewer at Praram 6 rd.

Column 1 indicated the alignment of sewer, a_2a_3

Column 2 identify the location of sewer, PRARAm 6 RD.

Column 3-4 showed the direction of sewer, from M_2 to M_3

Column 5 recorded the area tributary to the street inlets that discharge into the manhole at the upper and of the line 3.80 acres.

Column 6 gives the cumulative area tributary to a line for example in line a_2a_3, Column 6 is the sume of Column 6, Line a_1a_2 and Column 5, line a_2a_3, or (5.30+3.8) = 9.10 acres

Column 7-8 record the times of flow to the upper end of the drain and in the drain. For example, the inlet time to Manhole M_1 is estimated to be 20 minute, and the time of flow in line a_1a_2 is calculated to be $\frac{300x3.28}{60x3}$ = 5.5 minutes. From Column 15/(60xcol 14)

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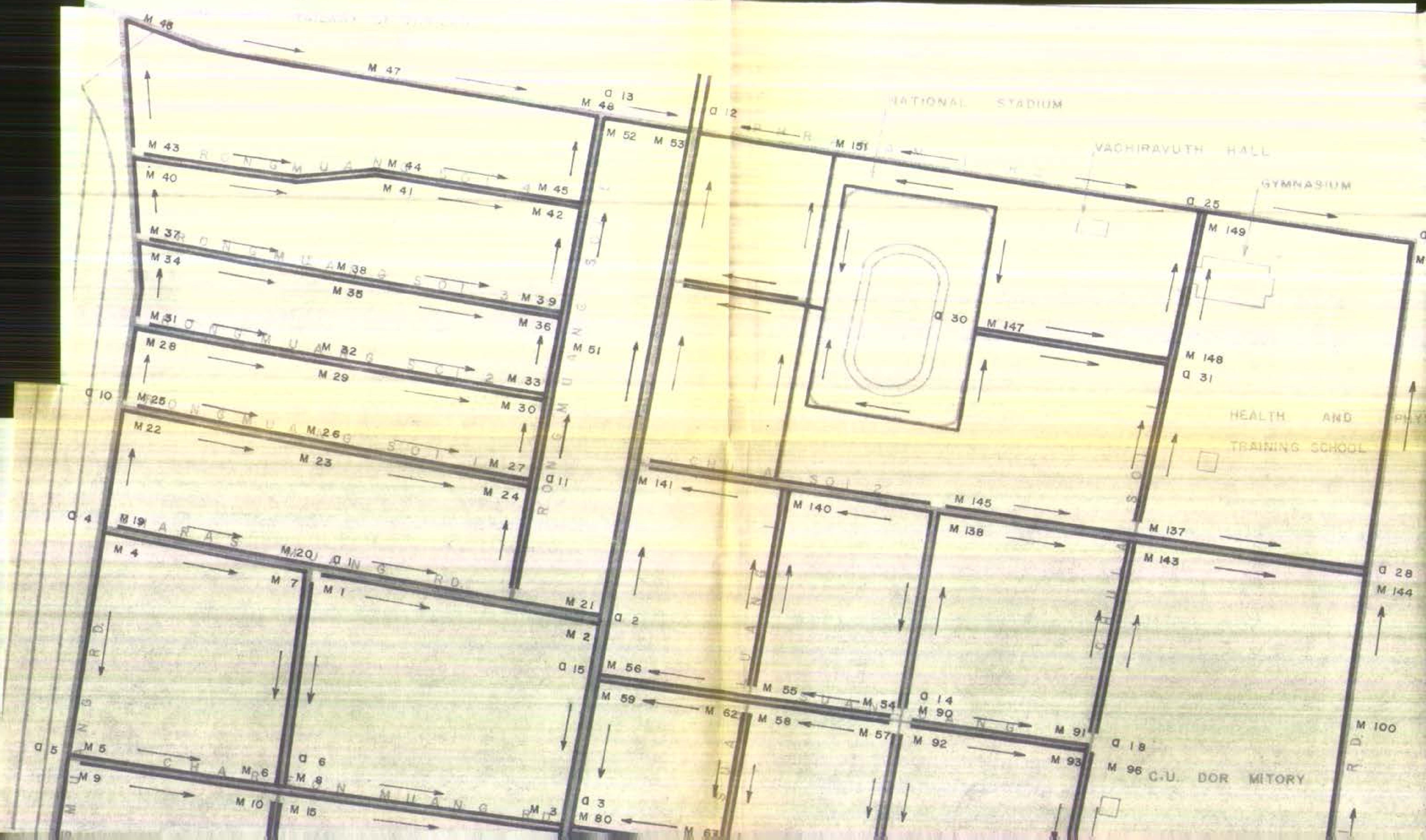
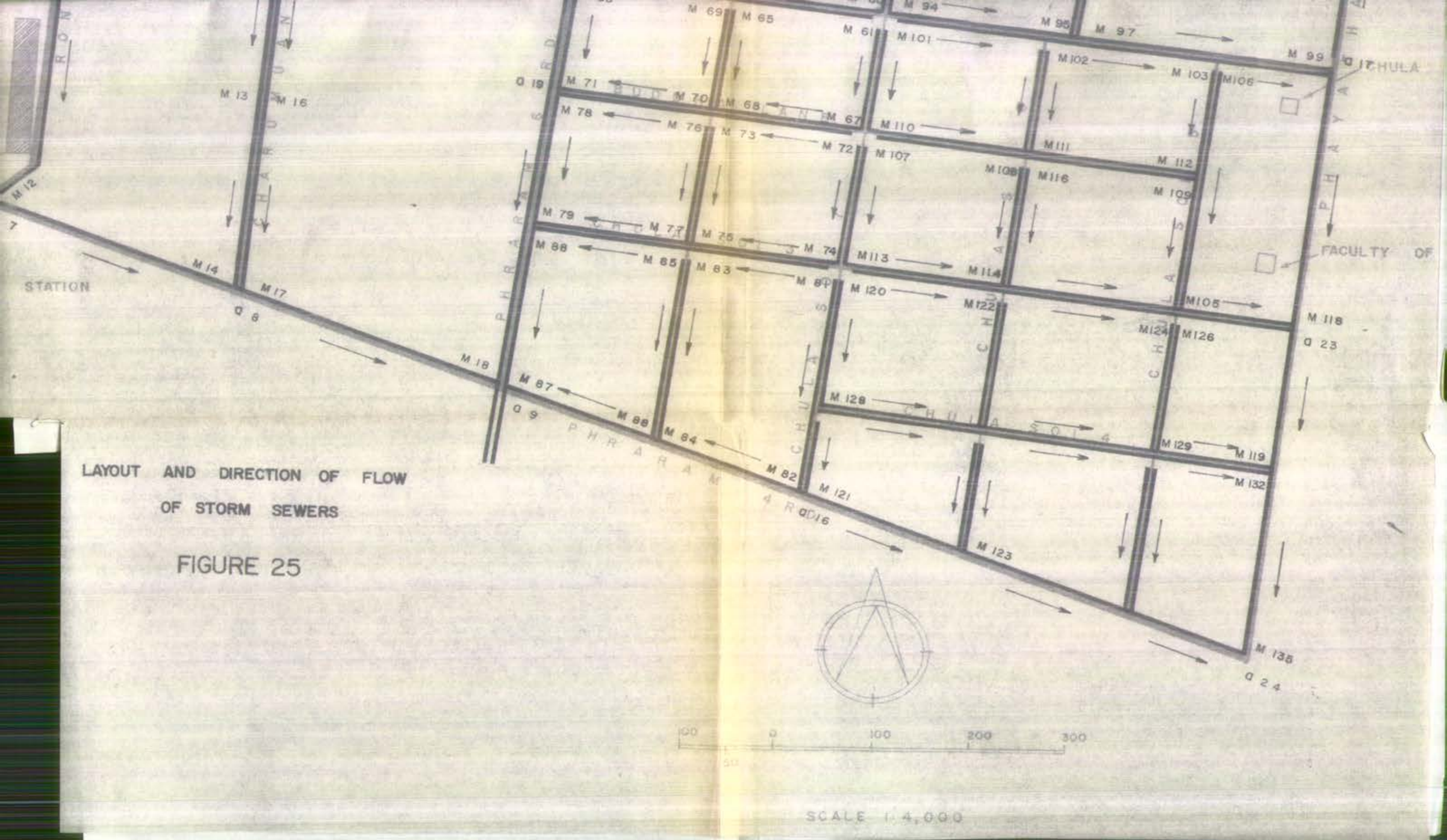
[9]Gordon M. Fair and John C. Geyer, Water Supply and Wastewater Disposal (New York: John Wiley & Sons, Inc., 1954), p. 440-441.


