People's Republic of Bangladesh

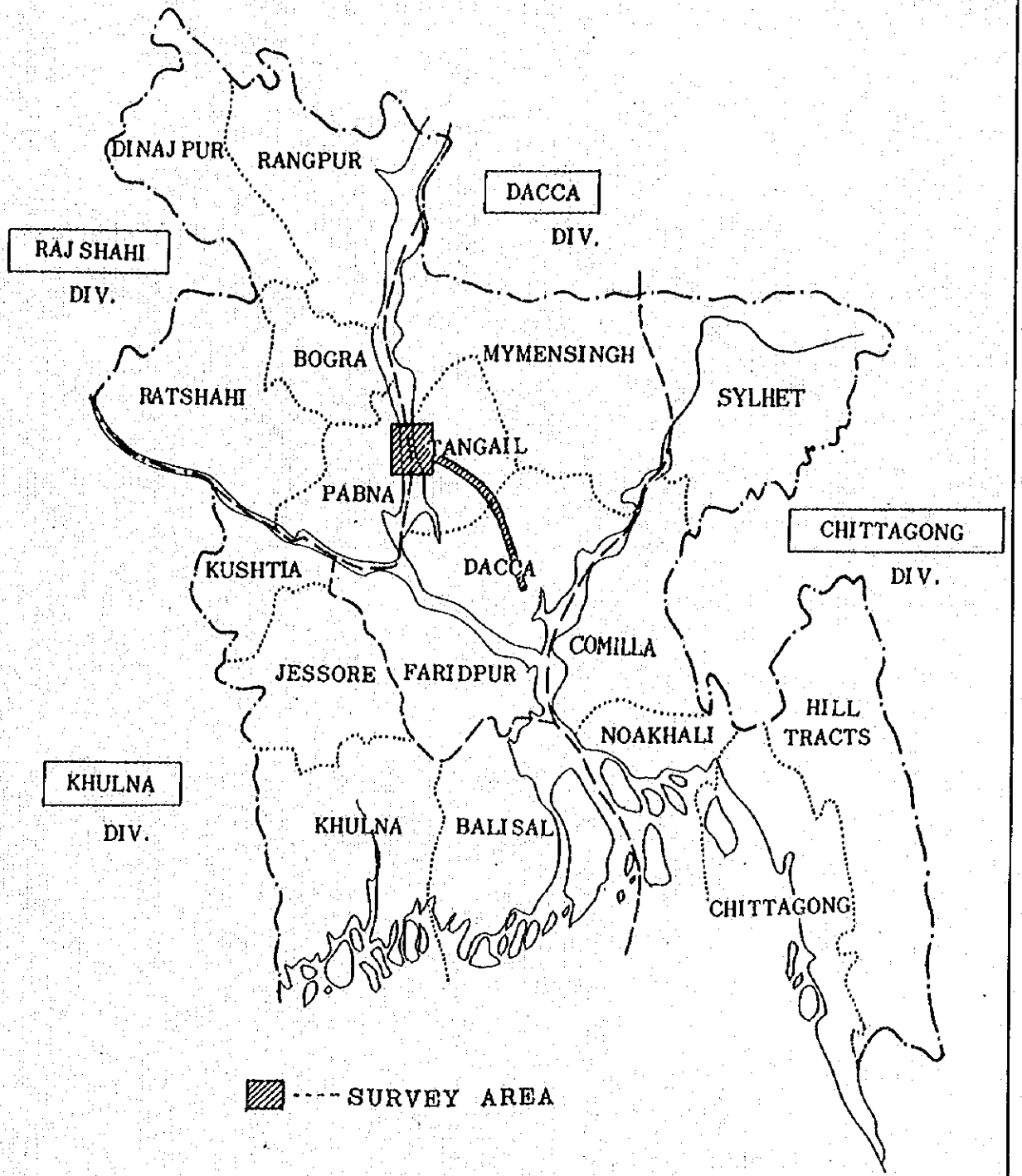
JAMUNA RIVER BRIDGE CONSTRUCTION PROJECT

TOPOGRAPHIC SURVEY REPORT

August, 1 9 7 5

Japan International Cooperation Agency
(J. I. C. A)
International Engineering Consultants Association
(I. E. C. A)

Fig 1. Location of Jamuna Survey Area



SUMMARY

This report shows the contents and achievement of the survey which was conducted as a part of the second feasibility survey, and we plan to undertake it this year (in 1975 fiscal).

I. Topographic Maps for River Planning

We made a 1/20,000 topographic map which is necessary for in accurate and detailed surveys of the first priority areas in the proposed bridge construction site in accordance with the recommendations in preparatory feasibility survey in 1972 fiscal. The survey was for the area of approximately 344 km^2, that is, about 26 km from north to south and about 21 km from west to east along the main stream of the Sirajganji river.

The making of topographic maps was based on the aerial photos taken from the airplane which was brought from Japan, and plotting work was carried out according to photogrammetry. Field surveys were made to collect the necessary data for plotting three (3) sheets of the original topographic maps and one (1) sheet of 1/50,000 mosaic photo.

II. Cross Section for River Planning

Following the cross sectional survey of the Jamuna river as a part of the first feasibility survey during the rainy season, cross sectional surveys were conducted at the interval of one (1) kilometer along the Jamuna river's main stream and at eight (8) places of small and medium rivers in the dry season by utilizing the established control points for the making of topographic maps of river planning, and during this survey period, water stages were observed at three (3) places of up, middle and down streams in the survey area. The achievements are shown in twenty-six (26) sheets of original cross section of the main stream and eight (8) sheets of original cross section of small and medium rivers, and water stage observation field notebook.

The topographic maps and cross sectional maps contrast each other.

III. Cross Sections of Bridge Construction Sites within Access Roads and Designed Railway Routes

Following the first feasibility survey conducted in 1973 fiscal, cross sectional surveys of river were conducted in the field at the bridge construction sites within roads and railway planning routes in the second survey. It covers about 130 km from Dacca through Tangail to Sirajganji.

Finals results are shown in nine (9) sheets of original cross section of railway, and one (1) sheet of original cross section roads.

Attached map _____ general view of survey area

Attached table _____survey result list

1. Original topographic map for river planning and positive
2. Original cross section for river planning and positive
3. Access roads, railway bridge construction site, original cross section and positive
4. Mosaic
5. Negative for reprint and original map
6. Negative for reduced reprint
7. Aerial triangulation final result book
8. Positive film
9. Control point survey book and detailed control point list
10. Leveling data book and calculation book
11. Bench mark pricking photo
12. Water depth measurement record book
13. Navigation control point survey calculation book
14. Water stage observation field book
15. Approach leveling book
16. Small river's longitudinal survey book

CONTENTS

CHAPTER I INTRODUCTION

CHAPTER I. INTRODUCTION

1-1. Backgrounds of Survey

The People's Republic of Bangladesh is divided into the different areas by the big rivers such as the Ganges river, Jamuna river and the Megna river. Of these areas, the construction of traffic routes which connect Dacca, its capital, with northwest area of this country, particularly the construction of a bridge over the Jamuna river has been its wishes for a long time.

The Japan International Cooperation Agency entrusted by the Ministry of Foreign Affairs of Japan dispatched a preparatory survey team to Bangladesh in 1972, and planned to implement three years's survey from 1973 to 1975 of the bridge construction in accordance with the preparatory survey results.

In connection with the plan, we made cross sectional surveys and also water discharge measurement at four sites for bridge construction during the rainy season in 1973, and in 1974 we took aerial photos, made topographic maps, and made cross sectional surveys at the various sites for bridge construction along the main stream, its branches, access roads along the railway routes during the dry season in connection with the first priority district. The survey results of 1973 were shown in the river investigation section of the first survey report. The survey data of 1974 are utilized as necessary information for the various fields of the second investigation, but they will be put together in an integrated report in which engineers in charge of survey, the surveying period, and working methods and scopes will be referred to in details.

1-2. Formation of Survey Team and Responsibility of Each Member.

1. Survey Team

Leader	Masao, Kikuchi	(Management)	Asia Air Survey Co., Ltd.
Member	Takashi Kawamura	(Coordination)	"
Member	Toshitsune Miyashita	(")	Toyo Aero-Survey Co., Ltd.

