ANNEX II. THE OVERALL PLAN

2.1 General

During the monsoon season, the Meghna and the Sitalakhya Rivers flowing along both sides of the project area yearly invade it, causing flood water level inside the area to come up to about 16 ft P.W.D.: the depth of inundation water reaches 7 ft on an average and 15 ft at the maximum. During the dry season, on the other hand, the project area suffers from quasi-drought conditions because of little rain. Solutions to such adverse natural environments have been sought by encircling the project area by polder dike in order to prevent flood water, dry season irrigation by pumping up river water through full use of pumps and drainage of the inundation water during the monsoon season back into the rivers by use of the same pumps. Project area would be determined of its size, depending upon the extents of the enclosure by river dike system.

In order to reduce the construction costs, embankment would be made the minimum by fully utilizing the beds of existing roads and railways. Two alternative plans, Plan A and Plan B, have been proposed, by taking into consideration topographical maps and field reconnaissance for techno-economic comparative study (see Figs. 2-1 and 2-2).

2.2 Alternative Plans and Beneficiary Area

Alternative Plan A covers the entire area of 133,300 ac being enclosed by the Meghna and the Sitalakhya River, while alternative Plan B embraces an area of 111,600 ac which corresponds to that of Plan A minus the southern part of the Narayanganj-Baidya Bazar Road and the western lowland along the Meghna River.

Areas covered by these two alternative plans are given as follows:

Table 2-1 Comparison of Areas between Plan A and Plan B

ALT-Plan	Total (Gross) Area	Irrigable Area	Village & Forest, Others
A	133,300 Ac (54,000)ha	106,100 (43,000)ha	27,200 (11,000)ha
B	111,600 Ac (45,200)ha	88,200 (35,700)ha	23,500 (9,500)ha

2.3 Comparative Studies on Flood-Protection Embankment

Although construction of new dike system has been proposed for the flood-protection purpose, the maximum utilization of the existing roads and railways would be considered to reduce construction costs. The railway roadbeds to be used as flood-protection dikes are generally equipped with required cross section, but the road between Narayanganj and Baidya Bazar is short of the projected cross section. Roadbeds of the existing roads and railways need to be heightened to attain the projected crest height as flood-protection dike.

Table 2-2 shows the difference in extension dike length between Plan A and Plan B. Plan A would have dike length longer by 16.6 mi in new embankment and by 5.5 mi in total. On the Meghna River bank, its embankment would be higher by 1.5 ft on an average.

Table 2-2 Comparison of Dike Length Between Plan A & B

(Unit Mile)

Item \ ALT Plan	A	B
1 Sitalakya River		
New Dike	21.5 2.6 } 24.1	21.5
Existing Road (Dacca-Chittagong)	3.4	3.4
Exisiting Railway (Narsingdi-Modanganj)	6.8	4.2
Sub total	34.3	29.1
2 Meghna River		
New Dike	30.0	16.0
Existing Railway		7.0
Sub total	30.0	23.0
3 N-B Road /1		6.7
Total	64.3	58.8
Item		
New Dike	54.1	37.5
Existing Road	3.4	10.1
Existing Railway	6.8	11.2

/1 N-B ; Narayanganj-Baidya Bazar Road

Fig. 2—1 PLAN A— PROJECT AREA 133.000 Ac

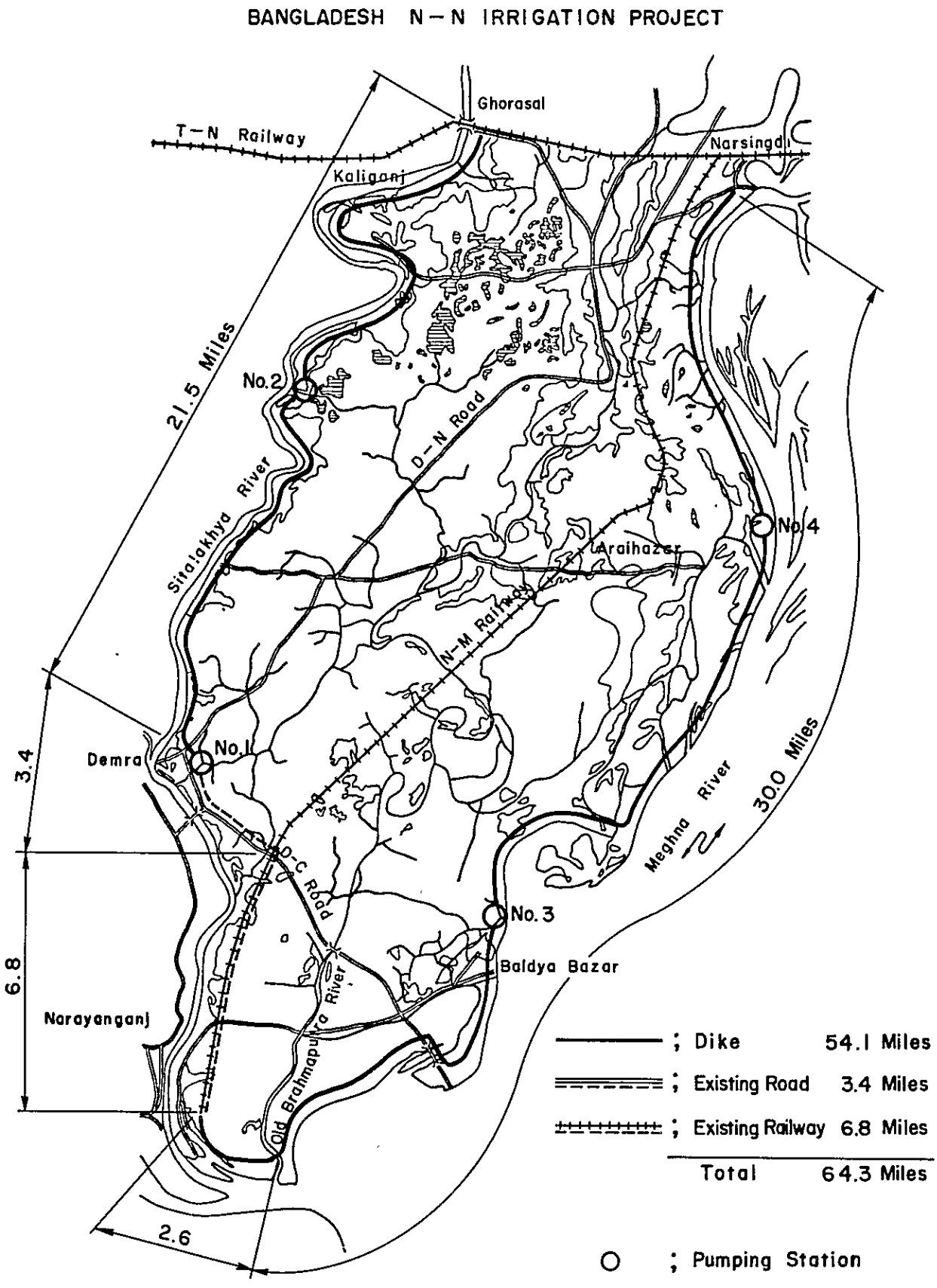
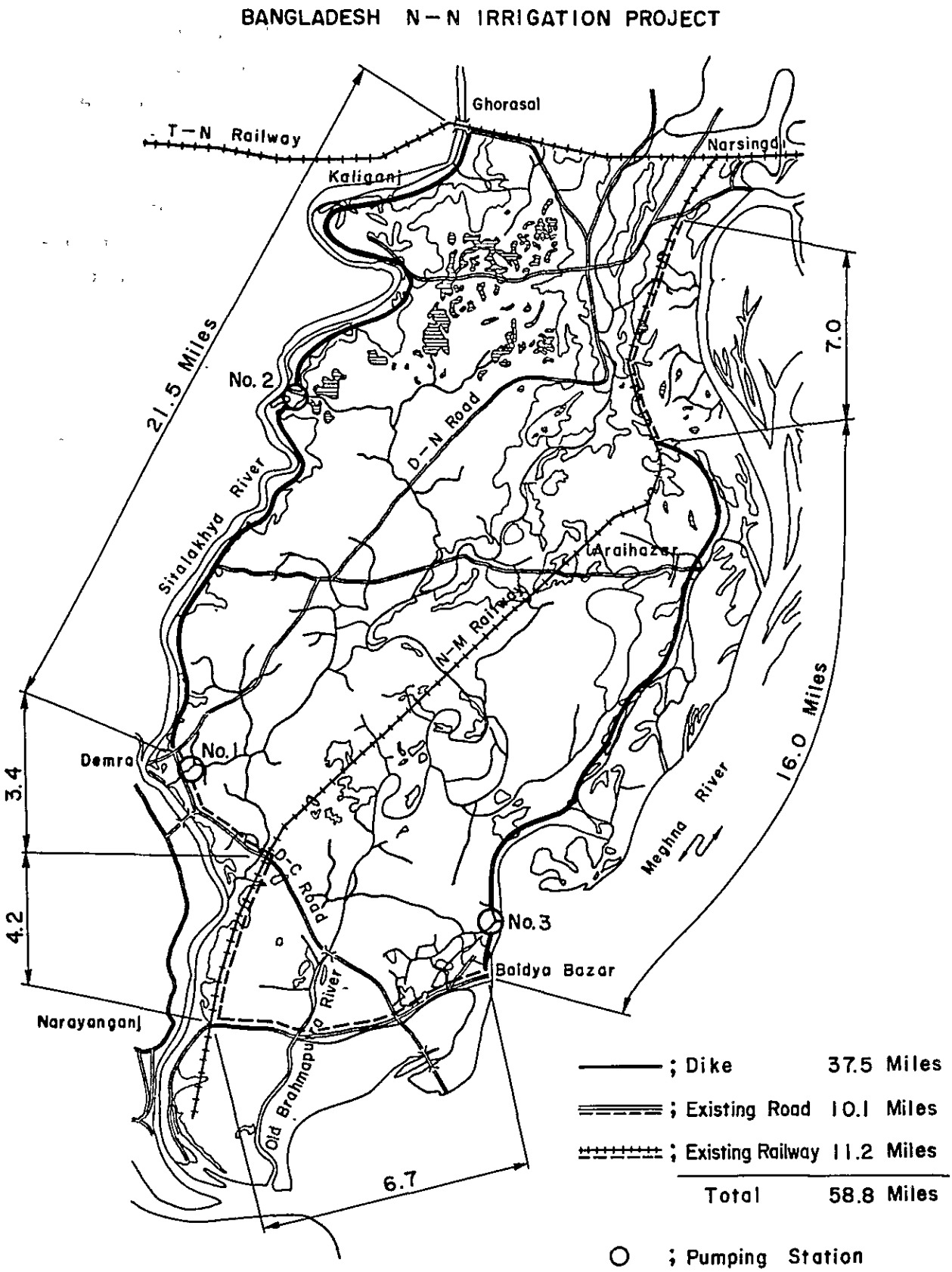


Fig. 2—2 PLAN B— PROJECT AREA 111.600 Ac



2.4 Number, Location and Capacity of Pumping Station

Since pumps would be used not only for irrigation, but for drainage also, it is not so simple to decide their location. If it should be solely for irrigation purpose, the pump would naturally be best located on the height in the upstream portion and, should it be for drainage alone, the low-lying place in the downstream portion would be the best. As ours needs to serve the both purposes, it would be located inbetween. The following conditions would be taken into full consideration in deciding its location:

(a) Accessibility to the existing drainage facilities;
(b) Conveniences for intaking river water;
(c) The highest possible elevation to set pumping station foundation;
(d) Conveniences of power supply; and
(e) Easiness of construction works.

As a result, pumping station sites have been selected at four points in Plan A area and three points in Plan B area as shown in Figs. 2-1 and 2-2. Beneficiary area covered by each pumping station is shown in Table 2-3. Pumping Station No. 4 would become unnecessary for the alternative Plan B. Since access roads and transmission lines are not available in its vicinity, Pumping Station No. 4 would cost more for its construction.

Table 2-3 Comparison of Beneficiary Areas by Pumping Stations between Plan A and Plan B

Beneficiary Area / Pumping Station	ALT - A		ALT - B	
	Irrigation	Drainage	Irrigation	Drainage
	AC	AC	AC	AC
No. 1	35,400 (14,350)	37,000 (15,000)	32,400 (13,150)	37,000 (15,000)
No. 2	33,200 (13,450)	34,600 (14,000)	33,200 (13,450)	34,600 (14,000)
No. 3	19,300 (7,800)	34,000 (13,800)	22,600 (9,100)	40,000 (16,200)
No. 4	18,200 (7,400)	27,700 (11,200)	- (-)	- (-)
Total	106,100 (43,000)	133,300 (54,000)	88,200 (35,700)	111,600 (45,200)

Note: Figures in parenthesis imply hectares.

Irrigation and drainage capacities of the pumping stations to be provided in these two plan areas would be as shown in Table 2-4; their capacities have been arrived at through hydraulic analysis.

Table 2-4 Comparison of Drainage Discharges of Pumping Stations between Plan A and Plan B

ALT-Plan / Pumping Station	A	B
No. 1	1,236 cusecs = 35 m^3/sec	1,236 cusecs = 35 m^3/sec
No. 2	1,236 " = 35 "	1,236 " = 35 "
No. 3	1,165 " = 33 "	1,413 " = 40 "
No. 4	954 " = 27 "	-
Total	4,591 cusecs = 130m^3/sec	3,885 cusecs = 110m^3/sec

2.5 Irrigation and Drainage Systems

(1) Irrigation System

The length of the main canals has been planned not to be so long in view of efficient water distribution, maintenance and operation. Canal system meant for gravity, irrigation and partition of the irrigable area fed by each pumping station has been made accordingly. The area irrigable by each of the pumping stations under the alternative plans is illustrated in Figs. 2-3 and 2-4. In the alternative Plan B, the main canal associated with Pumping Station No. 3 is somewhat longer, but it would cause no special problems.

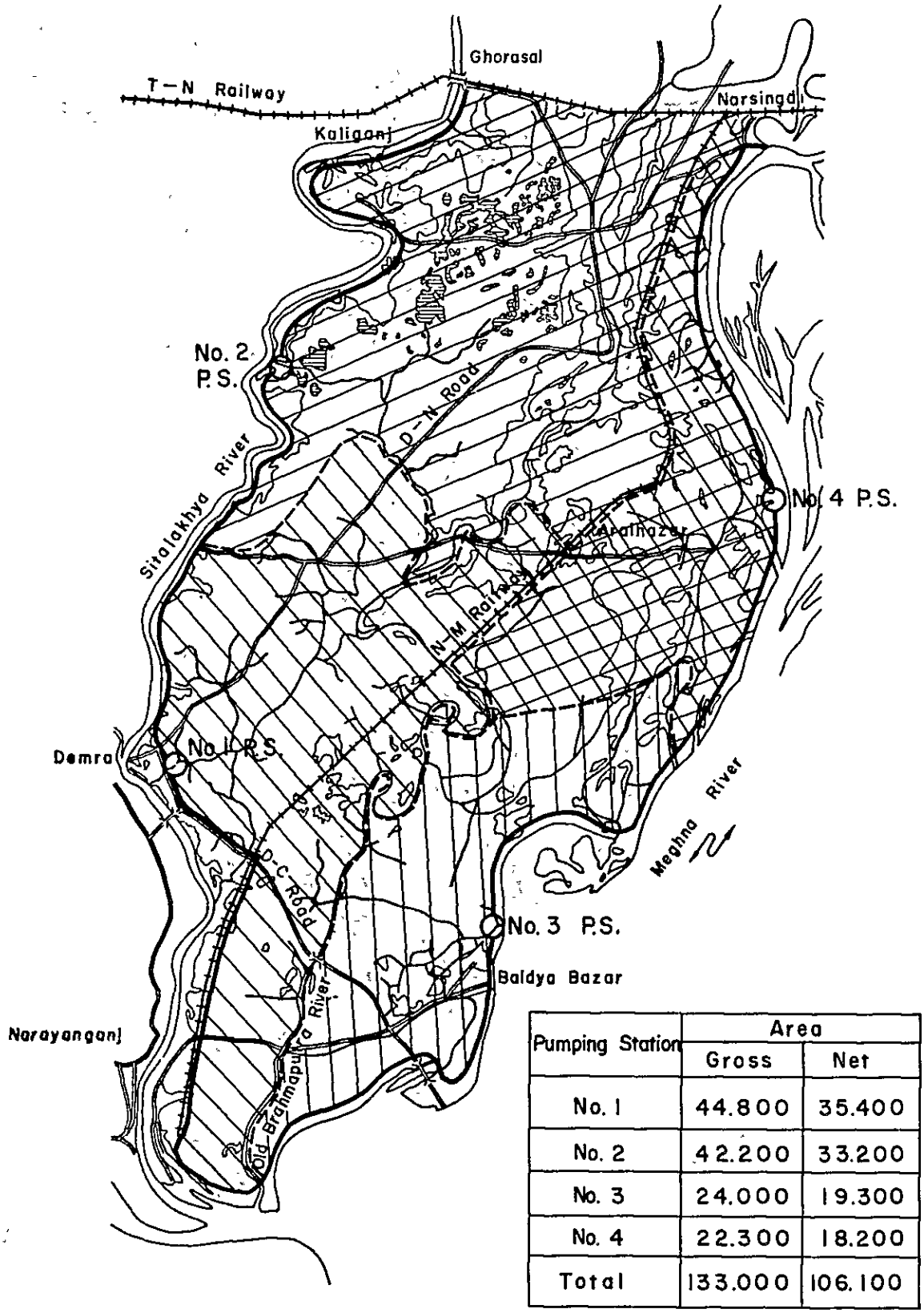
(2) Drainage system

The project area would be enclosed by either dike or roads and railway, and intrusion of outside water through all the openings (bridges and culverts inclusive) would be checked either by complete closure or by providing regulators. Therefore, drainage system aims at draining only rainfall water within the project area. Main drainage canals connected with each of the pumping stations have been so designed that the proposed drainage discharges from the Old Brahmaputra River or the Sonakhal Khal could be properly dealt with.