NATIONAL STADIUM
VACHIRAVUTH HALL
GYMNASIUM
HEALTH AND PHY
TRAINING SCHOOL
C.U. DOR MITORY
RONGMUANG SOI 4
RONGMUANG SOI 3
RONGMUANG SOI 2
RONGMUANG SOI 1
RONGMUANG
CHULA SOI 2
CHAROEN MUANG RD.
RD.
M 46
M 47
Q 13
M 48
Q 12
M 52
M 53
M 151
Q 25
M 149
M 43
M 44
M 40
M 41
M 45
M 42
M 37
M 38
M 34
M 35
M 39
M 36
M 31
M 32
M 28
M 29
M 33
M 51
M 30
Q 10
M 25
M 22
M 26
M 23
M 27
Q 11
M 24
Q 30
M 147
M 148
Q 31
M 141
M 140
M 145
M 138
M 137
M 143
Q 28
M 144
Q 4
M 19
M 4
M 20
M 7
M 1
M 21
Q 2
M 2
Q 15
M 56
M 55
M 54
Q 14
M 90
M 59
M 62
M 58
M 57
M 92
M 91
Q 18
M 93
M 96
M 100
Q 5
M 5
Q 6
M 6
M 8
M 9
M 10
M 15
M 3
Q 3
M 80
M 67



LAYOUT AND DIRECTION OF FLOW
OF STORM SEWERS

FIGURE 25

Hence the time of flow to the upper end of a_2a_3 is (20+5.5) = 25.5 m.

Column 9 is the ci value for the time of flow to the upper end of the line

c = .65 (commercial area)

i = 75 mm = 2.96 inches (from Fig 5 use 25.5 min duration)

Column 10 column 9 x column 6 for example, the runoff entering line a_2a_3 is 1.92 x 9.10 = 17.50 cfs.

Column 11-14 record the schoren size and resulting capacity and velocity of flow of the drains forthe tributary runoff and available or required grade. For example in line a_2a_3

Manning Formular $V = \frac{1.486\ R^{2/3}S^{1/2}}{n}$

V = velocity, the minimum velocity for storm sewer is 3 ft/sec

$R = \frac{\text{crossectional area}}{\text{wetted perimeter}}$

S = slope of hydraulic gradient

n = Kutter Coefficient of Friction

Try s = .0009, D = ϕ 1.00 metre and using

C = .QB

$R = \frac{\pi}{4} d^2 / \pi D = \frac{D}{4}$

D = ϕ 1.00 = 3.28'

$$V = \frac{1.486 \times (\frac{3.28}{4})^{.667}(.0009)^{1/2}}{.013}$$

$$= \frac{1.48 \times .876 \times .03}{.013} = 3.00 \quad \text{ft/sec.}$$

capacity = VA

$$= 3 \times \frac{\pi}{4} (3.28)^2$$

$$= 3 \times 8.445 = 25.4 \qquad ft^2$$

Column 15 is taken from the plan or profile of the street; 300 metres

Column 16 equal Column 15 x Column 12: For example, 240 x .0009 = .21 metres.