Member	Kazuyoshi Fukushima	(Control point)	Asia Air Survey Co., Ltd.
Member	Kiminori Muraishi	(")	"
Member	Moriyasu Ohe	(")	"
Member	Kunio Inove	(")	Toyo Aero-Survey Co., Ltd.
Member	Takushi Asano	(")	"
Member	Hideomi Okamura	(")	Hatsushu Surveying Co., Ltd.
Member	Takeshi Osawa	(")	"
Member	Masao Yoshikawa	(")	"
Member	Mitsuya Konno	(")	"
Member	Yoshiaki Otoku	(Leveling)	Asia Survey Co., Ltd.
Member	Yukio Tosaki	(")	Toyo Aero-Survey Co., Ltd.
Member	Tadahiro Yoshida	(Sounding)	Sanyo Hydrographic Co., Ltd.
Member	Katuhiko Nagao	(")	"
Member	Kingo Ando	(")	"
Member	Shigeru Kotao	(")	"
Member	Tetsuo Fijita	(")	"
Member	Mitsuhide Wakamatsu	(")	"
Member	Yoshio Yasumitsu	(Photographying)	"
Member	Nobumichi Takekawa	(")	"
Member	Seiji Kawakami	(")	Japan Airplane Transportation Co., Ltd.
Member	Tsukasa Takase	(")	"

2. Supervising Committee

Keiji Nishimura	G.S.I.
Toshitomo Kanakubo	"
Yukio Kitani	"

3. JICA Office

Osamu Wakatsuki	JICA Office in Dacca
Junji Ebihara	"
Masayuki Ijichi	"

1-3. Personnel Concerned of the Bangladesh Government

1-3-1. Management

S.S.M. Luteul Huq	Ministry of Communications
M.D. Touhid Khan	"
A.U. Med. Choudlhury	"
Mr. Hafizuddin	Survey of Bangladesh

1-3-2. Counterparts

Mr. Nural Amin Khan	Railway Engineer
Mr. Rahman	Road and Highway Engineer
Mr. T. Ali	Survey of Bangladesh
Mr. Sharafat Hossain Bhuiyan	"
Mr. Abdul Mannan	"
Mr. Delway Hossain	"
Mr. Rafique Ahmad	Water Development Board
Mr. Refiqul Karim	"
Mr. Rafiqul Islam	"
Mr. Fariduddin Ahmed	"
Mr. Abul Kashom	"
Mr. Giasuddin	"

1-3-3. Cooperators

Mr. Zainul Abedin	Tangail Governor
Mr. Siffidin Ahmed	Pabna Governor
Mr. Naoshi Yamamoto	Jamuna Office, Staff
Mr. Shahed Akhtar	"
Mr. Harunor Rashid	"
Mr. Wusuf Al. Aswad	Operator of Helicoptor
Mr. Balayat Hossain	Operator of Jeep
Mr. Abdul Hakim	"

1-4. Personnel Concerned of the Japanese Embassy to Bangladesh

Takashi Oyamada	Japanese Ambassador Extraordinary and Plenipotentiary
Koh-ichi Iizuka	Fist Secretary, Japanese Embassy
Nobuhiro Someya	"
Shojiro Imanishi	"
Yoshikazu Kaneko	Second Secretary, Japanese Embassy

1-5. Work Flow Table (general)

1. Preparation
   October ← → November 1974
2. Aerial Photography
   ← November → 1974
3. Ground Control and Sounding
   December 1974 ← → March 1975
4. Aerial Triangulation Method
   ← April → 1975
5. Constructional Mapping
   May 1975 ← → Aug. 1975

1-6. Daily Programme of Field Investigation and Outline of Action

The survey team in seven different groups left Japan respectively in accordance with the schedule of each survey party. During the survey period, staffs of management and coordination were changed and each survey party returned respecptively soon after its field survey was finished.

1-6-1. Departure and Returns

Headquarters; One member started in advance on 21st of October, returned on 26th of February.
The leader started on 7th November and returned on 9th February.
One member followed them and returned on 19th February.

Control Point Survey Party;

One member started on 7th November and returned on 31st January.

The main party of eight members started on 28th Junuary and returned on the same date as the above.

Leveling Checking Party;

One member started on 7th November and returned on 31st January.

Another member followed on 28th November and returned on the same date as the above.

Sounding Party;

One member started on 21st November and returned on 21st March.

The main party of five members started on 2nd December and returned 14th March.

Phototaking and Processing Party;

Tow members started on 11th November and returned on 13th December.

A two-crewed aeroplane started on 16th November and returned 10th December.

1-6-2. Outline of Action of Control Point Party

1. Field Preparation from November 8th to November 29th

The first member who arrived in Dangladesh on 8th November had good cooperation with the member of the headquarters who reached and started to take action for the receipt of the cargo of instrument and materials, and they received all the cargos at Dacca station before 12th November. These cargos were kept at three depots seperately. And they paid a courteous call on the government offices of Bangladesh, and confirmed the facilities which Bangladesh planned to afford to the Japanese survey team. And at the same time they coordinated a planned transportation of equipment and materials, and the chartering of

sea-trucks from Dacca to the survey base of the team, after making field reconnaissance for the planning of survey plan, reached Sirajgang as the first base on 29th November aboad a large scale sea truck fully loaded with the materials, going up the streams of Padoma river and Jamuna river.

2. Field Reconnissance for 18th November and 22nd November

Investigations of the situations on the spots were made for five days on the round trips in order to obtain necessary information for the survey planning and transportation plan of the materials and equipment. This reconnaissance was made with the participation of one member of the leveling checking party and one official of the Bangladesh government.

The subjects of the investigation were as follows;

(1) to find out whether or not there are control points to show clearly the position of the earth for the bridge construction site,

(2) whether or not it is possible to use the vehicles such as jeeps,

(3) whether or not the jeep can reach the opposite shore directly,

(4) whether or not it is necessary to build a tower for the survey of the land form in the survey area, and

(5) to investigate the conditions of bars in the main stream.

The conclusion was made from the results of the above investigation;

(1) It is convenient to give coordinate value to the bridge construction site, as the triangulation point which the British Survey Department set up within 15 km in the north from the construction site.

(2) There are no roads good for the operation of vehicles along the river shore except some part, because arable lands and villages scatter there.

(3) At the moment of investigation, it is easy to land the shore by sea truck, but water receding in future may limit landing points.

(4) The land form is a flood plain of the Jamuna river, and the most part of it is cultivated and it is a flat land which has no hills.

(5) The river bed of the Jamuna is complicated and has depths, there are unvisible bars here and there.

(6) Direct collimation toward the opposite shore is comparatively easy because of the land form and the conditions of other factors, and it is unnecessary to build a tower.

And a final field survey plan was made on the basis of the results of the investigation.

3. Arrival of the Main Survey Party and Its Preparations from 29th November to 5th December

The main survey party arrived in Dacca on 29th November, and they were given a welcome party of the Japanese residents at the official residence of the Japanese ambassadore on the evening of the following day. On the 1st December, they left for Sirajgang as the first base by railway.

4. Control Point Survey and River Crossing Leveling from 7th December to 10th January

Surveying work was started at the Sirajganj office (JICA office) as the base on 7th December. On 16th December, they moved to the JICA base camp (Singuli village) as planned beforehand.

After the starting of survey work, the water level went down as time passed so that bars came to appear in the river. This made moving around by boat impossible, and it was anticipated that the seasonal wind would blow and sand storms would take place from the latter part of February. Therefore, it was hoped that surveying would be finished earlier than planned in order to have good contact with the sounding party and leveling

party which were to come in succession. For this purpose, we had to carry out the working methods which were made in the field survey planning, and besides, attitude, power and team work fitted for the field work were needed a great deal.

(1) Formation of Team

One team consists of three survey engineers, one counterpart and two or three laborers. Three teams participated in the work.

(2) Survey Instrument

Geodimeter

AGA geodimeter 8-type	1 piece
Geodimeter 6 BL type	1 "
Wild T2 type	4 pieces
Heliotrope	6 "
Other auxiliary instrument	some

(3) Transportation Means

Sea trucks	:	water transportation for personnel & equipment	2 vessels
speed boat	:		1 vessel
Truck	:	land transportation for personnel & equipment	1 set
Jeep	:	same as above	2 sets

(4) Working Schedule

Main stream triangulation chain point selection & observation:

9th December to 31st December

Working for Traiangulation point:

7th December to 10th December

Polaris azimuth observation:

12th, 21st and 24th December

River crossing leveling:

12th and 30th December

Inland traverse point selection and observation:

3rd January to 10th January 1975

Photo pricking:

7th December to 18th January

We could utilize a helicopter because of the continuation of good weather and of no strong winds, and besides, working was carried out smoothly becuae of the good camping facilities, and this made us able to finish the selectional observation as planned. Although we had been worrying, we could finish the work easily because pricking points were at each place in the photos which were necessary for aerial triangulation. However, it was difficult to make vertical angle observation because the collimation-line goes over the global surface with little margin.

5. Field calculation and Arrangements from 11th January to 15th January

Of the calculation and arrangements on the field, the subjects to check or the calculation to conduct during the process of construction were finished during the above period, and our work entered into the stage of integrating all the results.

(1) Calculating and Checking

Our observation books were studied carefully, because it would have been too late if some mistakes had been found out after reaching Japan. And we coordinate the results by evaluating the survey good or had. Particularly, we did our best for perfection of pricking results.

