EAST PAKISTAN

[illegible] ROAD CONSTRUCTION PROJECT

THE 2ND SURVEY REPORT

MARCH 1971

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

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PREFACE

The Government of Japan, in response to the request of the Government of the Islamic Republic of Pakistan for the execution of field survey in relation to the Ducca/Fabridur Road Project in the Province of East Pakista, had entrusted the execution of the survey to the Overseas Technical Cooperation Agency.

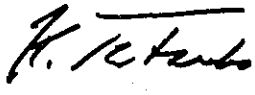
The Overseas Technical Cooperation Agency on its part organized a survey team, headed by Mr. Takahiko Hayanari, Director of Maintenance and Facilities Department , Japan Highway Public Corporation , and sent it to East Pakistan on two occasions. The first phase team was sent during the period of February-March 1970 for technical and economic survey on the road and bridge construction and the results of the survey were summarized in the Report of Survey For the Ducca/Faridpur Toad Project which was submitted in August 1970. After a study of the results of the first phase survey, the need for another survey on the state of major rivers including the Padma River during the rainy season was recognized and as a result, the team was again sent during the period of October - November 1970 for a survey in the rainy season. This report is the summarization of the results of the second survey.

Thanks to the immeasurable cooperation of officials of the Pakistan Government, the field survey was carried out smoothly and the report of survey is now ready for presentation.

It is strongly hoped that the report will contribute to the development of the Province of East Pakistan and at the same time help promote friendly relations between the Islamic Republic of Pakistan and Japan.

In conclusion I would like to take this opportunity to express my profound gratitude to the officials of the Ministry of Foreign Affairs, staffs of the Japanese Embassy in Pakistan and Japanese Consulate-General in Ducca and members of the Japan Highway Public Corporation, Highway Engineering Institute, Tokyo and other related organizations for their cooperation in making the survey a success and for their help in the preparation of the report of survey.

June 1971



Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

Discussion with engineers of R & H, the government of East Pakistan

Left bank of the Padma at the proposed bridge site

View of down stream of the Padma from the proposed bridge site

Reconnaissance survey
along the Padma

River bank being scoured

Left bank of the proposed bridge
site of the Dhaleswari

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PART I. OUTLINE OF SURVEY

PART I OUTLINE OF SURVEY

1. Background of the Survey

The government of Japan received a request in April, 1969 from the government of Pakistan to execute surveying on Dacca-Faridpur Road Project in East Pakistan. Responding this request the Government of Japan dispatched a survey team in February, 1970. The team carried out a series of surveying activities such as collecting information and site observations over the period of about one month. After returning to Japan the team made the feasibility study of the project with outline designs, and the report was explained to the Government of Pakistan officially in October, 1970.

The report presented following conclusions:

- The new road project holds not only technical feasibility but also economical.
- As for the crossing facility of the Padma, construction of the bridge would be more economical than the ferry service.
- As sufficient surveying for the Padma Bridge plan has not been made, the further study regarding this design should be carried on with the surveying by experts in river engineering and hydrology in coordination with embankment plan of WAPDA.

Being based on the above conclusions of the first survey team, further survey and the technical feasibility study on the several bridge plans, especially on the Padma Bridge plan which has been proposed in the previous report, were performed from hydrological and river engineering points of view by the second survey team.

However, the fact should be noticed that the final conclusion for such an important structure as the Padma Bridge should be made not only with the former sufficient informations and the results of the recent survey but also with the outcomes of more detailed site survey which should be carried out in the future.

2. Conclusions and Recommendations

As indicated in the first survey report of September 1970, the new road project between Dacca and Faridpur contributes very much to the economical and social development of the East Pakistan, and plays considerably important role as well in the improvement of road transportation in Asia making Asian Highway Route No. 1 more complete. The most difficult problem for the realization of the project is the feasibility of the Padma Crossing Bridge, and this has been pointed out already in the first report.

Several problems have been revealed as follows concerning the Padma Bridge plan after studying information obtained formerly and additional site survey by land and air;

(1) Conditions of the river banks were the same as had been surveyed in the previous survey. As better bridge site could not be found than the site proposed in the previous report, this proposed site is considered to be most appropriate for the bridge construction.

(2) As indicated in the first report, the left bank of the bridge site is rather stable with slight erosion, and the right bank is not stable. In general, changes of the river banks have been large for the past 10 years, and further investigation and study will be needed in the future about the changes.

(3) The proposed high water level at the bridge site can be regarded as 7.82 m PWD (25.7 fut PWD) when the flood protecting banks along with the Polder Plan are completed. Therefore, the clearance under the bridge girder proposed in the previous report is sufficient taking additional consideration on the navigation clearance of IWTA.

(4) As for the bridge length, the former proposal for the bridge length which conforms to the bank slopes of the WAPDA Polder Plan was considered to be the best. Required total length of the bridge becomes about 8 km (5 miles) according to the present plans of Dacca south-west Project on the left bank and Shles-war Project on the right bank. More detailed study should be done in the future in association with the promotion of thePolder Plan.

(5) The fact has been revealed that there is a valley of maximum depth of -36m PWD (-120 feet PWD) and the width of more than 400 m (1,300 feet) near the bridge site river bed and that this valley has moved for years. Generally, the changes of the river bed are quite large. The study on lowering the pier foundation and extension of the center span will be needed.

(6) As for the partial scouring which may occur around the pier foundations, assumption can be made that it will be more than 20 m (66 feet) deep. Detailed study is needed with the model test, etc.

(7) As described before, the necessity of enlarging the dimensions of the bridge has become clear. This means that further survey and observation will be needed with long careful studies on the various problems before the start of the bridge construction. Therefore, a kind of intermediate plan consisting of partial short span bridges on the right bank and unstable left bank sides with the ferry service covering the central deep water part will become worth consideration.

(8) As for Daleswari Bridge and Arial Khan Bridge, survey of the cross sections of the river and geological investigations are still needed, but the proposed plan proposed in the first report will have no need for fundamental alteration, as the river conditions are comparatively stable. Type and the details of the structure should be decided in accordance with the decision of the details of the Polder Plan as in the case of the Padma Bridge. Especially for the Arial Khan Bridge the Polder Plan is important. The present Polder Plan proposes the installation of a flood gate for the flood control. This enables the bridge length shorter, and suggest further the preferable idea of having a combined structure of the flood gate and the bridge in order to lower the construction cost.

Padma River is one of the largest rivers in the world, and the river conditions are quite unstable. Planning of the bridge crossing such rivers should be carefully carried on. Above conclusions are derived from the results of outlined observations at present, and further analysis of the hydrological data, continuous surveying of the river sections including those during the flood season with the observation of the river bank changes and the model tests will be very important to ascertain the safety and technical feasibility of the bridge.

Planning of these bridges should also be carried on not only by departments related to road planning themselves but also by river authorities, survey bureaus and other related administrative agencies. Joint-execution of the construction should be considered especially with the agencies which are to execute such flood protecting projects as Polder Plan. Organizing such coordinating function as a committee composed of the related governmental agencies should be considered for this purpose. This organization will contribute very much to the bridge planning and the coordination between bridge plans and the polder plan as well.

3. Members and Schedule of Survey Team

As in the case of previous first survey team, four-member survey team headed by Takahiko HAYANARI (Chief, Maintenance and Facility Department, Japan Highway Public Corporation) carried out the survey.

Members of the team are as follows:

Chief	Takahiko HAYANARI	Chief, Maintenance and Facility Department Japan Highway Public Corporation
Member		
	Masatomo KAWAMOTO	Supervising engineer Kanto District Construction Bureau Ministry of Construction
	Shinya KURASAWA	Engineer Planning Department Japan Highway Public Corporation
	Ryoji IMAOKA	Engineer Tonegawa Upstream Construction Office Kanto District Construction Bureau Ministry of Construction

Works performed by the team can be classified into two stages, which are site survey with collecting data and information in Pakistan and study on the results obtained after the team's return to its home country.

The reconaissance works in East Pakistan were executed during the period of 27 days between October 18, and November 13, 1970 in order to understand the conditions in rainy season to some extent with the possibility of observing the river banks as water level of the river begins to decrease. Collecting data and information was carried out by all the members of the team in close relation with WAPDA, IWTA and Survey Bureau. Site survey consists of surface survey on microbuses, boats (as it was not possible to approach to the bridge site by land) and aerial observation from a hydro-aircraft of the Pakistan Government.

Itinerary of the team in East Pakistan

1970 October 14	HAYANARI, Chief of the team left Tokyo.
16	Explanation of the results of previous survey to the related governmental officials in the Central Government of Pakistan and Japanese Ambassador, Mr. Sono by HAYANARI.
17	Three members of the team left Tokyo.
19	Explanation of the results of previous survey to Mr. K. ALI, Mr. M. RAHMAN, other officials, Consulate General Mr. HIGAKI and Deputy Consulate, Mr. FUNAKOSHI with the discussion on the schedule of the second survey.
20	Site observation on the bridge construction at Shitarakeya, and the Megna.
21	Site survey between Decca and Aricha
23 - 27	Collection of hydrological data, aerial photos, maps, etc.
28 - November 2	Site survey by microbus and boat (Dacca - Faridpur - Padma River - Banga - Kuscha - Harding Bridge - Jessore - Kulna)
3	Aerial survey by hydro-aircraft
4 - 9	Collection of hydrological data and informations of Polder Plan. Producing of interim report
10	Site survey of Daleswari and Brighanga Rivers by launch
12	Submission of interim report to Mr. Q. J. Ahmed
13	The team left Pakistan

The team received kind and sincere cooperation from the persons concerned in the Government of East Pakistan. Deep appreciation is extended to all of the following gentlemen who helped very much the survey activities of the team.

1) Government of East Pakistan

Mr. M. Keramat Ali
Deputy Chief Secretary, CSP, ACS (P&D)

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Mr. Ahmed Abdur Rouf CSP
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2) Roads and Highways

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Mr. A. R. Choudhury
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Mr. Haque
S. E.

Mr. M. A. Samad
Executive Engineer, Structural Designer

Mr. Md. Fahad Hossain Khan
E. E.

Mr. Ali Reza Khan
E. E., Planning Circle

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Mr. Md. Salehuddin
E. E., Kalayanpur

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S. D. E., Manikganj

4) Survey of Pakistan

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Deputy Surveyor General

Mr. Waheduddin Ahmad
Head Draft man

5) Water and Power Development Authority

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Chief Engineer of Hydrology

Mr. G. R. Chowdry
Chief Engineer, Water Investigation Organization

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6) Inland Water Traffic Authority

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Chief Engineer

Mr. M. A. Malick
Senior Engineer

Mr. M. A. Hena
Chief Hydrographer

Mr. I. Ahmed
Senior Hydrographer

Mr. Nurul Alam
Hydrographer

PART II. DETAILS

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1. Rivers

East Pakistan, as called "the floating land on the river", lies mostly on the alluvial land along the world big rivers pouring into the bay of Bengal.

These big rivers flowing into East Pakistan are the Ganges from the northwest, the Brahmaputra from the northeast and the Meghna from the east. The total catchment area of these three major rivers is approximately 1,530,000 km^2 (590,400 $mile^2$) which equals to about 11 times of the whole area of East Pakistan.

Outlines of these three major rivers are as follows:

(1) The Ganges

The Ganges keeps its basin in the southern part of the Himalayas and spreads largely from the near border of West Pakistan to the bay of Bengal.

This river which is originated near the India - Tibet border and at the northern part of India, gathers many tributaries in the Hindustan Plain flowing to southeast until it reaches East Pakistan. The main stream of this river turns out to be a river named the Padma after confluence with the Brahmaputra near Aricha while it has many branches at the part of down stream.

The course of this river down-stream is considerably changeable and at a certain era, the main stream has flowed through Calcutta in India. Even now, there exist many old branches in the area between the Hoovry and the Padma.

Main characteristics of the Ganges are as follows:

Catchment Area

From the origin to Farakka	952,000 km^2 (367,400 $mile^2$)
From the origin to Harding Bridge	976,000 km^2 (376,900 $mile^2$)
From the origin to Goalundo	977,000 km^2 (377,400 $mile^2$)
The Padma	13,000 km^2 (5,000 $mile^2$)
Total (from the origin to the mouth of the Meghna)	990,000 km^2 (382,400 $mile^2$)

Length of the main stream

From the origin to Goalundo	2,200 km (1,370 mile)
From the origin to the bay of Bengal	2,530 km (1,570 mile)

Average annual precipitation in the catchment area

The upper-stream	1,270 mm (50 inches)
The middle-stream	760 mm (30 inches)
The delta area	1,730 - 2,160 mm (68 - 85 inches)

Average annual discharge

At Harding Bridge (1934-1962)	11,600 m^3/sec(410,000 cfs)

(2) The Brahmaputra

The Brahmaputra is originated in the glacier of the Himalayas at an elevation of 5,100 m. This river flows eastward from the north slope of the Himalayas gathering many tributaries. The flow turns its direction rapidly to the southwest near the India-China border and enters into Assam District in India. The river is called the Brahmaputra after confluence with two large branches The Dibang and The Lahit near Sadiya in India. It flows southward further around the footstep of the Assam Mountains and joins with the Ganges near Aricha after entering into the alluvial plain in East Pakistan.

In old days historically, this river flowed to the southeast from near Bahadurabad through the center of Mymensingh and joined to the Meghna near Bhairab Bazar. But since the end of 18th century, the main stream of this reiver has moved gradually to the Jamuna as it is now, and the old Bramaputra has remained only as a tributary only at a time of flood.

Main characteristics of this river are as follows:

Catchment Area

Tibet	292,000 km^2 (113,000 $mile^2$)
India and Bhutan	241,000 km^2 (93,000 $mile^2$)
East Pakistan	47,000 km^2 (18,000 $mile^2$)
Total	580,000 km^2 (224,000 $mile^2$)

Length of the main stream

From the origin to Goalundo	2,600 km (1,600 mile)

Average annual precipitation in the catchment area

Whole catchment area	2,130 mm (84 inches)
East Pakistan	1,750 - 2,260 mm (69~89 inches)

Average annual discharge

Bahadurabad (1956-1962)	19,200 m^3/sec(678,000 cfs)

(3) The Meghna

Many branches that is originated in the east part of East Pakistan and the Assam mountains area join with each other and form the Meghna. This river, flowing to the southwest, joins with the Padma near Chandpur and flows into the bay of Bengal creating a huge river mouth, many branches and alluvial lands.

Main characteristics of this river are as follows:

Catchment area

From the origin to Ehairab Bazar	65,000 km^2 (25,000 $mile^2$)
From Bhairab Bazar to Chandpur	15,000 km^2 (6,000 $mile^2$)
Total	80,000 km^2 (31,000 $mile^2$)

Length of the main stream

From the origin to India-East

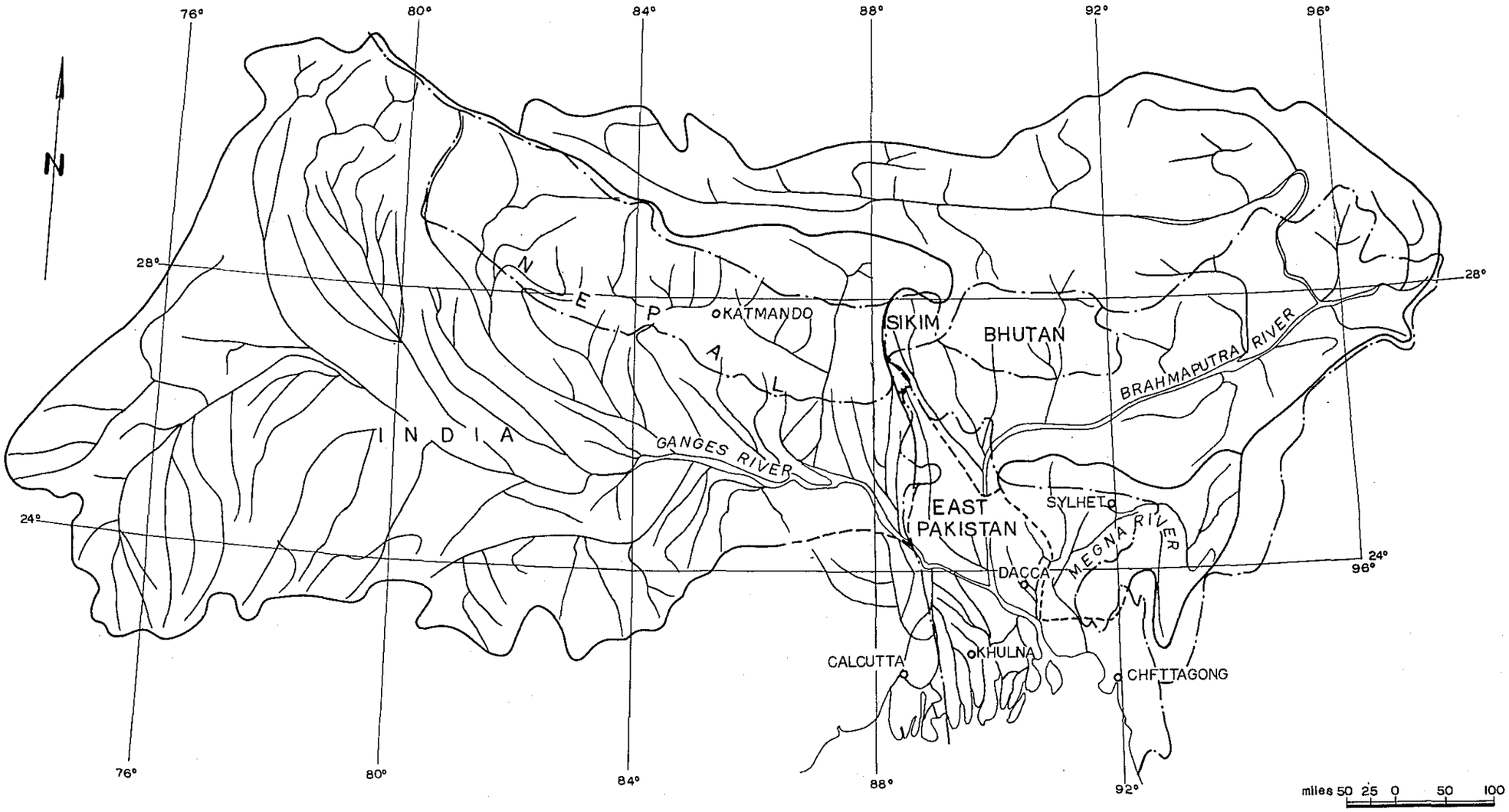


Fig. - 1 BASIN MAP GANGES, BRAHMAPOTRA AND MEGNA RIVER

Pakistan border	400 km (250 mile)
From border to Bairab Bazar	280 km (176 mile)
From Bairab Bazar to Chandpur	140 km (84 mile)
From Chandpur to the Bay of Bengal	130 km (80 mile)
Total	950 km (590 mile)

Average annual precipitation in the catchment area

Total area	3,510 mm (138 inches)
Assam mountains area	3,990 - 5,000 mm (157 - 197 inches)
Plain area in East Pakistan	2,010 - 3,000 mm (79 - 118 inches)

Average annual discharge

Bhairab Bazar	3,500m^3/sec(124,000 cfs)

The Ganges and the Brahmaputra, as described above, join with each other near Aricha under the name of Padma and it flows down to southeast. The catchment area at the confluence point reaches about 1,560,000 km^2.

The Padma flows into the Bay of Bengal after confluence with the Meghna near Chandpur, about 100 km down-stream from Aricha.

The total catchment area of these three major rivers reaches approximately 1,650,000 km^2, and the catchment area within the territory of East Pakistan occupies only 7.5% of the total area.

2. Floods

East Pakistan has a geographic characteristic of the world largest delta which spreads over East Pakistan with very low altitude along the three big rivers of Panges, Brahmaptra and Meghna except for the Chittagong Hilltract in the eastern part.

Average altitude of nearly all the area is between 6m (20 ft) to 15 m (50 ft) with the variation such as 76 m (250 ft) at the northern part, 46 m (150 ft) at 480 km (300 miles) inland from the sea, 15 m (50 ft) at 320 km (200 miles) inland and 3 m (10 ft) or less near the sea shore.

Average annual precipitation of this country varies largely from 220 inches at Shilhet to 55 inches at Rajshahi, and its 80% concentrates in the rainy season from June to September. This brings about the annual floods with the additional flow from the Himalayas during snow melting season. Therefore, the Padma has the annual water level pattern which is made up of the peak high water level in July - September and the lowest water level in March - April, as shown on Fig. 2 and 3.

Except for some areas of the right bank of the Bramaphutra where flood preventing embankment has been constructed, flood control has not been executed satisfactorily in East Pakistan as a whole. More than 20% of the total area is covered by water in the rainy season every year, and this happens to nearly 80% of the land along the Padma.

Annually flooded area is shown in Table 1.