Column 17 is obtained from

$$hi = (d+h_v) + k\ h_v$$

$$he = 4(d+hr)+.24\ hr$$

$$A(d+hr) = (d_1-hr_1) - (d_2-hr_2)$$

$$= (1.00+\frac{v_1^2}{2g}) - (.80+\frac{v_2^2}{2g})$$

$$\text{but } v_1=v_2 = 1.00-.80+\frac{v_1^2}{2g} - \frac{v_2^2}{2g} = .20$$

$$.24\ hr = -\frac{v_1^2}{2g} + \frac{v_2^2}{2g} = 0$$

$$h_i = .20 \qquad \text{metres.}$$

Column 18 is identify the invert elevation; For example the level for the ground elevation to the sewer is about .50 metres and the diameter of sewer .80 metres, so that the upper end of invert level is .5+.80 = 1.30 and lower end is 1.30+300 = 1.66 in the line a_2a_3 plus drop in manhole is 1.66+.20 = 1.82

The description of pumps at the end of klong illustrated in Table 28. Figure 26 shows the section and length of storm sewers. Illustrative computations for a system of storm drains are shown in Table 29 to 41.

TABLE 28 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN: STREET (2)	MANHOLE: FROM (3)	MANHOLE: TO (4)	INCREMENT (6)	TOTAL (7)	TIME OF FLOW: UPPER END	TIME OF FLOW: IN DRAIN		
a1 a2	CHARASMUANG RD.	M1	M2	5.32	5.32	20.00	5.5		
a2 a3	PRARAM 6 R D.	M2	M3	3.80	9.10	25.50	4.3		
a4 a5	HONGMUANG R D.	M4	M5	3.92	3.92	20.00	4.70		
a5 a6	CHAREONMUANG R.D.	M5	M6	3.20	7.12	24.70	4.00		
a4 a1	CHARASMUANG R.D.	M4	M7	3.20	3.20	20.00	4.00		

LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH in ft (15)	TIME in min (16)	MANHOLE: TRANSITION		
a1 a2	Ø .60	.0012	16.2	3.00	300	.36	.00		
a2 a3	Ø 1.00	.0009	25.4	3.01	240	.21	.20	.55	
a4 a5	Ø.60	.0018	5.2	3.02	260	.47			
a5 a6	Ø.60	.0012	15.2	3.00	220	.26	.20		
a4 a1	Ø.60	.0013	5.2	3.02	220	.40	.00		

TABLE 29 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN STREET (2)	MANHOLE NUMBER FROM (3)	MANHOLE NUMBER TO (4)	TRIBUTARY AREA acres INCREMENTAL (5)	TRIBUTARY AREA acres TOTAL (6)	TIME OF FLOW min TO INLET AND DRAIN (7)	TIME OF FLOW min IN DRAIN (8)	RUN-OFF c.f.s. PER ACRE (9)	RUN-OFF c.f.s. TOTAL (10)
a1 a6	CHARUMUANG RD.	M7	M6	3.92	7.12	24.00	4.40	1.94	13.80
a1 a6	CHARUMUANG RD.	M1	M8	3.92	3.92	20.00	4.40	2.12	8.32
a6 a3	CHAREONMUANG RD.	M8	M3	18.16	23.48	28.40	5.45	1.84	43.30
a5 a6	CHAREONMUANG RD.	M9	M10	3.20	3.20	20.00	4.00	2.12	6.78
a6 a3	CHAREONMUANG RD.	M10	M11	3.20	8.96	24.00	5.45	1.94	17.40

	DESIGN				PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY c.f.s. (13)	VELOCITY f.p.s. (14)	LENGTH ft. (15)	FALL ft. (16)	MINIMUM TRANSITION ft. (17)	INVERT ELEVATION UPPER END (18)	INVERT ELEVATION LOWER END (19)
a1 a6	ø .80	.0012	15.2	3.02	240	.29	.20	1.70	1.99
a1 a6	ø.60	.0018	9.2	3.02	240	.43	.00	1.10	1.53
a6 a3	□ 1.20X1.20	.0009	55.0	3.40	300	.27	.40	2.43	2.70
a5 a6	ø.60	.0010	9.2	3.02	220	.40	.00	1.10	1.50
a6 a3	ø1.00	.0009	25.4	3.01	300	.27	.40	1.80	2.17

TABLE 30 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN STREET (2)	MANHOLE FROM (3)	MANHOLE TO (4)	TRIBUTARY AREA acres INCREMENT (5)	TRIBUTARY AREA acres TOTAL (6)	RUNOFF cfs DESIGN (7)	RUNOFF cfs RATIO (8)	RUNOFF cfs AREA (9)	RUNOFF cfs TOTAL (10)
a3 a17	CHAREONMUANG RD.	M94	M95	2	4.60	22.92	3.65	1.99	9.12
a3 a17	CHAREONMUANG RD.	M97	M99	11.4	16.53	26.57	5.10	1.15	15.20
a3 a17	CHAREONMUANG RD.	M102	M103	1.7	3.6	22.92	3.28	1.99	7.13
a20 a21	CHULA SOI 5	M106	M105	3.6	3.6	20.00	5.10	1.14	4.10
a22 a23	CHULA SOI 3	M113	M114	3.4	5.1	22.92	2.92	1.99	10.01