(2) Taking-Over of Results

Of the above-mentioned survey results, those of rivercross leveling were taken over by the leveling checking party, and control point results by the sounding party. The result of

position measurement at the boring point which was conducted by the working squad was also handed over to the boring squad.

As the result of checking on the field, its survey results were all satisfactory in the topographic mapping and surveying. And it was confirmed that the mission of the control point investigation squad was completely terminated.

6. Withdrawing of Personnel and Equipment 16th January to 28th January

The control point survey party left necessary equipment and materials for the sounding party still conducting the work after they had completed surveying, and were engaged in inspecting and packing equipment and materials in Dacca in order to transfer the abovementioned cargos to Japan.

Sea trucks were used to transport the equipment to the base camp and materials at the time of starting the survey. This water transport required a few days in arriving the terminal. However, the same transport methods might be accompanied with danger because the general situations had changed. Therefore, the helicopter was utilized for the purpose of sending valuable cargos so that they would arrive in Dacca in a short time.

All the work of the control point investigation party in Bangladesh was finished when the departure procedures of the personnel concerned and farewell greetings to government offices concerned of Bangladesh were made.

7. Conclusion of Control Point Investigation Party's Survey Work

Bottlenecks which always occur in working abroad are not working itself of the selection of point or observation but unpleasant conditions of transport, storage of the cargos and also poor living conditions for team members.

We were favored by the good will of Bangladesh government offices.

From the stand-point of the Japanese people, the Bangladesh appear not to be punctual, and they seem not always to keep their promises. Despite these factors, the transport and storage were conducted as planned. The weather was very pleasant not different from that of Japan. And the camping facilities were well furnished because much attention was paid to lodging, meals, rest, etc. and all the surveying were carried out without troubles.

1-6-3. Leveling Checking Party and Its Outline of Action

1. General

This investigation was a survey of leveling route with 260 km in length which was set up in the adjacent of the Jamuna river for the purpose of making a height control point for the cross sectional river survey and topographic mapping. In the area covered by topographic mapping.

P.W.D. datum height was adopted for a height datum, and also for both land area and river area.

Part of the leveling was entrusted to a private survey enterpriser in Bangladesh in order to foster its survey enterprisers, and the investigation party was to check their results.

2. Preparations on the Field 8th November to 6th December

(1) Receipt and Storage of Instrument and Materials

The member who had reached on 8th November left the headquarters to conduct the receipt and storage of the instrument and materials in cooperation with the control point survey party.

(2) We requested two private survey companies (Survey Corporation and Survey Organization) to submit us an estimate by showing them our specification.

We decided unofficially to entrust it to Survey Corporation around 20th November after making a study of its amount, their techniques, etc.

The team discussed the details of working specification with Survey Corporation for the period of 23th November to 26th November, and we made preparations of making a contract. On 27th, we made an investgation of the existing bench mark on the field by helicopter, and made a selection of B.M. No. 9 (L-7B. 25), deciding this bench mark as a datum point of leveling this time. This mark was established at Survey of Bangladesh mosque, and it is located on the floor of a mosque of Pacca in Randhunibatri village.

In the general conference of the team on 4th December, (refer to 2-1), as the result of decesion for survey area, the private survey enterpriser was entrusted to take care of southern side from B.M. No. 9 and the downstream part from the bridge axis, and the upperstream part would be taken care of by the Japanese team. And an official contract was made with Survey Corporation.

3. Field Reconnaissance 18th November to 22nd November

We made a field reconnaissance with the control point survey party which had started in advance. (refer to 1-6-2,)

4. Arrival of party Started Later and Its Survey Preparations 29th November to 6th December

One member of the leveling checking party had started later, arrived in Dacca on 29th November, and left with the control point survey party for the Sirajiganji base for making survey preparations. (refer to 1-6-2 & 3)

On 6th December, we showed the leveling routes fixed point on the photo mosaic to the representative on the field of Survey Corporation, and at the same time visited their camp to inspect their instrument.

Their instrument were a tilting level produced by Wild and Hilger Watts company of England and we ordered them to adjust their unaccurate line of collimation.

5. Leveling 9th December to 16th January 1975

On 9th December, the Japanese team left the point of B.M. No. 9 for Sirasiganji in the upperstream area, and the native team for the downstream direction in order to conduct leveling.

During the working period, they moved to the base camp in Singuli and continued to take leveling.

(1) Formation of Team

The Japanese team consisted of two survey engineers, one native counterpart and two laborers. The handling of staff was taken care of by two laborers under the guidance of the counterpart. The selection of point, observation and recording were done by the survey engineers. The native team consisted of four to six members.

(2) Survey Instrument

Sokkisha B-2 auto level	1 unit
Staff and footplate	2 units

(3) Transport instrument

Jeep for personnel, equipment and materials, land use	1
Sea truck (for water use)	1
Speed boat (for water use)	1

(4) Working Schedule

Japanese team

a. right bank of the main stream and upperstream bars ; 11th December to 20th December

b. left bank of the main stream ; 21st December to 5th January

Native team

a. right bank of the main stream ; 9th December to 18th December

b. left bank ; 20th December to 5th January

And checking of survey result of the right bank of the main stream was conducted on 6th and 7th January, and checking of survey result of the left bank was conducted on 9th January.

Checking of pricking photo and geographic names was conducted on 10th to 16th January.

There are a lot of sandy soil in comparison, and although a footplate was used, a re-survey of 30% was needed because the plate could not be fixed firmly. (Any that has a large error was re-checked.) The daily mean leveling was a progress of 6 km per day, because it took much time to reach the survey point from the base camp. For the reason of requiring the height of the leveling route which passes through the periodical crossing stake of B.W.D.B., the route was revised by confirming the position directly with the guidance of the counterpart of WAPDA Sirajiganji office.

6. Withdrawing of Personnel and Equipment (refer to 1-6-2 & 6)

7. Conclusion of Leveling Checking Survey Party

The overseas operation of this time was entrusted to the native survey enterpriser to undertake a part of leveling work so that we were given technical cooperation of the Bangladesh survey enterpriser. As a result, although there were differences among the survey methods of two teams, and unsufficiency was noticed which was caused by the shortage of experience, full cooperation of Bengladesh and Japanese engineers in operations gave good effects to the general parts of this project with great sifnificance.

1-6-4. Outline of Action of Sounding Party

1. Preparations on the Field 22nd November to 6th December

The member who had started in advance on 22nd November arrived in Bangladesh, and took the receipt of all equipment and materials which had been sent beforehand. And he started to

conduct the unpacking, inspection and improvement of the cargos. He started to conduct the field reconnaissance by helicopter and jeep on the route of railway plan and access road from Dacca to the bridge construction site of the Jamuna river. In cooperation with the JICA Dacca office, he tested the speed boat for delivery, and also he built a wireless and antenna for wireless communication between Dacca and the base camp through Sirajiganji.

2. Arrival and Preparations on Field of Survey Main Party 3rd to 6th December

The main party arrived in Dacca on 3rd December and stayed at two different places in groups for one month's working as planned. They made preparations for survey and coordination of the equipment.

3. Cross Sectional Survey of Construction Point along Access Roads and route of Railway Plan

The party started to conduct surveying work in Dacca as the base on 7th December. Through Dacca to Tangail road (all weather road), they proceeded respectively to the survey point. For this purpose, laborers were hired to carry the equipment and materials. This movement was completed one by one beginning with closest places to Dacca.

On 26th, the investigation of access roads from Tangail to the base camp was completed, and the connection with B.M. (bench mark) established by Survey of Bangladesh was finished except for a part of it.

The working schedule was as follows;

Routes of Railway Plan:

Tungi (F) coordination and arrangements --- 7th & 8th Nov.

Turag (E-2), Ballmail
(E-1) investigation and
arrangements --- 9th & 10th Nov.
Shimultali (D-2) --- 11th Nov.
Latifpur (D-3) investigation --- 12th Nov.
Lahajong (C) investigation --- 14th Nov.
Putiajani (A), Futzani (B)
investigation --- 17th Nov.

Small rivers S--107 investigation -- 19th & 20th Nov.
Arrangements of invesigations on
small rivers and railway routes -- 21st to 24th Nov.
Investigation of access roads from
Tangail to base camp -- 26th Nov.

4. Moving to Base-Camp (Singuli) and Cross Sectional Survey of the Jamuna River and Its Branches, 2nd January 25th February we transported the equipment and materials to Nara-Yanganji port and loaded them on sea trucks in order to move to the base-camp on 2nd January, and on 3rd these sea trucks left the base camp. We transported the main equipment and materials by railway and by helicopter on 5th January. All the personnel of the survey investigation party got together at the base camp.
And the party made a field reconnaissance on the control point and bench mark which is necessary to determine the establishment of three guages at suitable places, and navigation control points. And at the same time we equipped the survey ship, and started to make the cross sectional survey from the southern part of the main stream, establishing a navigation control point on 11th January.