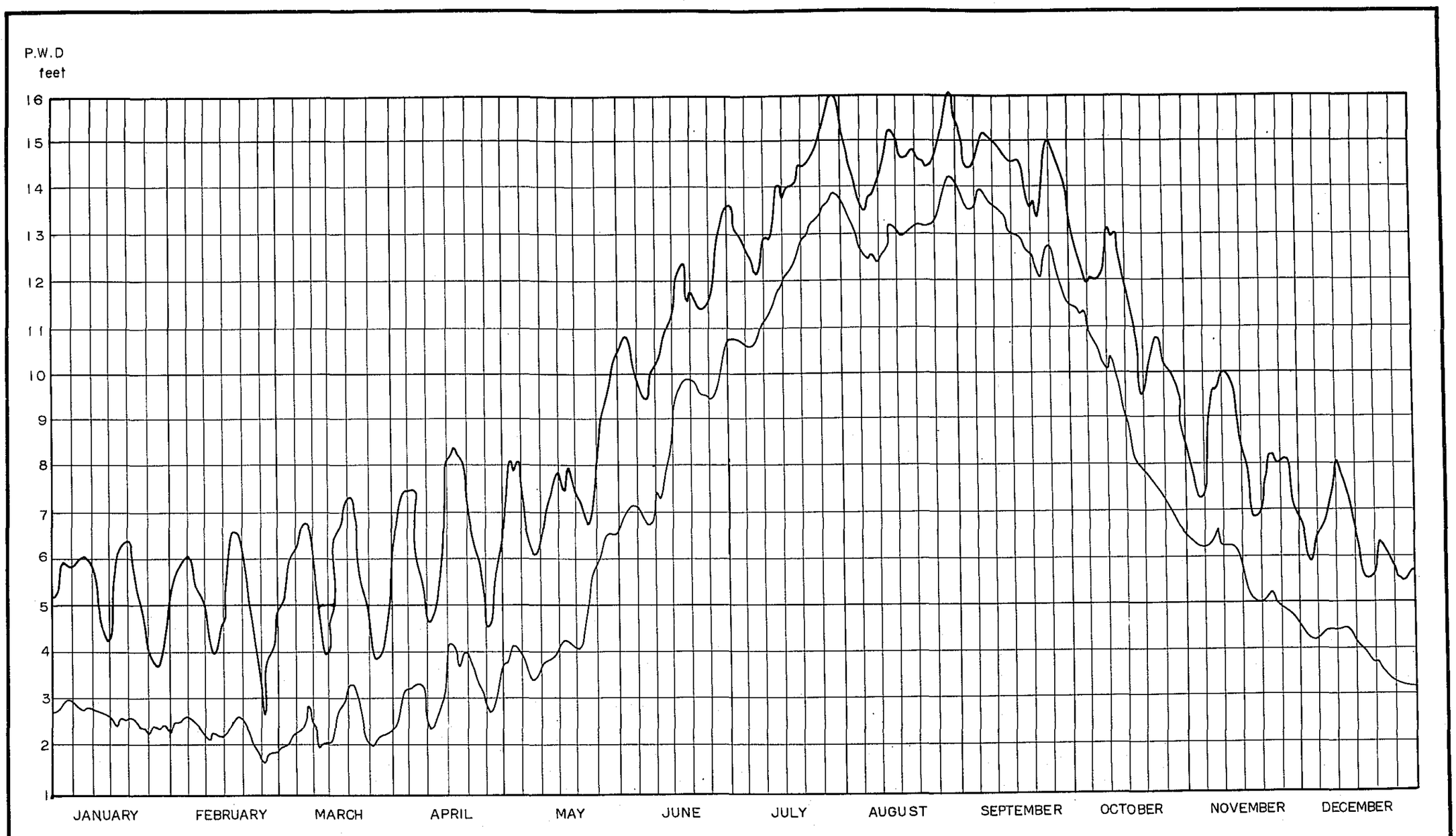


Fig. - 2 YEARLY HYDROGRAPH OF CHANDPUR 1969

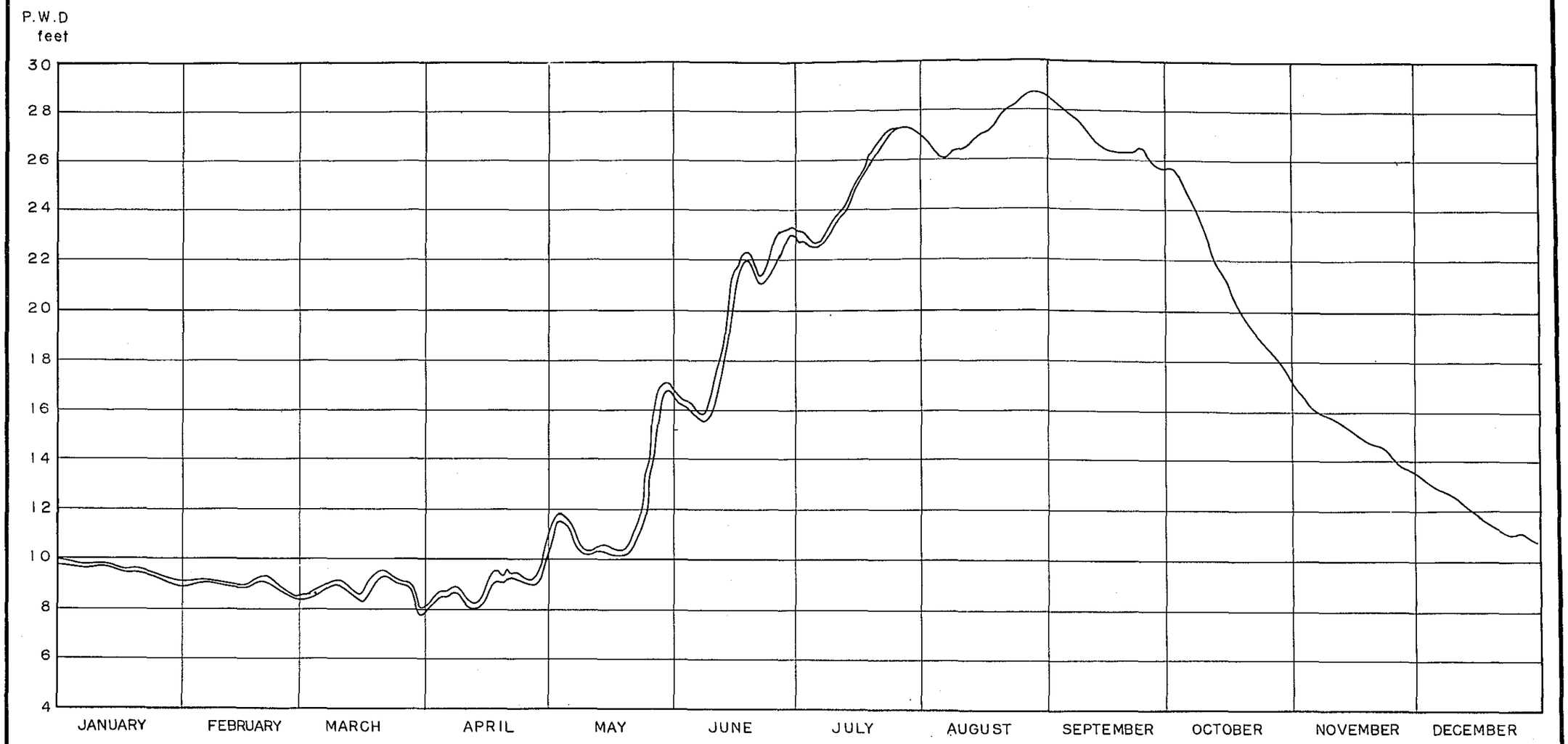


Fig. - 3 YEARLY HYDROGRAPH OF GOALUNDO 1969

Fig.- 4 FLOOD INUNDATION CHART

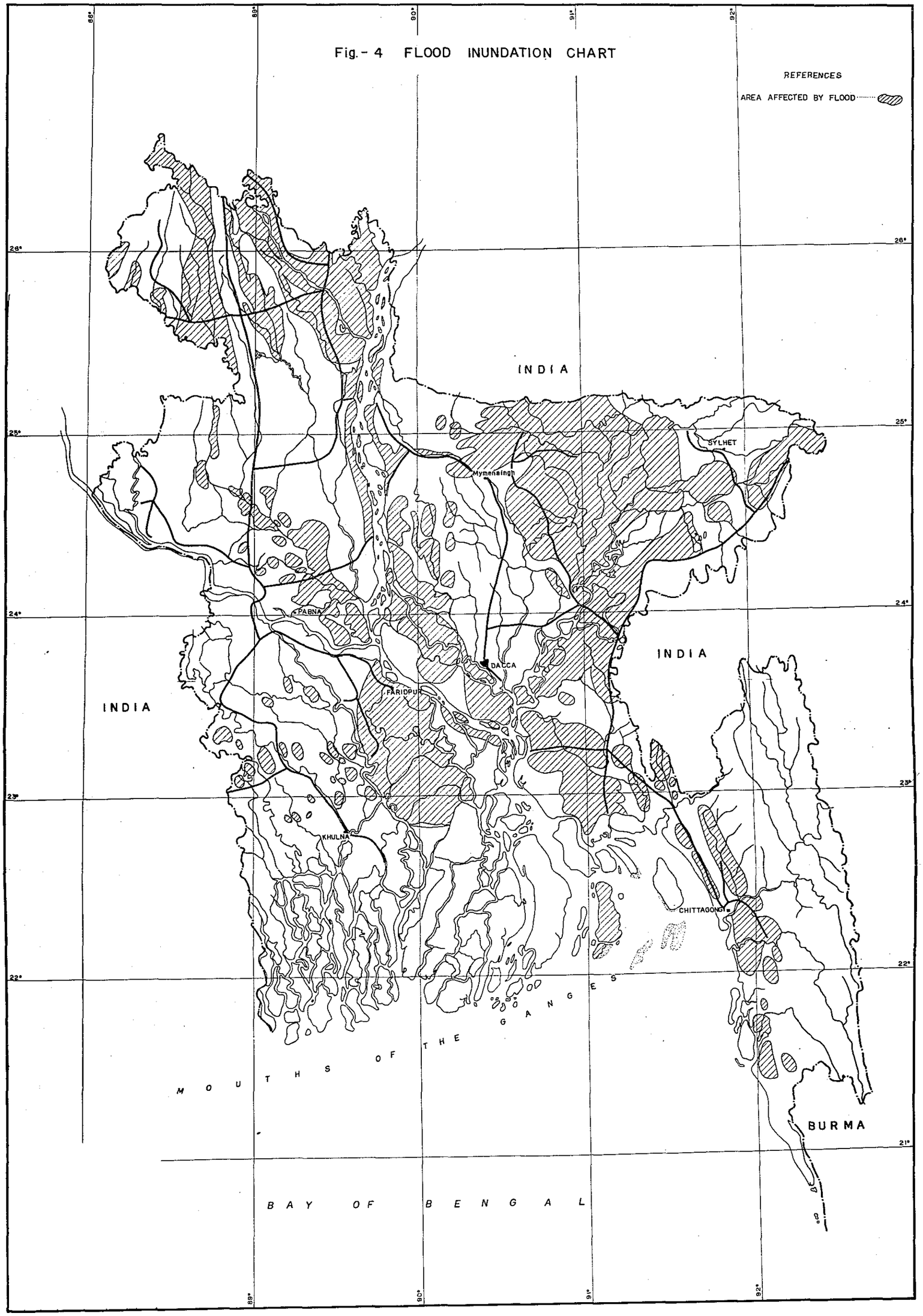


Table 1. Annually Flooded Area *

Year	Flooded area ($mile^2$)	Percentage to the total area (%)
1954	14,200	25.7
1955	15,000	27.2
1956	13,700	24.8
1960	1,186	2.5
1961	2,440	4.4
1962	14,400	26.1
1963	13,600	24.6
1964	12,000	21.7
1965	11,000	20.0
1966	12,900	23.4
1967	9,900	17.9
1968	14,400	26.1
Average	11,200	20.3

* Refer to the appendix No. 11

Gradient of the water surface of the Padma downstream from Goalundo during flood is about 1/25,000. "Polder project" which is a general project including flood protecting embankments and irrigation plans is now being planned and partly started by WAPDA. Natural conditions concerned with the river will be changed considerably by the completion of this project.

3. Water Level and Discharge

3-1 Water Level

Water levels and discharges of the rivers in East Pakistan have been observed by WAPDA (Water and Power Development Authority) and IWTA (Inland Waterway Transport Authority). The data of fairly long period at some important points on the Ganges, the Brahmaputra, the Padma, etc. are available, but reliability is not sufficient in some parts. Results of the observation carried out by WAPDA since 1964 are formulated in "Water Year Book".

Records of the annual highest water level at some important points are shown in Table 2 *.

Plotting values calculated using the following Thomas - Plot formula and using the data in Table 2 are illustrated by normal probability distribution as shown on Fig. 5, 6, 7 and 8.

* Refer to appendix, No. 4 and No. 8

ANNUAL HIGHEST WATER LEVEL (PADMA)

feet P.W.D.

Station & Station No. / Year	Hardinge Bridge 90	Goalundo 92	Kushumhati 93	Bhagyakul (Mawa) 93.5L	Tarpasha 94
1910	47.85				
11	47.05				
12	45.26				
13	45.15				
14	46.77				
15	47.05				
16	47.65				
17	47.50				
18	46.70				
19	47.50				
1920	44.30				
21	47.42				
22	48.00				
23	47.08				
24	46.75				
25	47.65				
26	47.15				
27	45.70				
28	45.90				
29	45.70				
1930	46.40				
31	47.70				
32	45.40				
33	47.00				
34	48.50				
35	48.00				
36	48.90				
37	47.10				
38	48.60				
39	46.10				
1940	46.10				
41	45.60				

ANNUAL HIGHEST WATER LEVEL (PADMA)

feet P.W.D.

Station & Station No. / Year	Hardinge Bridge 90	Goalundo 92	Kushumhate 93	Bhagyakul (Mawa) 93.5L	Tarpasha 94
1942	47.10				17.90
43	44.60				18.00
44	44.60				17.30
45	45.80	28.71	24.58		19.30
46	47.00	(28.67)	22.70		19.10
47	47.30	28.03	22.68		18.40
48	48.70	29.89	22.30		19.20
49	47.50	27.87	24.55		19.50
1950	48.30	29.54			19.30
51	46.40	28.41			18.50
52	48.80	29.63			19.60
53	48.30	29.37	24.00		19.80
54	48.90	31.25	25.75		21.00
55	48.70	31.00	27.60		21.40
56	47.79	28.02	22.90		20.10
57	45.90	30.58	24.65		19.80
58	47.80	30.01	27.50		20.60
59	47.31	28.65	26.20		20.50
1960	47.41	29.26	26.08		20.00
61	48.21	28.78	24.70		18.30
62	47.51	30.00	26.10		20.00
63	47.21				
64	47.21	29.80			
65	45.01	28.45	24.65	19.57	18.85
66	46.86	29.45	25.50	20.91	19.51
67	47.36	27.20	22.75	18.85	17.05
68	46.04			20.44	
69	48.14			20.72	
1970	45.46			20.86	