DESIGN					PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	M.H. LOSS TRANSITION m (17)	INVERT ELEVATION m UPPER END (18)	INVERT ELEVATION m LOWER END (19)
a3 a17	ø .60	.0018	9.2	3.02	200	.36	.04	1.50	1.86
a3 a17	ø 1.00	.0012	29.2	3.43	280	.33	.40	2.26	2.59
a3 a17	ø .60	.0018	9.2	3.02	180	.32	.00	1.39	1.71
a20 a21	ø .60	.0018	9.2	3.02	280	.50	.00	1.10	1.60
a22 a23	ø .80	.0012	16.2	3.00	160	.19	.20	1.20	1.39

REMARKS — M93 M95, designed as M94 M95

M[illegible] M[illegible] M[illegible] [illegible]

TABLE 31 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN: STREET (2)	MANHOLE: FROM (3)	MANHOLE: TO (4)	TRIBUTARY AREA, acres: INCREMENT (5)	TRIBUTARY AREA, acres: TOTAL (6)	TIME OF FLOW, min: TO UPPER END (7)	TIME OF FLOW, min: IN DRAIN (8)	RUNOFF, cfs, Q: PER ACRE (9)	RUNOFF, cfs, Q: TOTAL (10)
a4 a10	RONGMUANG R D.	M19	M22	1.32	1.32	20.00	2.55	1.96	2.58
a10 a11	RONGMUANG SOI 1	M22	M25	1.32	4.56	22.55	4.00	1.84	8.40
a10 a11	RONGMUANG SOI 1	M25	M24	4.56	8.80	26.55	4.00	1.72	15.20
a12 a11	RONGMUANG SOI 5	M29	M27	1.32	1.32	20.00	2.55	1.96	2.58
a11 a13	RONGMUANG SOI 5	M27	M30	12.40	13.19	30.55	1.82	1.63	21.50

	DESIGN				PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	M.H. LOSS, TRANSITION m (17)	INVERT ELEVATION m.: UPPER END (18)	INVERT ELEVATION m.: LOWER END (19)
a4 a10	ø .60	.0018	9.2	3.02	140	.25	.00	1.10	1.35
a10 a11	ø .60	.0018	9.2	3.02	220	.40	.04	1.39	1.79
a10 a11	ø .80	.0012	15.2	3.00	210	.25	.20	1.99	2.24
a12 a11	ø .60	.0018	9.2	3.02	140	.25	.00	1.10	1.35
a11 a13	ø 1.00	.0005	25.4	3.01	100	.09	.20	2.44	2.53

REMARK : M25 M28 M31 M34 M37 M40 M43 M46 designate MH M22, M25 M28 M28 M29 M31 M32 M34 M35 M37 M39 M40 M41 M43 M44 M46 M47 designate MH M26 M22, M26 M27 M30 M40 M32 M34 M36 M38 designate MH M25 M26,

TABLE 32 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE	LOCATION OF DRAIN			TRIBUTARY AREA acre, a		TIME OF FLOW min		RUNOFF cfs, Q	
	STREET	MANHOLE NUMBER FROM	TO	INCREMENT	TOTAL	TO UPPER END	IN DRAIN	PER ACRE	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
a5 a7	RONGMUANG R D.	M 9	M12	6.60	6.60	20.00	6.40	2.12	14.00
a7 a8	PRARAM 4 R D.	M12	M14	6.60	11.00	26.40	5.45	1.89	20.80
a6 a8	CHARUMUANG R D.	M10	M13	5.52	5.52	20.00	4.40	2.12	11.70
a6 a8	CHARUMUANG R D.	M13	M14	5.52	8.00	24.40	2.92	1.94	15.50
a6 a8	CHARUMUANG R D.	M15	M16	6.36	6.36	20.00	4.40	2.12	13.40

	DESIGN				PROFILE				
LINE	SECTION in	SLOPE per 1000	CAPACITY cfs	VELOCITY fps	LENGTH m	FALL m	M.H. LOSS, TRANSITION m	INVERT ELEVATION m. UPPER END	INVERT ELEVATION m. LOWER END
(1)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
a5 a7	Ø .80	.0012	16.2	3.00	350	.42	.00	1.30	1.72
a7 a8	Ø 1.00	.0009	25.4	3.01	300	.27	.20	1.92	2.19
a6 a8	Ø.80	.0012	16.2	3.00	240	.29	.00	1.30	1.59
a6 a8	Ø1.00	.0009	25.4	3 .01	160	.15	.20	1.79	1.94
a6 a8	Ø.80	.0012	16.2	3.00	240	.29	.00	1.30	1.59

TABLE 33 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE	LOCATION OF DRAIN			TRIBUTARY AREA		RATE OF FLOW		SIZE AND SLOPE	
	STREET	MANHOLE FROM	MANHOLE TO	INCREMENT (acres)	TOTAL (acres)	CONCENTRATION (cfs)	RUNOFF (cfs)	PIPE SIZE (in)	SLOPE (ft per 100 ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
a6 a8	CHARUMUANG R D.	M18	M17	6.36	9.80	24.40	2.92	1.94	19.00
a8 a9	PRARAM 4 R D.	M17	M18	28.80	34.73	31.85	5.45	1.73	60.02
a3 a9	PRARAM 5 R D.	M11	M18	40.44	49.20	33.85	8.57	1.69	83.00
a4 a1	CHARUSMUANG R D.	M19	M20	3.68	3.68	20.00	4.00	1.56	7.20
a1 a2	CHARUSMUANG R D.	M20	M21	3.68	7.75	24.00	6.45	1.82	14.10