(1) Formation of Team

It consists of 6 survey engineers, 6 counterparts and 5 to 6 laborers. Of these members, we had three counterparts make fixed time water stage observations, and we devided

the team into a navigation party, survey ship party and according to the situation, a leveling party.

(2) Surveying Instrument

Electric distance measuring instrument

Hydrodist MRBz, mk-II	1 unit
Tellurometer CA-1,000	1 "

Echo sounder

PS--10e	1 "
RS--61	1 "

Transit

TM--10B	1 "

Level

B--2	1 "

Computer

Y.H.P. MODEL--10	1 "
Other auxiliary instrument	some

(3) Transportation Equipment

Sea truck (equipped as survey ship)	1 unit
Sea truck (transporation for personnel & equipment & materials)	1 "
Speed boat (same as the above)	2 units
Rubber boat (for surveying a shallow)	1 unit
Jeep (transporation for personnel, land use)	1 "

(4) Working Flow Table, 7th January to 24th February

Water guage establishment	; 7th to 10th January
Navigation control point, sounding S--Nos. 15, 16 & 17	; 11th & 12th January
Water stage observatory data collection	; 16th January
Naviagation control establishment, sounding S--Nos. 21, 22 & 23	; 17th to 20th January

Sounding, S--Nos. 24, level No. 23 & 24 ; 21st & 22nd January

Middle & small river survey S--Nos. 102 & 108 ; 21st January

Inspection of water guage establishment and determination ; 29th January

Establishment of navigation control point and sounding

S--Nos. 5 & 6 ; 30th January to 1st February

S--Nos. 1 to 4 ; 3rd February to 5th February

Water stage observatory data collection ; 5th February

Establishment of navigation control point and sounding

S--Nos. 1 to 3 ; 6th to 7th February

S--Nos. 7 to 10 ; 8th February

Traverse J--No. 7, J No. 6--1 & J Nov. 5 ; 7th to 12th February

Middle and small river investigation

S--Nos. 105 & 107 ; 10th & 13th February

Traverse and level (inland area) ; 15th to 22nd February

Photographing of river (by helicopter) ; 24th February

We had to suspend to carry on the working because of strong wind blowing which had been occurring as time passed and especially of sand storm on the 23rd, although the weather had been fine during the whole working period. However, we succeeded in finishing the survey because our surveying had been proceeding comparatively well.

Nevertheless, our surveying period was in the dry season, and the main stream was in the lowest water season. Therefore, bars and shallows appeared here and there in the main stream, and it became difficult for us to operate

the survey ship. We had to shift the sounding equipment to a rubber boat or had to make water stage measurement from the land or to apply various methods for the completion of the survey. Unluckily, there occurred an attacking accident at the our base camp, and we had to shorten our period of stay by continuing our efforts day and night without taking a holiday.

5. Withdrawing of Personnel and Equipment and Materials and Supplementary Survey, 25th February to 11th March

After the completion of the survey we left some parts of the equipment and materials in the base camp for the purpose of promoting withdrawing, and the large parts of the cargos were air-lifted to Dacca. And we conducted the approach leveling from the B.M. in connection with the three points of Tungi, Futzain and Patiajani), in Dacca from 27th February to 1st March.

The whole operation of the sounding party in Bangladesh was completed along with the finish of neccessary procedures such as their departure, farewell greetings to the government offices concerned of Bangladesh.

6. Conclusion of Survey Work of Sounding Party

In comparison with the cross sectional survey during the rainy season in 1973, higher accuracy in survey result was achieved during the whole operation this time for the following reasons;

(1) The control points which had been established by the control point survey party and leveling checking party were fully utilized.

(2) Up-to-date aerial photo mosaics and aerial photos were available.

(3) In adition to the completely furnished facilities of camping, much attention was paid to lodging, meals, resting, etc.

(4) The survey operation was not under the season of sand storm.

1-6-5. Outline of Action of Photo-Taking and Processing Party

1. Preparations in Field, 12th to 21st November

Two members who had arrived in Bangladesh in advance in 12th November started to conduct the following before the arrival of the photo-taking aeroplanes;

(1) Taking-in procedures of the aeroplanes, planning of photography flight plans and other necessary procedures.

(2) Negotiation and procedures for the use of photo processing facilities and equipment and assistance of native employees of the Survey of Bangladesh.

(3) Bringing-in of equipment and materials for photo processing, inspection and necessary preparations for the survey at the Survey of Bangladesh.

(4) Investigation of Meteorological Conditions

The equipment and materials which had been air-lifted to Dacca airport on 14th November were got through with the customs office on 18th of the same month, and were inspected carefully in the processing laboratory of the Survey of Bangladesh.

The problems which appeared during the negotiation with the Survey of Bangladesh were the durations of use of the dark room and of their equipment. The Japanese side wanted to use them until 10th December, but they wanted us to finish it before the end of November. However this disagreement was solved with good hospitality of the Ministry of Communications of Bangladesh so that at last we were permitted to use them as we had wished in the first place. We really appreciated the good will of Bangladesh very much.

As regards the meteorological conditions along with the checkups of statistical data, weather charts, information materials of upper air wind, we observed carefully daily

weather conditions, and came to conclusion that time of little cloudiness is two hours of eight o'clock am to 10 o'clock am. Therefore, we fixed up time for the flight for photo-taking.

2. Arrival of Photo-Taking Aeroplanes and Photo-Taking

The photo-taking aeroplane leaving Nagoya, Japan on 16th November arrived in Dacca air port on 20th of the same month via Okinawa, Ishigakijima, Manila, Danan, Bangkok and Rangoon. The aerial cameras were packed properly, and carried by the plane.

Photo-taking was the starting of this survey, and good results of this survey was dependent upon the quality of this photo-taking.

The first time limit was to finish photo mosaics which were necessary for the chekcup of bridge construction axis for the benefit of the survey parties of rivers, briges and roads, and of the the whole survey team including the supervisory committee members, which were expected to arrive there at the end of November. The second timelimit was to finish the photo-taking before the period of the agreement to use the facilities at the Survey of Bangladesh would expire, deducted with the number of the days necessary for photo processing.

The photo-taking sphere and its scale were two requirements such as the Sirajiganji area of 30 km x 30 km namely 900 km^2 and a scale of 1/30,000, and an area of 12 km x 25 km namely 300 km^2 for surveying.

(1) Formation of Team

One pilot, mechanic and cameraman were in charge of photo-taking, and one photo processing member was in charge of carrying films, liaison mission to the offices concerned, and also of driving the vehicle. According to the request of Bangladesh, the photo-taking was confirmed by a pilot of its air forces aboard the plane.

(2) Data of Aeroplane and Aerial Camera

Photo-taking aeroplane:

Aeroplane	Aerocommander 690FL
	Number of plane JA5197
Aerial cameras:	Wild RC-10, No. 1239
Focal length	151.50 mm
Angle of coverage	Wide angle 92°
Size	23 cm x 23 cm
Films	Kodax plus X

(3) Surveying Schedule

Reconnaissance of photo-taking area and test of photo-taking : 21st and 22nd November

1 : 33,000 crossing six strip

: 23rd November

(flight duration: 5 hours and 55 minutes)

1 : 10,000 six strips

: 24th November

Impossible to take photos due to cyclone

: 26th to 29 November

Reconnaissance flight of supervising committee members of river and bridge parties

: 1st December

Test flight for departure

: 3rd December

Departure from Dacca air port

: 5th December

Whether photo-taking is successful or not depends entirely on weather conditions, and working will be always accompanied by more hardship when it is conducted in a foreign country the information of which is not sufficient. But despite our worries, fine days and non-cloudiness made our work a success. And this contributed a great deal to future

activities of the survey team, and also convinced us to gain a fruitful completion of our operations.

3. Photo-Processing and Mosaicking

We examined and improved the dark room and equipment of the Survey of Bangladesh for photo processing, and also purchased some materials for repairs so that they could be used more or less effectively for our purpose.

In accordance with the request of Bangladesh, we had to make a statement of the bringing in and taking out of all equipment and materials, and of taking out of photographing materials and photographic results. Therefore, we had to spare much time to take out. However, the efforts of the processing party made us able to submit the required photos right in time, without making any troubles against the whole work.

(1) Formation of Team

It consists of two Japanese engineers (one of them was coincidently in charge of photo-taking) who were accompanied by two native employees of the Survey of Bangladesh. Later, two more native members were added to the party, amounting to five to six in all. We owed much to the native members who were execellent in techniques, and also were cooperative with us, working even on holidays.