Fig. - 5 WATER LEVEL PROBABILITY CHART

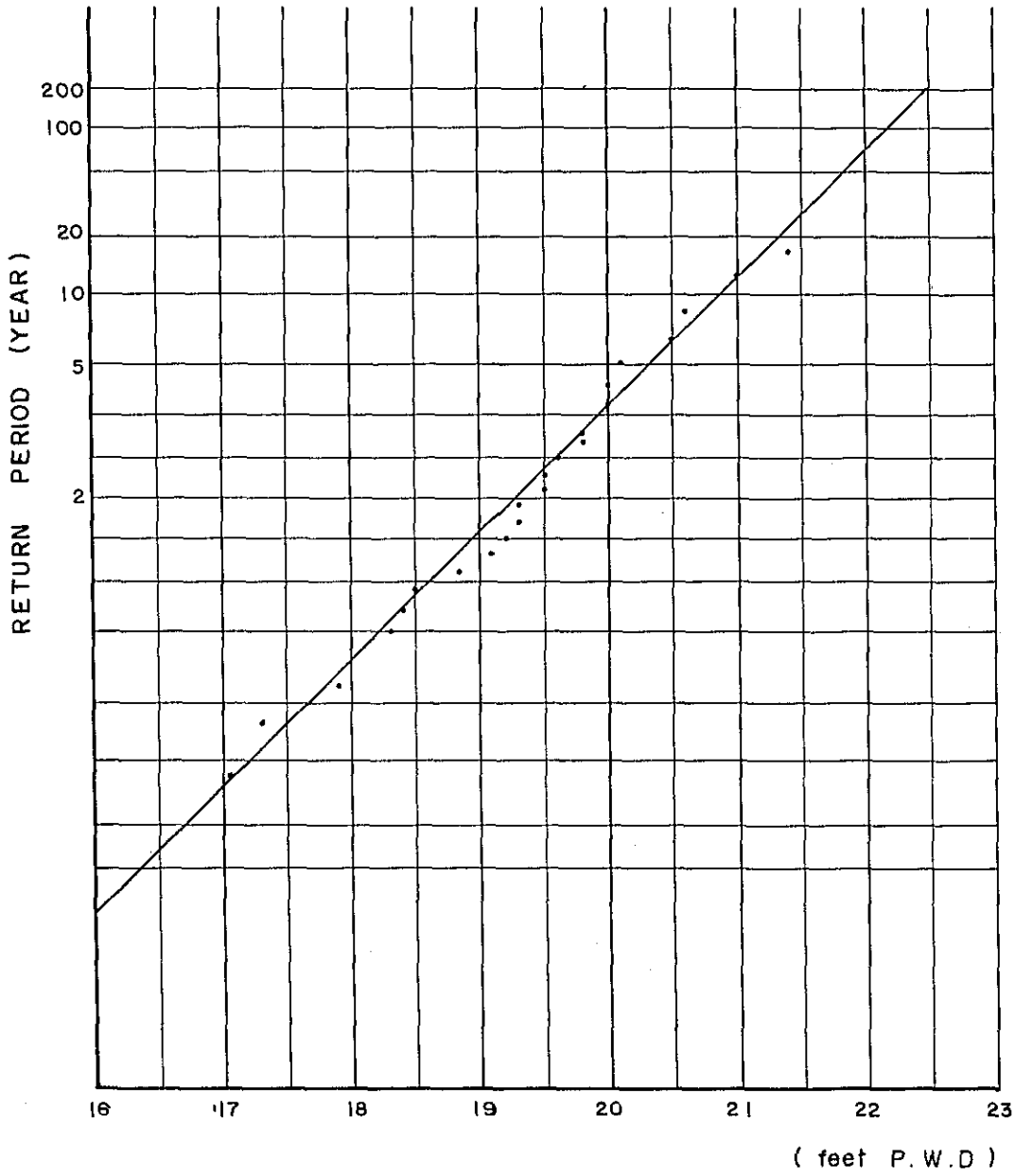


Fig. – 6 WATER LEVEL PROBABILITY CHART

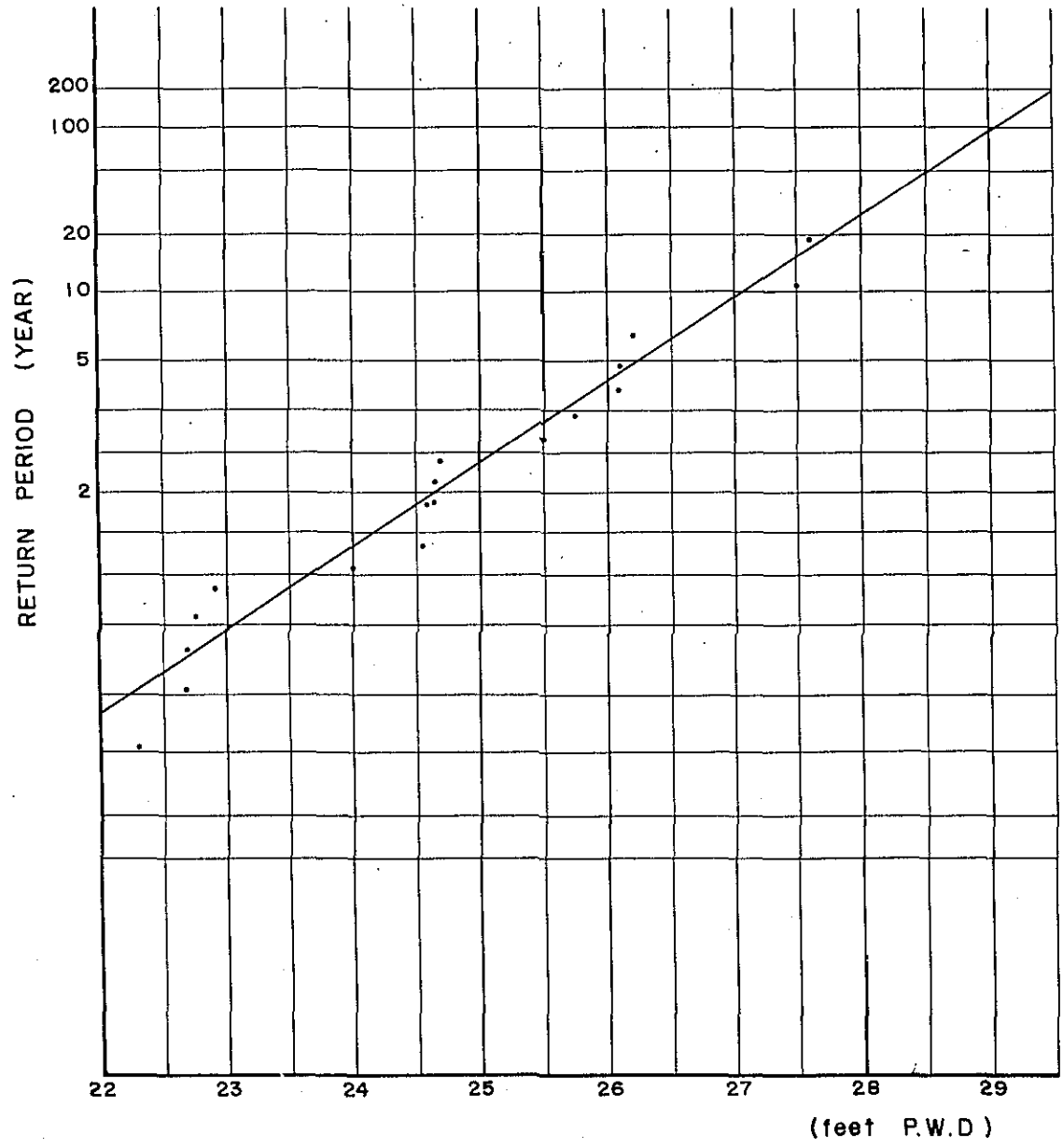


Fig. - 7 WATER LEVEL PROBABILITY CHART

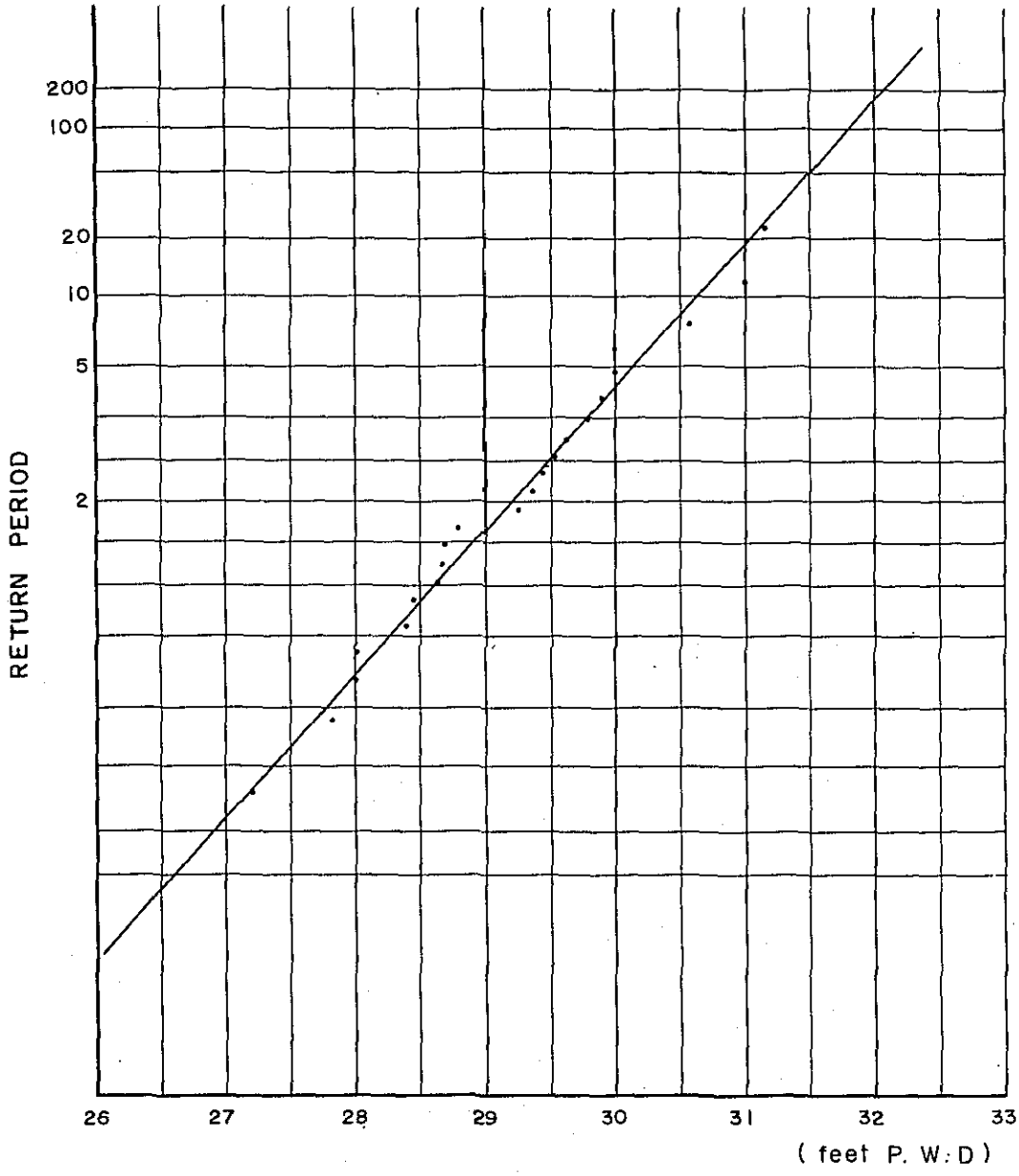
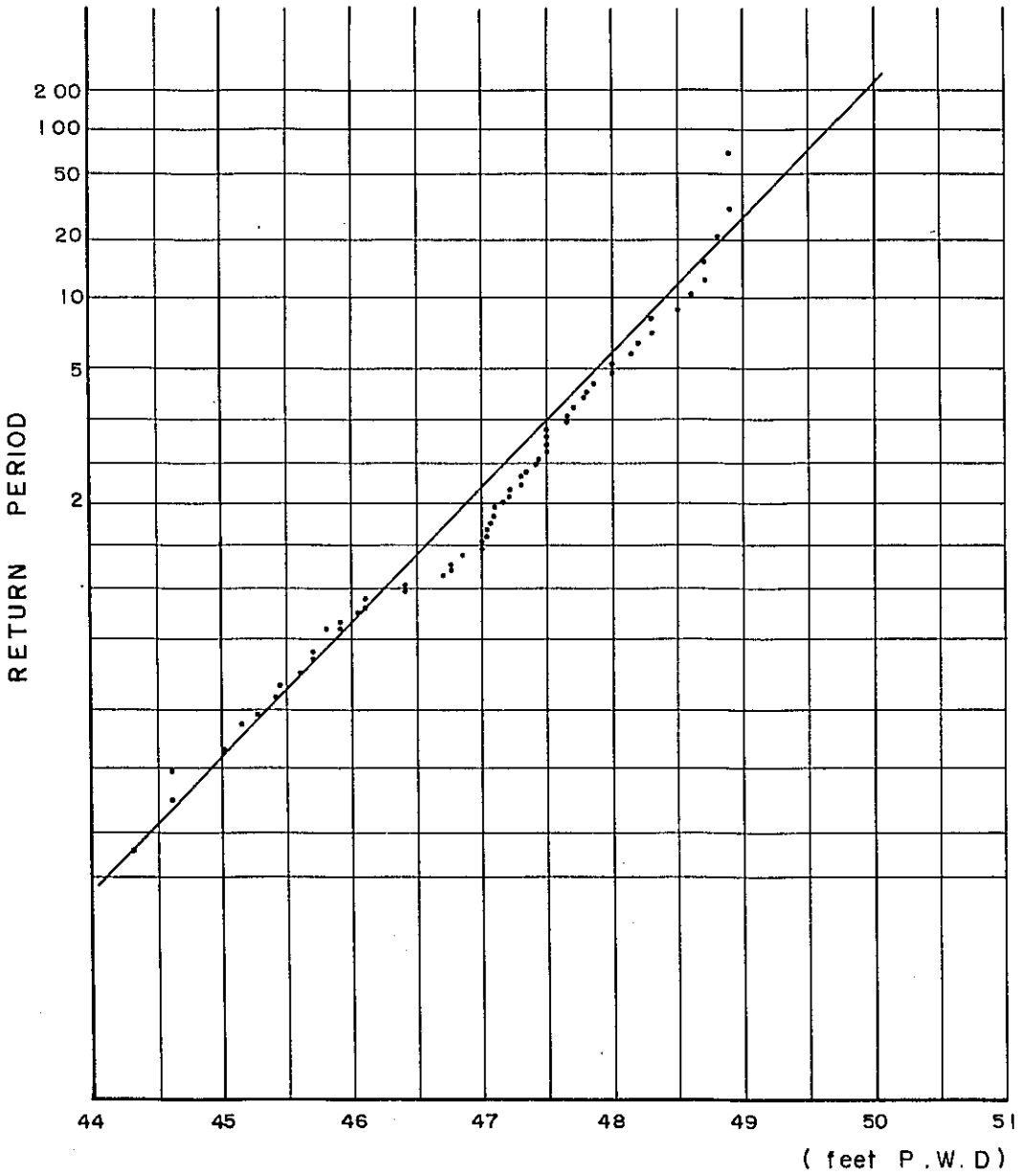


Fig. -8 WATER LEVEL PROBABILITY CHART



$$PN = \frac{i}{N+1}$$

N = Total number of data

i = Ordinal numbers of the data in order of each dimensions

Water levels which correspond to the return periods of 50, 100 and 200 years are obtained from these charts as follows;

(Unit: ft. P.W.D.)

Pt. No.	Point	Return Period (Years) 50	100	200
94	TARPASHA	21.85	22.18	22.50
93	KUSHUMHATI	28.54	29.05	29.51
92	GOALUNDO	31.50	31.80	32.08
90	HARDINGE BRIDGE	49.32	49.65	49.95

Water level profile of equal probability for 100 years, drafted from above table is shown on Fig. 9.

As a result, the water level of 100 year probability at Bhagyakul is estimated as 7.22 m (23.7 ft P.W.D.). As these charts show, the changes of water levels which correspond to the changes of return periods are comparatively small. For example, the change of water levels between 50 and 100 year returns at Kushumhati is only 0.16 m which is not so big.

3-2 Changes of High Water Level Caused by Flood Protecting Embankment

"Polder Project" which is mainly aimed for flood control is now being planned by WAPDA in East Pakistan. The embankments along both sides of the Padma shall be built according to this project. As inundation of flood will decrease after the completion of these embankments from that of present natural situation, a rise of the high water level should be expected. But this change is estimated to be not so big, and according to the report of "Polder Project",* the rise for 100 years return is only about 0.60 m.

3-3 Discharge

Records of the maximum annual discharges at some important points along the Padma are shown in Table 3.** As number of dater obtained are not sufficient and no corrections for inundation are made, nothing but figures about flood volume are shown here. However, according to the results of the survey executed by FAO, the flood volume is very small comparing to the peak discharge. It is reported that the flood volume was only 2.1% of the total discharge during the flood of 1967.***

The flood flow chart of the rivers in East Pakistan made by WAPDA is shown in Fig. 10. The estimated discharge of the Padma at Goalunds is 147,000 147,000 m^3/s (5,200,000 cft/s)**** according to fig. 10.

* Refer to the appendix No. 1 *** Refer to the appendix No. 9
** " " No. 5 **** " " No. 6

ANNUAL DISCHARGE RECORD

feet^3/sec

Station & Station No. / Year	Hardinge Bridge 90	Baruria Transit 91.9L	Goalundo Transit 91.9L	91.9L+91.9R	Bhagyakul (Mawa) 93.5L
1965	1,300,000			2,773,000	3,026,904
1966	1,480,000	2,874,000	376,000	3,250,000	3,012,000
1967	1,768,000	2,320,000	33,100	2,353,100	2,460,000

Fig.-9 PROFILE OF LEVEL WITH EQUAL PROBABILTY

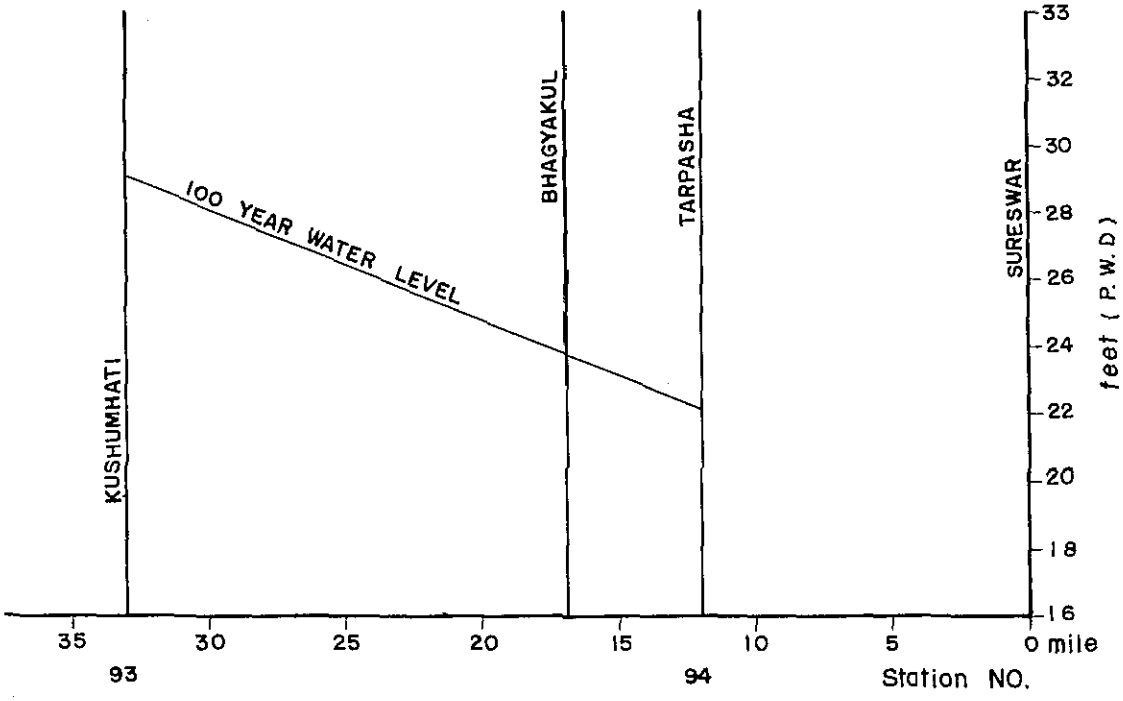
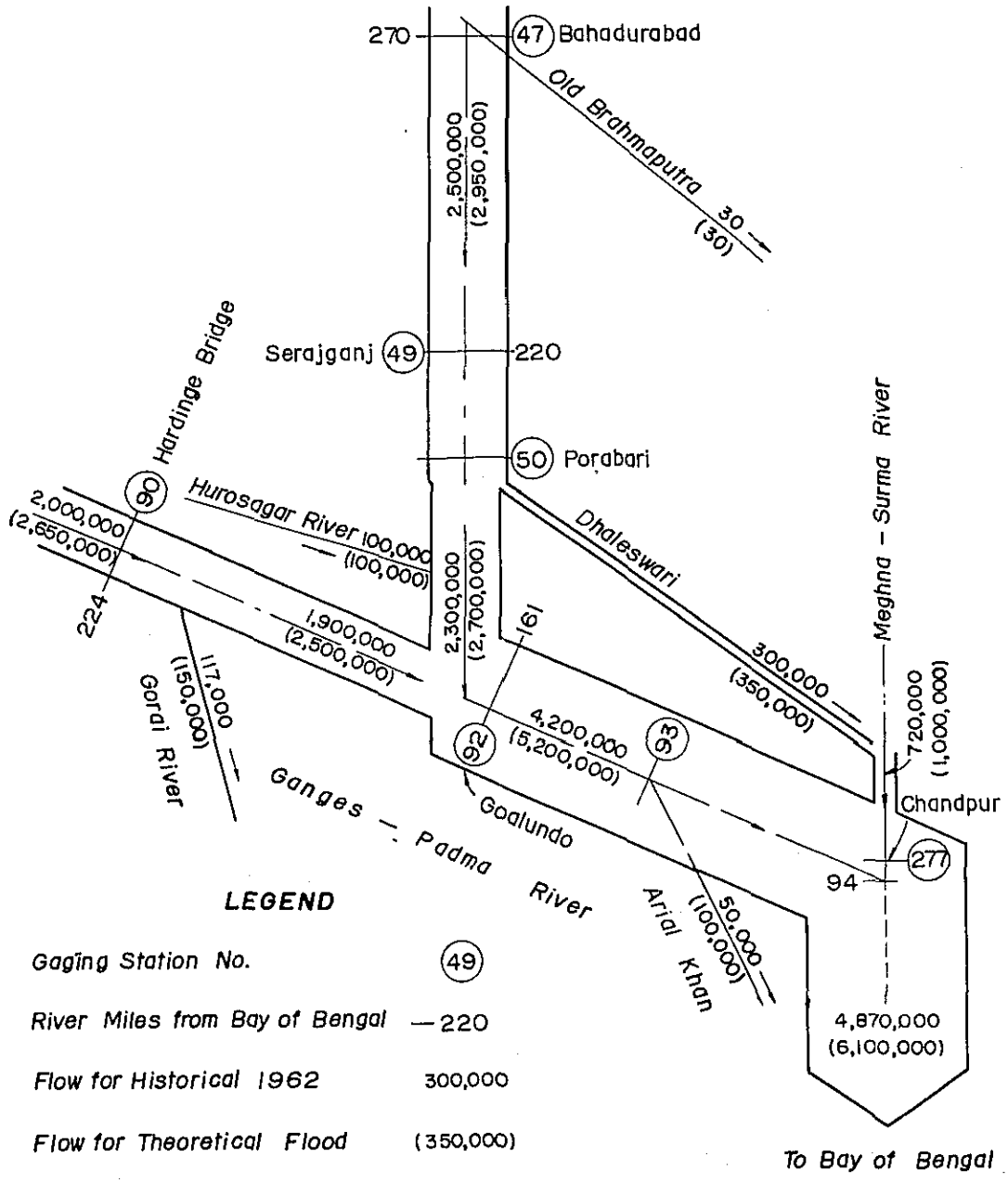


Fig.- 10 FLOOD WATER BALANCE



4. Considerations for Padma Bridge Project

4-1 Condition of River Banks at the Proposed Bridge Site

The river course of the Padma, as it is described in the first report of this project, changes largely year by year. While some parts of banks are being eroded, riverbeds of some parts are too shallow with piled sand and silt to keep the safe navigation.

Furthermore, position and size of river islands change almost every year. A certain engineer of WAPDA expressed this change "fantastic". This change is considered to continue unless a well planned river improvement works to settle the river course are completed.

Therefore, for the plan and design of a bridge over this river at present, it is necessary to study carefully to adopt a considerably high safety factor.

It was confirmed by this time reconaissance survey that the results of reconaissance survey concerning the river bank condition of the whole Padma made by the first team are true in general. Especially regarding the route-setting of the proposed Dacca - Faridpur Road, no other site for bridge construction than that found by the first team could not be found, though there are some problems which are described later. So the bridge site selected by the first team shall be described in more details as follows.

(a) The left bank

The bank from Bagyakul to Mawa seems to be most stable along the Padma. Fig. 11 shows the changes of the river course in recent years*. The left bank has not shifted much, but it has been eroded year by year though its progress is very slow. As there is a very deep valley, deeper than 30 m (100 ft), near the left bank and it has moved toward the left bank year by year, it is necessary to carry on the survey periodically.

(b) The right bank

The right bank is fairly unstable comparing with the left. As it can be seen in Fig. 11, the narrowest point exists near Mawa at present though it was near Bagyakul ten years ago. The land of the right side is very low and many rivers run in rainy season on it. So many traces of meshy streams can be noticed on the right side land.

The points of maximum and minimum width have a tendency to move down-stream parallelly as a snake swallowing eggs. The right bank has been eroded from the upper-stream part and the eroded soil has settled at the down-stream. Therefore, it should be noted that it is dangerous to rely on the right bank.

4-2 Clearance of the bridge

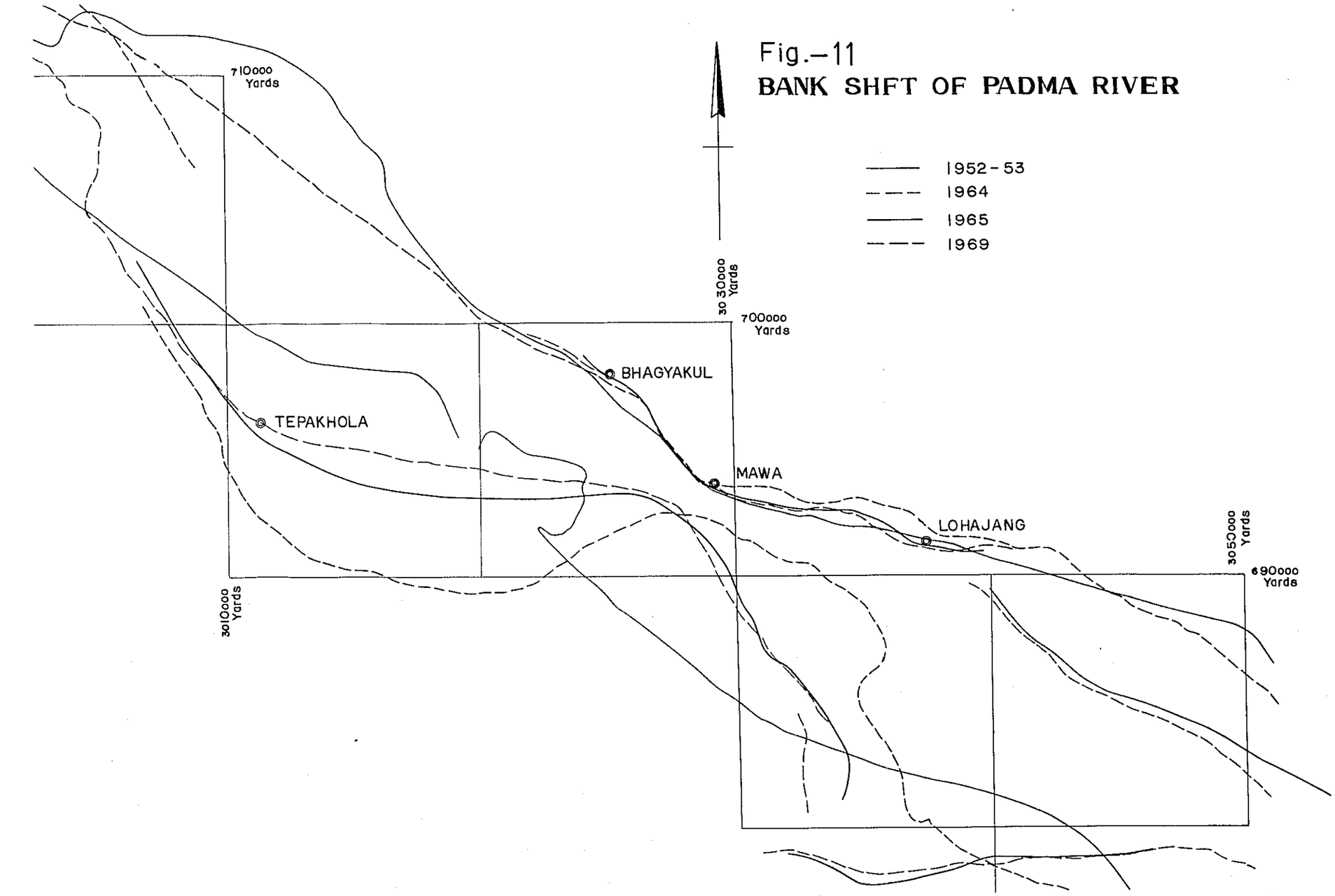
In case to construct a bridge across the Padma, the following conditions should be satisfied;

1. not to disturb flood flow
2. not to disturb navigation

* reference No. 12, 13

Fig.–11

BANK SHFT OF PADMA RIVER



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
BANK SHFT OF PADMA RIVER	
CHIEF ENG. S. Matsuda	SCALE
CHECKED BY E. Hayashi	SHEET NO. 10
DESIGNED BY K. Kawaguchi	DATE Jan. 1971
DRAWN BY M. Takeuchi	

(a) Design high water level

The relation between annual highest water level and its excess probability are shown in Fig. 5-8, as described in Chapter 3. "Water level and discharge". The degree of rise of water level according to decrease of frequency is not so large. And for the design high water level to decide the height of flood-protecting embankment now being planned by WAPDA the water-level of 100 year probability has been adopted*.

The 100 year probability water-level at the proposed bridge site is estimated as 7.22 m (23.7 ft PWD) from the survey conducted this time. As the rise of water level due to flood protecting embankment is estimated as 0.60 m the 100-year probability water level at the proposed bridge site after completion of flood protecting embankment becomes 7.82 m (25.7 ft PWD).

(b) Temporary rise of water level

In addition to rise of water level by increase of discharge described in (a), temporary rise of water surface should be considered. For instance it may be caused by a tidal wave from the Bay of Bengal. Water level of the Padma will rise by tidal wave caused by cyclons in the coast area of East Pakistan. According to the report of Polder Project made by WAPDA, tidal wave in the coast area will be weakened rapidly as it advances into land area. The most inland record of tidal wave in the past was 96 Km. Bagelhat, from the river mouth with 0.76 m height of wave.** But the rise of water level will be small and can be neglected at the proposed bridge site.

Wind will be another cause of temporary rise of water surface. The height of waves at the proposed bridge site was estimated as follows from topography and weather conditions in this report.

The width of the river was assumed as 25 km excluding islands, and then the following heights of waves were calculated using Molitor's method for the various wind speeds such as 10 m/s, 20 m/s, 45 m/s and 60 m/s.

Wind Speed U (m/s)	Wave Height (m)
10	1.12
20	1.52
45	2.10
60	2.37

According to a newspaper regarding the cyclon that the survey team, experienced actually in East Pakistan, the maximum wind speed was about 45 m/s and the maximum wave height near Aricha was about 2 m.

(c) Decision of vertical clearance of bridge

The before mentioned conditions as to vertical clearance of the bridge which should be satisfied are considered.

In order to secure the smooth flood flow a certain surplus height must be kept above the design high water level. In the Polder Project, plan the total surplus height is decided as 1.5 m (5 ft), including 0.9 m (3 ft) for waves and 0.6 m (2 ft) for pure surplus.* By the way flood of the Padma

* reference No. 1, 2 and 3
** reference No. 1

is composed mainly of snow-melted water of Himalayas and the peak of water level is observed in August or September. And wind that causes high waves is brought by cyclones that are observed from May till June and from October till November. These can be thought completely independent phenomena considering their origins. Therefore, as it can be said that there is very little possibility for the highest waves to occur simultaneously with the highest water level, only the following cases may be studied.

In this case the water level during May to June and October to November is supposed to be lower by 1.5 m than the design high water level as shown in Fig. 2, 3 and 4 and the height of the crest of waves was calculated by adding the half of wave height to the water level.

(i) During cyclone season (May to June and October to November)

Water level	6.32 m
Half of wave height when wind speed is 60 m/s	1.19 m
Total water level	7.51 m

(ii) During flood season (August to September)

Water level (design high water level)	7.82 m
Half of wave height of wind speed is 10 m/s	0.56 m
Total water level	8.38 m

From this comparison it is sufficient to consider only case (ii) and to adopt 1.5 m (5 ft) as the surplus height as in the Polder Project Plan.

Next, in order not to disturb the navigation, the regulation of clearance for the navigation authorized by IWTA should be observed as follows.

	Horizontal clearance	Vertical clearance
The Padma	76.25 m	18.30 m

This clearance limits are to be secured in the center span. The vertical clearance is to be based on the designed highest water level.