DESIGN					PROFILE				
LINE	SECTION in	SLOPE per 1000	CAPACITY cfs	VELOCITY fps	LENGTH ft	FALL ft	MANHOLE TRANSITION in	DIVERT ELEVATION UPPER END	DIVERT ELEVATION LOWER END
(1)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
a6 a8	Ø 1.00	.0009	23.4	3.01	160	.15	.20	1.79	1.94
a8 a9	□ 1.20X1.40	.0008	60.8	3.30	300	.24	.40	2.59	2.83
a3 a9	□ 1.40X1.60	.0007	83.0	3.40	470	.33	.40	3.10	3.43
a4 a1	Ø .60	.0018	9.2	3.02	220	.40	.00	1.10	1.50
a1 a2	Ø .80	.0012	16.2	3.00	300	.36	.20	1.70	2.06

TABLE 34 ILLUSTRATIVE COMPUTATIONS FOR DESIGN OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN STREET (2)	MANHOLE FROM (5)	MANHOLE TO (4)	TRIBUTARY AREA acre, a INCREMENT (5)	TRIBUTARY AREA acre, a TOTAL (6)	TIME OF FLOW min TO UPPER END (7)	TIME OF FLOW min IN DRAIN (8)	RUNOFF $cfs_{a,3}$ FOR AREA (9)	RUNOFF $cfs_{a,3}$ TOTAL (10)
a11 a13	RONGMUANG SOI 5	M33	M36	23.19	23.79	32.37	1.82	1.61	38.2
a11 a13	RONGMUANG SOI 5	M39	M42	33.79	34.39	34.19	1.82	1.56	53.7
a12 a13	RONGMUANG SOI 5	M51	M52	2.80	5.60	25.45	5.45	1.77	10.0
a2 a12	PRARAM 6 RD.	M21	M33	10.50	18.00	25.45	5.45	1.77	23.0
a13 a12	PRARAM I RD.	M48	M33	51.59	60.00	37.33	1.82	1.51	90.5

	DESIGN				PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	MINIMUM TRANSITION m (17)	INVERT ELEVATION UPPER END (18)	INVERT ELEVATION LOWER END (19)
a11 a13	□ 1.20X1.20	.0009	55.0	3.40	100	.09	.20	2.37	2.46
a11 a13	□ 1.20X1.20	.0009	55.0	3.40	100	.09	.10	2.56	3.65
a12 a13	Ø .80	.0012	16.2	3.00	300	.36	.20	1.84	2.20
a2 a12	Ø 1.00	.0009	25.4	3.01	600	.54	.20	2.26	2.80
a13 a12	□ 1.40X1.60	.0008	89.6	3.79	100	.08	.10	3.93	4.05

TABLE 35 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN			TRIBUTARY AREA acre, a		TIME OF FLOW min		RUNOFF cfs, Q	
	STREET (2)	MANHOLE FROM (3)	NUMBER TO (4)	INCREMENT (5)	TOTAL (6)	TO UPPER END (7)	IN SEWER (8)	PER ACRE (9)	TOTAL (10)
a14 a16	CHULA SOI 7	M 81	M82	3.68	3.68	20.00	4.90	2.12	7.80
a16 a9	PHRARAM 4 RD	M 82	M84	3.68	5.48	24.90	2.92	1.94	10.65
a16 a9	PHRARAM 4 RD.	M86	M87	11.78	13.58	27.80	2.92	1.84	25.00
a19 a9	PHRARAM 6 RD	M88	M87	51.14	53.78	30.72	3.65	1.74	93.60
a14 a13	SUANLUANG RD.	M92	M93	2.40	2.40	20.00	3.65	1.12	5.1

DESIGN					PROFILE				
LINE (1)	SECTION m (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	M.H. LOSS, TRANSITION m (17)	INVERT ELEVATION m. UPPER END (18)	INVERT ELEVATION m. LOWER END (19)
a14 a16	Ø .60	.0018	9.2	3.02	270	.48	0.00	1.10	1.58
a16 a9	Ø .80	.0012	16.2	3.00	160	.19	.20	1.78	1.97
a16 a9	Ø 1.00	.0012	29.2	3.45	160	.19	.20	2.17	2.36
a19 a9	□1.40X1.60	.0008	89.6	3.70	200	.16	.00	2.93	3.09
a14 a13	Ø .60	.0018	9.2	3.02	200	.36	.00	1.10	1.46

REMARKS :- M83 M84, M85 M86, designed as M81 M82

M90 M91, [illegible] designed as [illegible]

TABLE 36 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN: STREET (2)	MANHOLE: FROM (3)	MANHOLE: TO (4)	TRIBUTARY AREA (acres): INCREMENT (5)	TRIBUTARY AREA (acres): TOTAL (6)	TIME OF FLOW (min): TO UPPER END (7)	TIME OF FLOW (min): IN DRAIN (8)	RUNOFF (c.f.s.): FOR INCREMENT (9)	RUNOFF (c.f.s.): FOR TOTAL (10)
a14 a15	SUANLUANG RD.	M54	M55	1.52	1.52	20.00	2.92	2.12	3.22
a14 a15	SUANLUANG RD.	M55	M56	1.52	3.04	22.92	2.92	1.99	6.05
a14 a16	CHULA SOI 7	M57	M60	2.00	2.00	2.00	2.92	2.12	4.25
a3 a17	CHAREONMUANG RD.	M60	M61	2.00	4.00	22.92	2.92	1.99	7.95
a15 a3	PRARAM 6 RD.	M59	M60	7.04	9.04	25.84	2.92	1.92	17.30

DESIGN					PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY c/s (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	M.H. LOSS, TRANSITION in (17)	INVERT ELEVATION m: UPPER END (18)	INVERT ELEVATION m: LOWER END (19)
a14 a15	Ø .60	- .0018	9.2	3.02	160	.29	.00	1.10	1.39
a14 a15	Ø .60	.0018	9.2	3.02	160	.29	.00	1.39	1.68
a14 a16	Ø .60	.0018	9.2	3.02	160	.29	.00	1.10	1.39
a3 a17	Ø .60	.0018	9.2	3.02	160	.29	.04	1.43	1.72
a15 a3	Ø 1.00	.0009	25.4	3.01	160	.14	.40	2.12	2.26