(2) Processing Equipment and Final Results

Equipment and materials lended by the Survey of Bangladesh:

film drier	1 unit
rectifier (NG-V)	1 unit
contact printer	2 units
other auxiliary instrument and fixture	some

Equipment and materials shipped from Japan:

Developing machine	1 unit
Quick copy processor	1 unit

Slidus	1 unit
Others	some

And final results which were taken out from the Survey of Bangladesh are as follows;

Photo mosaics	13 sheets
Contact prints 1 : 33,000	172 sheets
-ditto- 1 : 10,000	339 sheets
Contact positive films	
1 : 33,000	85 sheets
Quick copy for working	about 800 sheets

(3) Working Schedule

Arrangement of the photo processing room and equipment : 13th to 17th November

Receiving of air-lifted equipment and delivery to the Survey : 18th November

Preparations of survey : 19th to 21st November

Photogaphed film development and orientation film : 22nd to 24th and 30th November

Making of photo mosaics (original) : 25th to 27th November

Reproduction of photo mosaics : 28th November

Making of quick copy : 24th to 30th November and 2nd December

Making of contact prints : 4th to 6th December

Making of positive film : 6th December

Reproduction of photo mosaics : 7th December

Taking out of equipment and materials and final results : 8th and 9th December

4. Conclusion of photo processing party

The photo-taking and photo processing were the most difficult operation which could not have been anticipated all through the survey operation. We had been known of the photo taking records which had been made in Bangladesh in 1971, but information since then was not available. Our team had to go to Bangladesh without knowing of details of their photo processing facilities at the Survey of Bangladesh, and of the land form in the field, particularly weather conditions. It was the first trial that we conducted the survey soon after the photo taking with its final results. But we were favored by good weather so that our trials were made a success.

It was one of the factor for this sucess that the Survey of Bangladesh and all the government offices concerned of Bangladesh made kind cooperation with us as the laws and regulations of Bangladesh allowed them to do so.

CHAPTER II TOPOGRAPHIC MAP SURVEY

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CHAPTER II TOPOGRAPHIC MAP SURVEY

CHAPTER II. TOPOGRAPHIC MAPPING SURVEY

2-1. Work Plan

The general work plan is shown in the work flow table of 1-5 the characteristic of the current survey operation in planning were as follows; the interim report of the initial survey was presented to the technical conference of the Japanese survey team and the government of Bangladesh in Dacca in October, and as a result, a first priority area for the second survey was to be decided, and despite this decision, the decision of bridge axis which was the fundamental for further survey sphere in details and the plan was to be made in the conference of the all the Japanese survey team in Dacca in December, centering on the photo mosaics which the survey team planned to make. In this situation, a survey plan of the field could no be discussed prior to the departure. Therefore, we made every effort to form a team, and to prepare and transport equipment and materials.

The survey investigation party was informed after the technical conference in Dacca toward the end of October of the decision to make Sirajiganj area the survey area for the second survey at the beginning of November. According to the instruction showing an outline of photo-taking sphere by JICA personnel in charge of secretariate in the middle of November, field investigation was conducted within the frame of the designated period. (refer to 1-6-2 and 1-6-4)

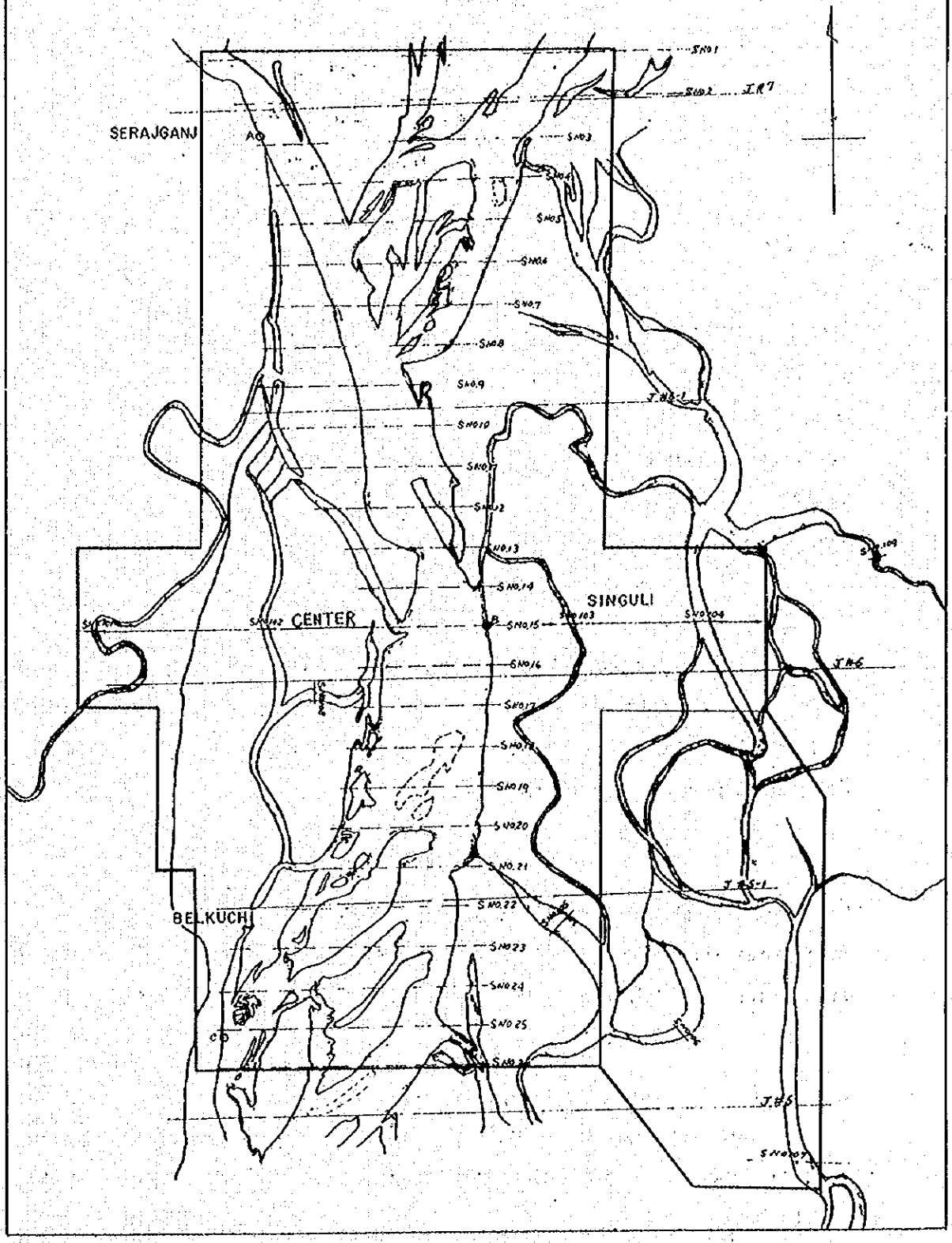
[Memorandum]

The representatives of the Jamuna Bridge survey team came to agreement after the consultation with Survey Investigation team and soil survey team as follows;

I. Survey

(1) Aerial photo plotting and photo map should be within the area which is shown in Figure 2. With the coffering of Dhaleswari river, this area includes the addition of 62 km^2 to 282 km^2 which we planned to have.

Fig. 2 LOCATION OF SERAJGANJ AREA



(2) The bridge axis and main stream cross sectional survey line are subject to the photos. (refer to figure 2)

(3) The cross sectional survey position of the small rivers should be as follows a figure-2 shows;

6 places in the plotting area

1 place for access road

9 places for railways

(4) In order not to alter the period of survey execution, the survey investigation team will be allowed to use the helicopter for about 40 hours for the establishment of reference points.

(5) Additional expenses necessary for the additional aerial triangulation and, plotting and drafting will be permitted.