Considering the above described for the vertical clearance of the proposed bridge more than 18.3 m should be secured above the design high water level for the center span and 1.5 m for the other spans.

Clearances of the bridge proposed in the first report satisfy these conditions sufficiently.

4-3 Bridge Length

As the river course of the Padma changes much year by year as described before, the position of the bridge abutment should be decided after sufficient survey and study. The decision based on data of short period of only ten years or so is dangerous. And also it is not a good policy to leave the river as

it is now from the stand point of land development of East Pakistan. It is necessary from now on to take measures positively for stabilization of the river course and for flood protecting.

In this sense it is quite right that the first survey team made their bridge plan on the basis of Polder Project Plan of WAPDA. Furthermore, it can be thought the best to decide the bridge length equal to the distance between the both side embankments of Polder Project.

There are the Dacca South-West Plder Project for the left side of the Padma and Faridpur Project and Shreswar Project for the right side. Brief explanations of each of the above three projects are given below.

The Dacca South-West Project includes the area surrounded by the Dhaleswari, the Burhi Ganga and the Padma, and according to the report published on August 1970 the widest area surrounded by the Khali Ganga, the Dhaleswari and the Padma is given the priority. Major purposes of this project are flood protection and irrigation of the area of 135,000 ha (334.100 acres) surrounded by the embankment of 250 km (155 miles). This project is scheduled to start in 1970 and is expected to completed in 1976 earlier than other two areas of the three.

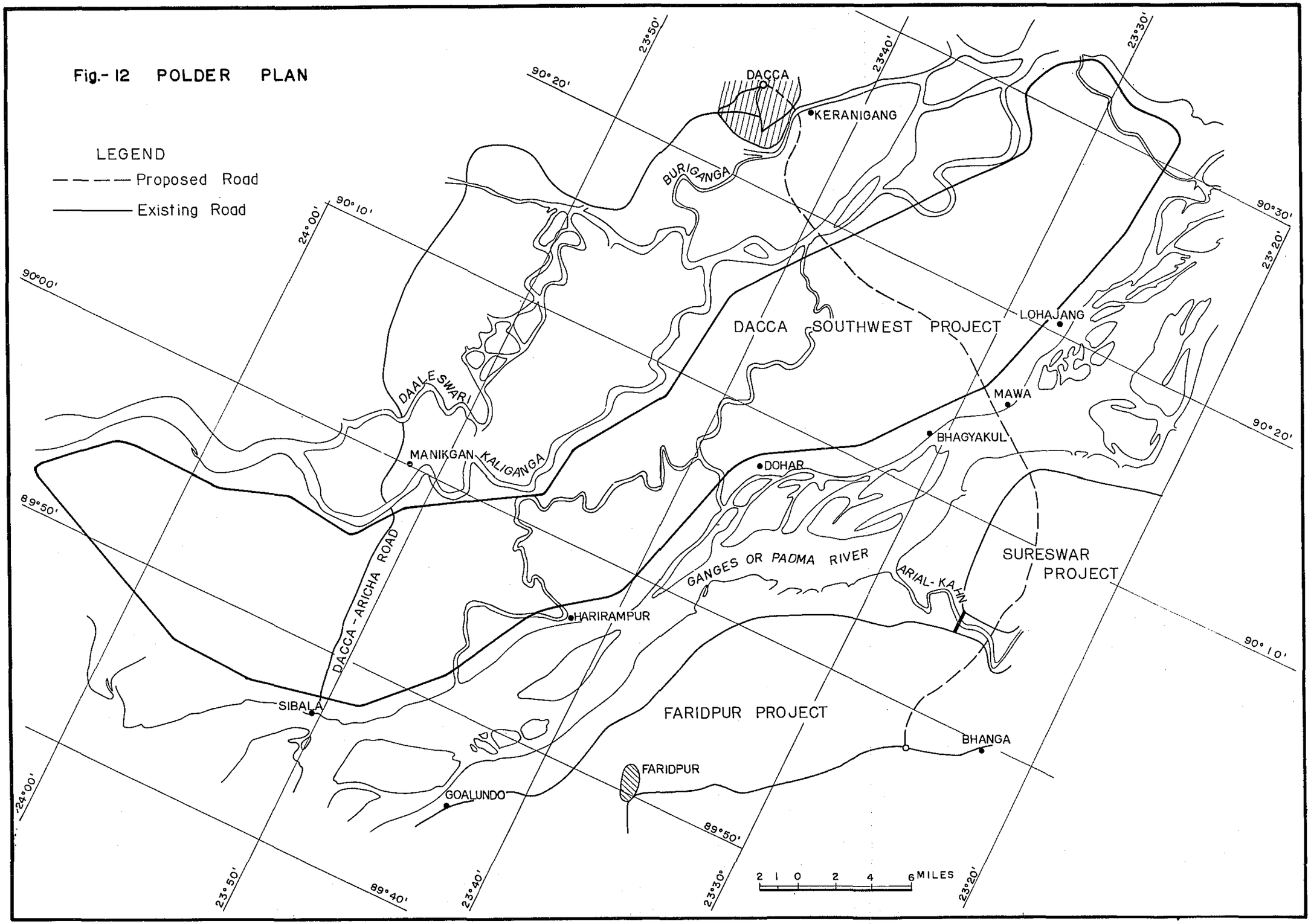
The Faridpur Project includes the vast area of 264,000 ha (653.000 acres) surrounded by the Padma and the Gorai, and the report was published in July, 1970. The starting time of this project has not been settled yet, but how to deal with the Arial Khan which runs on the area included in this project has a close relation to the Padma Bridge Project. The Arial Khan, whose designed discharge is 1,400 m^3/s (50,000 ft^3/s), is to be intercepted near the diverging point from the Padma by a flood control gate of 40 m (130 ft) length to reduce the flood discharge down to 700 m^3/s (25,000 ft^3/s).

The Shreswar Project is planned for the right side area of the Padma at the proposed bridge site and, according to the report published in July 1970, the embankments of 230 km (142 miles) in length are to be constructed to protect the land of 77,000 ha (190,000 acres). Main construction works are planned to complete in nine years, but when to start is not decided yet.

Generally speaking, the alignment of the embankments of Polder Project is decided to set back by about one mile from the coastal line. Figure 12 shows the alignment of embankments for the three projects above-mentioned, and shows that the distance between embankments on both sides at the proposed bridge site is about 8 km (5 miles). As the details of Polder Projects especially of Shreswar Project were not clear, the bridge length was assumed as three kilometers after the first reconaissance survey in March 1970. However the bridge length should be revised taking consideration of the unstable right bank.

Along with the realization of the Polder Project, further study is needed to decide the bridge length. And also it is worth while to study the stage-construction to construct at first only the short span bridge section on the unstable low land of the right bank as an approach road for ferry service and to construct main spans across the deep river in the future.

Fig.- 12 POLDER PLAN



4-4 Changes of RiverBed

The width of the Padma at the proposed bridge site is about 2 km in dry season, which is the narrowest part of the river from 50 km upstream to 50 km downstream section. In ordinary cases the narrow width of river means the deep depth and this was suggested at the proposed bridge site by the first survey team. Therefore, the center span was designed as 300 m in order to secure the horizontal clearance limit of 250 feet and the sufficient safety of the bridge foundation considering the movement of location of the deepest valley of the river bed. But as the result of study of data of river crossing surveys conducted by WAPDA and depth surveys by IWTA, it became clear that the movements of the river bed were remarkable generally and the valley in this point was very deep and wide.*

The cross section of the river very adjacent to the proposed bridge site is shown in Fig. 13. As this section does not coincide with the proposed bridge center line, this cannot be taken as the cross section of the bridge site, but it is very useful for getting the general idea about it. The depth at the deepest point reaches 36 m PWD (-120 ft PWD), as shown in Fig. 13, and the valley deeper than 18 m PWD (-60 ft PWD) spreads over the length of 360 m (1,200 ft). Furthermore, the valley moves year by year and it has moved towards the left bank recently. It is a remarkable fact that the valley has moved about 240 m (800 ft) in two years from 1968 to 1970. In addition to the horizontal movement of the deepest valley, the vertical movement of the river bed is notable and it reaches as much as 7.5 m (25 ft) in only two years. The change of the depth at the other point adjacent to this line reaches 12 m (40 ft) and further big movements can be imagined to happen in the long future.

The river bed around this area is composed of fine silt whose average diameter is about 0.05 mm. And as the maximum water speed at the proposed bridge site during flood exceeds 3 m/s (10 ft), the river bed will most probably be scoured easily in flood time. Moreover it should be considered that the speed will become more after completion of the Polder Project. Therefore, to secure of a safe bridge foundation it is necessary to pay a sufficient consideration to the movement of the river bed. For this purpose the depth of the bridge foundation should be made sufficiently deep and it is also necessary to study about the design of the bridge whose center span is not less than 700 m (2.300 ft). Final conclusion of this problem should be drawn after a complete study on the full study based on data of detailed surveys of the bridge site and of observations of the yearly movement of river beds for many years.

4-5 Partial Scouring of the River Bed

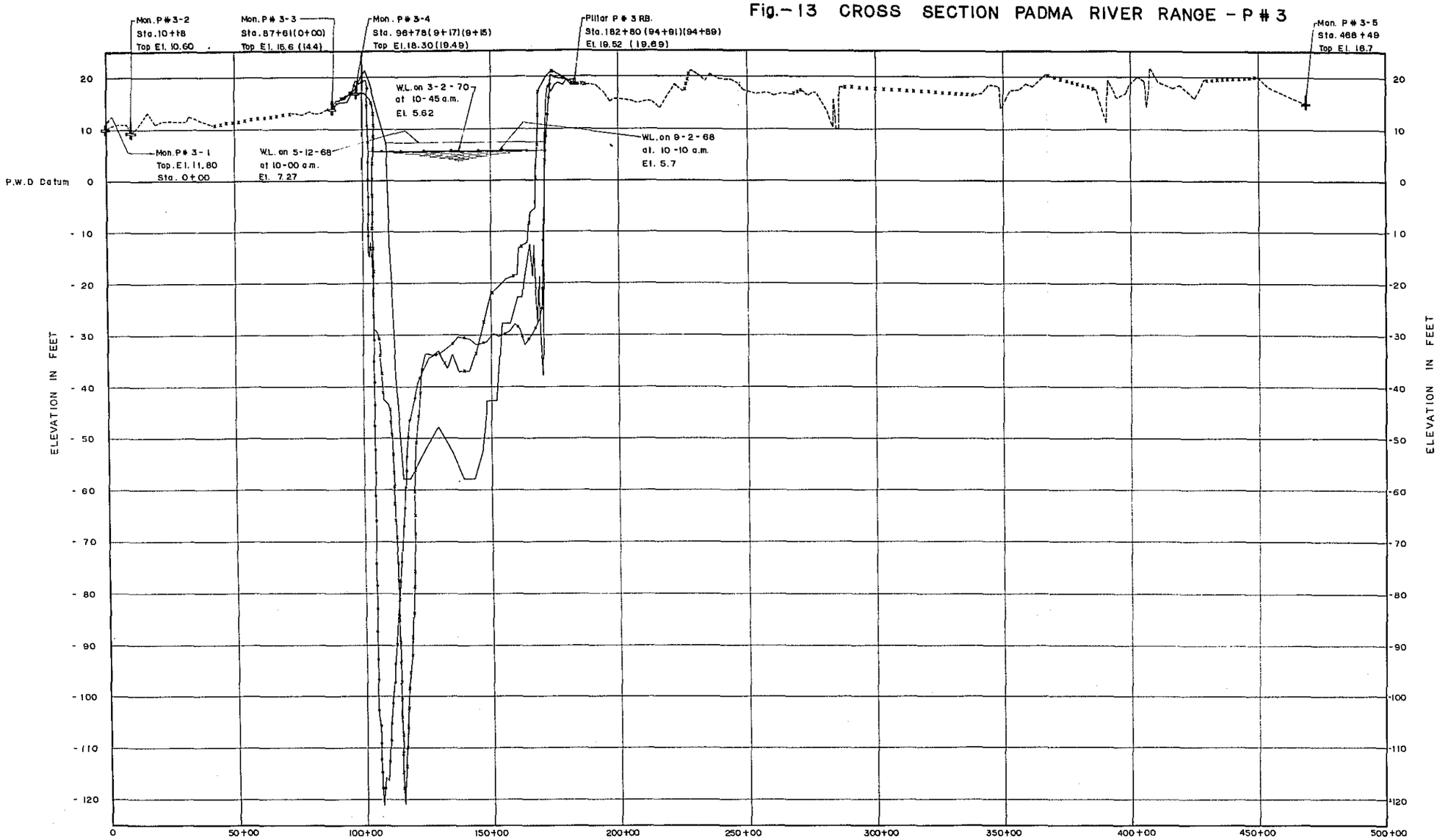
The scouring of river bed at the pier foundation is explained below. When the pier foundation is constructed, the affected river bed will be scoured and lowered, but it is very difficult to know the exact depth of scour.

Especially the river beds around the piers shall be scoured partially. This fact should be understood in the bridge design, but there cannot be found the reliable method to know the exact scouring depth at present. It is necessary to study the scouring effect carefully in such a big and deep river like the Padma.

Water depth at the proposed bridge site should be assumed at least 20 m in average from the designed high water level, as shown in Fig. 13. And piers of wall-type shape of 3.5 m width as are designed for the main span, on

* Reference No. 13, No. 15

Fig.– 13 CROSS SECTION PADMA RIVER RANGE – P # 3



LEGEND

Indicating Survey of Feb . 1968
Indicating Survey of Dec . 1968

Concrete Pillar 12'x12' Placed Jan. 1965

Concrete Mon. 6"x6" Placed Feb. 1966

Village on Section line

Indicating Survey of Feb. 1970

Co-ordinates of Pillars and Monuments.

Mon. P # 3-1	N 23°29'28.4" E 90 18'38.8"
Mon. P # 3-2	N 23°29'22.1" E 90°16'30.2"
Mon. P # 3-3	N 23°29' 1.06" E 90°15'24.17"
Mon. P # 3-4	N 23°28'58.20" E 90°15' 16.35"
Mon. P # 3-5	N 23°24'31.4" E 90°10' 19.4"
Pillar P # 3 R.B.	N 23°28'31.42" E 90°14'03.27"

SCALE 0 1 2 3 4 5000'

SCALE { Hor. 1" = 2000' Vert. 1" = 10'

INDEX MAP (1962)
1 : 500,000

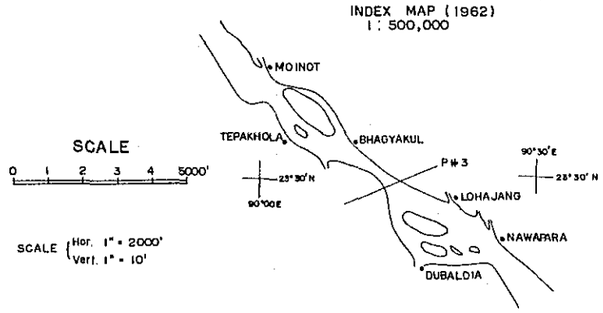
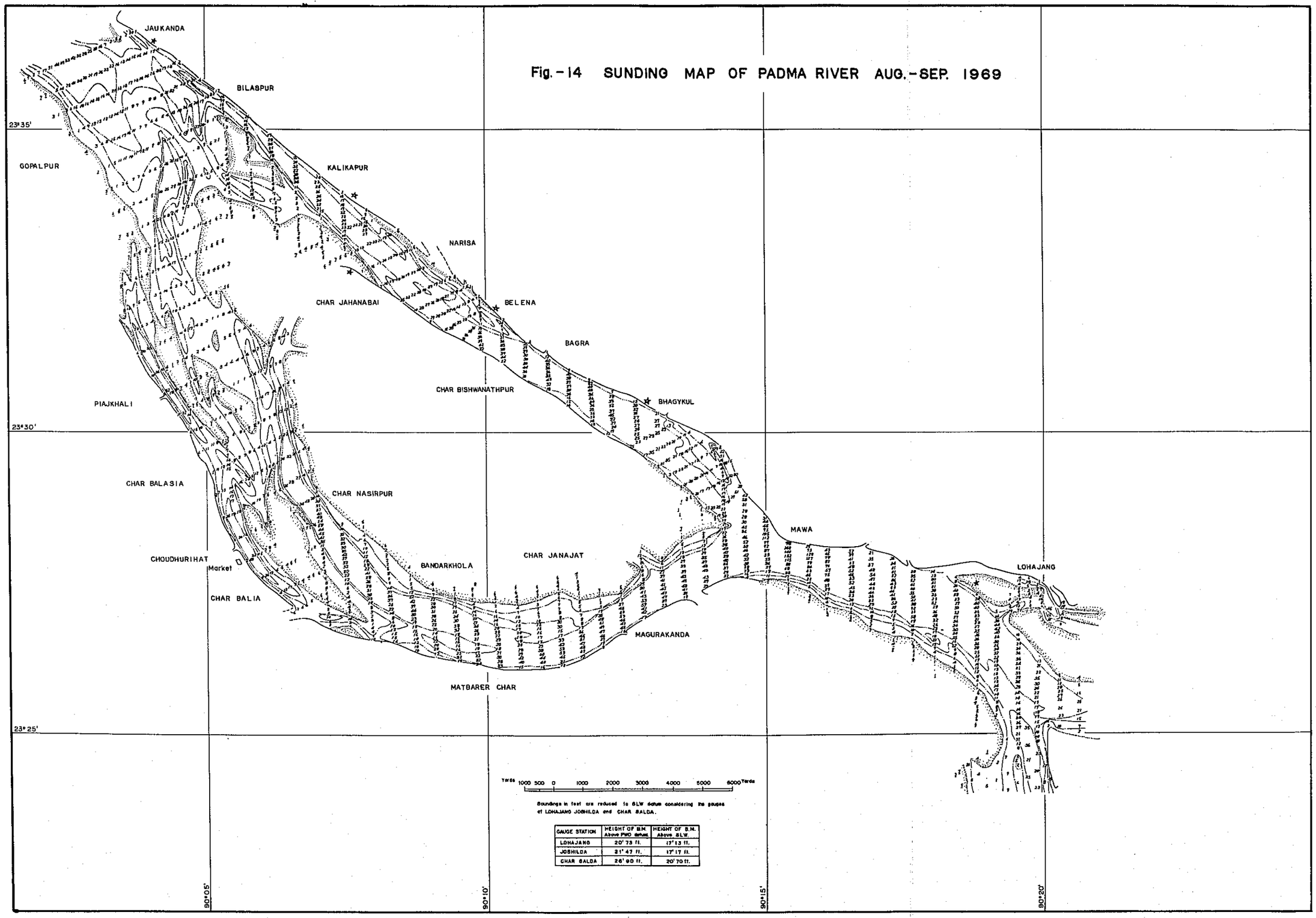


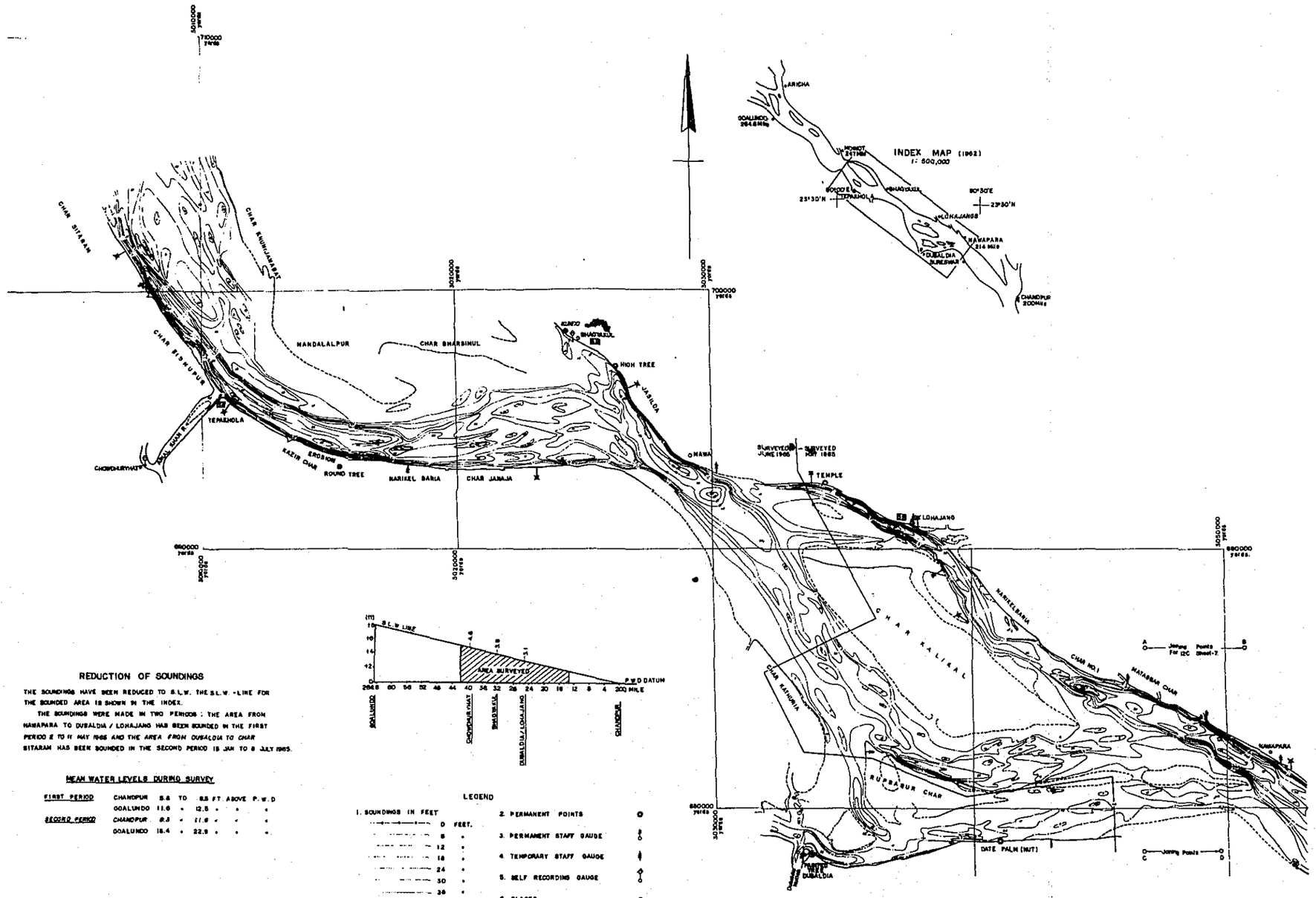
Fig. - 14 SUNDING MAP OF PADMA RIVER AUG.-SEP. 1969



Soundings in feet are reduced to SLW datum considering the gauges of LOHAJANG JOSHILDA and CHAR BALDA.

GAUGE STATION	HEIGHT OF B.M. Above PWD datum	HEIGHT OF B.M. Above SLW.
LOHAJANG	20' 73 ft.	17' 13 ft.
JOSHILDA	21' 47 ft.	17' 17 ft.
CHAR BALDA	26' 90 ft.	20' 70 ft.

Fig.-15 SUNDING MAP OF PADMA RIVER MAY-JUNE 1965



REDUCTION OF SOUNDINGS

THE SOUNDINGS HAVE BEEN REDUCED TO S.L.W. THE S.L.W. -LINE FOR THE SOUNDED AREA IS SHOWN IN THE INDEX.