REMARK : M64 M67 M65 M38 M69 M70 M57 M58 M64 M65 designed as M64 M55, M60 M59 M66 M66 designed as M60 M65, M65 M66 M67 M68 designed as

TABLE 37 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN: STREET (2)	MANHOLE: FROM (3)	MANHOLE: TO (4)	TRIBUTARY AREA acres: INCREMENT (5)	TRIBUTARY AREA acres: TOTAL (6)	TIME OF FLOW min: TO UPPER END (7)	TIME OF FLOW min: IN DRAIN (8)	RUNOFF cfs: PER ACRE (9)	RUNOFF cfs: TOTAL (10)
a18 a25	CHULA SOI 1	M91	M137	3.60	3.60	20.00	4.30	2.12	7.60
a17 a26	PHAYATHAI R.D.	M100	M144	3.20	6.80	22.92	4.30	.95	3.10
a27 a28	CHULA SOI 2	M143	M144	17.60	22.60	24.30	4.65	1.35	30.4
a28 a26	PHAYATHAI R.D.	M144	M146	30.00	38.80	28.95	6.60	1.30	50.5
a30 a31	SNAMKILA	M147	M148	5.28	8.08	20.00	3.65	1.30	93.0

	DESIGN				PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY c.f.s. (13)	VELOCITY f.p.s. (14)	LENGTH m (15)	FALL m (16)	M.H. LOSS: TRANSITION m (17)	INVERT ELEVATION: UPPER END (18)	INVERT ELEVATION: LOWER END (19)
a18 a25	Ø .60	.0018	9.2	3.02	240	.43	.00	1.10	1.53
a17 a26	Ø .80	.0012	16.2	3.00	240	.29	.20	1.59	1.88
a27 a28	□1.20x1.20	.0008	51.4	3.18	260	.21	.40	2.37	2.58
a28 a26	□1.20x1.40	.0009	64.2	3.56	390	.34	.20	2.78	3.12
a30 a31	Ø .60	.0013	9.2	3.02	200	.36	.04	1.36	1.72

REMARKS : M99 M100 M137 M145 M90 M130 M54 M139 M65 M140 M55 M141 M142 M69 Continued on [illegible]

TABLE 38 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN: STREET (2)	MANHOLE NUMBER: FROM (3)	MANHOLE NUMBER: TO (4)	TRIBUTARY AREA, acre, c: INCREMENT (5)	TRIBUTARY AREA, acre, c: TOTAL (6)	TIME OF FLOW, min: TO UPPER END OF DRAIN (7)	TIME OF FLOW, min: IN DRAIN (8)	RUNOFF, cfs, Q: PER ACRE (9)	RUNOFF, cfs, Q: TOTAL (10)
a18 a19	BUDDHA LANE	M67	M68	1.5	3.1	22.92	2.92	1.99	6.18
a18 a19	BUDDHA LANE	M70	M71	6.1	7.7	25.84	2.92	1.92	14.80
a17 a3	CHAREONMUANG RD.	M63	M80	8.0	10.0	25.84	2.92	1.92	19.20
a3 a19	PHRARAM 6 RD.	M68	M71	22.54	24.04	28.76	2.19	1.84	44.40
a19 a9	PHRARAM 6 RD.	M78	M79	35.54	37.54	30.95	2.92	1.74	65.40

	DESIGN				PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH ft (15)	FALL ft (16)	M.H. LOSS, TRANSITION ft (17)	INVERT ELEVATION: UPPER END (18)	INVERT ELEVATION: LOWER END (19)
a18 a19	Ø .60	.0018	9.2	3.02	160	.29	.04	1.43	1.72
a18 a19	Ø .60	.0012	16.2	3.00	160	.19	.20	1.92	2.11
a17 a3	Ø1.00	.0009	25.4	3.01	160	.14	.20	1.92	2.06
a3 a19	□1.20X1.20	.0006	52.0	3.40	120	.09	.20	2.26	2.46
a19 a9	□1.20X1.60	.0008	72.0	3.50	160	.13	.40	2.77	2.30

REMARKS:— M72 M73, M72 M74, M73 M75, M76 M77, designed as M67 M68
M78 M70, M76 M71, designed as M70 M71
M77 M79, designed as M78 M79

TABLE 39 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM DRAINS

LINE (1)	LOCATION OF DRAIN: STREET (2)	MANHOLE: FROM (3)	MANHOLE: NUMBER TO (4)	TRIBUTARY AREA, acres: INCREMENT (5)	TRIBUTARY AREA, acres: TOTAL (6)	TIME OF FLOW, min: UPPER END (7)	TIME OF FLOW, min: IN DRAIN (8)	RUNOFF, cfs: RUN OFF (9)	RUNOFF, cfs: TOTAL (10)
a22 a23	CHULA SOI 3	M117	M115	10.74	12.54	25.84	3.28	1.10	13.85
a22 a23	CHULA SOI 3	M105	M118	22.16	23.36	29.12	2.37	1.10	25.60
a17 a23	PHAYATHAI RD.	M104	M110	21.53	24.93	31.67	5.28	1.00	24.93
a23 a24	PHAYATHAI RD.	M134	M119	52.89	54.89	36.95	2.92	.95	52.00
a23 a24	PHAYATHAI RD.	M132	M135	63.09	66.09	39.87	4.00	1.00	66.09