II. Geological Survey

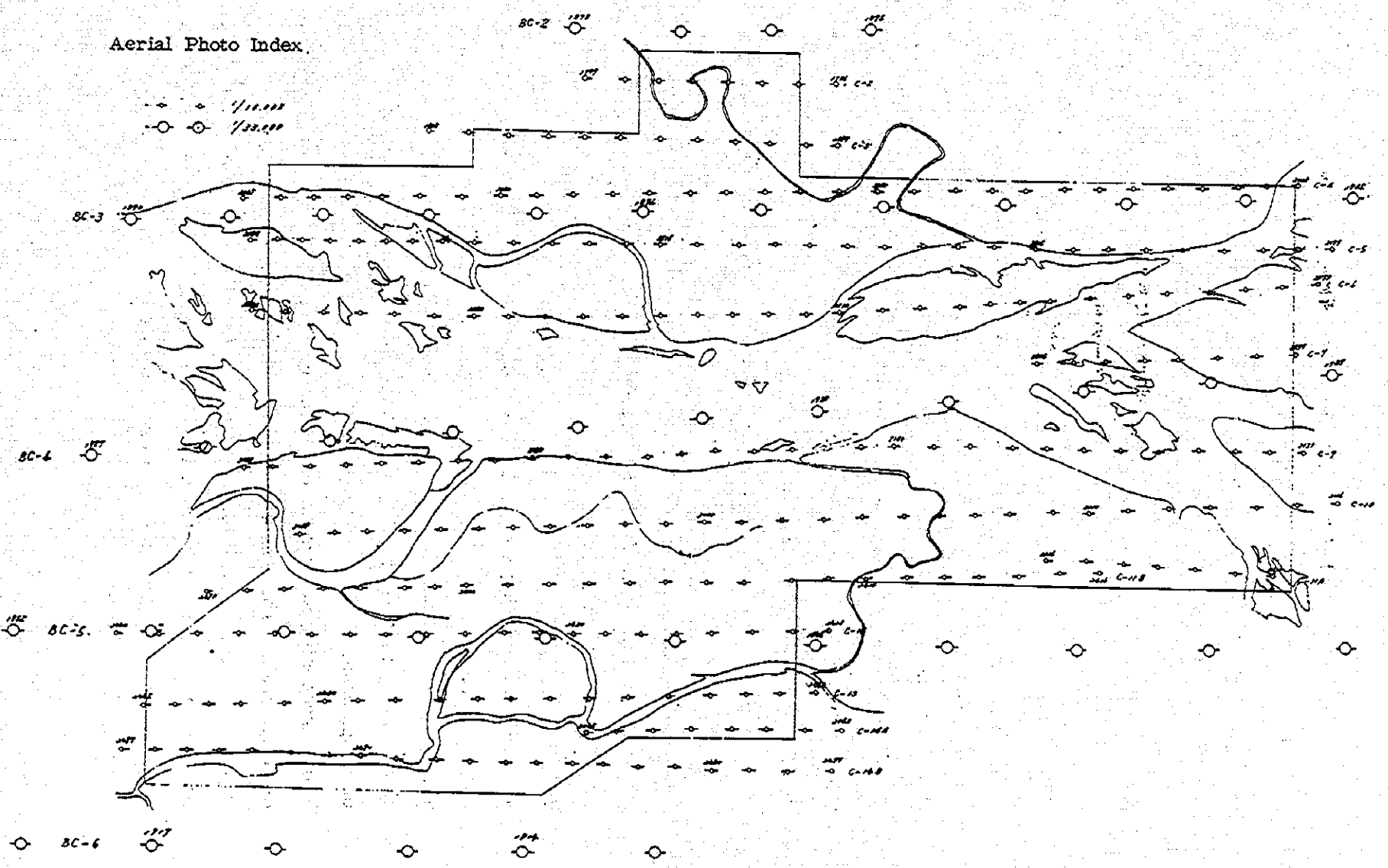
Along with the field reconnaissance, a survey planning was passed by the supervising committee according to the above-mentioned agreements.

2-2. Photo-Taking and Photo Processing

Photo taking was divided into a crossing strip course of 1:30,000 and a detailed survey strip course of 1:10,000, and we planned overlap to be 60%, and sidelap to be 20%. In connection with the photographing altitude, the crossing strip course is 16,500 feet, and the detailed survey course is 5,000 feet. At the photo-taking time, upper wind was weak, and there was no halation. The final index map of air photo-taking is shown in figure-3. And the negative films were submitted to the Survey of Bangladesh.

Photo processing was conducted in the necessary facilities of the Survey of Bangladesh. The contents of the work were the making of photo mosaics, contact photos, enlarged photos for working (1:5,000), and these photos were reprinted in accordance of every team's request. The originals of the photo mosaics were submitted to the Survey of Bangladesh.

Fig. 3. Jamuna River-Bridge Construction Project



2-3. Control Point Survey

The purpose of control point survey is to fix positioning control points for picture point.

The purpose of control point survey is the coordinate determination for the picture point to be usable for plotting, and also the determination of positioning control point for cross sectional survey. And in this connection, it is also to conduct Polaris observation for the purpose of examinining river crossing leveling and torsions of figures to combine water level surveys on both shores. What most stress was placed on for this purpose were the establishment positions of about 25 control points, a survey period and survey method.

2-3-1. Survey Method of Control Points

1. Control points at the edge of a river is to connect by triangulation chain the distance between base lines which were established by geodimeter in upper stream, middle stream and lower stream areas.
2. Control points established off the shore are connected with the routes of traverse by geodimeter in accordance with land forms and other conditions.
3. Movement from one control point to another on the shore is made by sea truck, and the jeep or helicopter is used on land for the same purpose.

2-3-2. River Crossing Leveling

Five river crossing water level points are to be established in the upper, middle and lower stream areas in the survey area in order to survey the relative height of control points on both opposite shores by angle observation, and these are to be connected together with the leveling routes which will be conducted seperately.

2-3-3. Polaris Observation

Polaris observation will be conducted for the purpose of determining azimuth from the established trig point in the geodetic net (4 km

north of Sollabari-Serajganj), and of examining torsion around in the center of the net.

2-3-4. Observation Method and Allowable Error

1. Distance measurement

   Maximum discrepancy among three frequencies: within three centimeters

2. Horizontal angle

   Two pairs, double angle difference: 20", observed difference: within 10"

3. Vertical angle

   One pair, constant difference: within 15"

4. River crossing leveling

   Six pairs of vertical angle observation: S (km) 1.6

5. Polaris observation

   Ten pairs

6. Pricking

   Clear ground features on the photos are pricked, their positions will be available for photo orientation.

2-3-5. Final Work Volume

1. Angle observation

Existing point	1 point
Picture control point and level control point	25 points
Supplementary point	15 points
	41 points

2. Distance observation

Base line four sides	13,420 km
Traverse routes 25 sides	54,580 km
Other auxiliary base lines four sides	

3. Polaris observation — 2 places

4. River crossing level observation — 5 places

5. Pricking points 30 places

6. Number of triangle formed 17 pieces

Please refer to figure-4 for the geodetic net.

2-3-6. Final Result and Accuracy of Survey

1. Relations and standards of position of existing trig point

This surveying is connected with the land survey net of Bangladesh. The trig point was one point of the triangulation chain survey which had been conducted by the Indian Survey Bureau of England in 1870's. It is situated at 89°40'33" 94 longitude and 24°29'48" 66 latitude, and the coordinate values of each control point is determined in the present survey.

The standards of the azimuth was determined from this point by polaris observation. The result of computation in connection with the vicinity of the bridge axis shows as follows;

West edge of bridge axis (No. 13):

Longitude 89°44'51"

Latitude 24°21'17"

East edge of bridge axis (No. 14):

Longitude 89°46'46"

Latitude 24°21'18"