THE SOUNDINGS WERE MADE IN TWO PERIODS : THE AREA FROM NAWAPARA TO DUBALDIA / LOHAJANG HAS BEEN SOUNDED IN THE FIRST PERIOD 2 TO 11 MAY 1965 AND THE AREA FROM DUBALDIA TO CHAR SITARAM HAS BEEN SOUNDED IN THE SECOND PERIOD 18 JUN TO 8 JULY 1965.

MEAN WATER LEVELS DURING SURVEY

FIRST PERIOD	CHANDPUR	8.6	TO	8.5	FT. ABOVE	P.W.D
	GOALUNDO	11.6	"	12.5	" "	"
SECOND PERIOD	CHANDPUR	8.3	"	11.6	" "	"
	GOALUNDO	18.4	"	22.9	" "	"

LEGEND

1. SOUNDINGS IN FEET
   - 0 FEET.
   - 6 "
   - 12 "
   - 18 "
   - 24 "
   - 30 "
   - 36 "
   - 42 "
   - 48 "
   - 54 "
   - 60 "
   - 90 "
   - 120 "
2. PERMANENT POINTS
3. PERMANENT STAFF GAUGE
4. TEMPORARY STAFF GAUGE
5. SELF RECORDING GAUGE
6. PLACES
7. AGA LIGHT
8. STEAMER STATION

a cylindrical caisson foundation of 12 m diameter are designed for the main span, according to the first time study report.

Scouring depths under such conditions above-mentioned were calculated with a few methods as follows:

(a) Andru's method

According to the Andru's method, the ratio of the maximum scouring depth at the pier nose (Ds) to an average water depth (h) is expressed in the following formula with no relation to the material of the river bed.

$$\frac{Ds}{h} = 1.8$$

So the scouring depth below the mean river bed can be calculated as 16 m (53 ft).

(b) Laursen's method

According to the Laursen's method, the relation between scouring depth (ds) divided by (b), which is the pier width, and water depth (h)/(b) is shown in Fig. 16.

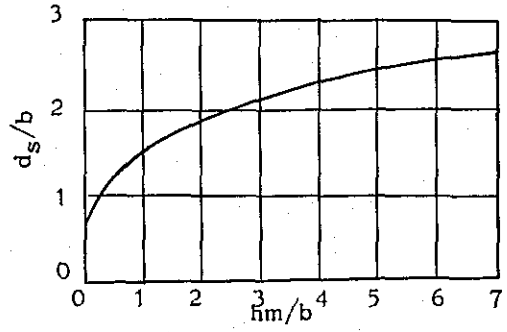
When 12 m, diameter of caisson foundation, is taken as the pier width, the scouring depth can be calculated as 21.6 m (72 ft) from Fig. 16 and 24 m (80 ft) with correction for the shape of the pier head and materials of the river bed.

On the other hand, when 3.5 m, the thickness of wall-type pier, is taken, the scouring depth can be calculated as 10 m (33 ft).

As results of calculation made above differ from each other, to know the exact scouring depth is very difficult. But as there is a report of very deep scouring at Hardinge Bridge, at least scouring depth of 20 m (67 ft) should be considered.

For the further study on the general and partial scouring effect influenced by the construction of piers in the river bed, model experiments and measurements in similar examples should be performed.

Fig. 16 Laursen's methodefor secouring depth



d_s = scouring depth below mean river bed
hm = water depth above mean river bed
b = pier width

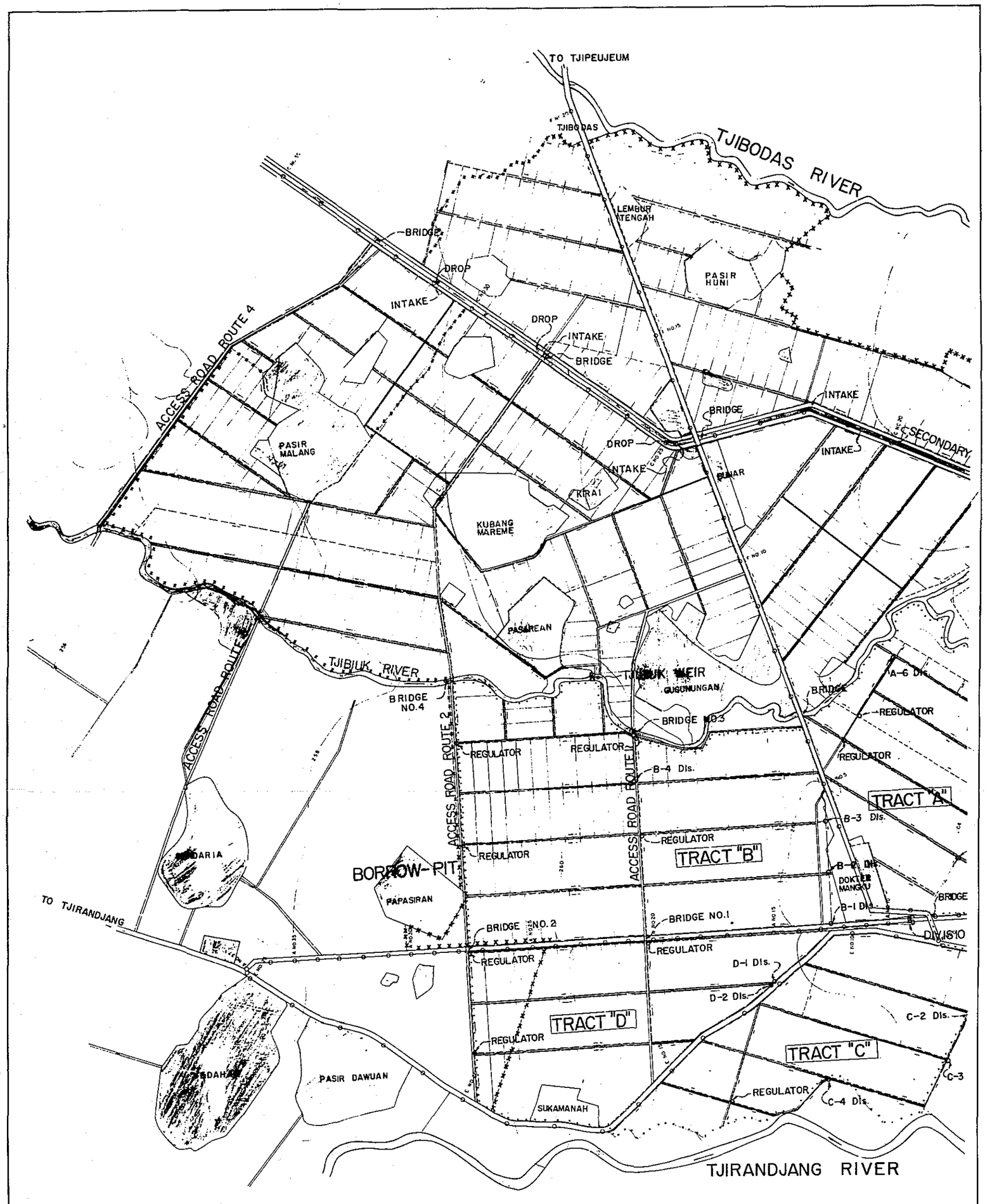


Fig.-16 LAURSEN'S EXCAVATION CHART AT BRIDGE PIER

5. Consideration on the Proposed Bridges on Daleswari and Arial Khan Rivers

5-1 Daleswari Bridge

River conditions of the Daleswari are far more stable than those of The Arial Khan. Although slight partial errosion of the banks in observed, the banks are generally stable, and especially, the banks at the proposed bridge site are stable. Both sides of the river at the bridge site are low, and are anticipated to be covered by water to a depth of 1.5 to 2 m (5 to 7 ft) in rainy season. But the banks will not be collapsed as the river flow is not so fast. Accordingly, the bridge length proposed in the first survey report is considered to be sufficient. However, as there is also Polder Plan in this area, the bridge length should be decided in accordance with the slope of embankments when the details of the plan is decided.

As for the change of the river bed, it would be about 3 m (10 ft) below mean water level with little undulation at bridge site where the river is generally straight, although partial deep scouring is observed at some other parts where the river is winding and the current is partially strong. The proposed depth of the pier foundation will be sufficient considering above conditions.

However, the further study will be needed as in the case of the Padma Bridge with additional site survey, geological investigation, hydrological survey and analysis, as above discussion concerning the soundness of the proposed bridge plan is based only on the information obtained so far.

5-2 Arial Khan Bridge

The Arial Khan is a branch of the Padma which parts itself from the Padma at the point 16 km (10 miles) upstream from the proposed Padma Bridge. The river is recently said to be diminishing gradually at this parting point. (This parting point is recently said to be closing gradually for the Arial Khan.) The river is also far more stable than the Padma, and its route and shape has not recently changed much except for the separating point with the Padma. According to the Faridpur Project of the Polder Plan, flood control gates shall be built so that the branch discharge of present 1,400 m^3/s may be lowered to 700 m^3/s during the flood. The length of the proposed flood gate is about 40 m (130 ft). and the distance between the both sides embankments proposed in the plan is expected to be considerably short. This enables to shorten the bridge length proposed in the previous report, and further suggests the necessity of both the coordination between the Polder Plan and the road bridge plan and the study of the combined structure and the location of bridge and flood control gate in coordination with the road project.

The Arial Khan has many bends, and the partial scourings at curved parts are noticeably serious. But the river bed at the straight part is comparatively stable, and the pier foundation will be safe if the bridge is planned at the river's straight part. The river route is generally straight at the proposed bridge site, and the river bed is apparently stable with the depth of about 1.5 m (5 ft) below average low water level. Special problems from hydrological points of view are not seen, but further investigation and study in details will be required as in the case of the Daleswari.

6. Required Further Survey

The survey activities of the 2nd survey team consist of site survey and technical feasibility study with analysis on collected information concerning the bridges proposed on the rivers of Padma, Daleswari and Arial Khan. But surveying is still in the preliminary stage, and revealed the problems which should be studied further in details in the next stage. Especially as for the Padma to which improvement works have scarcely been done in spite of its scale as one of the world largest, there are still many problems unsolved for which long period survey and investigation are required in the future.

Items of the future required survey classified into two groups of those presently carried on and those which are to be added in the future are as follows;

(A) Those which are presently executed and needs continuing in the future

(1) Hydrological and climatical survey

Items of surveying will be water level, current velocity, discharge, wind direction and velocity. As for water level, current velocity and discharge, surveying at the point where WAPDA has been surveying may be continued in the future. Wind direction and velocity will be needed in the structural design and construction plan of the bridge. As there is no data obtained formerly, observation of wind should be continuously carried on at Baghiakur or Mawa.

(2) Periodical measurements of cross section of the Padma

Exectuion of the Padma's cross section measurements at least once a year, preferably twice before and after the flood at a certain fixed point is strongly needed.

WAPDA has been continuing this survey from P-0 and P-7 between Megna merging point to Brhamaptra-Ganges separating point, and this this should be continued in the future. Surveying at the bridge site should be done more carefully, which will be discussed later in this report.

(3) Study of soil both in the river bed and floading in the river. WAPDA's investigation of classification, grain size and its distribution measurement on the river bed and floating should be continued.

(4) Depth measurement at the proposed bridge site surveying which is presently executed by IWTA should be continued periodically at least once a year to produce contour-maps of the river bed.

(B) Those which should be conducted newly in the future

(1) Observation on the changes of the river banks for the total length of the rivers

This can be conducted generally by aerial photographs. Aerial photographing should preferably be done at a certain fixed date in dry season at least once a year or twice a year with additional date in rainy season when the water level is the highest if possible.

(2) Periodical measurement of the cross section at the bridge site

At the proposed site of the bridge along the river route between 10 km (6 miles) up and down stream cross section measurement should be carried out periodically at least once a year or twice before and after the flood at space of 1 km. If the section is the same one as measured in the item, (A) (2), the measurement can be spared.

(3) Soil investigation at the proposed bridge site

Soil investigation by boring at both sides of the proposed bridge should be carried out. In the river section supersonic soil investigation can be applied with one boring investigation executed in the river which is to be used for checking the data obtained by supersonic method. More detailed boring investigation will be needed in accordance with the promotion of the bridge plan.

(4) Model tests with respect to the partial scouring caused by the piers

Concerning partial scouring which occurs around the pier because of the inerruption of the flow, there are some empiric formulae as described in this report. As actual behaviour differs from the results calculated from above formulae according to soil conditions, shape of the pier, etc, model tests should be conducted to study the influence of the pier to scouring.

(5) Influence of the piers on the behaviour of the river
- (Three-dimensional model test of the river) -

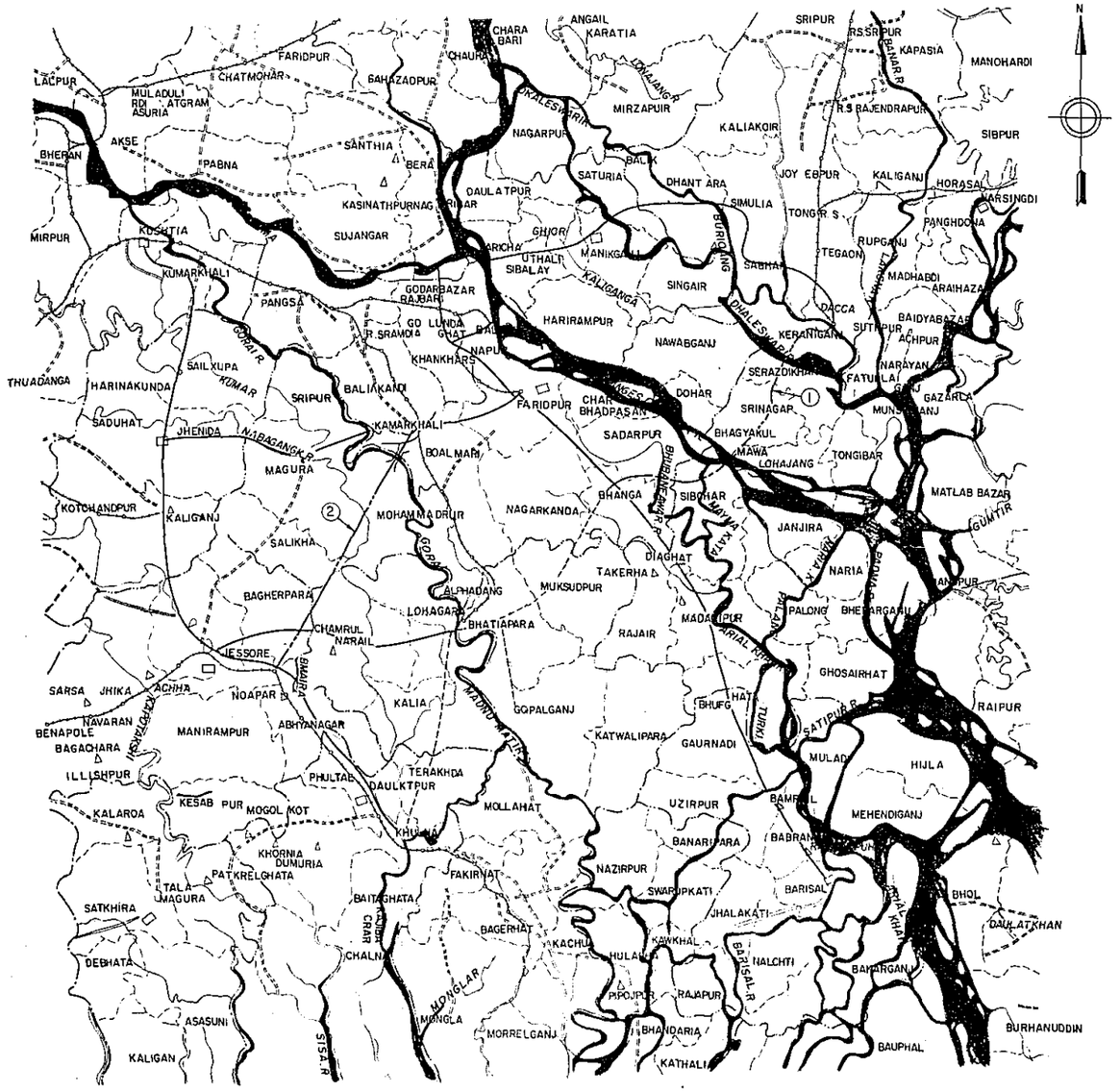
Banks, river bed, etc. of the river are sometimes affected by the change of the flow, when the piers are installed in the natural flow of the river. Careful studies on this influence with three-dimensional models experiments will be needed to obtain the final conclusions for such a bridge of large scale.

TABLE OF APPENDIX FOR REFERENCE

1.	DACCA SOUTHWEST PROJECT	August 1970
2.	FEASIBILITY REPORT (Draft) SURESWAR PROJECT	July 1970
3.	FEASIBILITY REPORT (Draft) FARIDPUR PROJECT	july 1970
4.	WATER YEAR BOOK	Volume II (WATER LEVEL) 1964, 1965, 1966, 1967
5.	WATER YEAR BOOK	Volume III (DISCHARGE) 1964, 1965, 1966, 1967
6.	FLOOD CONTROL PLAN FOR EAST PAKISTAN FIRST STAGE	EPWAPDA OCTOBER 1964
7.	FLOOD PROTECTION PLAN FOR EAST PAKISTAN	EPWAPDA MARCH 1967
8.	HYDROLOGICAL DATA COMPILED FOR MASTER PLAN	DEC. 1964 IECO
9.	FAO-SF SECOND HYDROLOGICAL SURVEY IN EAST PAKISTAN FLOOD FLOWS BETWEEN GOALUNDO AND BHAGYAKUL	1966 AND 1967
10.	REPORT OF THE ANALYSIS OF SUSPENDED AND BED MATERIALS OF DIFFERENT RIVERS OF EAST PAKISTAN	EPWAPDA
11.	ANNUAL FLOOD REPORT	(1960~1968)
12.	TOPOGRAPHIC MAP	1/250,000, 1/40,000, 1/16,000, 1/8,000
13.	HYDROGRAPHIC CHART	IWTA 1964, 1965, 1969
14.	ROUTE MAP	IWTA
15.	CROSS SECTION	EPWAPDA

PART III. DRAWINGS

ROUTE LOCATION MAP FOR PROJECT AREA



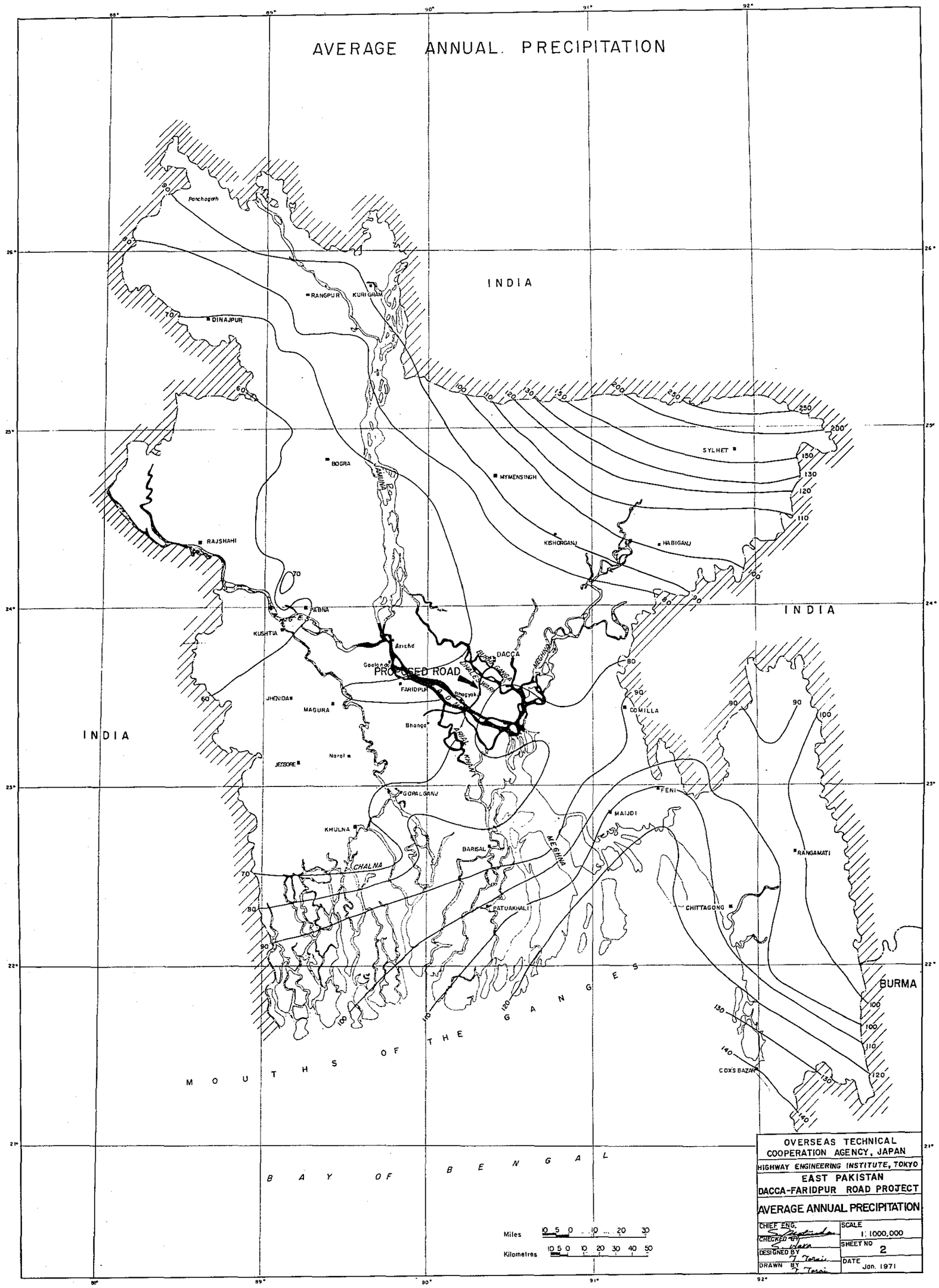
REFERENCS

- Existing road
- Proposed road
- Future road
- ① Dacca ~ Faridpur road
- ② Jessore ~ Madhukhali road

Miles 10 5 0 10 20
Kilometres 10 0 10 20 30 40

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
ROUTE LOCATION MAP FOR PROJECT AREA	
CHIEF ENG	SCALE 1:500,000
CHECKED BY	SHEET NO 1
DESIGNED BY	DATE Jan. 1971
DRAWN BY	