	DESIGN				PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	M.H. LOSS, TRANSITION m (17)	INVERT ELEVATION: UPPER END (18)	INVERT ELEVATION: LOWER END (19)
a22 a23	ø 1.00	.0009	25.4	3.01	180	.16	.20	2.09	2.25
a22 a23	ø 1.00	.0009	25.4	3.01	130	.11	—	2.25	2.36
a17 a23	ø 1.00	.0009	25.4	3.01	290	.26	—	2.59	2.85
a23 a24	□1.20X1.20	.0008	104.0	3.40	160	.16	—	3.00	3.16
a23 a24	□1.20X1.60	.0008	72.0	3.50	220	.17	.40	3.46	3.63

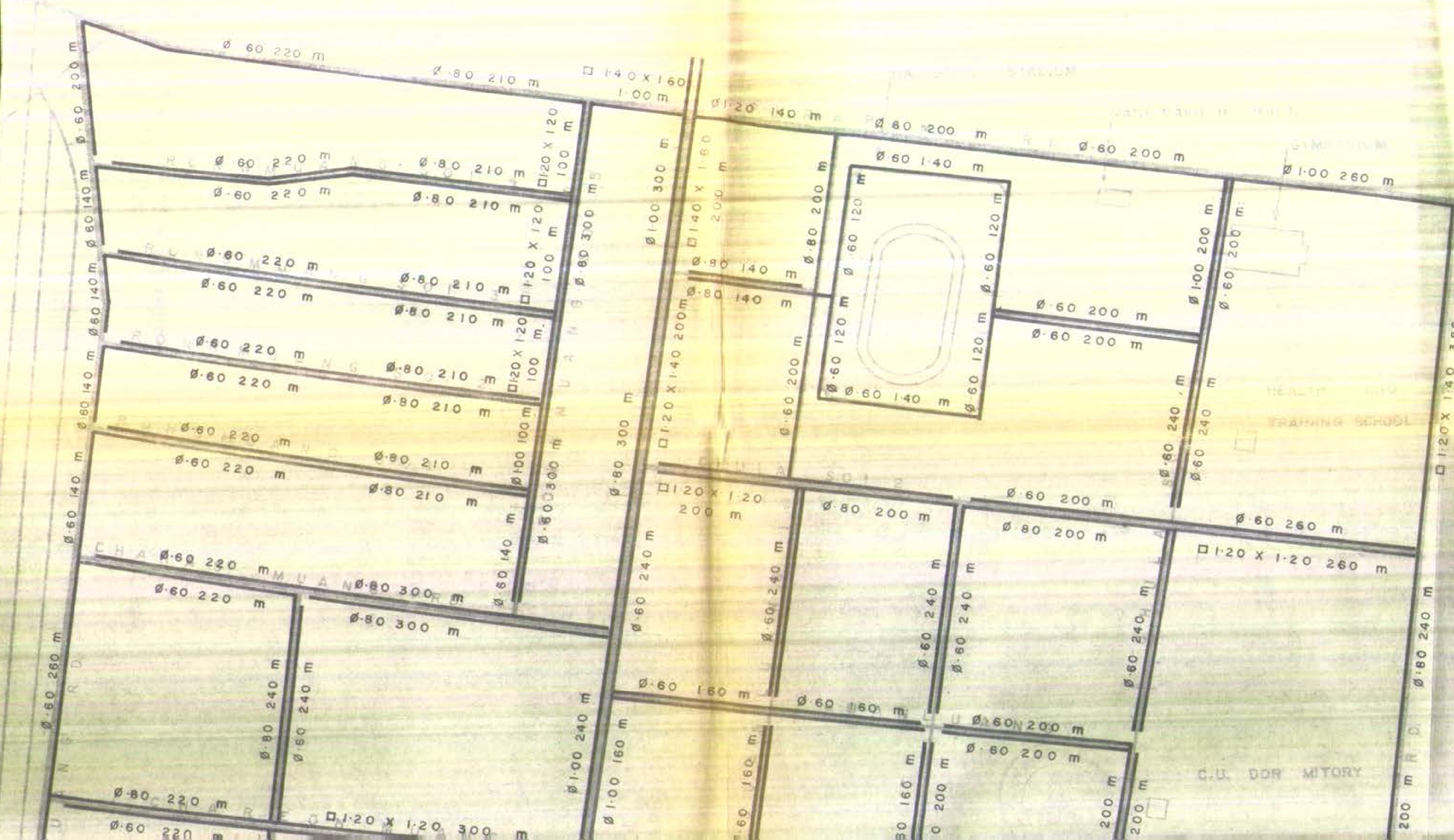
REMARKS — M105 M118, designed as M117 M115, M129 M119, M131 M135 designed as M129 M119, M131 M135, [illegible]

TABLE 40 ILLUSTRATIVE COMPUTATIONS FOR A SYSTEM OF STORM [illegible]