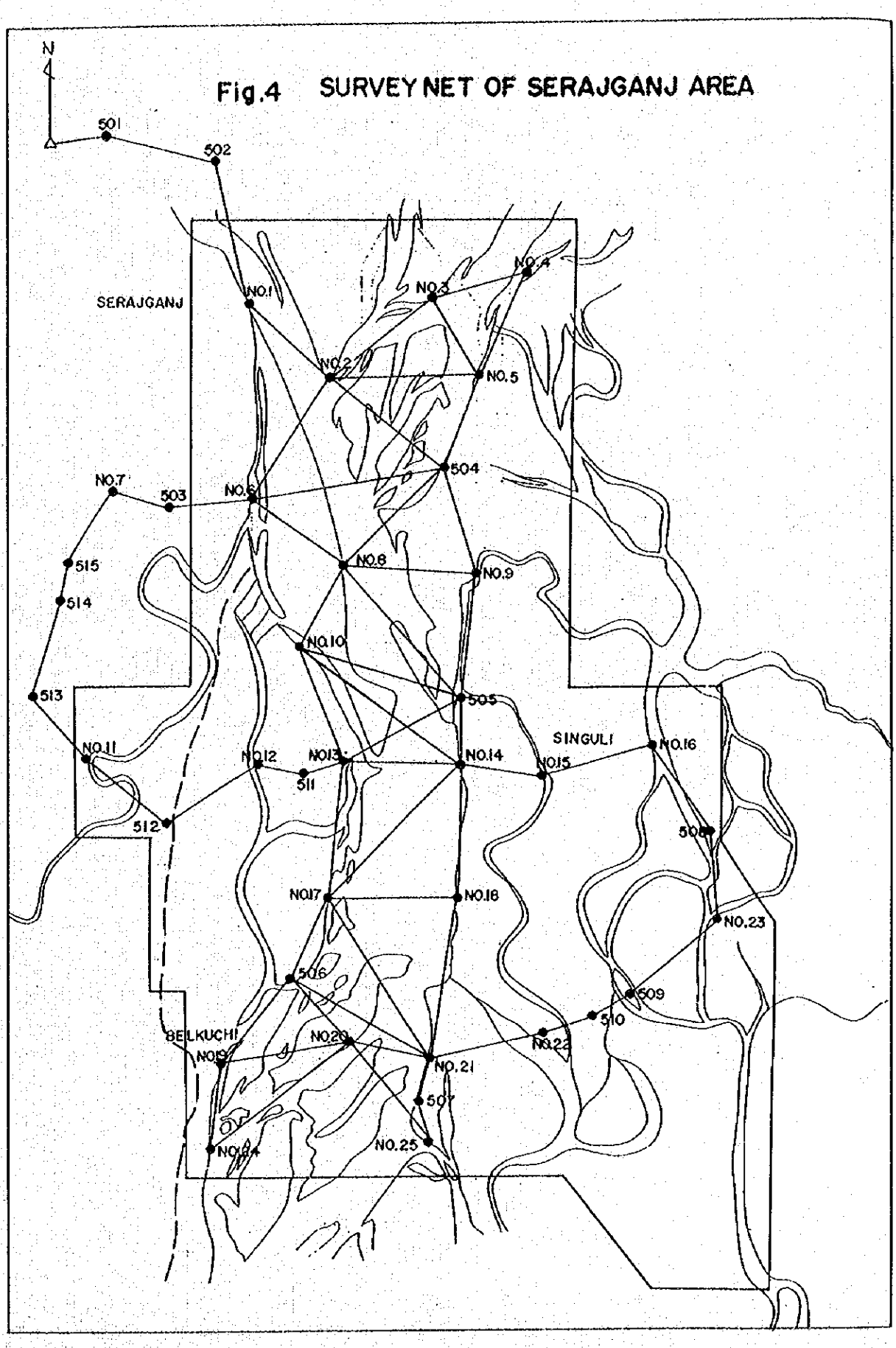
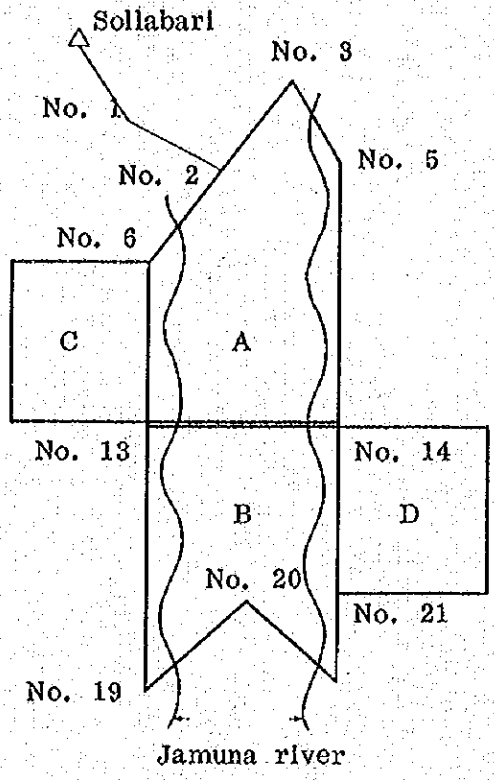


Fig.4 SURVEY NET OF SERAJGANJ AREA

2. Computation and inspection on the field

The figure-5 is a type specimen of the survey route.

(Fig.-5)



(1) Triangle closure and base line closure

Seventeen triangles were formed in the area where the rings of A and B made a triangle chain, and its closure errors are shown as follows;

Closure errors	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"
Numbers	3	2	1	3		3	2	1					1		1

The closure error of the base lines in the northern and central parts is 0.23m, and the distance between the central and southern parts was 0.10 m.

(2) The result of azimuth observation by Polaris at the trig point Sallabari and No. 14 shows as follows;

	Values of maximum & minimum	Mean square errors
Sallabari survey point	12"	1"09
No. 14	9"	1"16

(3) Approximate coordinate and elevation divergence

Numbers of routes	Distance	Direction angle divergence	X Divergence	Y Divergence	H Divergence	Closure ratio
	km	second	m	m	m	
A	34.2	0	+0.12	-0.05	+0.28	1:260,000
B	30.2	+27	+0.19	+0.23	+0.64	1:100,000
C	19.2	+17	-0.45	-0.05	+0.18	1: 42,000
D	17.9	+27	-0.27	+0.18	-0.76	1: 55,000

(4) River crossing leveling

Survey period	Distance	Mean square errors	Number of sets	Remarks
No.1-No.2	2,900m	4.8mm	5sets	One set equals to six pairs.
No.2-No.5	3,981	10.5	10	
No.13-No.14	3,235	4.5	7	
No.19-No.20	3,318	10.3	7	
No.20-No.21	2,892	13.9	7	

3. Homogeneous Adjustment Computation after Return to Japan

After returning to Japan, homogeneous adjustment computation longitude and latitude were made with the other observation data.

(1) Computation method

Computation was made according to the plane rectangular coordinate system, the origin of which was Sallabari, by Everest spheroid;

scale factor at original	1,000,000
angle weight	1
direction angle weight	100
distance weight	0.5

and it was converted into longitude and latitude then.

(2) Accuracy of observation (by computor)

	Number of observation	Maximum residual
Distance observation	33 sides	6 mm
Direction angle	2 directions	0 second
Horizontal angel	122 directions	5 seconds
Vertical angle	112 directions	14 seconds
One direction mean error	Horizontal angle	2.75 seconds
	Vertical angle	6.88 seconds

(3) Coordinate and elevation accuracy (by computor)

Mean square errors	0 - 10 cm	10 - 20 cm	20 - 30 cm	30 - 40 cm	40 - 50 cm	Total number of points determined

Mean square errors	0 - 5 cm	5 - 10 cm	10 - 15 cm	Total number of points determined

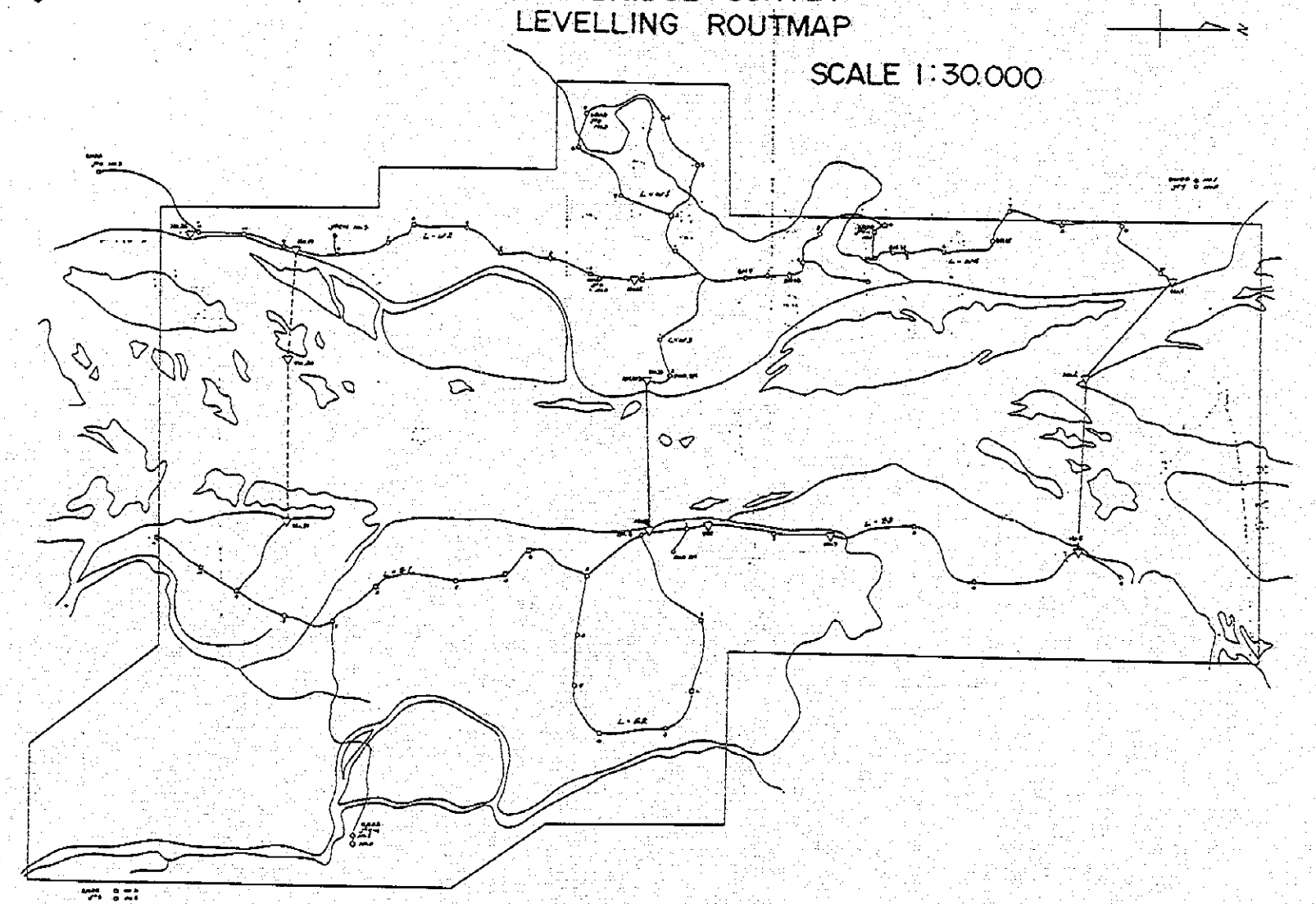
2-4. Leveling

Survey planning was made on the mosaic photos which had been taken in 1971, but the final survey planning was set up on the photo mosaics, which had been taken again, on the basis of the results of field reconnaissance and previous year's information of survey. A subject on planning calling our special attention was that all the routes passing the existing leveling points of BWDB which had been established in the survey area should be determined and that survey volume for the native survey enterprisers should be determined, and what method of checking should be adopted. Taking into consideration the above-mentioned requirements, the leveling routes in figure-6 were determined by adjusting the relations of photo plotting and sounding.