AVERAGE ANNUAL PRECIPITATION



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
AVERAGE ANNUAL PRECIPITATION	
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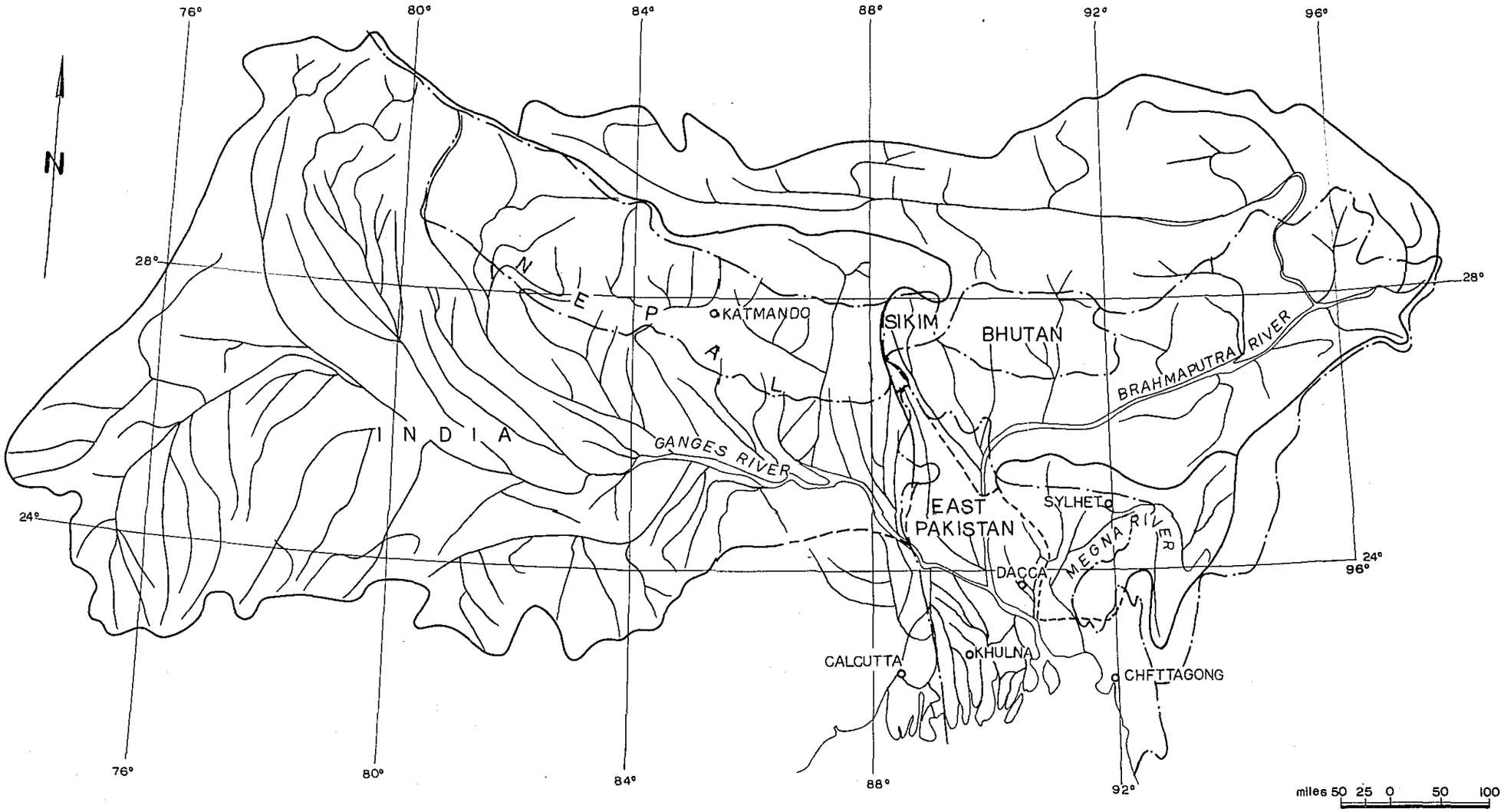
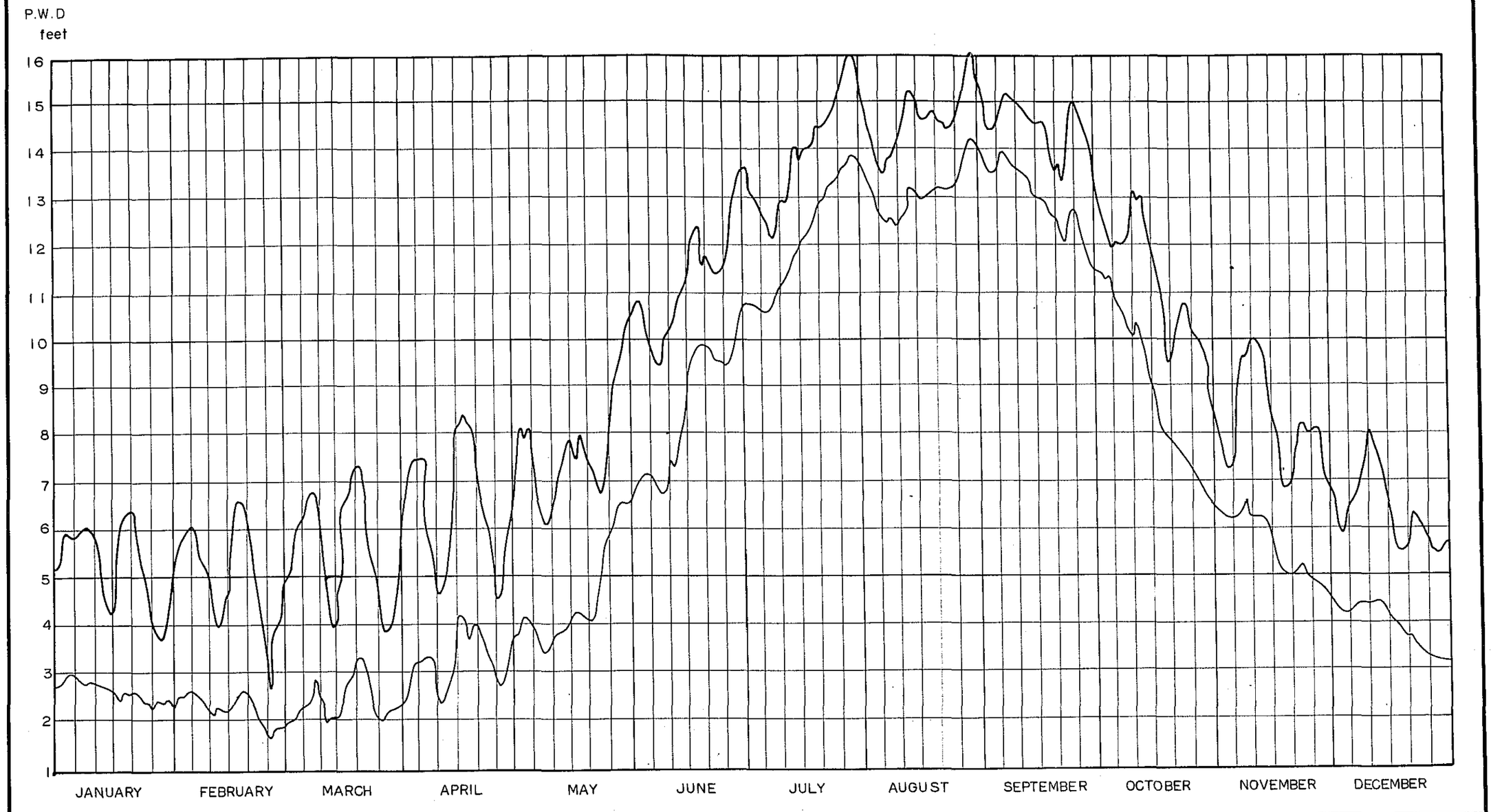
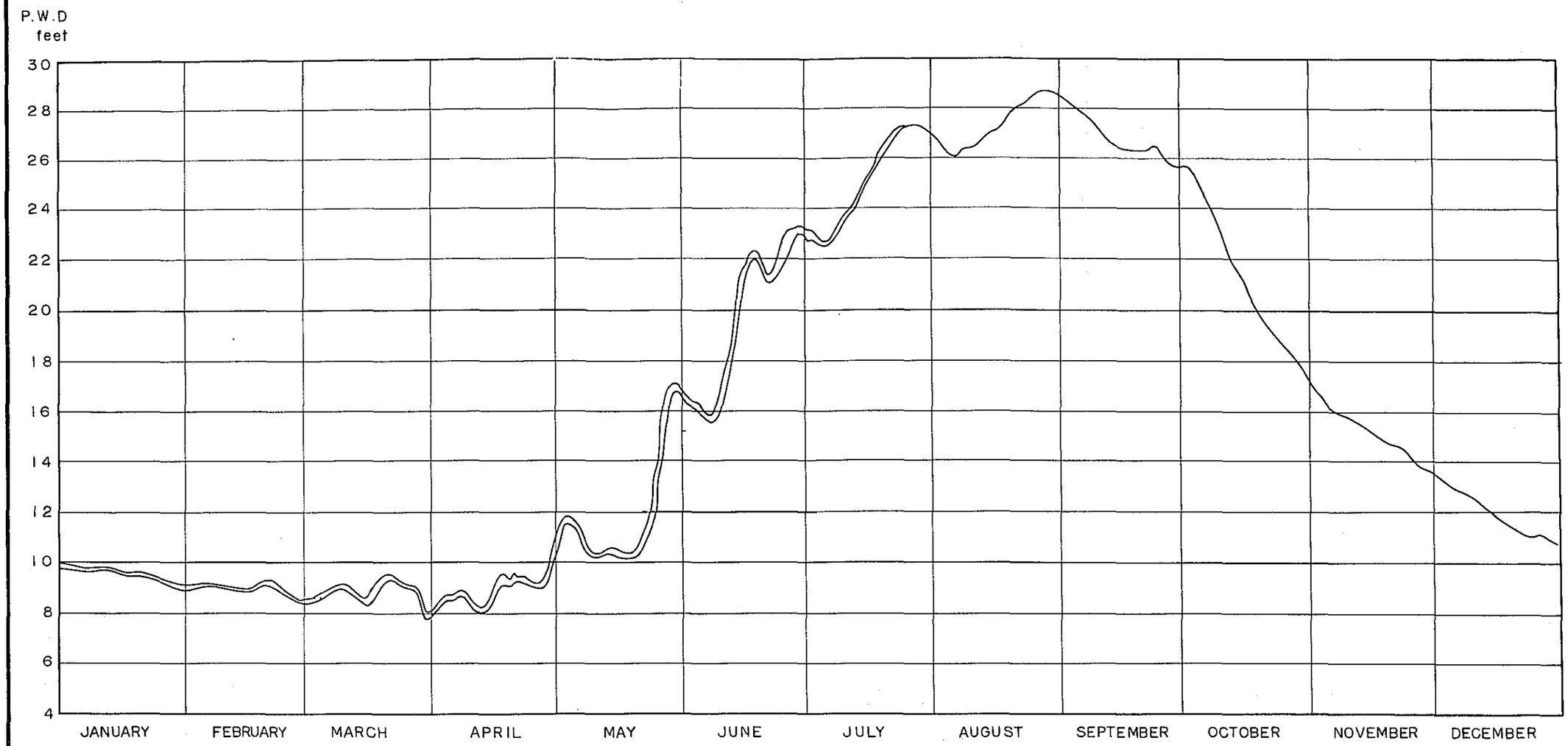
CHECKED BY	SHEET NO 2
DESIGNED BY J. Terai	
DRAWN BY J. Terai	DATE Jan. 1971



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
BASIN MAP GANGES, BRAHMAPOTRA & MEGNA RIVERS	
CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 3
DESIGNED BY	DATE Jan. 1971
DRAWN BY	



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
YEARLY HYDROGRAPH OF CHANDPUR 1969	
CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 4
DESIGNED BY	DATE Jan. 1971
DRAWN BY	



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN

HIGHWAY ENGINEERING INSTITUTE, TOKYO

EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

YEARLY HYDROGRAPH OF GOALUNDO 1969

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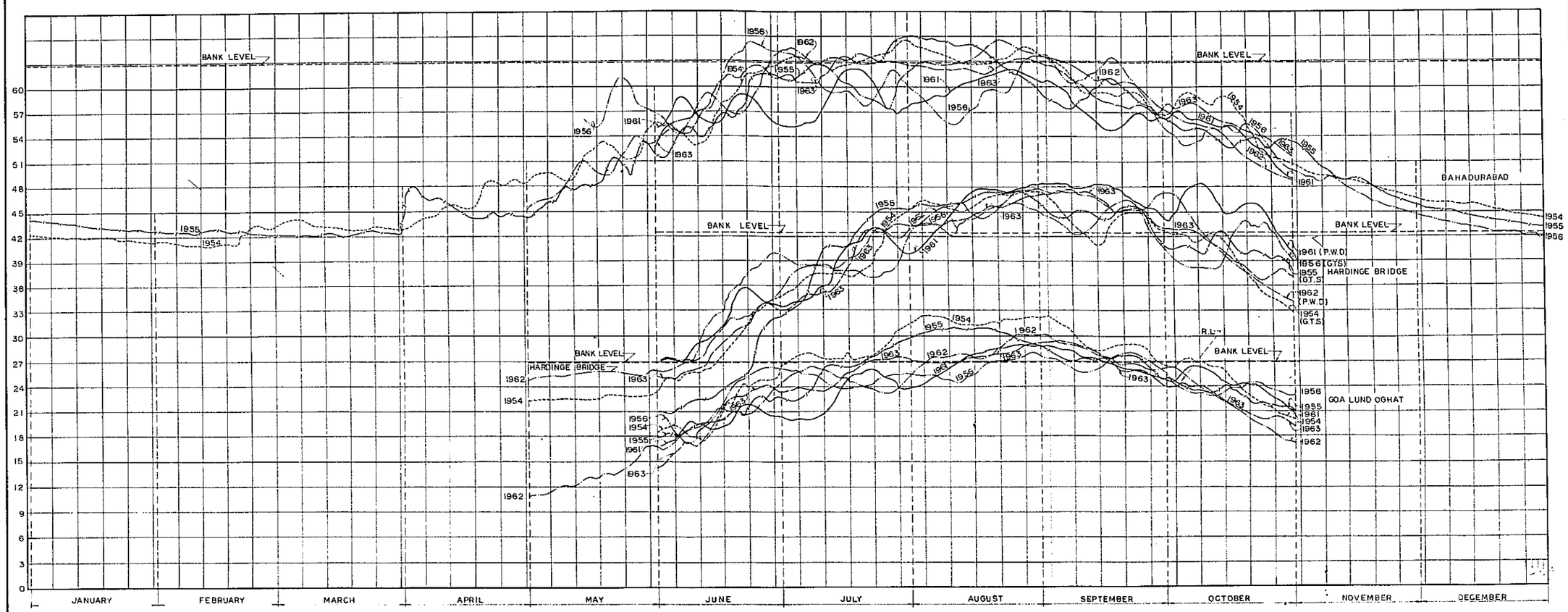
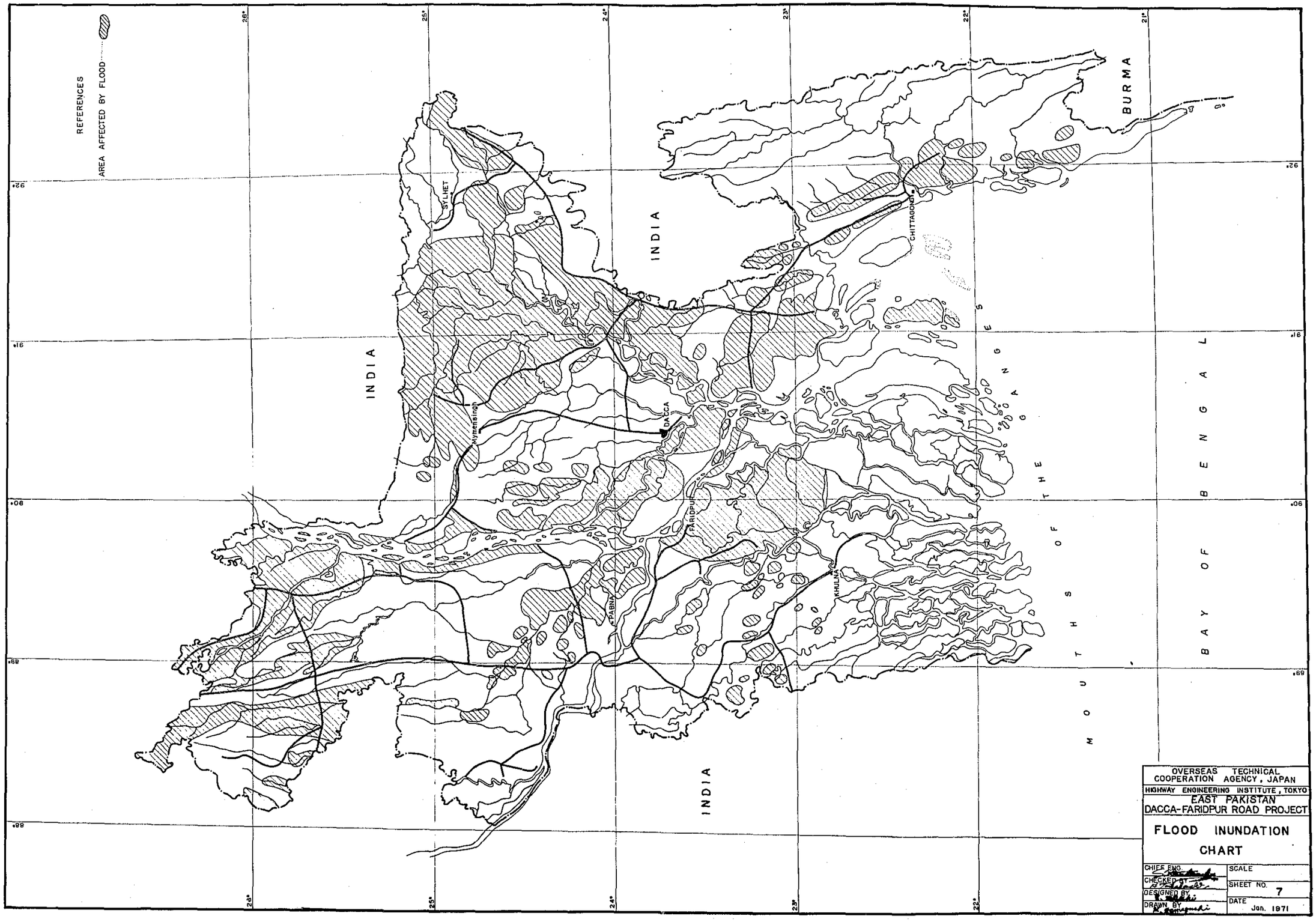
CHECKED BY H. Tanaka	SHEET NO. 5
DESIGNED BY	DATE Jan. 1971
DRAWN BY	



LEGEND

1. 1954
2. 1955
3. 1956
4. 1961
5. 1962
6. 1963

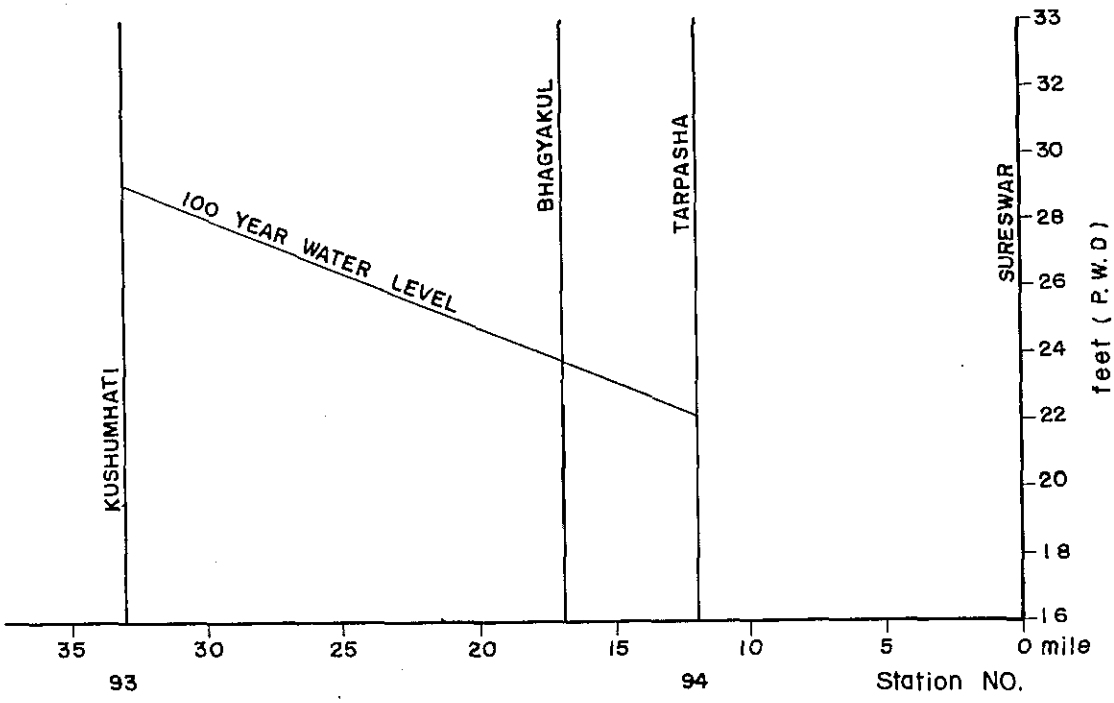
OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
SUPERIMPOSED FLOOD HYDROGRAPH OF GANGES AND BRAHMAPUTRA RIVERS	
CHIEF ENG. S. Tanida	SCALE
CHECKED BY. H. Ishihara	SHEET NO. 6
DESIGNED BY. E. Inuzuka	DATE Jan. 1971
DRAWN BY. K. Yamazaki	



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO
EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

FLOOD INUNDATION CHART

CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 7
DESIGNED BY	DATE Jan. 1971
DRAWN BY	



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
PROFILE OF WATER LEVEL WITH EQUAL PROBABILTY	
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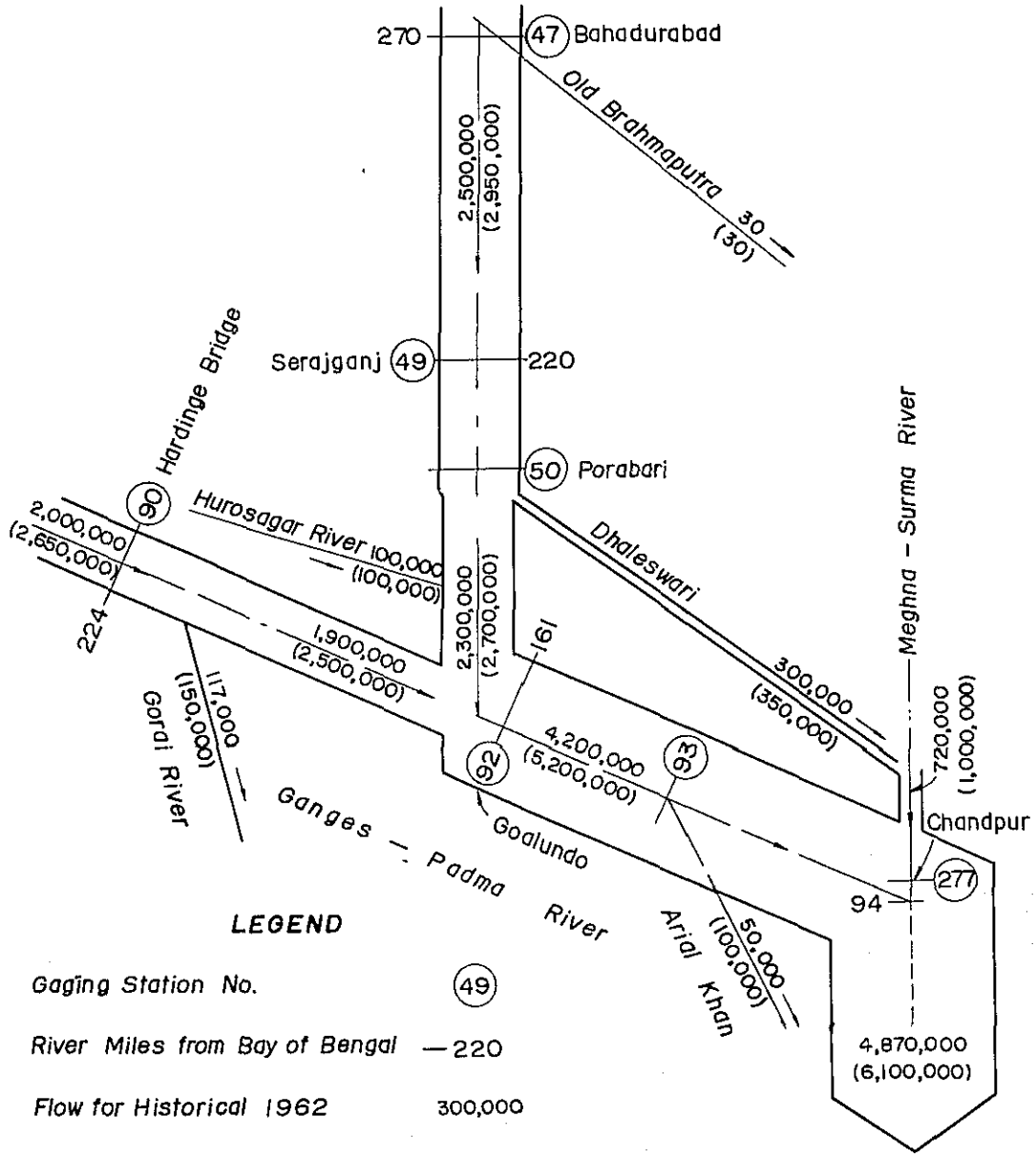
DRAWN BY	DATE Jan. 1971