The area to be drained by each pumping station is illustrated in Figs. 2-5 and 2-6. In the alternative Plan A, the location of Pumping Stations No. 3 and No. 4 might be arguable from the drainage point-of-view, because they are proposed more in upstream side, but this would cause no difficulty because of higher elevation they are going to occupy.

In case of Pumping Station No. 4, however, a regulating gate would have to be provided along the Old Brahmaputra River to regulate inflow of water therefrom.

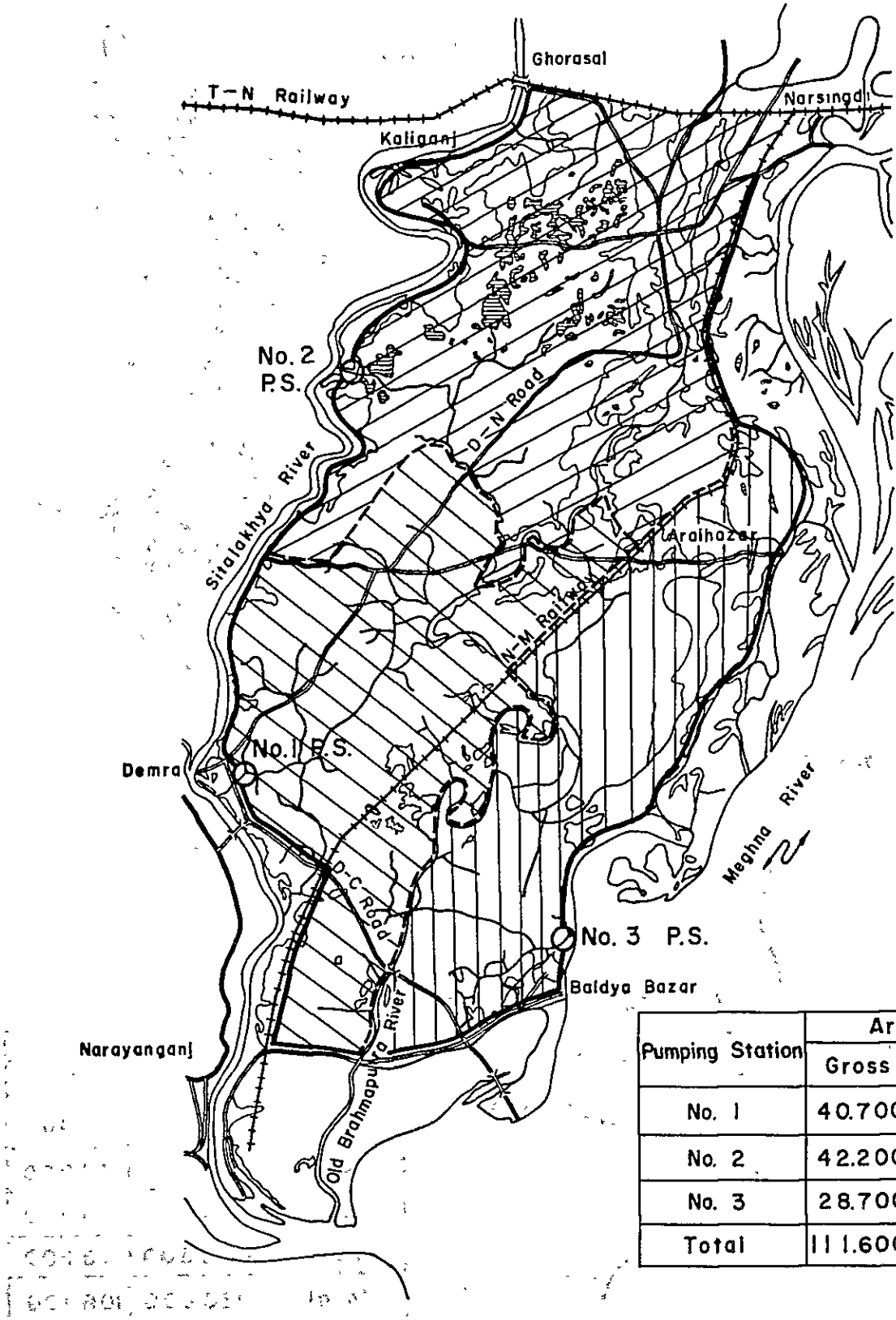
Fig. 2 – 3 PLAN A– IRRIGATION SYSTEM



Pumping Station	Area	
	Gross	Net
No. 1	44.800	35.400
No. 2	42.200	33.200
No. 3	24.000	19.300
No. 4	22.300	18.200
Total	133.000	106.100

Fig. 2-4 PLAN B-1 IRRIGATION SYSTEM

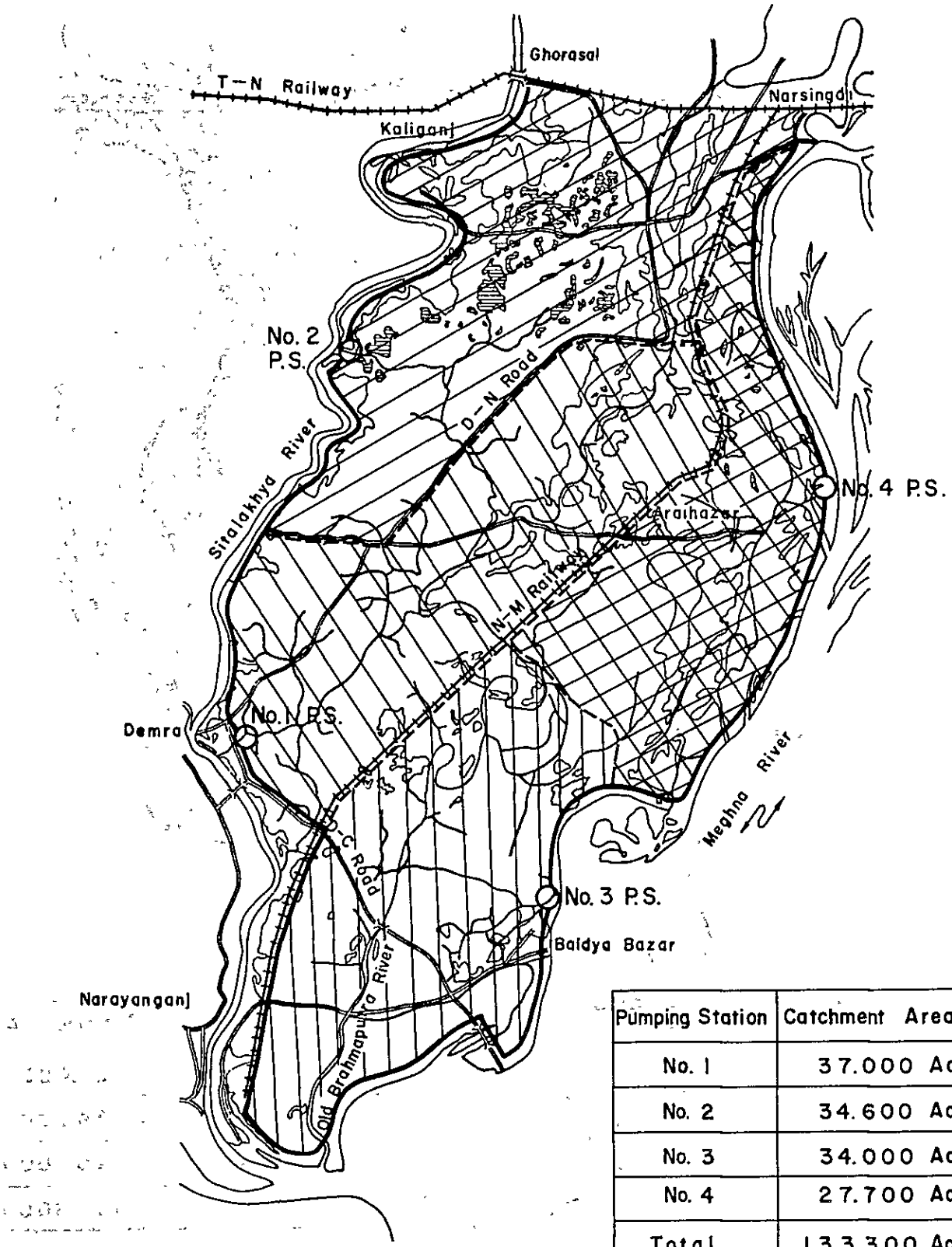
BANGLADESH N-N IRRIGATION PROJECT



Pumping Station	Area	
	Gross	Net
No. 1	40.700	32.400
No. 2	42.200	33.200
No. 3	28.700	22.600
Total	111.600	88.200

Fig. 2-5 PLAN - A- DRAINAGE SYSTEM

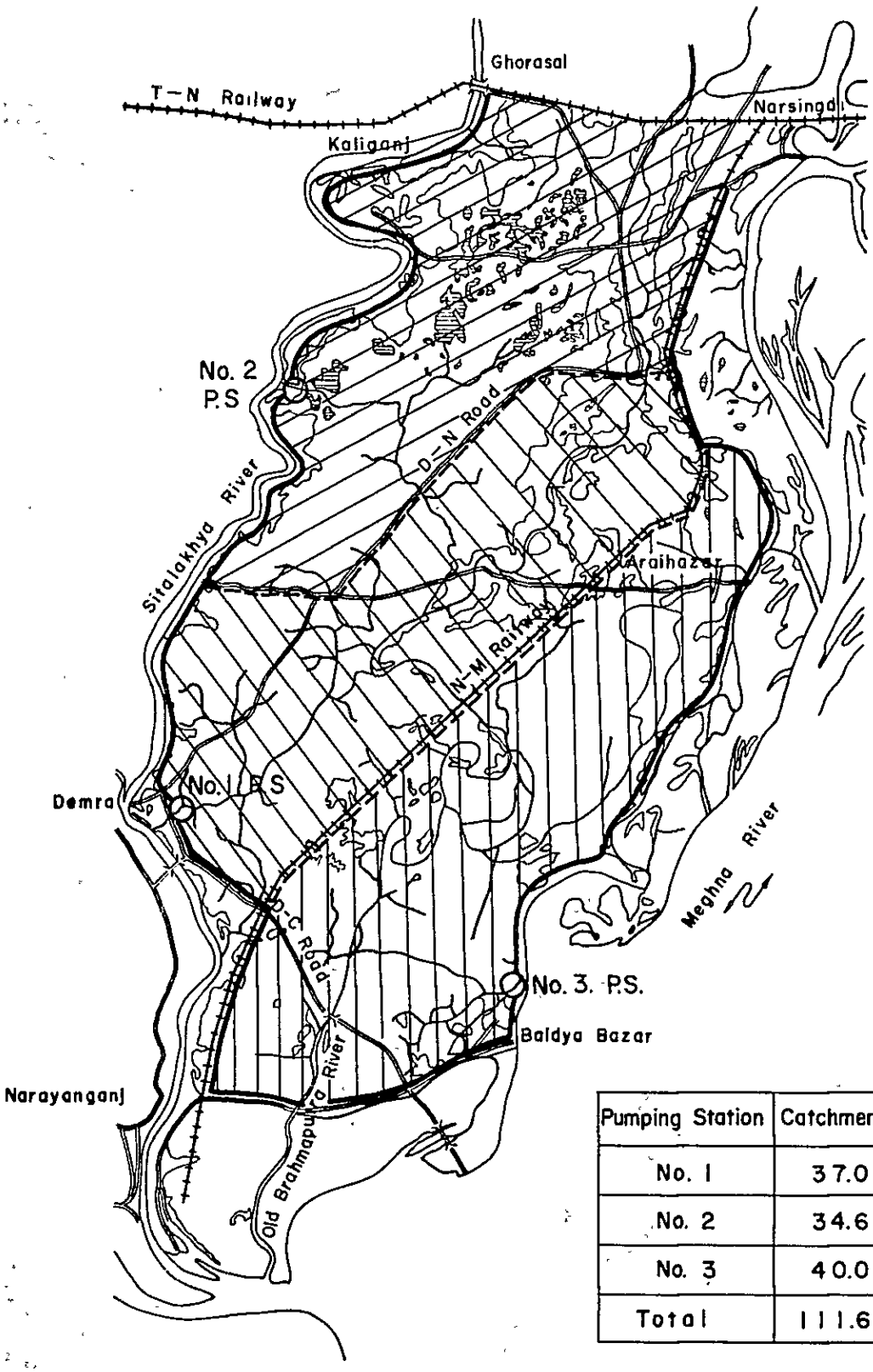
BANGLADESH N-N IRRIGATION PROJECT



Pumping Station	Catchment Area
No. 1	37.000 Ac
No. 2	34.600 Ac
No. 3	34.000 Ac
No. 4	27.700 Ac
Total	133.300 Ac

Fig. 2-6 PLAN B- DRAINAGE SYSTEM

BANGLADESH N-N IRRIGATION PROJECT



Pumping Station	Catchment Area
No. 1	37.000 Ac
No. 2	34.600 Ac
No. 3	40.000 Ac
Total	111.600 Ac

2.6 Cost Estimate

Cost comparison between Plan A and Plan B has been made with the estimated costs of dike, pumps, pumping stations and the structures related to dike only. The common components such as irrigation and drainage facilities and road network have been excluded, because the unit costs of the common components are almost equal between the two.

2.7 Identification of the Overall Project Plan

Through a series of comparative studies made in the preceding sections, Plan B has been found definitely more advantageous both technically and econnomically. Thereupon, the Plan B would be adopted as the overall project plan.