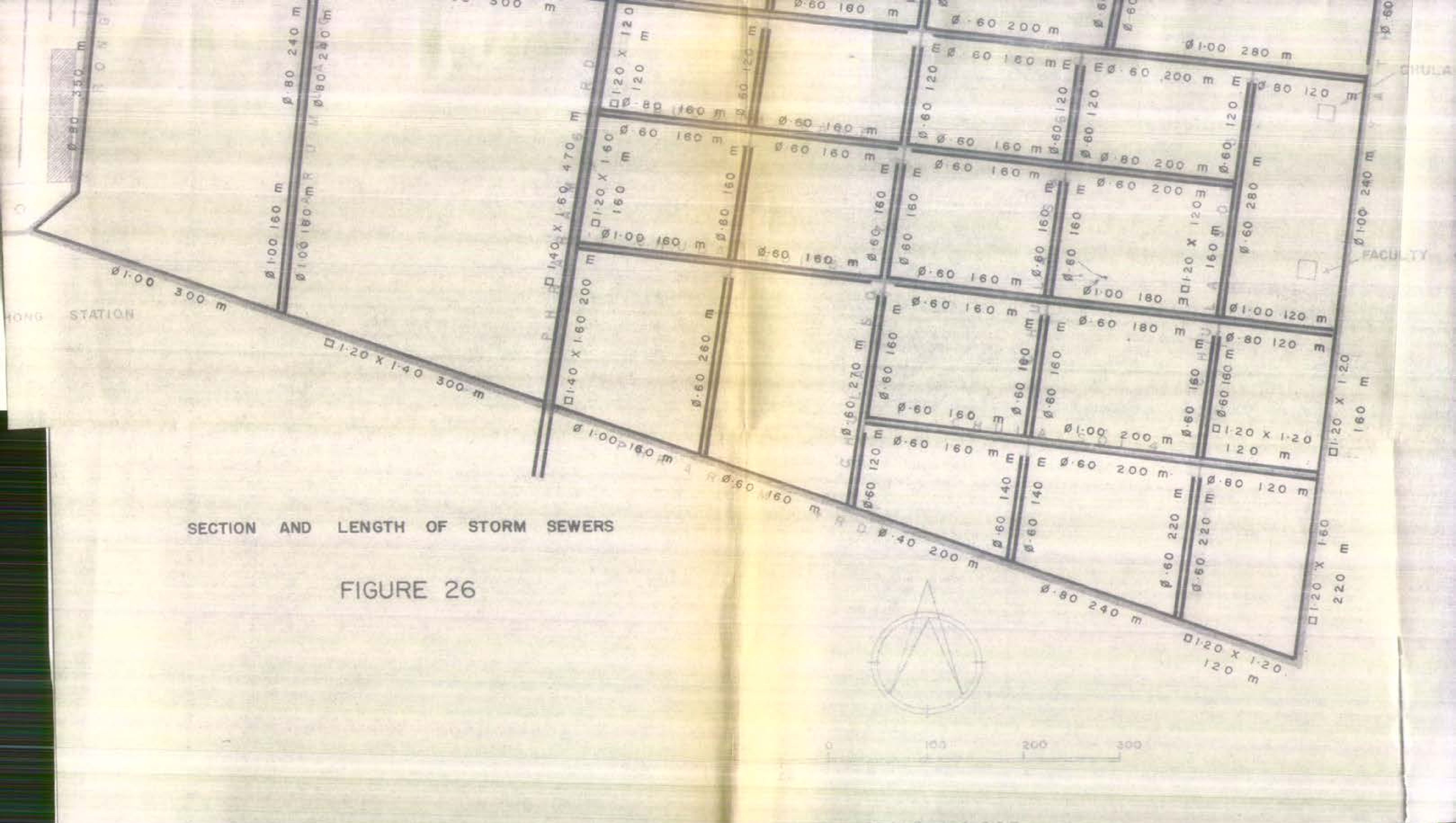
LINE (1)	LOCATION OF DRAIN STREET (2)	MANHOLE FROM (3)	MANHOLE TO (4)	DRAINAGE AREA, acres INCREMENT (5)	DRAINAGE AREA, acres TOTAL (6)	TIME OF FLOW min (7)	[illegible]	[illegible]	[illegible]
o31 o25	CHULA SOI I	M148	M149	14.04	20.04	23.65	3.28	1.05	21.8
o25 o26	PRARAM I RD.	M148	M146	23.34	26.94	26.93	4.30	1.00	23.34

DESIGN					PROFILE				
LINE (1)	SECTION in (11)	SLOPE per 1000 (12)	CAPACITY cfs (13)	VELOCITY fps (14)	LENGTH m (15)	FALL m (16)	MINOR TRANSITION m (17)	INVERT ELEVATION at UPPER END (18)	INVERT ELEVATION at LOWER END (19)
o22 o23	Ø .80	.0009	25.4	3.01	180	.16	.20	1.92	2.08
o25 o26	Ø 1.00	.0009	25.4	3.01	240	.21	—	2.08	2.29

REMARK : M140 M141 designed as M143 M144, M141 M130 designed as M144 M145, M151 M130 designed as M145 M146,



C.U. DOR MITORY
TRAINING SCHOOL
Ø 60 220 m
Ø 80 210 m
□ 1.40 X 1.60
1.00 m
Ø 1.20 140 m
Ø 60 200 m
Ø 60 200 m
Ø 1.00 260 m
Ø 60 1.40 m
Ø 60 200 m
Ø 1.00 300 m
□ 1.40 X 1.60 200 m
Ø 80 200 m
Ø 60 120 m
Ø 1.00 200 m
Ø 60 200 m
Ø 80 140 m
Ø 80 140 m
Ø 60 200 m
Ø 60 200 m
□ 1.20 X 1.40 200 m
Ø 60 200 m
Ø 60 1.40 m
□ 1.20 X 1.40 380 m
Ø 60 240 m
Ø 60 240 m
Ø 80 300 m
□ 1.20 X 1.20 200 m
Ø 80 200 m
Ø 60 200 m
Ø 80 200 m
Ø 60 260 m
□ 1.20 X 1.20 260 m
Ø 60 240 m
Ø 60 240 m
Ø 60 240 m
Ø 80 240 m
Ø 60 160 m
Ø 60 160 m
Ø 60 200 m
Ø 60 200 m
Ø 1.00 160 m
Ø 1.00 240 m
Ø 60 220 m
Ø 80 210 m
□ 120 X 120 100 m
Ø 80 300 m
Ø 60 140 m
Ø 60 200 m
Ø 100 100 m
Ø 80 300 m
Ø 60 220 m
Ø 80 300 m
Ø 80 300 m
Ø 80 240 m
Ø 60 240 m
Ø 60 260 m
Ø 80 220 m
Ø 60 220 m
□ 1.20 X 1.20 300 m



SECTION AND LENGTH OF STORM SEWERS

FIGURE 26