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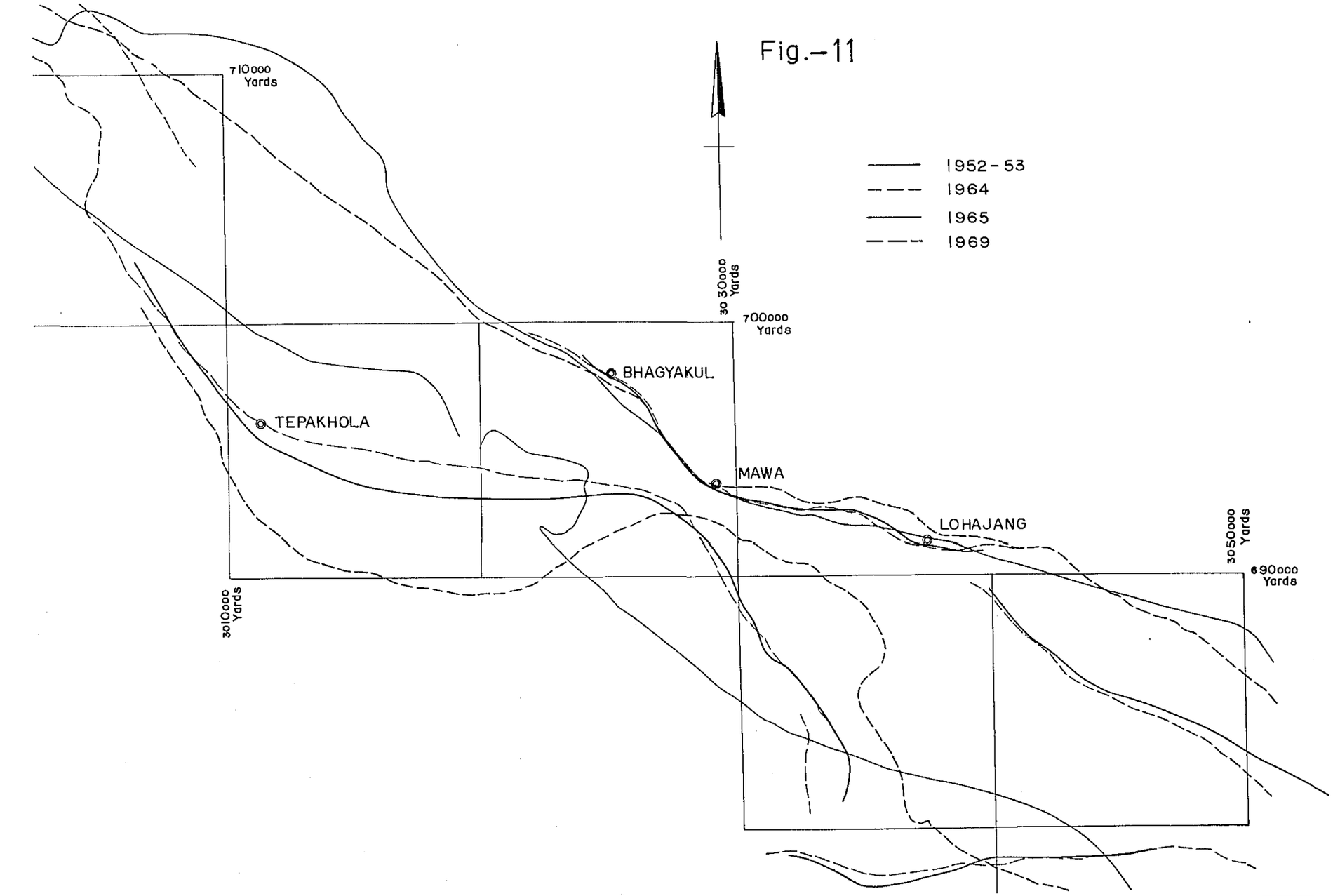
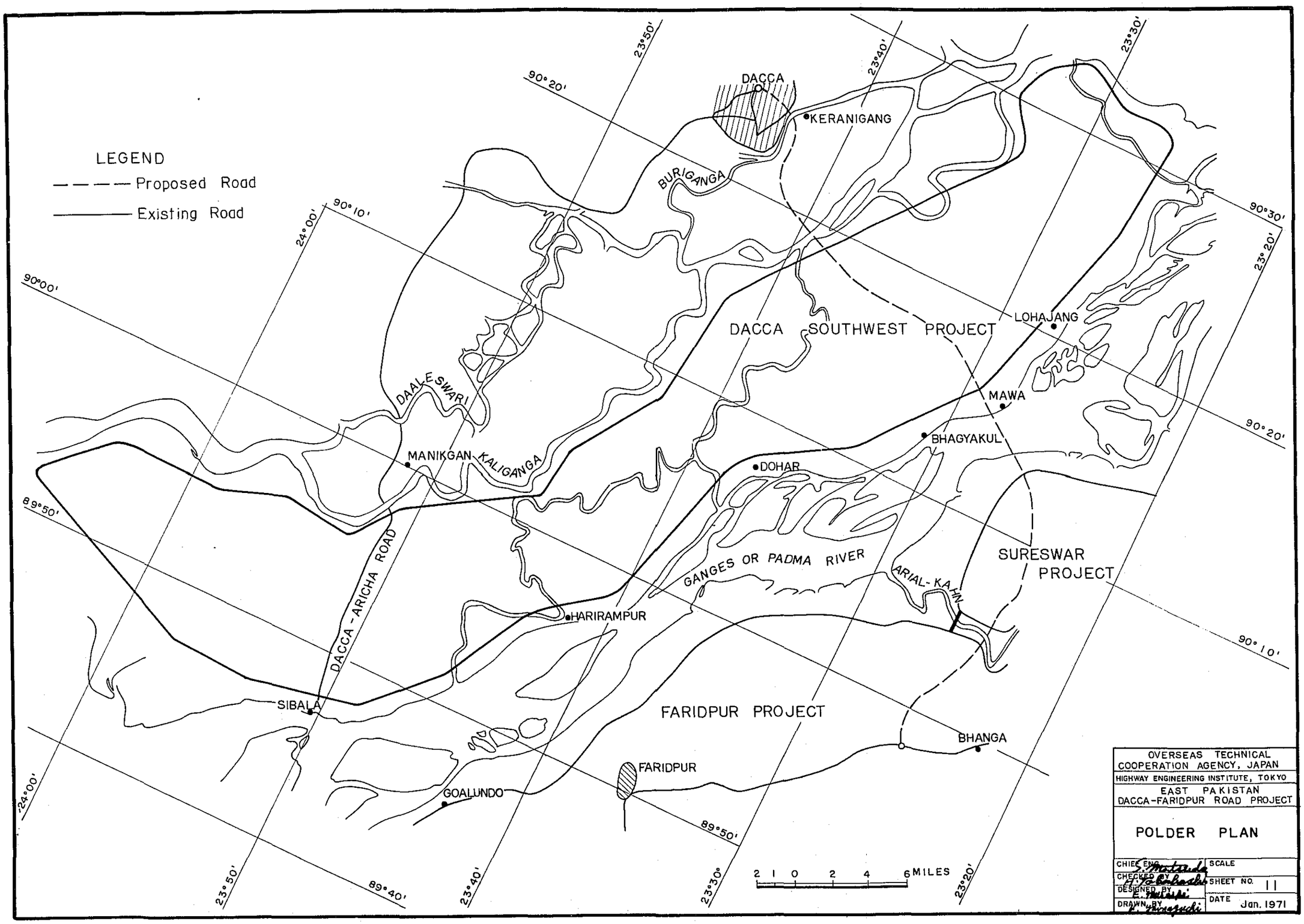
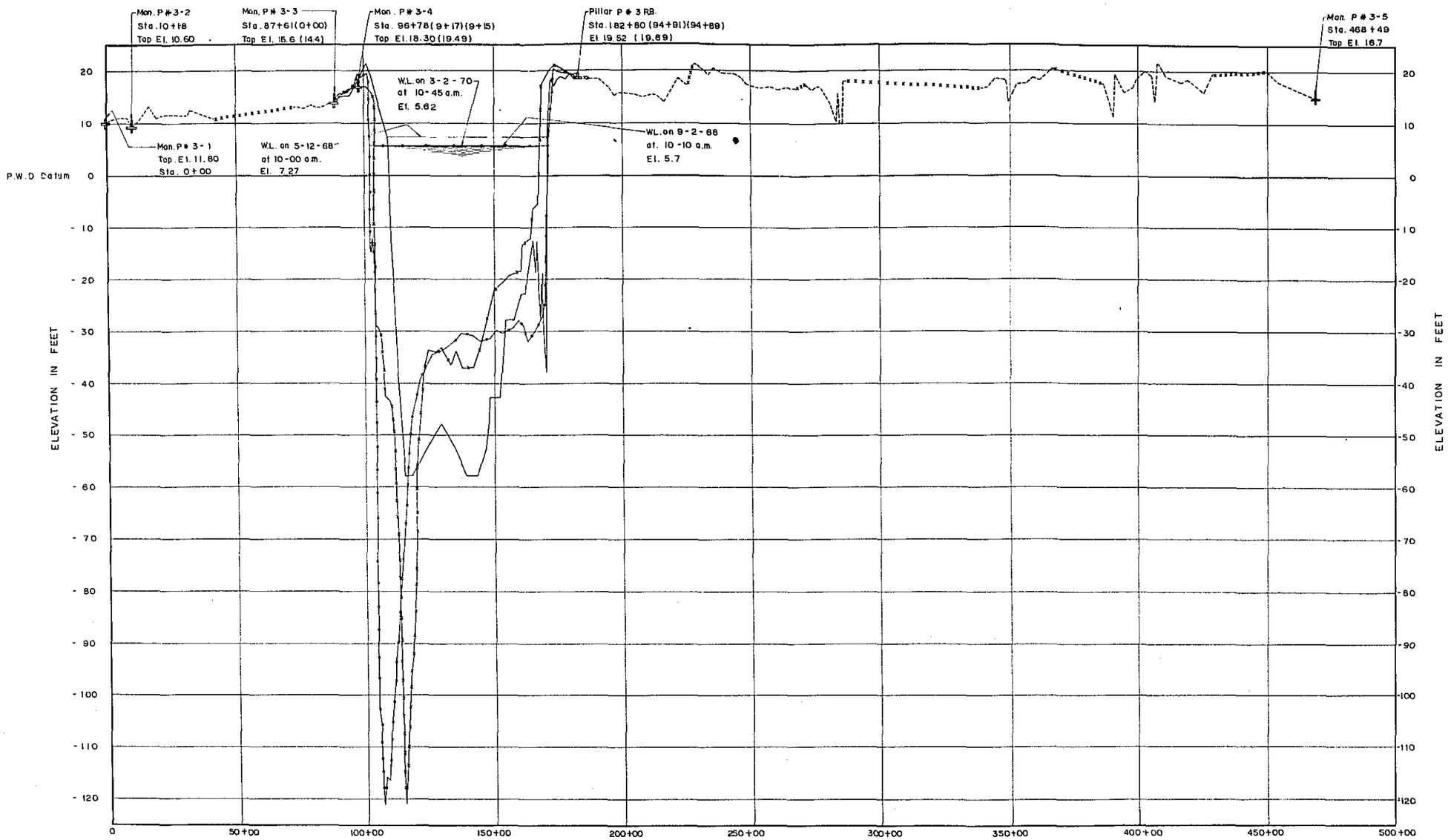
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
FLOOD WATER BALANCE	
CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 9
DESIGNED BY	
DRAWN BY	DATE Jan. 1971

Fig.–11



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
BANK SHFT OF PADMA RIVER	
CHIEF ENG. S. Matsuda	SCALE
CHECKED BY E. Nagashi	SHEET NO. 10
DESIGNED BY K. Yamazaki	DATE Jan. 1971
DRAWN BY T. Takahashi	


LEGEND
Proposed Road
Existing Road
DACCA
KERANIGANG
BURIGANGA
DACCA SOUTHWEST PROJECT
LOHAJANG
MAWA
BHAGYAKUL
DOHAR
DAALESWARI
MANIKGAN-KALIGANGA
DACCA-ARICHA ROAD
GANGES OR PADMA RIVER
ARIAL-KHAN
SURESWAR PROJECT
HARIRAMPUR
SIBALA
FARIDPUR PROJECT
BHANGA
FARIDPUR
GOALUNDO
23°50'
23°40'
23°30'
23°20'
90°20'
90°30'
90°10'
90°00'
89°50'
89°40'
24°00'
2 1 0 2 4 6 MILES
OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO
EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT
POLDER PLAN
CHIEF ENG.
CHECKED BY
DESIGNED BY
DRAWN BY
SCALE
SHEET NO. 11
DATE Jan. 1971



LEGEND

Indicating Survey of Feb . 1968
Indicating Survey of Dec . 1968

Concrete Pillar 12'x12' Placed Jan. 1965

Concrete Mon. 6'x6' Placed Feb. 1966

Village on Section line

Indicating Survey of Feb. 1970

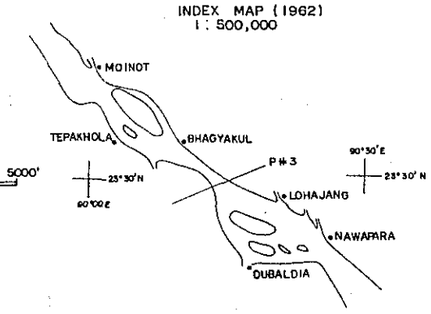
Co-ordinates of Pillars and Monuments.

Mon . P # 3-1	N 23°29'28.4" E 90 18'38.8"
Mon . P # 3-2	N 23°29'22.1" E 90°16'30.2"
Mon . P # 3-3	N 23°29' 1.08" E 90°15'24.17"
Mon . P # 3-4	N 23°28'58.20" E 90°15' 16.35"
Mon . P # 3-5	N 23°24'31.4" E 90°10' 19.4"
Pillar P # 3 R.B	N 23°28'31.42" E 90°14'03.27"

SCALE
0 1 2 3 4 5000'

SCALE { Hor. 1" = 2000'
Vert. 1" = 10'

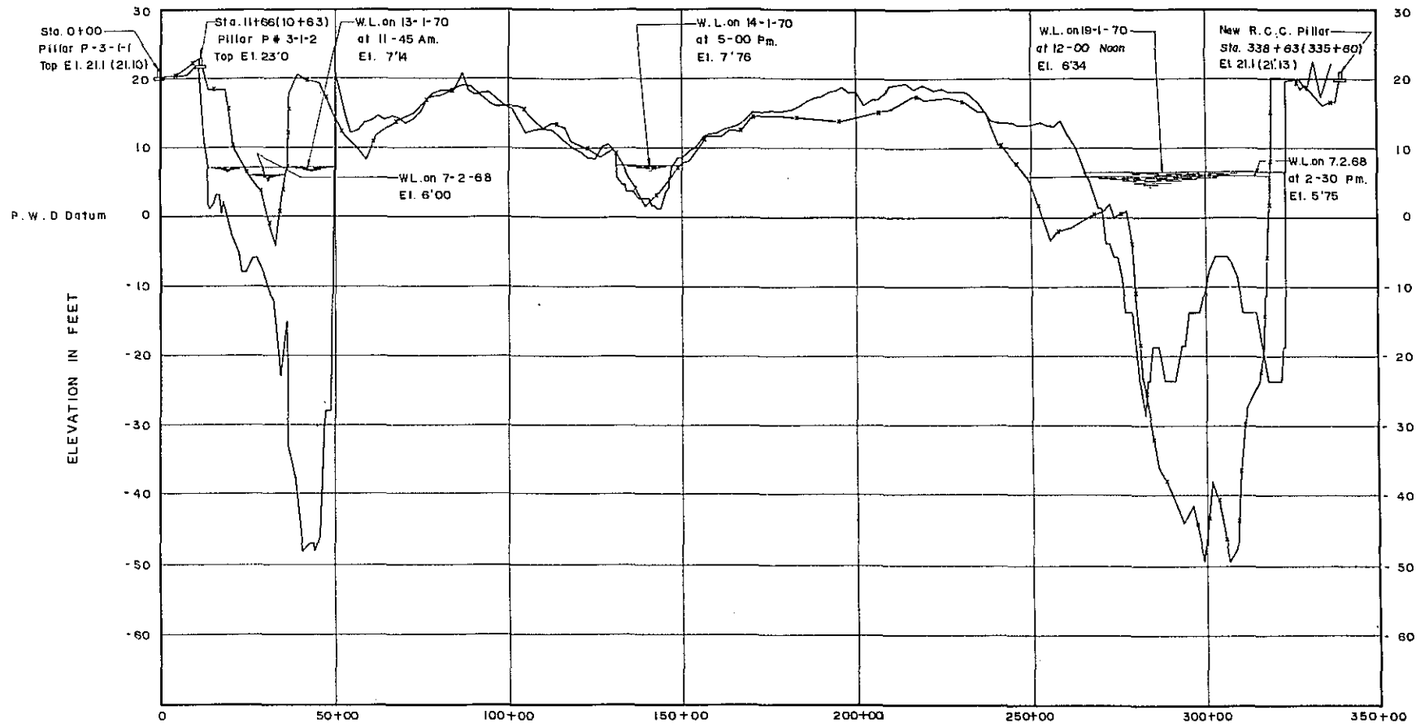
INDEX MAP (1962)
1 : 500,000

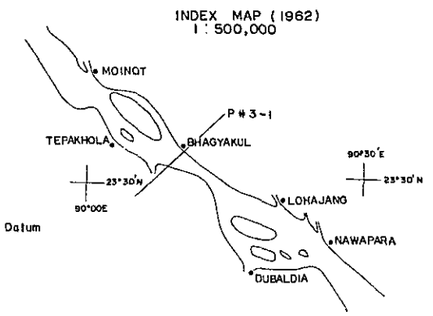


OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO
EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

CROSS SECTION PADMA RIVER RANGE-P#3

CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 12
DESIGNED BY	DATE Jan. 1971
DRAWN BY	





LEGEND

Indicating Survey of Feb 1968 ·····x—x—x—x—x—x

DO of Jan. 1970 ·····————————

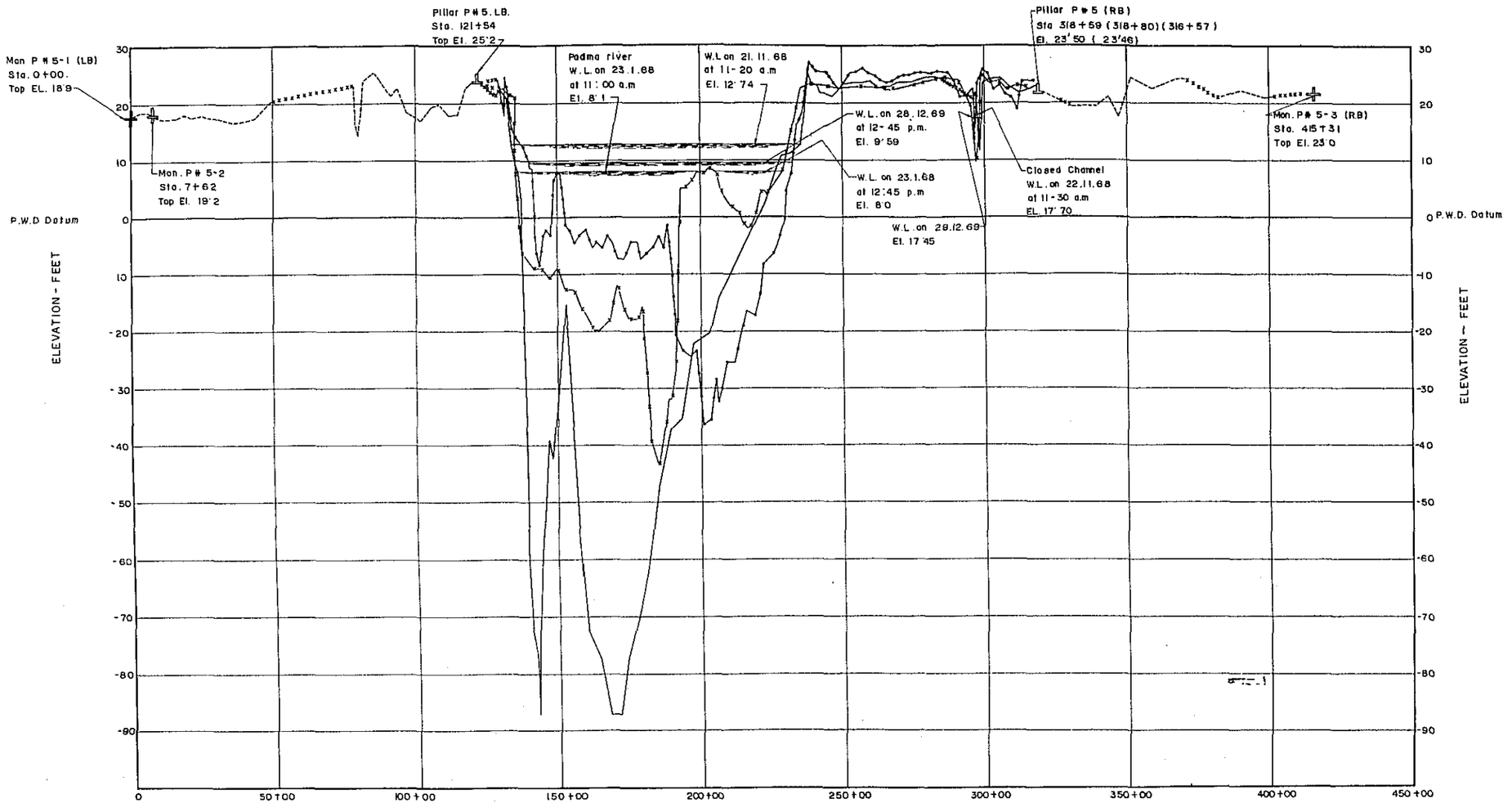
DO R.C.C pillar ····· 凸

SCALE

0 1 2 3 4 5000'