Table 2-5 Cost Comparison Between Plan A & Plan B

Unit 1000TK

ALT-Plan / Item	Unit	Unit Cost	Plan-A (106,100AC) Qty	Plan-A (106,100AC) Amount	Plan-B (88,200AC) Qty	Plan-B (88,200AC) Amount
I Dick						
Sitalakhya-Rin	Mile	1,400	24.1	33,740	21.5	30,100
Meghna-Rin	Mile	1,700	30.0	51,000	16.0	27,200
D - C Road	Mile	540	3.4	1,836	3.4	1,836
N - B Road	Mile	720			6.7	4,824
N - M Railway (D-C Road ~ Narsingdi)	Mile	800			7.0	5,600
N - M Railway (D-C Road ~ Narayanganj)	Mile		6.8		4.2	
Sub Total			64.3	86,576	58.8	69,560
2 Related Structure of Dick						
Closures	Nos	500	12	6,000	6	3,000
Sluiceway	Nos	3,000	15	45,000	8	24,000
Sluiceway(Brahmaputra)	Nos		1	30,000	1	20,000
Sub Total				81,000		47,000
3 Pumping Plans						
Mechanical Works	Stations	75,000	3	225,000	3	225,000
Mechanical Works	Stations		1	95,000		
Civil Works	Stations	30,000	3	90,000	3	90,000
Civil Works	Stations		1	45,000		
Sub Total				455,000		315,000
4 Contingence(20%)				124,515		86,312
Total				747,091 ≒747,000		517,872 ≒518,000
				17,400 Tk/ha		14,500 Tk/ha

ANNEX III: FLOOD-PROTECTION EMBANKMENT

ANNEX III FLOOD-PROTECTION EMBANKMENT

3.1 Stability Analysis of Levee Body

Stability for sliding at flood time and at the time of a sharp fall in water level has been analysed with the typical cross section of both the river dike and the railway banks. The stability analysis at the time of a sharp fall in water level has been made on the assumption that the flood water level has gone down considerably one month after the monsoon season is over, but the levee body still remains saturated with water which permeated therein during flood time.

(1) Design Parameter

No analysis of the particularities of material earth to be used for embankment having been conducted during the current survey, design parameters adopted by the similar project have been used. It is based on the judgement that there should be no radical change in soil texture on a vast flood plain spreading in the same deltaic region. They are the design parameters used for the stability analysis of river dike in the "Hail Haor Irrigation Project Feasibility and Definite Project Report", Vol. 1, October 1976. Seismological analysis has not been made.

Cohesion	C=200 psf = 0.977 t/m^2
Angle of Internal Friction	ϕ = 15°
Saturated Density	γ_{sat} = 123 lb/cuft = 1,970 t/m^3
Wet Density	γ_t = 114 lb/cuft = 1,826 t/m^3

(2) Flow Net

The levee body and its foundation are homogeneous and impermeable layer is found extending at 5 m below the sea level. Flow nets have been prepared on the assumption that permeability in the horizontal direction, which is a non-isotropy medium, is five times as large as that in the vertical direction. The flow nets are illustrated in Figs. 3-1 through 3-4. In both cases, Dupuit

Method has been used in drawing the flow nets which assume deformed cross sections because of its non-isotropy, and also by expanding its horizontal scale by 5 times of the original cross sections.

(3) The Results of Stability Calculation

The stability of railway embankment has been analysed by uniformly spreading on its crest, the railway load equivalent to 1 t/m^2. The results of the stability analysis are given in Table 3-1.

Table 3-1 Results of Stability Analysis

Condition	River Dike		Railway Bank	
	R/S	L/S	R/S	L/S
H.W.L.	1.4	1.4	1.3	1.3
Rapid Drawdown	1.4		1.3	

Fig. 3-1 SLOPE STABILITY ANALYSIS RIVER DIKE HIGH-WATER-LEVEL CONDITION

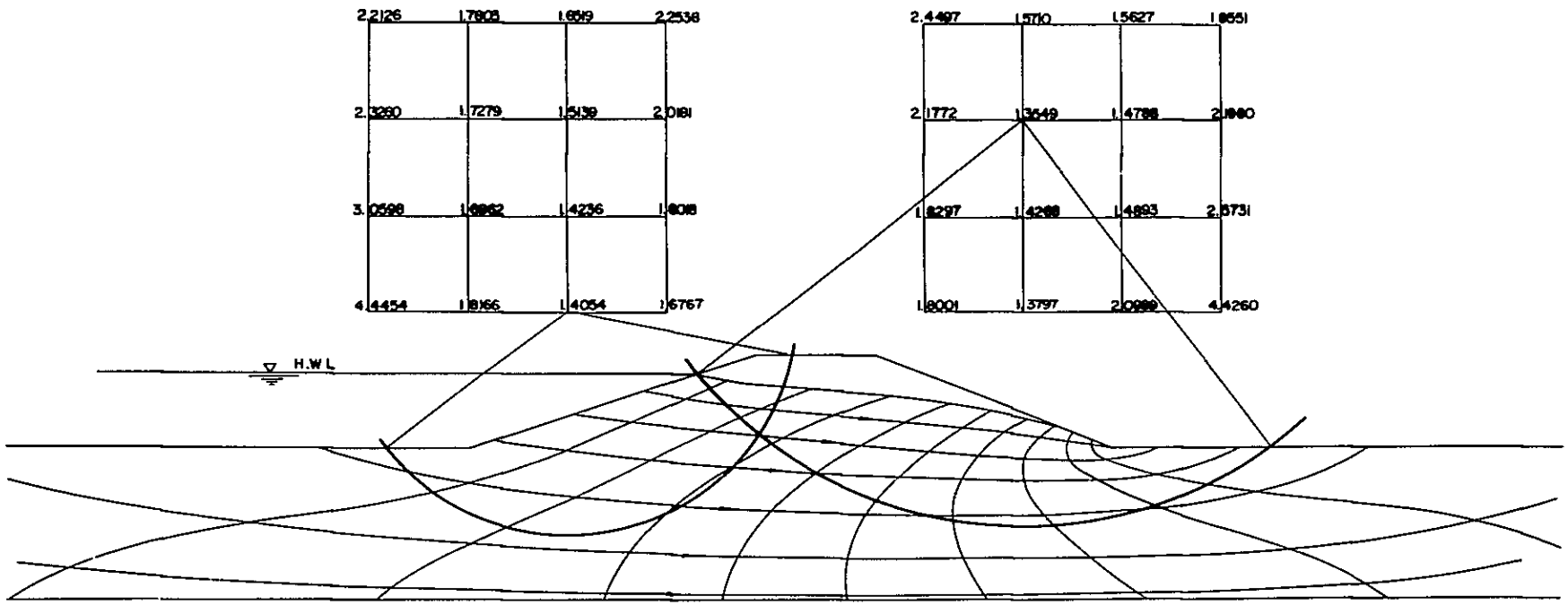


Fig. 3-2 SLOPE STABITY ANALYSIS RIVER DIKE RAPID DRAWDOWN CONDITION

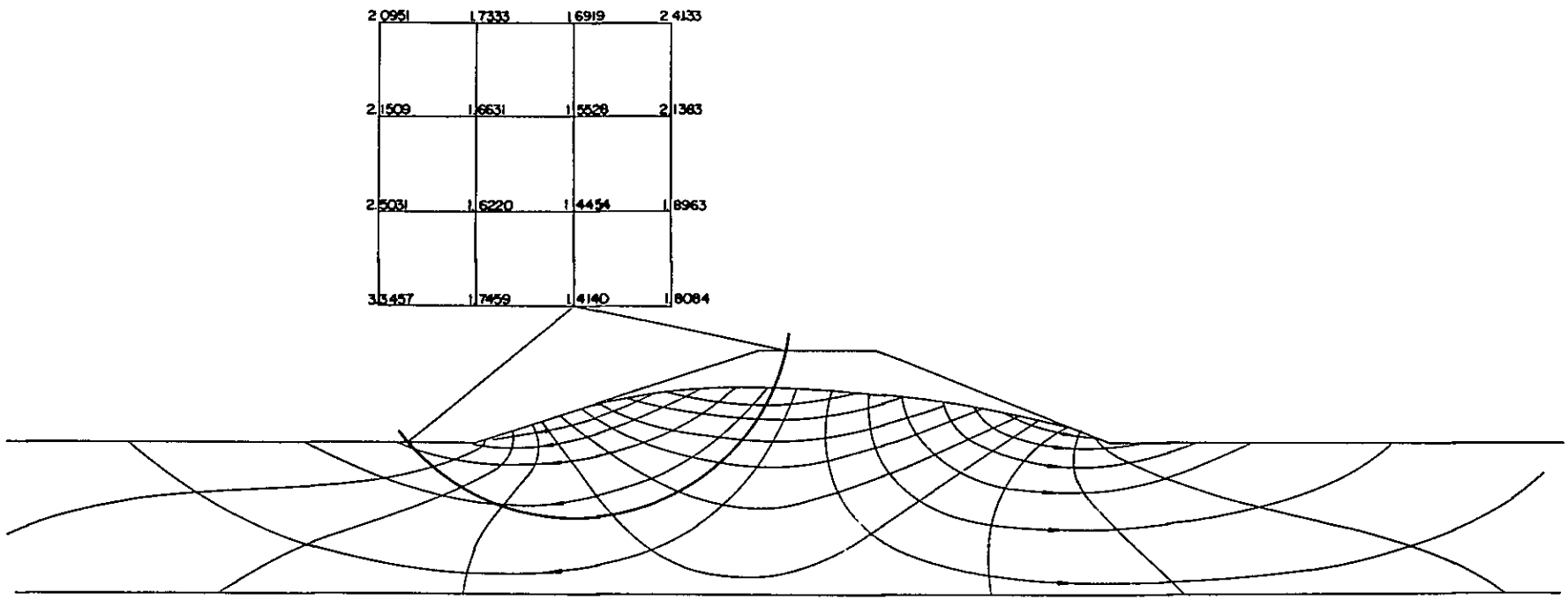


Fig. 3-3 SLOPE STABILITY ANALYSIS RAILWAY BANK
RAPID DRAWDOWN CONDITION

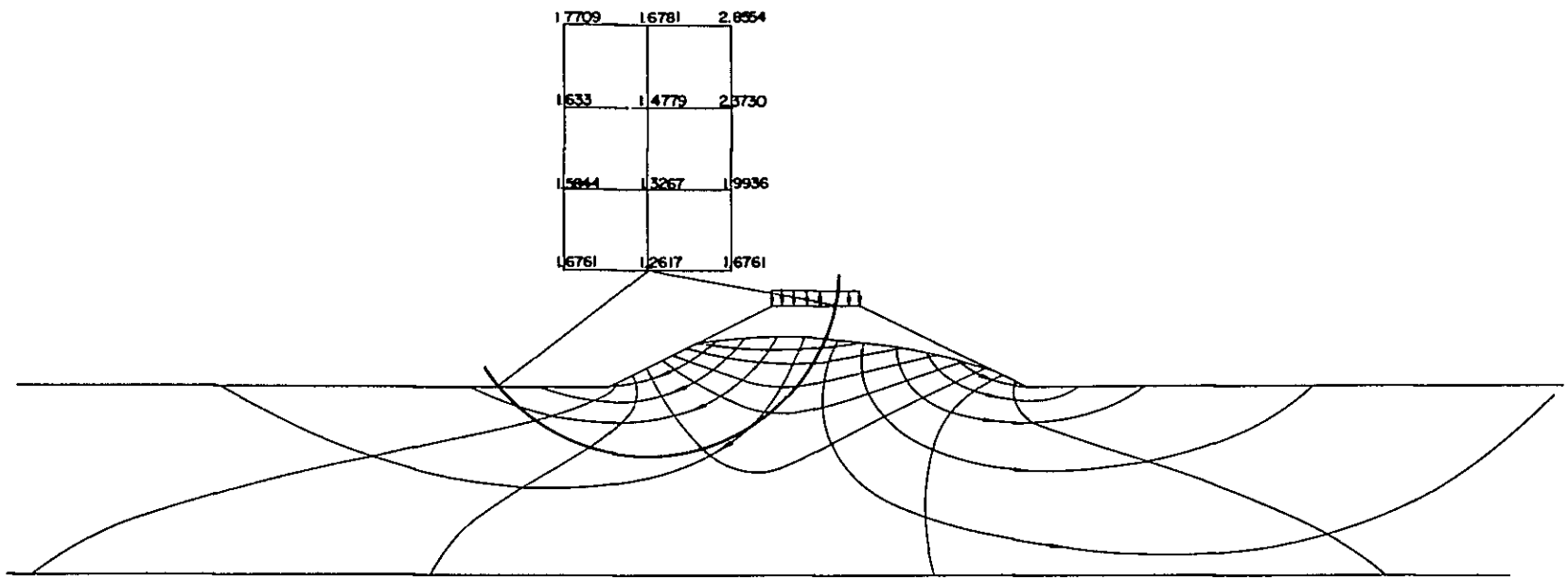
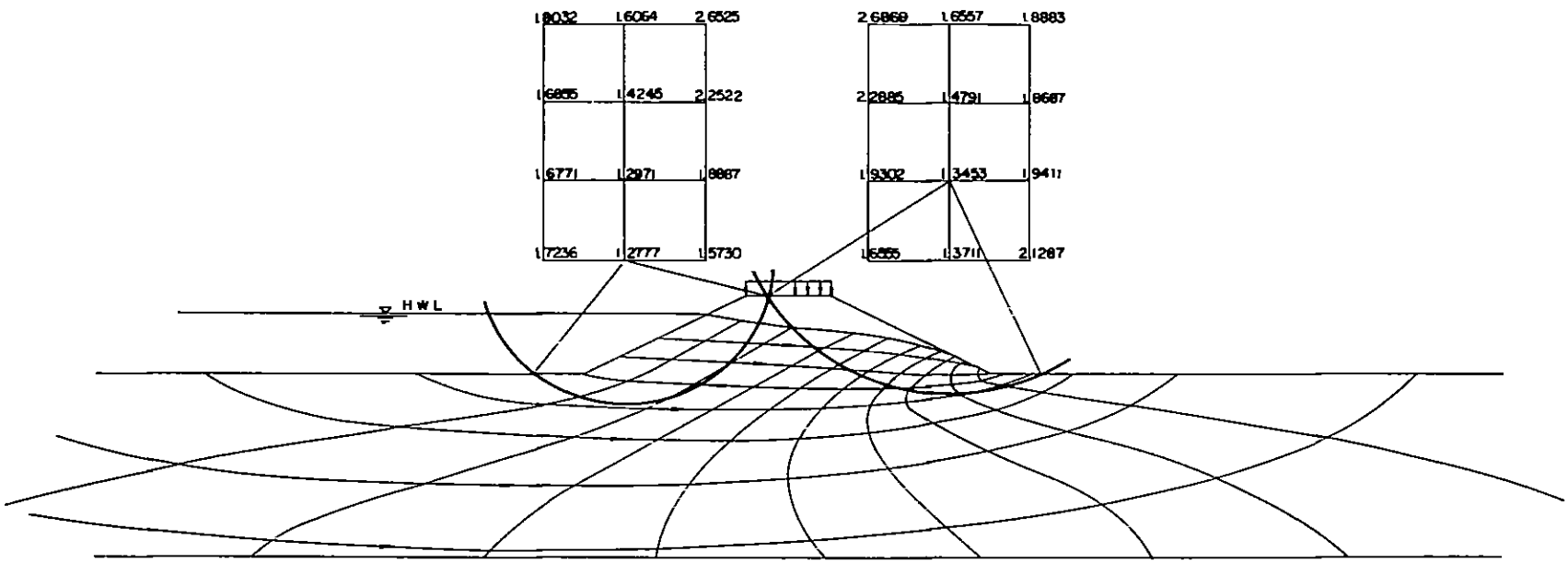


Fig.3-4 SLOPE STABILITY ANALYSIS RAILWAY BANK HIGH-WATER-LEVEL CONDITION



ANNEX IV: DRAINAGE

ANNEX IV — DRAWINGS

ANNEX IV DRAINAGE

4.1 Selection of Rainfall Data

(1) Rainfall Records

(i) Location of Rainfall Stations

The location of the rainfall stations whose data have more or less relevancy with the project area is shown in Fig. 4-1.

(ii) Base Years

Among the rainfall records obtained at the above-mentioned stations, those pertaining to 10 to 11 years have been used as follows:

Dacca	1967 - 1976	(10 Years)
Narayanganj	1967 - 1976	(")
Narsingdi	1965 - 1975	(11 Years)
Kaliganj	1965 - 1975	(")
Bancharampur	1966 - 1975	(10 Yeras)

(iii) Monthly Rainfall Comparison

Monthly rainfalls recorded at these five stations are shown in Tables 1-3 through 1-7. Mean monthly rainfalls for the last 10 years or 11 years are given in Fig. 4-2. Apparently, the monthly rainfalls recorded at Narsingdi are exceptionally large in comparison with others. Therefore, it is considered appropriate to exclude the rainfall records at Narsingdi in determining optimum pump capacity.