SCALE { Hor. 1" = 2000'
Vert. 1" = 10'

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
CROSS SECTION PADMA RIVER RANGE - P # 3-1	
CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 13
DESIGNED BY	DATE Jan. 1971
DRAWN BY	



LEGEND

Indicating Survey of Jan. 1968

Indicating Survey of Nov. 1968

Concrete pillar 12'x12'

Concrete Monument 6'x6'

Village on Section line

Indicating Survey of Dec 1969

Co-ordinated of Pillars and Monuments

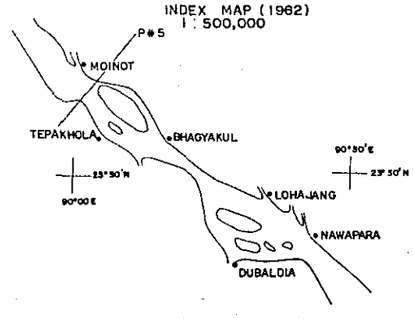
Mon. P # 5 - 1	N 23°-39'-42.0" E 90°-02'-30.0"
Mon. P # 5 - 2	N 23°-39'-35.7" E 90°-02'-25.6"
Mon. P # 5 - 3	N 23°-33'-34.9" E 89°-58'-43.4"
Pillar P-5 LB	N 23°-37'-59.7" E 90 - 01'-20.2"
Pillar P-5 RB	N 23 - 35'-13.4' E 89 - 59'-27.4"

SCALE

0 1 2 3 4 5000'

SCALE Hor. 1 "= 2000'
Verti. 1 "= 10'

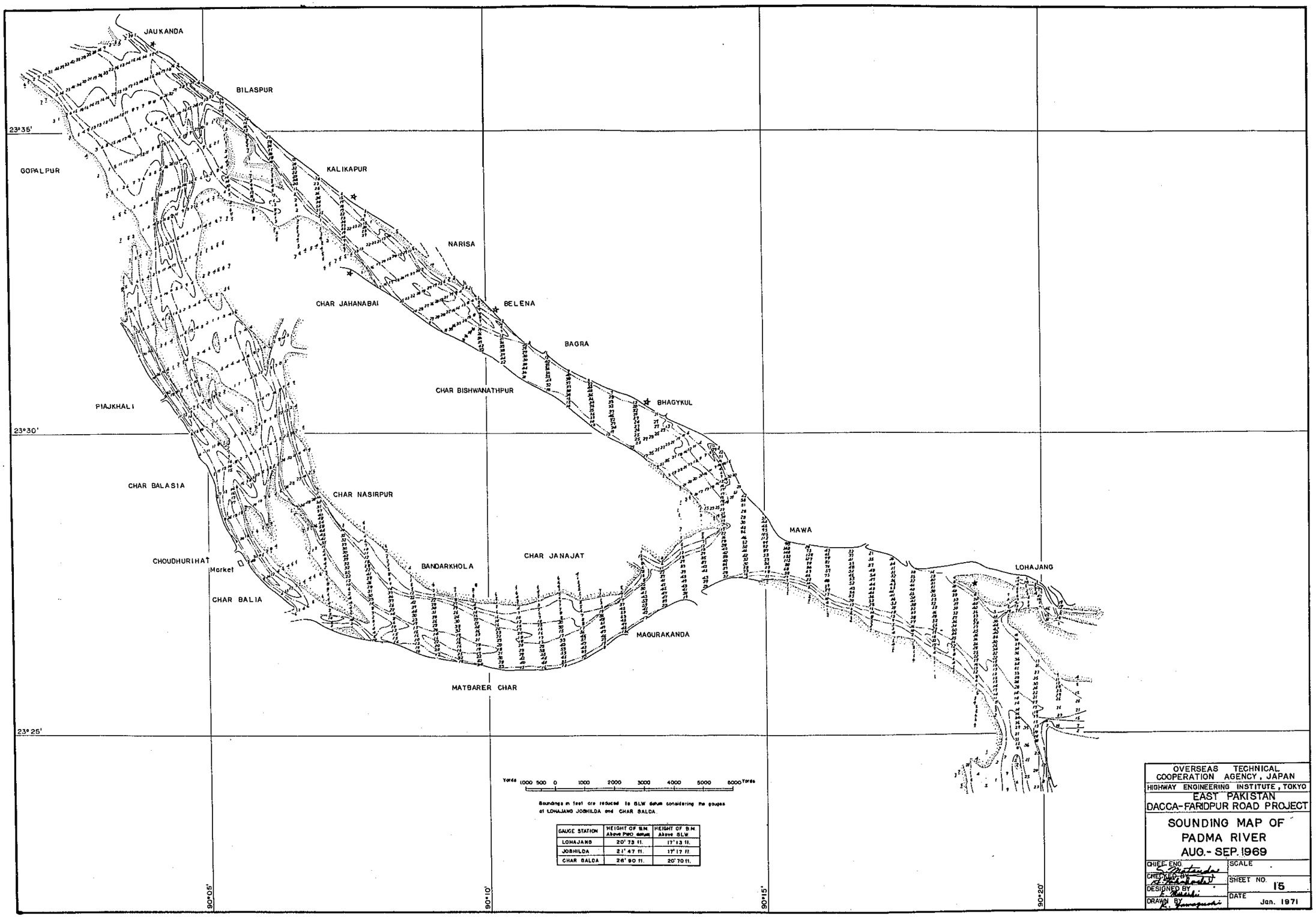
INDEX MAP (1962)
1 : 500,000



OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO
EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

CROSS SECTION
PADMA RIVER RANGE-P#5

CHIEF ENG.	SCALE
CHECKED BY	SHEET NO. 14
DESIGNED BY	DATE Jan. 1971
DRAWN BY	

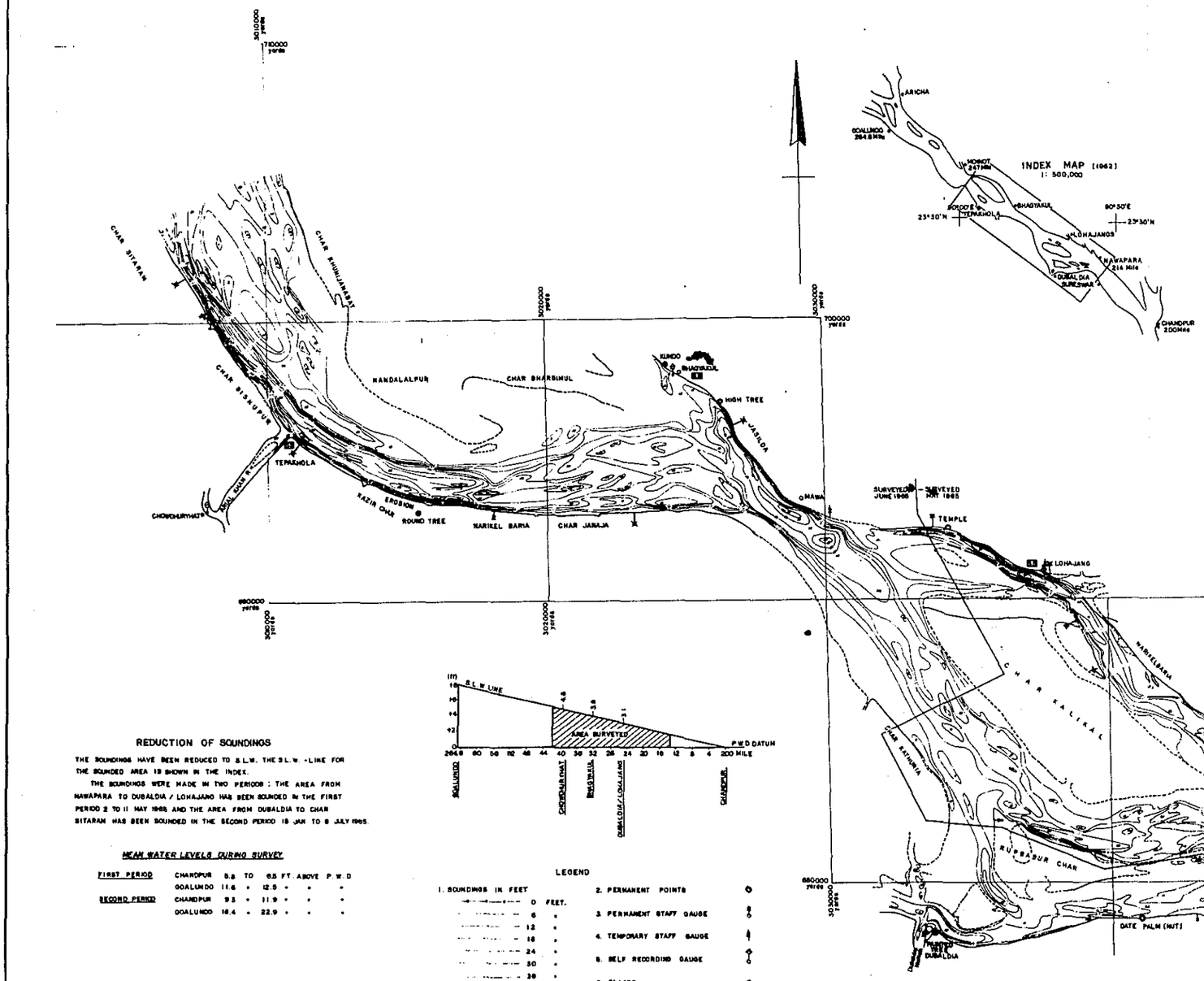


GAUGE STATION	HEIGHT OF S.M. Above PWD datum	HEIGHT OF S.M. Above SLW
LOHAJANG	20' 73 ft.	17'13 ft.
JOSHILDA	21' 47 ft.	17' 17 ft.
CHAR BALDA	26' 90 ft.	20' 70 ft.

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO
EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

SOUNDING MAP OF PADMA RIVER AUG.- SEP. 1969

CHIEF ENG. S. Watanabe	SCALE
CHECKED BY K. Takahashi	SHEET NO. 15
DESIGNED BY A. Takeda	DATE Jan. 1971
DRAWN BY K. Yamaguchi	



REDUCTION OF SOUNDINGS

THE SOUNDINGS HAVE BEEN REDUCED TO S.L.W. THE S.L.W. -LINE FOR THE SOUNDED AREA IS SHOWN IN THE INDEX.

THE SOUNDINGS WERE MADE IN TWO PERIODS ; THE AREA FROM NAWAPARA TO DUBALDIA / LOHAJANG HAS BEEN SOUNDED IN THE FIRST PERIOD 2 TO 11 MAY 1965 AND THE AREA FROM DUBALDIA TO CHAR SITARAN HAS BEEN SOUNDED IN THE SECOND PERIOD 18 JAN TO 8 JULY 1965.

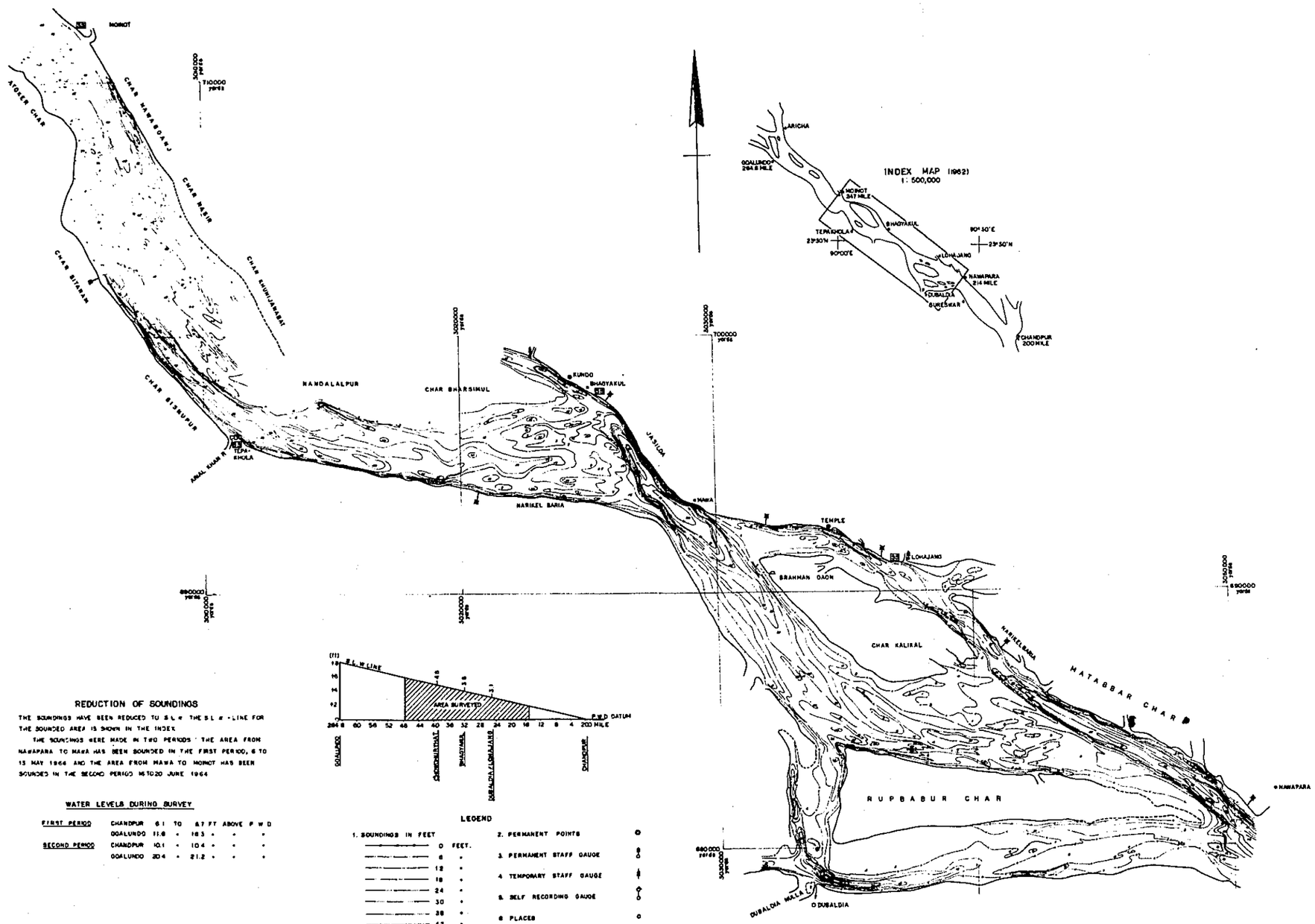
MEAN WATER LEVELS DURING SURVEY

FIRST PERIOD	CHANDPUR	5.8	TO	6.5	FT. ABOVE	P.W.D
	GOALUNDO	11.6	"	12.5	" "	"
SECOND PERIOD	CHANDPUR	9.5	"	11.9	" "	"
	GOALUNDO	18.4	"	22.9	" "	"

LEGEND

1. SOUNDINGS IN FEET
   - 0 FEET.
   - 6 "
   - 12 "
   - 18 "
   - 24 "
   - 30 "
   - 36 "
   - 42 "
   - 48 "
   - 54 "
   - 60 "
   - 90 "
   - 120 "
2. PERMANENT POINTS
3. PERMANENT STAFF GAUGE
4. TEMPORARY STAFF GAUGE
5. SELF RECORDING GAUGE
6. PLACES
7. AGA LIGHT
8. STEAMER STATION

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN	
HIGHWAY ENGINEERING INSTITUTE, TOKYO	
EAST PAKISTAN DACCA-FARIDPUR ROAD PROJECT	
SOUNDING MAP OF PADMA RIVER MAY-JUNE 1965	
CHECKED	SCALE
DESIGNED	SHEET NO 18
DRAWN	DATE Jan. 1971



REDUCTION OF SOUNDINGS

THE SOUNDINGS HAVE BEEN REDUCED TO S.L.# THE S.L.# -LINE FOR THE SOUNDED AREA IS SHOWN IN THE INDEX.

THE SOUNDINGS WERE MADE IN TWO PERIODS. THE AREA FROM NAWAPARA TO MAWA HAS BEEN SOUNDED IN THE FIRST PERIOD, 6 TO 13 MAY 1964 AND THE AREA FROM MAWA TO MOIROT HAS BEEN SOUNDED IN THE SECOND PERIOD 16 TO 20 JUNE 1964.

WATER LEVELS DURING SURVEY

FIRST PERIOD	CHANDPUR	6.1	TO	8.7 FT	ABOVE	P.W.D
	GOALUNDO	11.8	"	18.3 "	"	"
SECOND PERIOD	CHANDPUR	10.1	"	10.4 "	"	"
	GOALUNDO	20.4	"	21.2 "	"	"

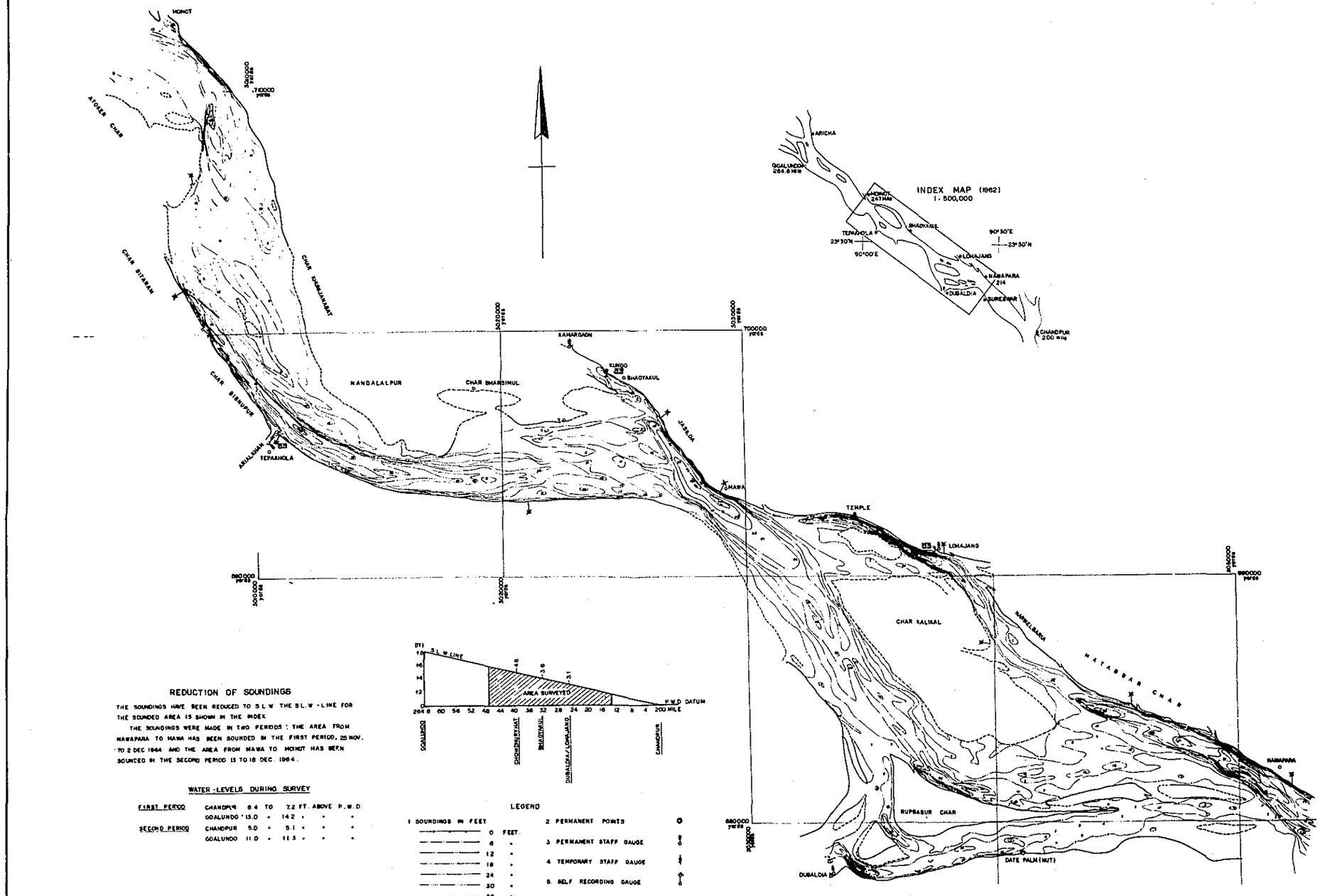
LEGEND

1. SOUNDINGS IN FEET
   - 0 FEET.
   - 6 "
   - 12 "
   - 18 "
   - 24 "
   - 30 "
   - 36 "
   - 42 "
   - 48 "
   - 84 "
   - 80 "
   - 90 "
   - 120 "
2. PERMANENT POINTS
3. PERMANENT STAFF GAUGE
4. TEMPORARY STAFF GAUGE
5. SELF RECORDING GAUGE
6. PLACES
7. AGA LIGHT
8. STEAMER STATION

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO
EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

SOUNDING MAP OF PADMA RIVER MAY-JUNE 1964

SHEET ENG.	SCALE
CHECKED BY	SHEET NO. 17
DESIGNED BY	DATE Jan. 1971
DRAWN BY	



REDUCTION OF SOUNDINGS

THE SOUNDINGS HAVE BEEN REDUCED TO S.L.W. THE S.L.W.-LINE FOR THE SOUNDED AREA IS SHOWN IN THE INDEX.

THE SOUNDINGS WERE MADE IN TWO PERIODS ; THE AREA FROM NAWAPARA TO MAWA HAS BEEN SOUNDED IN THE FIRST PERIOD, 25 NOV. TO 2 DEC 1964 AND THE AREA FROM MAWA TO MOHOT HAS BEEN SOUNDED IN THE SECOND PERIOD IS TO 18 DEC. 1964.

WATER-LEVELS DURING SURVEY

FIRST PERIOD	CHANDPUR	8.4	TO	7.2	FT. ABOVE	P.W.D.
	GOALUNDO	13.0	"	14.2	"	"
SECOND PERIOD	CHANDPUR	5.0	"	5.1	"	"
	GOALUNDO	11.0	"	11.3	"	"

LEGEND

1. SOUNDINGS IN FEET
   - 0 FEET
   - 6 "
   - 12 "
   - 18 "
   - 24 "
   - 30 "
   - 36 "
   - 42 "
   - 48 "
   - 54 "
   - 60 "
   - 90 "
   - 120 "
2. PERMANENT POINTS
3. PERMANENT STAFF GAUGE
4. TEMPORARY STAFF GAUGE
5. SELF RECORDING GAUGE
6. PLACES
7. AQA LIGHT
8. STEAMER STATION S.S

OVERSEAS TECHNICAL COOPERATION AGENCY, JAPAN
HIGHWAY ENGINEERING INSTITUTE, TOKYO

EAST PAKISTAN
DACCA-FARIDPUR ROAD PROJECT

SOUNDING MAP OF PADMA RIVER NOV.- DEC. 1964

SCALE	
SHEET NO	18
DATE	Jan. 1971