(2) Identification of Basic Rainfall Pattern

In order to determine the optimum pump capacity for the project area, it is necessary to identify the amount of rainfall and to determine rainfall patterns.

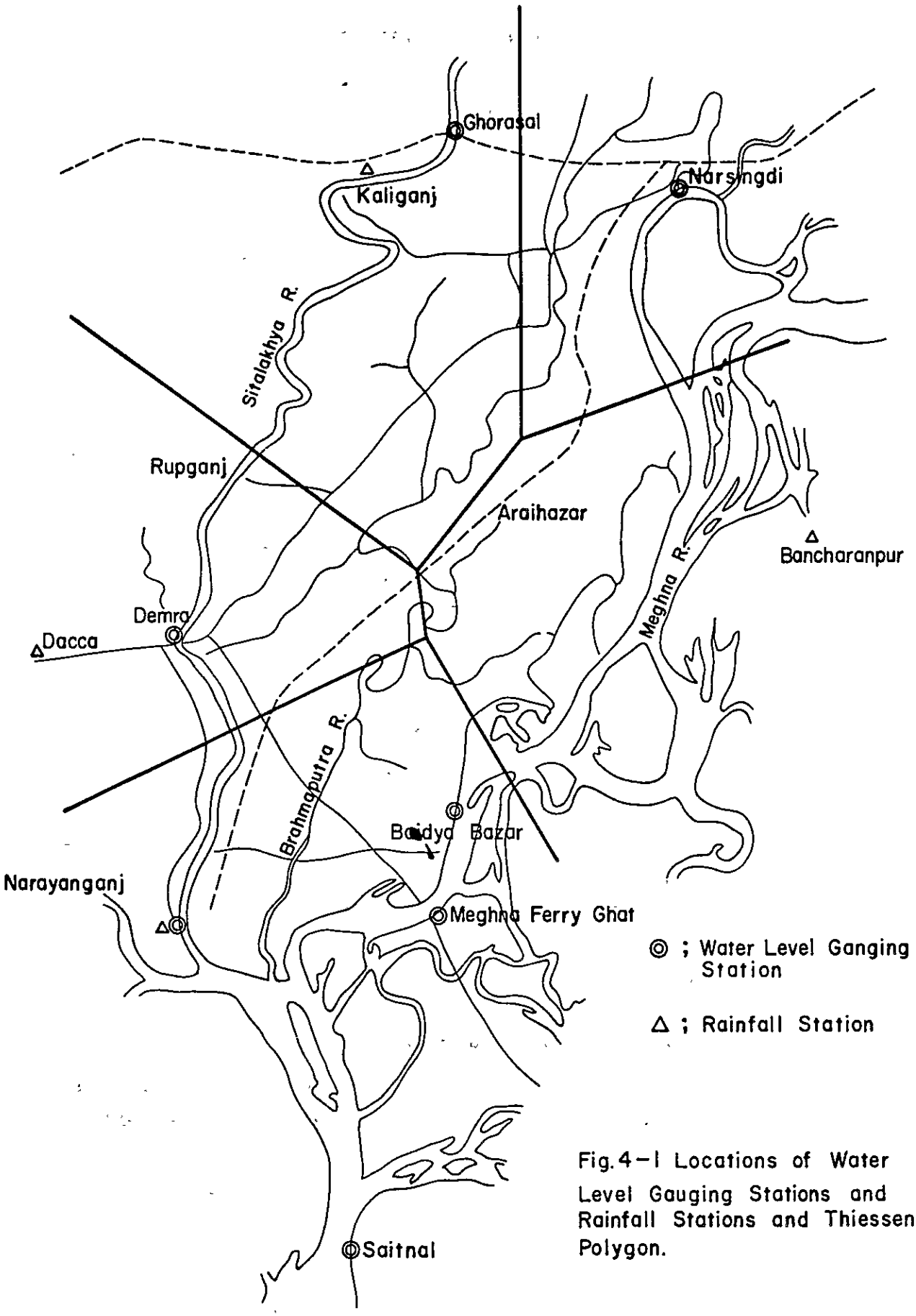


Fig. 4-1 Locations of Water Level Gauging Stations and Rainfall Stations and Thiessen Polygon.

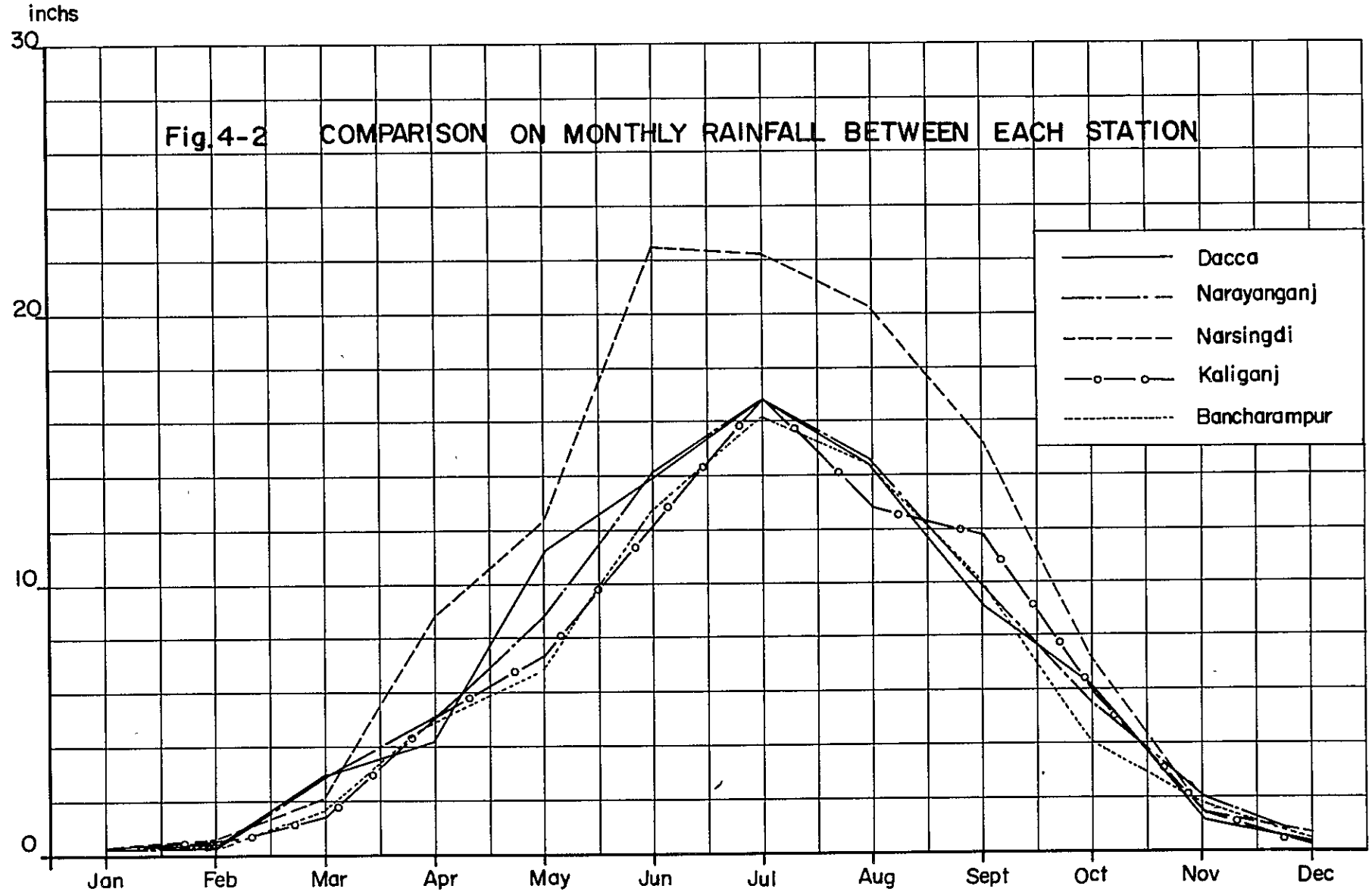

inchs
30
20
10
0
Fig.4-2 COMPARISON ON MONTHLY RAINFALL BETWEEN EACH STATION
Dacca
Narayanganj
Narsingdi
Kaliganj
Bancharampur
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec

Table 4-1 Continuous Rainfall Days and Cumulative Rainfall

Station: Dacca (1)

Year / C.day	1967	1968		1969		1970			1971		1972	
1	3.53	5.69	5.44	4.51	3.37	5.95	2.16	4.56	9.89	2.91	4.24	9.09
2	4.85	9.41	8.73	4.87	4.08	10.28	3.09	6.45	12.90	4.64	6.46	9.86
3	6.94	10.07	9.65	5.09	4.93	10.86	3.73	8.00	13.95	5.87	7.96	10.40
4	8.95	10.28	11.83	5.24	6.28	11.42	4.19	9.01	13.95	6.82	9.45	10.40
5	9.20	10.52	13.92	5.60	7.82	11.87	4.30	11.43	13.96	8.67	10.75	10.40
6	9.27	11.49	14.46	5.60	9.17	12.04	5.05	12.41	14.14	9.45	11.17	13.10
7	9.38	11.49	14.52	5.61	9.19	12.27	6.18	12.53	15.10	9.71		13.21
8	9.40	12.84	15.90	6.72	9.31	12.39	6.89	12.61	15.63	10.02		
9	9.42	14.46	15.90	6.72	11.45	12.46	7.00	12.66	15.93	10.21		
10	12.26	14.54	17.07	9.14	12.74		7.05	13.50	15.93	11.50		
11	14.27	15.60	17.32	9.31	13.42			13.50	15.96	12.07		
12	14.55	15.66	17.36	9.39	13.74			14.29	16.14	12.22		
13	14.56	15.71	17.37	10.13	15.50			14.29	17.80	12.97		
14	14.60	15.71	17.40	10.37	15.72			14.31				
15		15.76		10.43	16.22			14.41				
C.days	14	15	14	15	15	9	10	15	13	13	6	7

Table 4-1 Continuous Rainfall Days and Cumulative Rainfall

Station: Dacca (2)

Year / C.day	1973				1974		1975		1976			Mean
1	3.95	4.19	6.61	2.16	4.30	2.42	5.85	5.64	6.43	4.06	3.55	
2	6.09	5.26	6.97	3.23	7.24	3.24	9.02	6.89	10.35	4.10	5.64	
3	6.28	6.36	7.29	3.62	7.45	3.31	13.39	7.21	12.96	6.14	7.58	
4	7.63	7.76	7.37	5.14	7.47	3.38	14.57	7.30	16.38	7.23	8.88	
5	7.63	7.98	7.37	5.41	8.03	4.85	16.45	7.79	17.16	8.35	9.40	
6	10.58	8.37	7.42	5.58	9.51	5.60	17.93	7.83	17.16	8.35	9.65	
7	10.82	8.51	8.48	5.71	9.93	5.65	18.23	7.83	19.59	8.40		
8	10.99	8.63	10.74	5.72	10.67	7.21	19.85	7.86	20.71	8.68		
9		8.84	10.90	6.04	10.81	8.04	19.94	8.67	21.49	8.92		
10		9.84	11.00	8.39	14.85	8.07	20.00	9.17	21.93	9.50		12.35
11		10.28		8.98	15.53	8.07	20.00	9.33		10.65		
12				9.50	15.88	8.60	20.34	9.75		10.66		
13				9.79	15.92		20.78	9.90		10.70		
14				9.90	16.00		21.17	9.95		10.98		
15				10.20	16.91		21.24	10.18		10.99		
C.days	8	11	10	15	15	12	15	15	10	15	6	12.1

Table 4-2 Continuous Rainfall Days and Cumulative Rainfall

Station: Narayanganj(1)

Year / C.day	1967		1968		1969	1970		1971			1972	
1	4.65	2.32	5.32	4.64	2.90	3.04	2.31	3.66	3.56	3.49	6.57	3.10
2	8.16	4.09	10.37	8.55	5.49	4.08	4.06	5.25	4.35	6.09	7.20	4.70
3	9.10	5.46	11.12	10.55	7.05	4.47	5.97	6.15	4.35	6.61	7.47	6.11
4	11.39	5.46	11.73	12.16	7.54	4.58	6.49	6.17	4.35	9.09	7.58	7.08
5	11.51	9.11	12.44	15.23	8.44	4.63	6.64	6.26	4.44	11.02	7.58	9.16
6	11.84	9.11	14.24	15.52	9.47	5.27	7.12	6.74	6.26	11.74	7.58	9.81
7		9.56	14.68	15.75	10.06	5.27		7.74	6.44	12.13	7.86	
8		9.65	14.94	16.28	11.75	6.67		8.83	6.44	12.22	8.33	
9			16.39	16.28	11.75	7.61			6.44	12.42	8.52	
10			17.04	17.08	12.03				9.69	13.20	10.10	
11			17.09	17.48	12.13					13.41	10.54	
12			17.34		13.22					13.90	11.09	
13			17.34		13.77					13.95	11.16	
14			17.74									
C.days	6	8	14	11	13	9	6	8	10	13	13	6

Table 4-2 Continuous Rainfall Days and Cumulative Rainfall

Station: Narayanganj(2)

Year / C.day	1973			1974		1975		1976			Mean
1	2.56	3.40	6.71	2.63	3.10	5.19	3.58	3.60	4.13	4.13	
2	2.56	4.60	8.06	4.38	3.89	9.67	6.53	5.15	7.42	7.63	
3	4.66	4.60	8.06	5.21	3.89	12.62	6.78	7.70	7.51	8.47	
4	7.21	4.94	9.96	6.67	5.19	15.02	7.58	9.53	11.64	9.78	
5	7.21	4.99	9.96	7.51	5.42	16.85	8.83	9.53	11.89	9.78	
6	8.90	5.62	10.72	8.89	6.20	18.54	11.63	9.58	11.89	9.78	
7		8.04	11.70	10.48	6.20	18.99	12.00	9.58	11.94	9.78	
8		8.34	12.41	10.79	6.29	19.28	12.05	11.84	12.66	9.85	
9		8.95	12.50	12.36	7.72	19.53	13.21	12.60	12.87	9.85	
10		11.23	13.31	12.57	8.36	19.62	13.78	13.76	14.62	11.44	11.89
11		12.23		12.70	8.52			14.68	15.58	12.56	
12		12.77		15.03	8.52					12.65	
13		13.30		15.03	9.16					14.04	
14		13.78		15.65						14.88	
15		13.95		16.99						15.09	
C.days	6	15	10	15	13	10	10	11	11	14	10.5

Table 4-3 Continuous Rainfall Days and Cumulative Rainfall

Station: Narsingdi(1)

Year / C.day	1964		1965				1966		1967			1968
1	4.62	5.36	4.79	2.93	4.45	4.73	7.34	3.76	3.92	3.46	4.97	3.99
2	6.07	9.59	8.85	5.44	6.82	5.19	8.30	6.67	7.44	5.67	6.38	6.62
3	7.84	11.52	9.22	6.30	8.60	6.13	9.18	9.42	10.10	7.07	7.61	8.33
4	9.17	12.17	9.58	7.64	9.22	7.36	12.54	11.04	12.31	7.70	8.83	9.89
5	9.40	12.39	9.90	8.07	9.22	8.23	12.87	11.63	12.85	8.07	9.71	10.17
6	10.08	12.39	11.08	10.29	9.45	11.45	14.62	11.96	15.16	8.30	9.71	14.12
7	11.31	13.45		10.29	11.59	11.70	15.08	12.17	16.07	9.56	10.04	16.87
8	14.18	13.99		10.35			15.46	12.17	17.32	9.94	10.58	17.84
9		16.86		10.43			15.88	12.45	18.74	10.58	11.35	18.26
10		17.25		12.40			16.10	14.88	19.11	13.35	13.17	
11		17.25		12.82			16.41			15.78	14.11	
12		17.47		13.28			16.59			16.19	14.48	
13		17.84		13.67			17.51			17.14	14.48	
14		21.33		13.90			17.67			17.38	16.16	
15		23.20		14.87			18.19				17.08	
C.days	8	15	6	15	7	7	15	10	10	14	15	10

Table 4-3 Continuous Rainfall Days and Cumulative Rainfall

Station: Narsingdi(2)

Year / C.day	1968	1969			1970			1971			1972	
1	3.38	3.88	5.72	4.36	5.98	7.57	5.78	7.94	5.89	4.83	4.58	2.78
2	5.59	6.81	6.68	7.04	6.86	9.12	7.31	12.56	10.21	7.62	7.53	3.84
3	6.16	8.36	8.15	8.96	10.80	9.50	8.97	16.27	11.18	8.44	10.41	6.57
4	9.02	8.70	9.78	10.54	12.99	9.74	10.85	20.09	12.84	8.81	10.93	7.25
5	12.37	11.31	10.10	14.23	13.67	10.40	12.01	24.27	13.18	9.04	11.16	7.25
6	12.68	13.28	10.47	15.60	14.00	11.18	12.90	27.54	13.39	10.88	11.30	7.69
7	12.89	14.60	12.11	16.88	14.22	11.74	13.03	29.08	13.80	13.55	13.76	7.90
8	13.27	16.41	14.99	17.79	14.22	11.96	13.50	29.89	14.65	16.39	16.73	8.08
9		17.74	15.42	18.20	14.31	12.21		30.30	17.02	16.73	16.85	9.72
10		19.16	17.19	18.55	14.45				17.87		17.53	12.07
11		19.94	19.50								17.84	12.94
12		20.41	20.48								19.46	
13			21.19								19.60	
14			21.55								19.83	
15			21.73								20.01	
C.days	8	12	15	10	10	9	8	9	10	9	15	11

Table 4-3 Continuous Rainfall Days and Cumulative Rainfall

Station: Narsingdi(3)

Year / C.day	1972	1973				1974		Mean
1	2.33	5.12	2.95	3.62	5.66	7.12	3.91	
2	4.11	10.03	4.03	4.68	9.14	9.33	6.68	
3	5.55	13.48	4.85	6.46	9.52	9.68	8.96	
4	6.52	16.19	5.64	7.40	9.63	10.22	10.88	
5	7.28	16.55	6.10	8.56	9.63	10.54	11.20	
6	8.10	20.63	7.42	11.91	10.35	12.51	12.07	
7	9.88	21.40	7.42	12.99	11.03	12.81	12.33	
8	9.88	21.72	7.56	13.54	11.19	13.53	12.45	
9	11.53	22.41	10.03	14.18	11.51	13.97	12.90	
10	11.84	22.41	11.61	16.04		19.15	13.22	15.54
11	12.02	22.68	12.55	17.01		19.23	13.43	
12		23.56	12.69	17.68		19.69	13.59	
13		23.56	14.35	18.26		20.93		
14		23.93	16.81	18.98		23.10		
15		26.55	18.53	19.29		23.74		
C.days	11	15	15	15	9	15	12	11.3

Table 4-4 Continuous Rainfall Days and Cumulative Rainfall

Station: Kaliganj(1)

Year / C.day	1964			1965				1966		1967	1968	
1	4.85	2.58	2.67	7.00	1.40	3.13	3.21	4.91	3.33	6.28	5.23	4.94
2	5.92	2.99	5.26	7.46	2.58	3.28	3.72	6.86	3.80	9.68	6.95	7.94
3	7.25	3.35	6.24	8.97	3.56	3.85	3.75	7.38	6.84	12.63	7.85	7.96
4	7.48	4.34	6.85	9.33	4.72	4.24	3.79	7.91	7.31	13.41	8.45	8.46
5	7.75	5.02	7.30	9.63	5.76	5.76	4.76	8.32	7.95	13.79	10.75	8.57
6	8.40	5.02	7.30	9.72	6.14	7.55	5.30	8.32	8.42	13.96	10.90	8.99
7	8.40	5.70	7.30	9.72	6.56	7.80	6.92	9.51	8.69	14.04	10.95	11.44
8	8.66	7.95	8.10	9.82	7.72	8.83	7.12	9.94	8.80	14.09	11.40	13.04
9	9.26	8.60	9.52		8.53		7.30	9.94	8.80		11.44	13.74
10	10.31				8.85		8.39	10.22	9.16		12.13	13.97
11	10.90				8.93		8.51	10.63	9.34		12.13	13.97
12	12.33				9.17		8.81	10.63	9.36		13.65	14.25
13	12.82				9.48		9.97	11.82	9.57		13.74	
14	12.95				9.77		10.49	12.25	10.24		13.74	
15					10.06		11.32		10.82		13.97	
C.days	14	9	9	8	15	8	15	14	15	8	15	12

Table 4-4 Continuous Rainfall Days and Cumulative Rainfall

Station: Kaliganj(2)

Year / C.day	1969			1970			1971	1972	1973	1974		Mean
1	3.02	3.49	4.61	3.44	2.89	3.51	6.14	1.95	4.88	4.05	5.74	
2	4.79	4.01	5.13	5.51	3.80	5.59	8.66	2.57	7.75	7.35	5.74	
3	5.82	4.24	5.30	7.53	4.74	6.76	9.16	2.80	8.63	8.70	6.64	
4	7.04	4.49	5.37	8.02	6.35	7.29	9.16	4.12	9.53	9.45	7.58	
5	8.94	4.63	6.34	8.31	8.99	7.86	9.35	5.27	10.13	11.50	10.46	
6	9.28	5.19	7.13	8.38	9.64	8.51	9.35	5.89	10.51	13.44	12.23	
7	9.50	5.19	7.13	8.38	9.91	8.53	10.29		10.87	16.04	14.45	
8	10.82	7.10	7.13	8.42	10.91	8.62	10.81		12.92	16.69	17.85	
9	11.21	7.47	8.76	8.61	11.18	8.86	11.44		13.82	17.09	17.85	
10	11.40	8.98	9.20		11.57	8.90	11.44		14.42	17.59	18.15	10.87
11		9.18	9.20		11.69	9.02	11.66		14.80	17.59	18.78	
12		9.30	9.24			9.17	13.75		15.16	17.99	19.52	
13		10.81					14.27		15.51	17.99	22.12	
14		11.01							15.63	19.59	22.96	
15		11.30							15.75	22.59		
C.days	10	15	12	9	11	12	13	6	15	15	14	11.9

Table 4-5 Continuous Rainfall Days and Cumulative Rainfall

Station: Bancharanpur(1)

Year / C.day	1965		1966	1967		1968	1969	1970	1971	1972	1973	
1	3.65	2.22	5.63	4.62	2.81	3.80	9.62	3.55	3.60	2.14	3.27	7.16
2	3.87	3.67	9.88	9.14	5.11	6.79	10.16	5.29	7.07	3.87	5.63	8.39
3	4.24	3.94	13.73	9.96	5.23	9.09	10.53	6.89	9.87	5.39	6.86	8.39
4	5.99	5.50	15.01	10.08	6.30	12.79	11.58	8.49	9.87	5.96	7.73	12.16
5	7.55	5.97	15.30	12.48	6.61	13.59	12.34	9.02	9.87	8.08	7.99	13.55
6	7.55	6.12	16.15	12.70	7.43	15.19	12.34	11.60	9.87	8.33	9.12	13.90
7	7.83	6.33	18.70	12.85	7.55	15.47	12.34	12.12	9.99	9.03	10.71	14.19
8	10.58	6.98	18.70	13.33	9.99	15.60	12.34	12.12	12.05	9.03	12.44	14.42
9	10.58	7.43	19.08	13.72	12.07		13.89	13.45	12.62	9.55	14.90	15.19
10	10.70	9.43	22.68		13.61		16.19	13.73		9.80	16.25	
11	10.70	9.86	23.30		13.73		16.60	13.84		11.37	18.31	
12	11.47	11.41			13.95					11.44		
13	11.47	11.63			14.05					11.59		
14	12.71	11.98										
15		12.45										
C.days	14	15	11	9	13	8	11	11	9	13	11	9

Table 4-5 Continuous Rainfall Days and Cumulative Rainfall

Station: Bancharanpur(2)

Year / C.day	1974			Mean
1	4.26	3.62	2.33	
2	5.78	3.98	3.17	
3	6.04	6.20	4.76	
4	6.29	6.44	5.68	
5	6.29	8.00	6.56	
6	8.57	8.28	6.83	
7	10.04	8.35	8.85	
8	10.04	10.07	10.47	
9	10.04	10.07	10.59	
10	11.44	10.33	11.12	13.49
11		11.05	11.44	
12			13.36	
13			15.72	
14			15.88	
15			16.16	
C.days	10	11	15	11.3

(i) Continuous Rainfall Days

Tables 4-1 through 4-5 show the continuous rainfall days and cumulative rainfall in each base year at five stations. Average continuous days have been found 10.5 - 12. Continuous 10-day rainfall, therefore, would be used as the basic rainfall pattern for pumping capacity calculation.

4.2 Calculation of Probable Rainfall

On the basis of the rainfall records at Dacca, the rainfalls of different probabilities have been computed by the following methods.

(1) Adjustment of Rainfall Records

Continuous rainfall days have been categorized into the following six cases: (1) 1-day continuous rainfall; (2) 2-day continuous rainfall; (3) 3-day continuous rainfall; (4) 4-day continuous rainfall; (5) 5-day continuous rainfall; (6) 10-day continuous rainfall. The maximum continuous rainfall in each year for the six cases is shown in Table 4-6.

(2) Probability Calculation

In order to identify the rainfalls of different probabilities from the available rainfall data, the following four methods would be used:

(i) Hazen Method;
(ii) Thomas Method;
(iii) Gumbel Method; and
(iv) Iwai Method.

Probable rainfalls computed by the above-mentioned four methods with different probable years such as 2, 3, 4, 5, 10, 15, 20, 30, 40, and 50 years are given in Tables 4-7 through 4-10.

Table 4-6 Continuous Rainfall

Year	Daily Rainfall					Total	Year	Daily Rainfall					Total
	1st	2nd	3rd	4th	5th			1st	2nd	3rd	4th	5th	
	3.84					3.84		9.09					9.09
	3.53	1.32				4.85		9.09	0.77				9.86
	3.53	1.32	2.09			6.94		0.54	9.09	0.77			10.40
1967	3.53	1.32	2.09	2.01		8.95	1972	0.0	0.54	9.09	0.77		10.40
	3.53	1.32	2.09	2.01	0.28	9.23		2.70	0.0	0.0	0.54	9.09	12.33
	3.65	1.20	0.02	0.02	0.11			0.11	2.70	0.0	0.0	0.54	
	6th	7th	8th	9th	10th			6th	7th	8th	9th	10th	
	0.07	0.25	3.53	1.32	2.09	12.26		9.09	0.77	0.0	0.0	0.0	13.21
	5.69					5.69		6.61					6.61
	3.72	5.69				9.41		6.61	0.36				6.97
	0.66	3.72	5.69			10.07		0.32	6.61	0.36			7.29
1968	0.66	3.72	5.69	0.21		10.28	1973	1.35	0.19	2.14	3.95		7.63
	2.09	2.18	0.92	3.29	5.44	13.92		6.61	0.36	0.0	0.05	1.06	8.08
	0.54	2.09	2.18	0.92	3.29			0.08	0.32	6.61	0.36	0.0	
	6th	7th	8th	9th	10th			6th	7th	8th	9th	10th	
	5.44	0.06	1.38	0.0	1.17	17.07		0.05	1.06	2.26	0.16	0.10	11.00
	4.51					4.51		4.57					4.57
	0.36	4.51				4.87		2.94	4.30				7.24
	3.37	0.32	1.76			5.45		0.35	2.94	4.30			7.59
1969	0.71	3.37	0.32	1.76		6.16	1974	0.35	2.94	4.30	0.21		7.80
	1.54	1.35	0.85	0.71	3.37	7.82		2.94	4.30	0.21	0.02	0.56	8.03
	1.29	2.14	0.12	0.02	1.35			2.94	4.30	0.21	0.02	0.56	
	6th	7th	8th	9th	10th			6th	7th	8th	9th	10th	
	0.85	0.71	3.37	0.32	1.76	11.93	.	1.48	0.42	0.74	0.14	4.04	14.85
	5.95					5.95		5.85					5.85
	4.33	5.95				10.28		5.85	3.17				9.02
	0.58	4.33	5.95			10.86		5.85	3.17	4.37			13.39
1970	0.56	0.58	4.33	5.95		11.42	1975	5.85	3.17	4.37	1.18		14.57
	0.56	0.58	4.33	5.95	0.45	11.87		5.85	3.17	4.37	1.18	1.88	16.45
	0.84	0.05	0.12	1.55	4.56			0.09	5.85	3.17	4.37	1.18	
	6th	7th	8th	9th	10th			6th	7th	8th	9th	10th	
	1.89	1.01	2.42	0.98	0.08	13.50		1.88	1.48	0.30	1.62	0.06	20.00
	9.89					9.89		6.43					6.43
	3.01	9.89				12.90		6.43	3.92				10.35
	3.01	9.89	1.05			13.95		6.43	3.92	2.61			12.96
1971	0.0	3.01	9.89	1.05		13.95	1976	6.43	3.92	2.61	3.42		16.38
	0.01	0.0	3.01	9.89	1.05	13.96		6.43	3.92	2.61	3.42	0.78	17.16
	0.30	0.53	0.96	0.18	0.01			6.43	3.92	2.61	3.42	0.78	
	6th	7th	8th	9th	10th			6th	7th	8th	9th	10th	
	0.00	3.01	9.89	1.05	0.0	15.93		0.0	2.43	1.12	0.78	0.44	21.93

Table 4-7 Probable Continuous Rainfall by Hazen Method

Probable Year \ Continuous Days	1	2	3	4	5	10
2	5.9	8.2	9.5	10.3	11.4	14.8
3	6.9	9.4	10.8	11.8	12.9	16.3
4	7.5	10.1	11.7	12.7	13.9	17.2
5	7.9	10.7	12.3	13.4	14.6	17.9
10	9.3	12.3	14.1	15.4	16.6	19.8
15	10.0	13.2	15.1	16.5	17.7	20.7
20	10.5	13.8	15.8	17.3	18.5	21.4
30	11.2	14.6	16.8	18.3	19.5	22.4
40	11.7	15.2	17.5	19.1	20.2	23.0
50	12.1	15.7	18.0	19.6	20.8	23.5

Table 4-8 Probable Continuous Rainfall by Thomas Method

Probable Year \ Continuous Days	1	2	3	4	5	10
2	5.9	8.2	9.5	10.3	11.4	14.8
3	7.0	9.6	11.1	12.1	13.3	16.6
4	7.7	10.6	12.2	13.3	14.5	17.7
5	8.2	11.3	13.0	14.1	15.3	18.6
10	9.7	13.3	15.3	16.6	17.9	20.9
15	10.5	14.4	16.6	18.1	19.3	22.1
20	11.1	15.2	17.5	19.1	20.3	23.0
30	12.0	16.3	18.8	20.5	21.7	24.2
40	12.6	17.1	19.7	21.5	22.7	25.0
50	13.0	17.7	20.4	22.2	23.4	25.7

(Unit : inches)

Table 4-9 Probable Continuous Rainfall by Gumbel Method

Continuous Days / Probable Year	1	2	3	4	5	10
2	6.0	8.2	9.5	10.3	11.4	14.7
3	7.2	9.6	11.1	12.1	13.3	16.6
4	7.9	10.5	12.1	13.3	14.5	17.9
5	8.5	11.2	12.9	14.1	15.4	18.8
10	10.2	13.1	15.1	16.6	18.0	21.5
15	11.1	14.2	16.4	18.0	19.5	23.0
20	11.8	14.9	17.3	19.0	20.5	24.1
30	12.7	16.0	18.5	20.4	22.0	25.5
40	13.4	16.7	19.4	21.4	23.0	26.6
50	13.9	17.3	20.0	22.1	23.8	27.4

Table 4-10 Probable Continuous Rainfall by Iwai Method

Continuous Days / Probable Year	1	2	3	4	5	10
2	5.9	8.2	9.5	10.3	11.4	14.8
3	6.9	9.4	10.9	11.8	13.0	16.4
4	7.6	10.2	11.7	12.7	14.1	17.4
5	8.1	10.8	12.4	13.4	14.8	18.2
10	9.7	12.5	14.3	15.4	17.1	20.5
15	10.6	13.4	15.3	16.5	18.3	21.7
20	11.3	14.0	16.0	17.3	19.2	22.7
30	12.2	14.9	17.0	18.3	20.4	24.0
40	12.9	15.6	17.7	19.1	21.3	24.9
50	13.4	16.0	18.2	19.6	22.0	25.6

(3) Basic Probable Rainfall

The rainfalls of different probabilities computed by different methods in the preceding section are given altogether in Table 4-11. The probable rainfalls computed by Thomas Method are nearly equivalent to those obtained by Gumbel Method, the difference between them is that while in Thomas Method the less the continuous rainfall days are, the more will be the probable rainfalls, in Gumbel Method the more the continuous rainfall days, the more will be the probable rainfalls. In calculating probable rainfalls, there exists no difference in accuracy between the Thomas and the Gumbel Methods. Judging from the intention of the project and regional characteristics of the project area, it would be preferable to assume larger rainfall amount and more continunous rainfall days in calculating probable rainfalls. Therefore, the Gumbel Method would be used to compute the basic probable rainfalls.

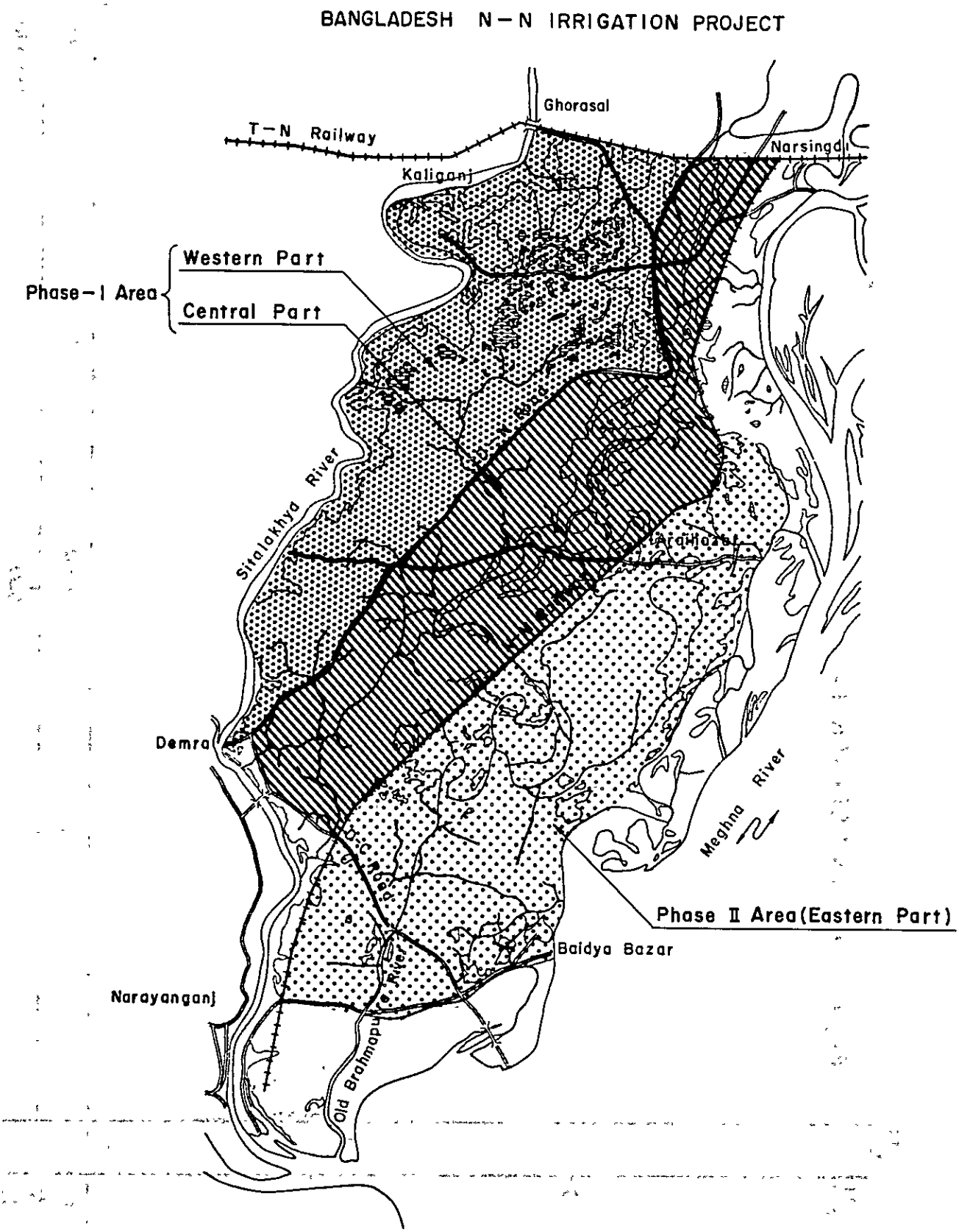
4.3 H-A, V Curve

Table 4-11 Probable Continuous Rainfall

(Unit : inches)

Continuous days / Method / Probable year	1				2				3				4				5				10			
	Hazen	Thomas	Gumbel	Iwai	Hazen	Thomas	Gumbel	Iwai	Hazen	Thomas	Gumbel	Iwai	Hazen	Thomas	Gumbel	Iwai	Hazen	Thomas	Gumbel	Iwai	Hazen	Thomas	Gumbel	Iwai
2	5.9	5.9	6.0	5.9	8.2	8.2	8.2	8.2	9.5	9.5	9.5	9.5	10.3	10.3	10.3	10.3	11.4	11.4	11.4	11.4	14.8	14.8	14.7	14.8
3	6.9	7.0	7.2	6.9	9.4	9.6	9.6	9.4	10.8	11.1	11.1	10.9	11.8	12.1	12.1	11.8	12.9	13.3	13.3	13.0	16.3	16.6	16.6	16.4
4	7.5	7.7	7.9	7.6	10.1	10.6	10.5	10.2	11.7	12.2	12.1	11.7	12.7	13.3	13.3	12.7	13.9	14.5	14.5	14.1	17.2	17.7	17.9	17.4
5	7.9	8.2	8.5	8.1	10.7	11.3	11.2	10.8	12.3	13.0	12.9	12.4	13.4	14.1	14.1	13.4	14.6	15.3	15.4	14.8	17.9	18.6	18.8	18.2
10	9.3	9.7	10.2	9.7	12.3	13.3	13.1	12.5	14.1	15.3	15.1	14.3	15.4	16.6	16.6	15.4	16.6	17.9	18.0	17.1	19.8	20.9	21.5	20.5
15	10.0	10.5	11.1	10.6	13.2	14.4	14.2	13.4	15.1	16.6	16.4	15.3	16.5	18.1	18.0	16.5	17.7	19.3	19.5	18.3	20.7	22.1	23.0	21.7
20	10.5	11.1	11.8	11.3	13.8	15.2	14.9	14.0	15.8	17.5	17.3	16.0	17.3	19.1	19.0	17.3	18.5	20.3	20.5	19.2	21.4	23.0	24.1	22.7
30	11.7	12.0	12.7	12.2	14.6	16.3	16.0	14.9	16.8	18.8	18.5	17.0	18.3	20.5	20.4	18.3	19.5	21.7	22.0	20.4	22.4	24.2	25.5	24.0
40	11.7	12.6	13.4	12.9	15.2	17.1	16.7	15.6	17.5	19.7	19.4	17.7	19.1	21.5	21.4	19.1	20.2	22.7	23.0	21.3	23.0	25.0	26.6	24.9
50	12.1	13.0	13.9	13.4	15.7	17.7	17.3	16.0	18.0	20.4	20.0	18.2	19.6	22.2	22.1	19.6	20.8	23.4	23.8	22.0	23.5	25.7	27.4	25.6

Fig.4-3 EXPLANATION OF PHASED AREA



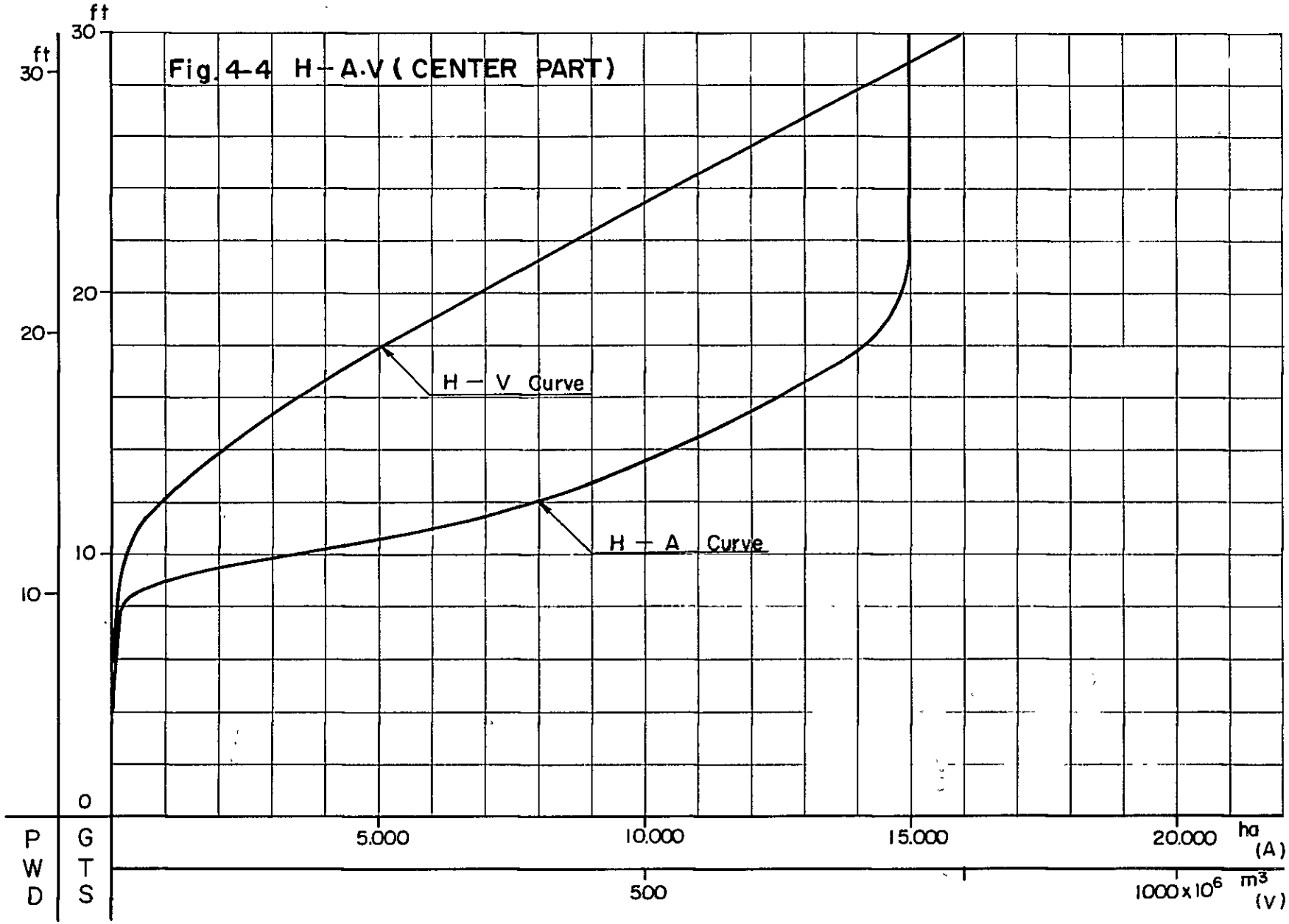


Fig. 4-4 H-A.V (CENTER PART)
ft
30
20
10
0
H — V Curve
H — A Curve
5.000
10.000
15.000
20.000
ha
(A)
500
1000x10^6
m3
(V)
P
W
D
G
T
S

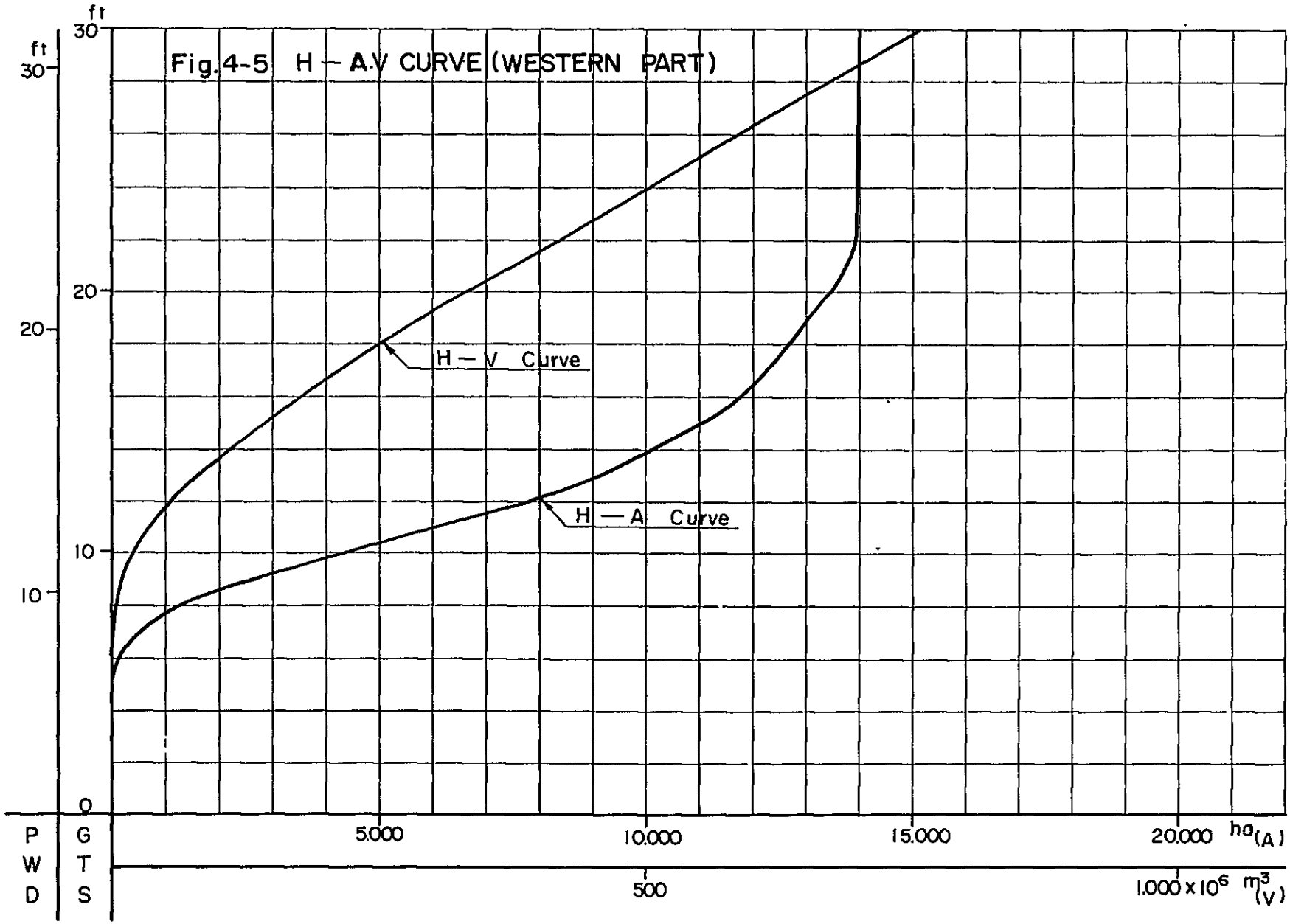


Fig.4-5 H — A.V CURVE (WESTERN PART)
ft
30
20
10
0
H — V Curve
H — A Curve
5.000
10.000
15.000
20.000
ha (A)
500
1.000 x 10^6 m^3 (V)
P G
W T
D S

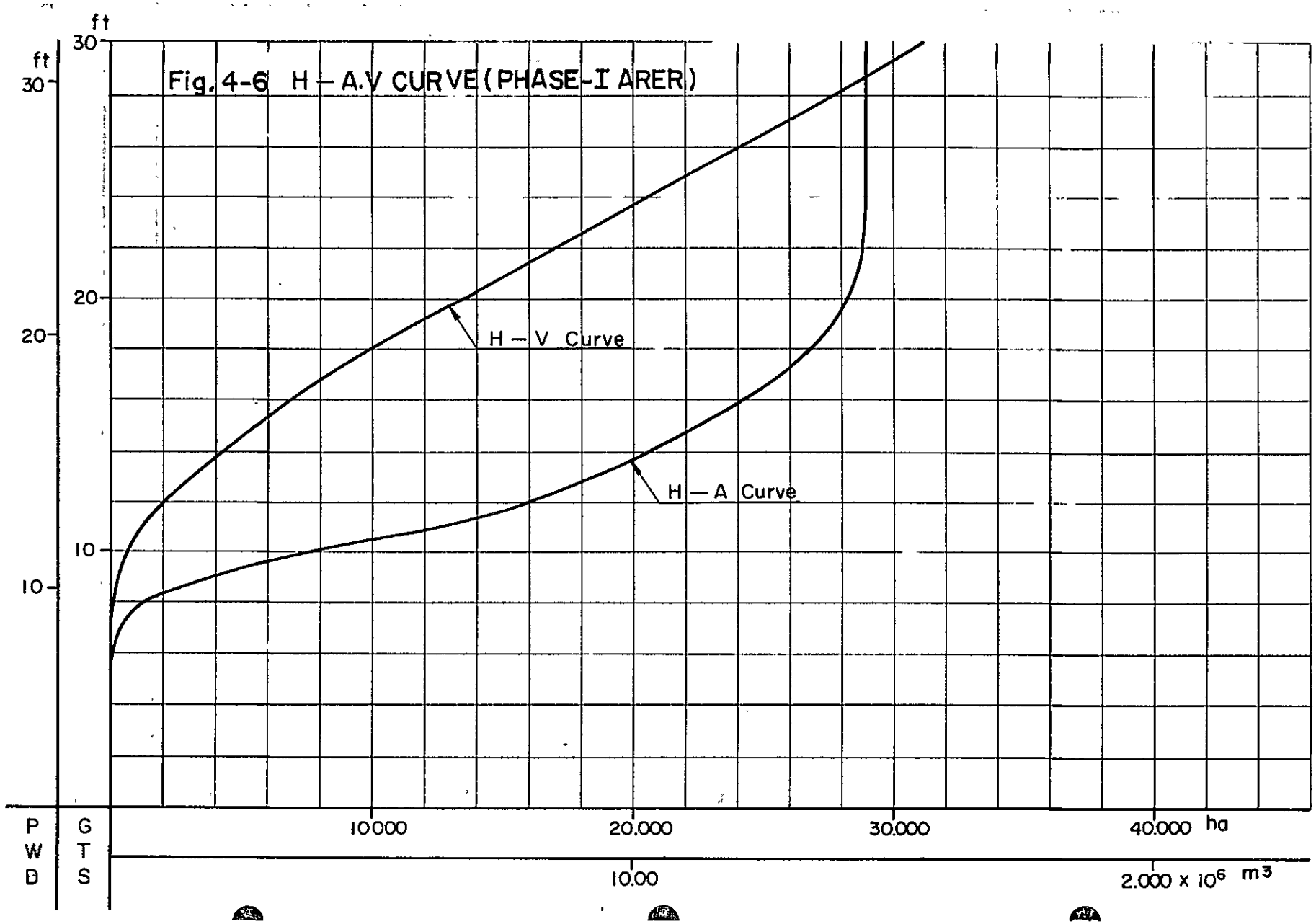


Fig. 4-6 H – A.V CURVE (PHASE-I ARER)
ft
30
20
10
H – V Curve
H – A Curve
10000
20.000
30.000
40.000 ha
10.00
2.000 x 10⁶ m3
P W D
G T S

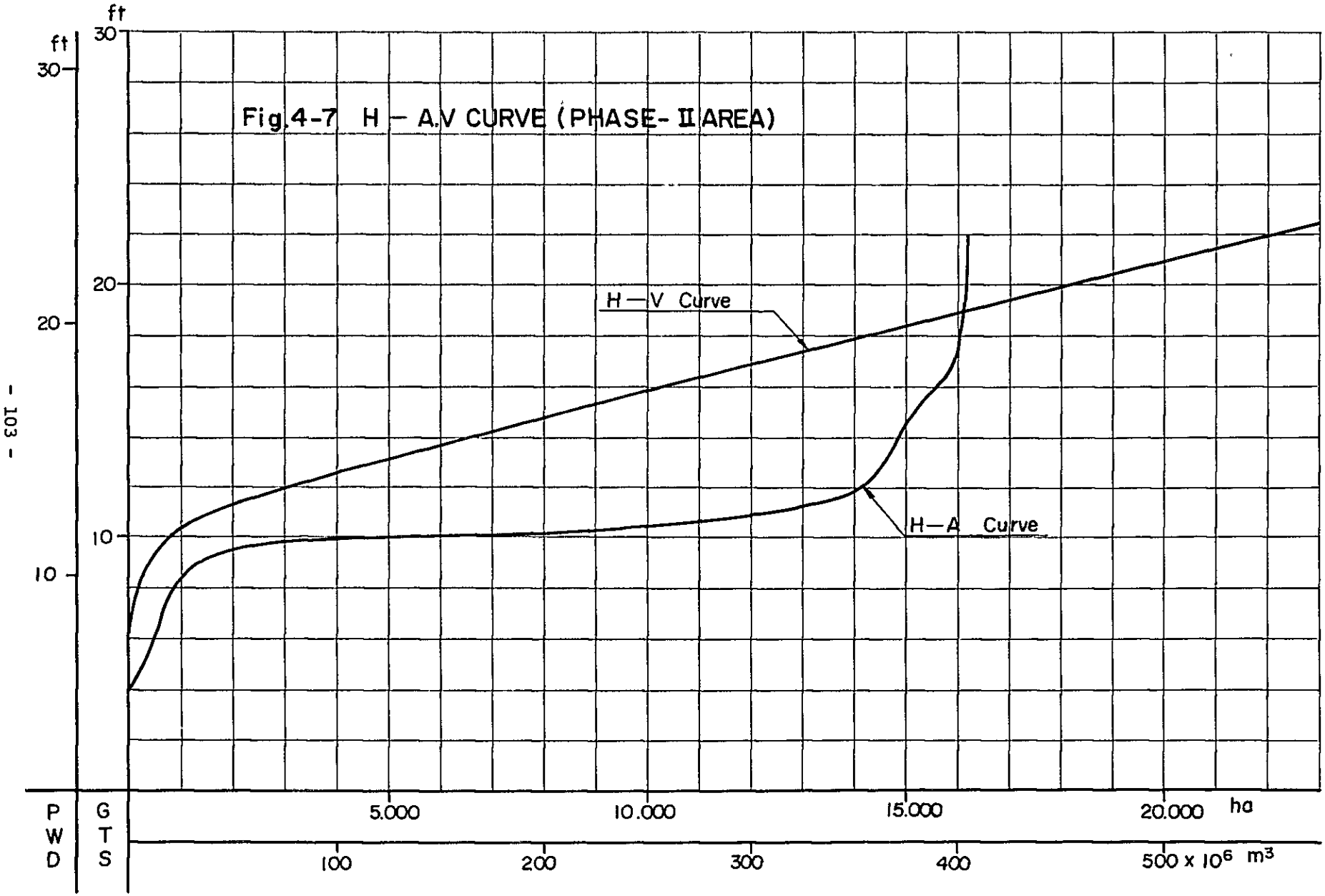

ft
30
20
10
Fig.4-7 H – A.V CURVE (PHASE- II AREA)
H—V Curve
H—A Curve
5.000
10.000
15.000
20.000
ha
100
200
300
400
500 x 10⁶ m³
P W D
G T S

Table 4-12 Area and Capacity of Central Part (Phase I) by Elevation

Elevation	Accum. Area	Capacity	Accum. Capacity
		$x10^6m^3$	$x10^6xm^3$
7.5 ft. P.W.D.	30 ha	0	0
9.5 ft. P.W.D.	160 ha	0.6	0.6
11.5 ft. P.W.D.	3,440 ha	11.0	11.6
13.5 ft. P.W.D.	7,980 ha	34.8	46.4
15.5 ft. P.W.D.	10,510 ha	56.4	102.8
17.5 ft. P.W.D.	12,520 ha	70.2	173.0
19.5 ft. P.W.D.	14,150 ha	81.3	254.3
21.5 ft. P.W.D.	14,860 ha	88.4	342.7
23.5 ft. P.W.D.	15,000 ha	91.0	433.7
25.5 ft. P.W.D.	15,000 ha	91.4	525.1
27.5 ft. P.W.D.	15,000 ha	91.4	616.5
29.5 ft. P.W.D.	15,000 ha	91.4	707.9
31.5 ft. P.W.D.	15,000 ha	91.4	799.3
33.5 ft. P.W.D.	15,000 ha	91.4	890.7
35.5 ft. P.W.D.			
Total	15,000 ha		890.7

Table 4-13 Area and Capacity of Western Part (Phase I) by Elevation

Elevation	Accum. Area	Capacity	Accum. Capacity
	ha	$x10^6m^3$	$x10^6m^3$
7.5 ft. P.W.D.	100	0	0
9.5 ft. P.W.D.	1,240	4.1	4.1
11.5 ft. P.W.D.	4,280	16.8	20.9
13.5 ft. P.W.D.	7,930	37.2	58.1
15.5 ft. P.W.D.	10,010	54.7	112.8
17.5 ft. P.W.D.	11,750	66.3	179.1
19.5 ft. P.W.D.	12,590	74.2	253.3
21.5 ft. P.W.D.	13,370	79.1	332.4
23.5 ft. P.W.D.	13,940	83.2	415.6
25.5 ft. P.W.D.	13,960	85.0	500.6
27.5 ft. P.W.D.	13,970	85.1	585.7
29.5 ft. P.W.D.	13,980	85.2	670.9
31.5 ft. P.W.D.	13,990	85.3	756.2
33.5 ft. P.W.D.	14,000	85.3	841.5
35.5 ft. P.W.D.			
Total	14,000		$x10^6m^3$ 841.5

Table 4-14 Area and Capacity of Phase I Area by Elevation

Elevation	Accum. Area	Capacity	Accum. Capacity	Irrigable Area
	ha	$x10^6m^3$	$x10^6m^3$	ha
7.5 ft. P.W.D.	130	0	0	0
9.5 ft. P.W.D.	1,400	4.7	4.7	
11.5 ft. P.W.D.	7,720	22.9	32.5	7,370
13.5 ft. P.W.D.	15,910	72.0	104.5	
15.5 ft. P.W.D.	20.520	111.1	215.6	17,670
17.5 ft. P.W.D.	24,270	136.5	352.1	
19.5 ft. P.W.D.	26,740	155.5	507.6	22,150
21.5 ft. P.W.D.	28,230	167.5	675.1	
23.5 ft. P.W.D.	28,940	174.2	849.3	22,960
25.5 ft. P.W.D.	28,960	176.4	1,025.7	
27.5 ft. P.W.D.	28,970	176.5	1,202.2	22,990
29.5 ft. P.W.D.	28,980	176.6	1,378.8	
31.5 ft. P.W.D.	28,990	176.7	1,555.5	23,010
33.5 ft. P.W.D.	29,000	176.7	1,732.2	23,020
35.5 ft. P.W.D.				
Total	ha	$x10^6m^3$	$x10^6m^3$	ha
	29,000		1,732.2	23,020

Table 4-15 Area and Capacity of Phase II Area (Eastern Part) by Elevation

Elevation	Accum. Area	Capacity	Accum. Capacity
	ha	$x10^6m^3$	$x10^6m^3$
7.5 ft. P.W.D.	460 ha	0	0
9.5 ft. P.W.D.	1,320	5.4	5.4
11.5 ft. P.W.D.	4,550	17.9	23.3
13.5 ft. P.W.D.	13,280	54.3	77.6
15.5 ft. P.W.D.	14,270	84.0	161.6
17.5 ft. P.W.D.	15,410	90.5	252.1
19.5 ft. P.W.D.	16,310	96.7	348.8
21.5 ft. P.W.D.	16,360	99.6	448.4
23.5 ft. P.W.D.	16,410	99.9	548.3
Total	ha 16,410	$x10^6m^3$	$x10^6m^3$ 554.4

4.4 Results of Drainage Calculation

Table 4-16 Drainage Calculation by Pump ($Qp=3200$ cusecs) ($90m^3/s$)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$59.82^{\times 10^3}$	$59.82^{\times 10^3}$	$6.30^{\times 10^3}$	$53.52^{\times 10^3}$	11.80	40,760
2	36.47	89.99	"	83.69	12.60	61,360
3	24.28	107.97	"	101.67	12.90	65,110
4	31.82	133.49	"	127.19	13.25	68,790
5	7.26	134.45	"	128.15	"	"
6	0	128.15	"	121.85	13.20	68,570
7	22.61	144.46	"	138.16	13.40	71,140
8	10.42	148.58	"	142.28	13.45	71,440
9	7.26	149.54	"	143.24	"	"
10	4.09	147.33	"	141.03	13.40	71,140
11		141.03	"	134.73	13.35	69,750
12		134.73	"	128.43	13.25	68,790
13		128.43	"	122.13	13.20	68,570
14		122.13	"	115.83	13.10	67,560
15		115.83	"	109.53	13.00	66,690
16		109.53	"	103.23	12.90	65,110
17		103.23	"	96.93	12.80	63,850
18		96.93	"	90.63	12.70	62,990
19		90.63	"	84.33	12.60	61,360
20		84.33	"	78.03	12.45	58,940
21		78.03	"	71.73	12.30	56,270
22		71.73	"	65.43	12.15	52,610
23		65.43	"	59.13	11.95	46,930
24		59.13	"	52.83	11.80	40,760
25		52.83	"	46.53	11.60	33,490
26		46.53	"	40.23	11.30	25,940
27		40.23	"	33.93	11.05	22,050
28		33.93	"	27.63	10.80	17,790
29		27.63	"	21.33	10.40	12,930
30		21.33	"	15.03	10.00	9,630

Table 4-16 Drainage Calculation by Pump (Q_p= 3200 cusecs) ($90 m^3/s$)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
		$\times 10^3$	$\times 10^3$	$\times 10^3$		
31		15.03	6.30	8.73	9.50	6,720
32		8.73	"	2.43	7.50	1,460
33		2.43	"	0	"	"

(110m^3/s)

Table 4-17 Drainage Calculation by Pump (Qp= 3900 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	59.82 $\times 10^3$	59.82 $\times 10^3$	7.70 $\times 10^3$	52.12 $\times 10^3$	11.75	38,290
2	36.47	88.59	"	80.89	12.50	60.270
3	24.28	105.17	"	97.47	12.80	63,850
4	31.82	129.29	"	121.59	13.20	68,570
5	7.26	128.85	"	121.15	13.15	68,420
6	0	121.15	"	113.45	13.05	67,040
7	22.61	136.06	"	128.36	13.25	68,790
8	10.42	138.78	"	131.08	13.30	69,160
9	7.26	138.34	"	130.64	"	"
10	4.09	134.73	"	127.03	13.25	68,790
11		127.03	"	119.33	13.15	68,420
12		119.33	"	111.63	13.05	67,040
13		111.63	"	103.93	12.90	65,110
14		103.93	"	96.23	12.80	63,850
15		96.23	"	88.53	12.60	61,360
16		88.53	"	80.83	12.50	60,270
17		80.83	"	73.13	12.35	57,160
18		73.13	"	65.43	12.15	52,610
19		65.43	"	57.73	11.95	46,930
20		57.73	"	50.03	11.70	37,050
21		50.03	"	42.33	11.40	28,010
22		42.33	"	34.63	11.10	22,700
23		34.63	"	26.93	10.75	17,040
24		26.93	"	19.23	10.30	11,810
25		19.23	"	11.53	9.75	8,300
26		11.53	"	3.83	9.00	4,940
27		3.83	"	0	7.50	1,460

Table 4-18 Drainage Calculation by Pump (Q_p= 4600 cusecs) ($130 m^3/s$)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$59.82^{\times 10^3}$	$59.82^{\times 10^3}$	$9.10^{\times 10^3}$	$50.72^{\times 10^3}$	11.75	38,290
2	36.47	87.19	"	78.09	12.45	58,940
3	24.28	102.37	"	93.27	12.75	63,330
4	31.82	125.09	"	115.99	13.10	67,560
5	7.26	123.25	"	114.15	13.05	67,040
6	0	114.15	"	105.05	12.95	65,700
7	22.61	127.66	"	118.56	13.15	68,420
8	10.42	128.98	"	119.88	"	"
9	7.26	127.14	"	118.04	13.10	67,560
10	4.09	122.13	"	113.03	13.05	67,040
11		113.03	"	103.93	12.90	65,110
12		103.93	"	94.83	12.80	63,850
13		94.83	"	85.73	12.60	61,360
14		85.73	"	76.63	12.45	58,940
15		76.63	"	67.53	12.20	53,890
16		67.53	"	58.43	11.95	46,930
17		58.43	"	49.33	11.65	35,860
18		49.33	"	40.23	11.30	25,940
19		40.23	"	31.13	10.95	20,010
20		31.13	"	22.03	10.45	13,500
21		22.03	"	12.93	9.85	8,740
22		12.93	"	3.83	9.00	4,940
23		3.83	"	0	7.50	1,460

Table 4-19 Drainage Calculation by Pump (Q_p= 5300 cusecs) ($150 m^3/s$)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$59.82^{\times 10^3}$	$59.82^{\times 10^3}$	$10.50^{\times 10^3}$	$49.32^{\times 10^3}$	11.65	35,860
2	36.47	85.79	"	75.29	12.40	58,050
3	24.28	99.57	"	89.07	12.70	62,990
4	31.82	120.89	"	110.39	13.00	66,690
5	7.26	117.65	"	107.15	12.95	65,700
6	0	107.15	"	96.65	12.80	63,850
7	22.61	119.26	"	108.76	13.00	66,690
8	10.42	119.18	"	108.68	"	"
9	7.26	115.94	"	105.44	12.95	65,700
10	4.09	109.53	"	99.03	12.85	64,710
11		99.03	"	88.53	12.70	62,990
12		88.53	"	78.03	12.45	58,940
13		78.03	"	67.53	12.20	53,890
14		67.53	"	57.03	11.90	44,460
15		57.03	"	46.53	11.60	33,490
16		46.53	"	36.03	11.15	23,350
17		36.03	"	25.53	10.70	16,300
18		25.53	"	15.03	10.00	9,630
19		15.03	"	4.53	9.10	5,430
20		4.53	"	0	7.50	1,460

(170m^3/s)

Table 4-20 Drainage Calculation by Pump (Q_p= 6000 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$59.82^{\times 10^3}$	$59.82^{\times 10^3}$	$11.90^{\times 10^3}$	$47.92^{\times 10^3}$	11.60	33,490
2	36.47	84.39	"	72.49	12.30	56,270
3	24.28	96.77	"	84.87	12.60	61,360
4	31.82	116.69	"	104.79	12.95	65,700
5	7.26	112.05	"	100.15	12.85	64,710
6	0	100.15	"	88.25	12.65	62,170
7	22.61	110.86	"	98.96	12.85	64,710
8	10.42	109.38	"	97.48	12.80	63,850
9	7.26	104.74	"	92.84	12.75	63,330
10	4.09	96.93	"	85.03	12.60	61,360
11		85.03	"	73.13	12.35	57,160
12		73,13	"	61.23	12.05	50,040
13		61.23	"	49.33	11.65	35,860
14		49.33	"	37.43	11.20	23,990
15		37.43	"	25.53	10.70	16,300
16		25.53	"	13.63	9.90	9,190
17		13.63	"	1.73	7.50	1,460
18		1.73	"	0	"	"

Table 4-21 Drainage Calculation by Pump (Q_p= 3200 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$0.84^{\times 10^3}$	$0.84^{\times 10^3}$	$6.30^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	54.42	54.42	"	48.12	11.60	33,490
3	29.49	77.61	"	71.31	12.30	56,270
4	40.65	111.96	"	105.66	12.95	65,700
5	10.98	116.64	"	110.34	13.00	66,690
6	17.49	127.83	"	121.53	13.20	68,570
7	13.77	135.30	"	129.00	13.30	69,160
8	2.79	131.79	"	125.49	13.25	68,790
9	15.07	140.56	"	134.26	13.35	69,750
10	0.56	134.82	"	128.52	13.30	69,160
11		128.52	"	122.22	13.20	68,570
12		122.22	"	115.92	13.10	67,560
13		115.92	"	109.62	13.00	66,690
14		109.62	"	103.32	12.90	65,110
15		103.32	"	97.02	12.80	63,850
16		97.02	"	90.72	12.70	62,990
17		90.72	"	84.42	12.60	61,360
18		84.42	"	78.12	12.45	58,940
19		78.12	"	71.82	12.30	56,270
20		71.82	"	65.52	12.15	52,610
21		65.52	"	59.22	11.95	46,930
22		59.22	"	52.92	11.80	40,760
23		52.92	"	46.62	11.60	33,490
24		46.62	"	40.32	11.30	25,940
25		40.32	"	34.02	11.05	22,050
26		34.02	"	27.72	10.80	17,790
27		27.72	"	21.42	10.40	12,930
28		21.42	"	15.12	10.00	9,630
29		15.12	"	8.82	9.50	6,720
30		8.82	"	2.52	7.50	1,460
1		2.52	"	0	"	"

Table 4-22 Drainage Calculation by Pump (Q_p= 3900 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$0.84^{\times 10^3}$	$0.84^{\times 10^3}$	$7.70^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	54.42	54.42	"	46.72	11.60	33,490
3	29.49	76.21	"	68.51	12.25	55,820
4	40.65	109.16	"	101.46	12.85	64,710
5	10.98	112.44	"	104.74	12.95	65,700
6	17.49	122.23	"	114.53	13.10	67,560
7	13.77	128.30	"	120.60	13.15	68,420
8	2.79	123.39	"	115.69	13.10	67,560
9	15.07	130.76	"	123.06	13.20	68,570
10	0.56	123.62	"	115.92	13.10	67,560
11		115.92	"	108.22	12.95	65,700
12		108.22	"	100.52	12.85	64,710
13		100.52	"	92.82	12.75	63,330
14		92.82	"	85.12	12.60	61,360
15		85.12	"	77.42	12.45	58,940
16		77.42	"	69.72	12.25	55,820
17		69.72	"	62.02	12.05	50,040
18		62.02	"	54.32	11.80	40,760
19		54.32	"	46.62	11.60	33,490
20		46.62	"	38.92	11.25	25,290
21		38.92	"	31.22	10.95	20,010
22		31.22	"	23.52	10.55	14,820
23		23.52	"	15.82	10.05	10,170
24		15.82	"	8.12	9.40	6,420
25		8.12	"	0.42	7.50	1,460
26		0.42	"	0	"	"

Table 4-23 Drainage Calculation by Pump (Q_P= 4600 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$0.84^{\times 10^3}$	$0.84^{\times 10^3}$	$9.10^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	54.42	54.42	"	45.32	11.50	31,120
3	29.49	74.81	"	65.71	12.15	52,610
4	40.65	106.36	"	97.26	12.80	63,850
5	10.98	108.24	"	99.14	12.85	64,710
6	17.49	116.63	"	107.53	12.95	65,700
7	13.77	121.30	"	112.20	13.05	67,040
8	2.79	114.99	"	105.89	12.95	65,700
9	15.07	120.96	"	111.86	13.05	67,040
10	0.56	112.42	"	103.32	12.90	65,110
11		103.32	"	94.22	12.75	63,330
12		94.22	"	85.12	12.60	61,360
13		85.12	"	76.02	12.40	58,050
14		76.02	"	66.92	12.20	53,890
15		66.92	"	57.82	11.95	46,930
16		57.82	"	48.72	11.65	35,860
17		48.72	"	39.62	11.30	25,940
18		39.62	"	30.52	10.95	20,010
19		30.52	"	21.42	10.40	12,930
20		21.42	"	12.32	9.75	8,300
21		12.32	"	3.22	7.50	1,460
22		3.22	"	0	"	"

Table 4-24 Drainage Calculation by Pump (Q_p= 5300 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$0.84^{\times 10^3}$	$0.84^{\times 10^3}$	$10.50^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	54.42	54.42	"	43.92	11.45	30,080
3	29.49	73.41	"	62.91	12.10	51,330
4	40.65	103.56	"	93.06	12.75	63,330
5	10.98	104.04	"	93.54	"	"
6	17.49	111.03	"	100.53	12.85	64,710
7	13.77	114.30	"	103.80	12.90	65,110
8	2.79	106.59	"	96.09	12.80	63,850
9	15.07	111.16	"	100.66	12.85	64,710
10	0.56	101.12	"	90.72	12.70	62,990
11		90.72	"	80.22	12.50	60,270
12		80.22	"	69.72	12.25	55,820
13		69.72	"	59.22	11.95	46,930
14		59.22	"	48.72	11.65	35,860
15		48.72	"	38.22	11.20	23,990
16		38.22	"	27.72	10.80	17,790
17		27.72	"	17.22	10.15	10,720
18		17.22	"	6.72	9.30	6,180
19		6.72	"	0	7.50	1,460

Table 4-25 Drainage Calculation by Pump (Qp= 6000 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$0.84^{\times 10^3}$	$0.84^{\times 10^3}$	$11.90^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	54.42	54.42	"	42.52	11.40	28,010
3	29.49	72.01	"	60.11	12.00	49,400
4	40.65	100.76	"	88.86	12.70	62,990
5	10.98	99.84	"	87.94	12.65	62,170
6	17.49	105.43	"	93.53	12.75	63,330
7	13.77	107.30	"	95.40	12.80	63.850
8	2.79	98.19	"	86.29	12.60	61,360
9	15.07	101.36	"	89.46	12.70	62,990
10	0.56	90.02	"	78.12	12.45	58,940
11		78.12	"	66.22	12.15	52.610
12		66.22	"	54.32	11.80	40,760
13		54.32	"	42.42	11.40	28,010
14		42.42	"	30.52	10.95	20,010
15		30.52	"	18.62	10.30	11,810
16		18.62	"	6.72	9.30	6,180
17		6.72	"	0	7.50	1,460

Table 4-26 Drainage Calculation by Pump (Qp= 3200 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$2.33^{\times 10^3}$	$2.33^{\times 10^3}$	$6.30^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	5.02	5.02	"	0	"	"
3	19.44	19.44	"	13.14	9.85	8,740
4	20.28	33.42	"	27.12	10.75	17,040
5	8.56	35.68	"	29.38	10.85	18,530
6	30.61	59.99	"	53.69	11.80	40,760
7	50.61	104.30	"	98.00	12.80	63,850
8	0.56	98.56	"	92.26	12.75	63,330
9	12.84	105.10	"	98.80	12.85	64,710
10	0	98.80	"	92.50	12.75	63,330
11	10.88	103.38	"	97.08	12.80	63,850
12		97.08	"	90.78	12.70	62,990
13		90.78	"	84.48	12.60	61,360
14		84.48	"	78.18	12.45	58,940
15		78.18	"	71.88	12.30	56,270
16		71.88	"	65.58	12.15	52,610
17		65.58	"	59.28	11.95	46,930
18		59.28	"	52.98	11.80	40,760
19		52.98	"	46.68	11.60	33,490
20		46.68	"	40.38	11.30	25,940
21		40.38	"	34.08	11.05	22,050
22		34.08	"	27.78	10.80	17,790
23		27.78	"	21.48	10.40	12,930
24		21.48	"	15.18	10.00	9,630
25		15.18	"	8.88	9.50	6,720
26		8.88	"	2.58	7.50	1,460
27		2.58	"	0	"	"

Table 4-27 Drainage Calculation by Pump (Qp= 3900 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$2.33^{\times 10^3}$	$2.33^{\times 10^3}$	$7.70^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	5.02	5.02	"	0	"	"
3	19.44	19.44	"	11.74	9.75	8,300
4	20.28	32.02	"	24.32	10.55	14,820
5	8.56	32.88	"	25.18	10.65	15,560
6	30.61	55.79	"	48.07	11.60	33,490
7	50.61	98.70	"	91.00	12.70	62,990
8	0.56	91.56	"	83.86	12.60	61,360
9	12.84	96.70	"	89.00	12.70	62,990
10	0	89.00	"	81.30	12.50	60,270
11	10.88	92.18	"	84.48	12.60	61,360
12		84.48	"	76.78	12.45	58,940
13		76.78	"	69.08	12.25	55,820
14		69.08	"	61.38	12.05	50,040
15		61.38	"	53.68	11.80	40,760
16		53.68	"	45.98	11.55	32,310
17		45.98	"	38.28	11.20	23,990
18		38.28	"	30.58	10.95	20,010
19		30.58	"	22.88	10.50	14,080
20		22.88	"	15.18	10.00	9,630
21		15.18	"	7.48	9.30	6,180
22		7.48	"	0	7.50	1,460

Table 4-28 Drainage Calculation by Pump (Qp= 4600 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$2.33^{\times 10^3}$	$2.33^{\times 10^3}$	$9.10^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	5.02	5.02	"	0	"	"
3	19.44	19.44	"	10.34	9.60	7,410
4	20.28	30.62	"	21.52	10.45	13,500
5	8.56	30.08	"	20.98	10.40	12,930
6	30.61	51.59	"	42.49	11.40	28,010
7	50.61	93.10	"	84.00	12.60	61,360
8	0.56	84.56	"	75.46	12.40	58,050
9	12.84	88.30	"	79.20	12.50	60,270
10	0	79.20	"	70.10	12.25	55,820
11	10.88	80.98	"	71.88	12.30	56,270
12		71.88	"	62.78	12.10	51,330
13		62.78	"	53.68	11.80	40,760
14		53.68	"	44.58	11.50	31,120
15		44.58	"	35.48	11.10	22,700
16		35.48	"	26.38	10.70	16,300
17		26.38	"	17.28	10.15	10,720
18		17.28	"	8.18	9.40	6,420
19		8.18	"	0	7.50	1,460

Table 4-29 Drainage Calculation by Pump (Qp= 5300 cusecs)

Date	Runoff [ac·ft]	Total Submerged Volume [ac·ft]	Pump discharge [ac·ft]	Submerged Volume [ac·ft]	Submerged Water Level [ft]	Submerged Area [ac]
1	$2.33^{\times 10^3}$	$2.33^{\times 10^3}$	$10.50^{\times 10^3}$	$0^{\times 10^3}$	7.50	1,460
2	5.02	5.02	"	0	"	"
3	19.44	19.44	"	8.94	9.50	6,720
4	20.28	29.22	"	18.72	10.30	11,810
5	8.56	27.28	"	16.78	10.15	10,720
6	30.61	47.39	"	36.89	11.20	23,990
7	50.61	87.50	"	77.00	12.45	58,940
8	0.56	77.56	"	67.06	12.20	53,890
9	12.84	79.90	"	69.40	12.25	55,820
10	0	69.40	"	58.90	11.95	46,930
11	10.88	69.78	"	59.28	"	"
12		59.28	"	48.78	11.65	35,860
13		48.78	"	38.28	11.20	23,990
14		38.28	"	27.78	10.80	17,790
15		27.78	"	17.28	10.15	10,720
16		17.28	"	6.78	9.30	6,180
17		6.78	"	0	7.50	1,460