Fig.6

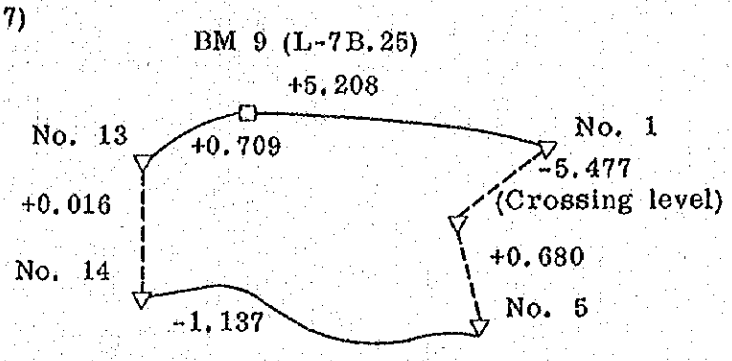
JAMUNA BRIDGE SURVEY
LEVELLING ROUTMAP

SCALE 1:30.000



2-4-1. Result and Accuracy of Survey Conducted by Japanese Survey Team

The conditions of height which were checked in the link of results of survey of the Japanese survey team are shown in figure-7. (Fig.-7)



(Figures: m unit)

In figure-7, the closure error computed up to BM 9 is -0.001 m. As long as the route is concerned, accuracy is remarkably high. Each distance was duplicately measured, and broken line parts show the results of river crossing level. Plus and minus of the fiugres show the height from the direction of BM 9.

The comparison of the existing results of the existing level points which had been established by Bangladesh and the results of the present survey is shown as follows;

(Converted into height of PWD. unit: m)

Name of points	BM 9	BM 10	J#6-1 No. 1 West shore	J#6-1 No. 2 West shore	BM 14	BM 15	PWD. BM (West shore)	PWD. BM (West shore)
Existing results	13,208	13,328	12,231	13,359	13,947	14,407	12,691	12,478
Present results	13,208	13,363	12,232	13,360	13,994	14,392	12,693	12,480
Discre-pancy	0	0.035	0.001	0.001	0.047	0.015	0.002	0.002

As the result, the results of the periodical cross section stake of W.B.D.B. is very small in discrepancy. The result of B.M. shows the discrepancy of 3 to 5 cm.

2-4-2. Checking of survey results of Bangladesh native enterpriser

Checking was conducted on L-W2 of the west shore route at three places, and on L-E1 of the east shore at one place. The results are shown as below;

Routes	L-W2			
From - to	1-3	8-9	10-11	BME-2
Distance	2 km	1.2 km	1.1 km	2 km
Duplicate closure errors	3 mm	12 mm	19 mm	7 mm

The results of the checking show as large accuracy as allowable error of 20 mm S (km).

The comparison of the existing results and the results of the present survey is available as follows;

(Converted into height of PWD. unit: m)

Names of routes	J#6 No. 3	J#6 No. 6	J#5-1 No. 3	J#5 No. 3	J#5-1 No. 4	J#5-1 No. 5
Existing results	11,491	12,497	12,561	11,634	12,478	11,954
Present results	11,427	12,326	12,640	11,777	12,283	11,753
Discre-pancy	0.064	0.171	0.079	0.143	0.195	0.201

As the result, much discrepancy is noticed between the periodical cross stake existing established in the southern half part of the survey area and the existing results. Partly because it was unable to check at the established BM of the Survey of Bangladesh, it was difficult to make decision on the present survey results. However, we are informed that no survey has been conducted since the re-bury of J#5-1 No. 4 and J#5-1 No. 5.

2-5. Field Investigation

For topographic mapping, field investigation is conducted on place names and famous ground features on the photos only.

The determination of most of land classification was interpreted at the plotting stage.

2-6. Aerial Traiangulation

We have increased picture points on the photo by conducting analytical aerial triangulation with the computor for the orientation of aerial photos in accordance with control point survey and level survey.

2-6-1. Computation Method and Errors

We made the block computation of four courses, cross strips No. 2 to No. 5 to obtain homogeneous adjustment, as a result, the discrepancy from the actual measured points is:

Standard errors	Planimetric position	0.71 m
	Height	0.65 m,

and this is sufficient accuracy for making 1:20,000 topographical plotting. As the result of the computation, Judging from the computation, we were convinced that it would be possible to make longitudinal profile photogrammetry in the additional plotting area as shown in I Survey (1) in the Memorandum. Therefore, we all decided to extend the longitudinal profile photogrammetry.

2-6-2. Results and Accuracy of Aerial Triangulation

For photo orientation the plotting sphere, the adjusted values of all picture points for the photo orientation within plotting sphere by computor differ from the actually measured values on the field as the following table shows;

Residual	X direction	Y direction	$\frac{X \quad Y}{\sqrt{(X^2 + Y^2)}}$	H
cm	points	points	points	points
0 to 19	5	8	2	6
20 to 39	9	5	5	6
40 to 59	5	7	4	7
60 to 79	4	2	7	2
80 to 99	2	1	5	2
100 to 120		1	1	1
120 to 140		1	1	
140 to 150				1
Total	25	25	25	25

2-7. Plotting Work

We have made 20,000 topographic maps through the picture point survey on the photos by aerial triangulation.

2-7-1. Instrument Plotting

The plotting instrument used in survey was a Topocart B of Zeis. We did not draw contour lines on land, but plotted a point at the ratio of about four points in 1 km^2. Thus we have surveyed and plotted the positions of the periodical cross stakes, established BM and newly set up BM. And also the longitudinal profile photogrammetry of the land part extending up to the main stream cross sectional line which was surveyed in cross sectional survey has been measured in the plotting instrument.

In connection with the results, although the planimetric position is good in accuracy, but the measurement of height has come to the edge of the limits of ± 1.5 m.

2-7-2. Format and Legend

The maps have been divided into south-north direction 7'30" and west-east direction 11'30", and it covers the survey area of 344 km^2 which has been determined already. The area of the neat line is 96 cm x 69 cm. In connection with the legend, the Survey of Bangladesh has agreed to our draft making some correction for final decision.

2-7-3. Drafting

The originals were made by inking on polyester base. According to the results of the survey by cross sectional survey, the water parts of the Jamuna river represent the contour line of 2 m interval by PWD standard height.

2-8. Completed Topographic Maps

The completed topographic maps have been made in accordance with the above-mentioned requirements. Your attention is invited to that the conditions of river edge lines and land part in the topographic maps were as of 25th November 1974, that is, at the time of aerial photo-taking. And the elevation of cross sectional lines in the main stream part show the conditions of the river bed which were based on PWD. (refer to cross sectional map).

CHAPTER III CROSS SECTIONAL SURVEY

CHAPTER III. CROSS SECTIONAL SURVEY

3-1. Establishment of Navigation Control Point

Forty-five points were established with the interval of 1 km both in the upper and down stream, centering on the planned bridge axis line BMW to BME (direction angle $90^{o}27'20''$, and the location was determined by angle and distance observation with the Tellurometer and transit from the control point. (fig.-8) And the traverse measurement determined the locations of nine control points along middle and small rivers and access roads.

3-2. Establishment and Observation of Water Guage

Water guages were established on the survey sphere at each point respectively of upper, middle and down stream, that is, as shown at A (Sitajganj), B (Singauli) and C (Jamtail). Observation was conducted five times, at 6, 8, 10 in the morning, and at 2 and 6 in the afternoon every day.

The datum plane of posititon and water level is considered as related to the results of survey the control points and water levels which have been surveyed.

The standard of PWD has been used for the elevation standard.

3-3. Cross Sectional River Survey

The location measurement being conducted on the survey line by Hydrodist, sextant and transit on the basis of the navigational point stake, cross sectional survey was taken with the echo sounder, lead and level. In connection with the small rivers and access roads, the transit and steel tape were used for location measurement and the lead and level were used for the cross sectional survey.

Correction was made on water stage observation and level survey according to the results of cross sectional survey at twenty-six places of the main stream of Jamuna river, and inserted sounding charts with the interval of

Fig. 8 LOCATION OF SERAJGANJ AREA

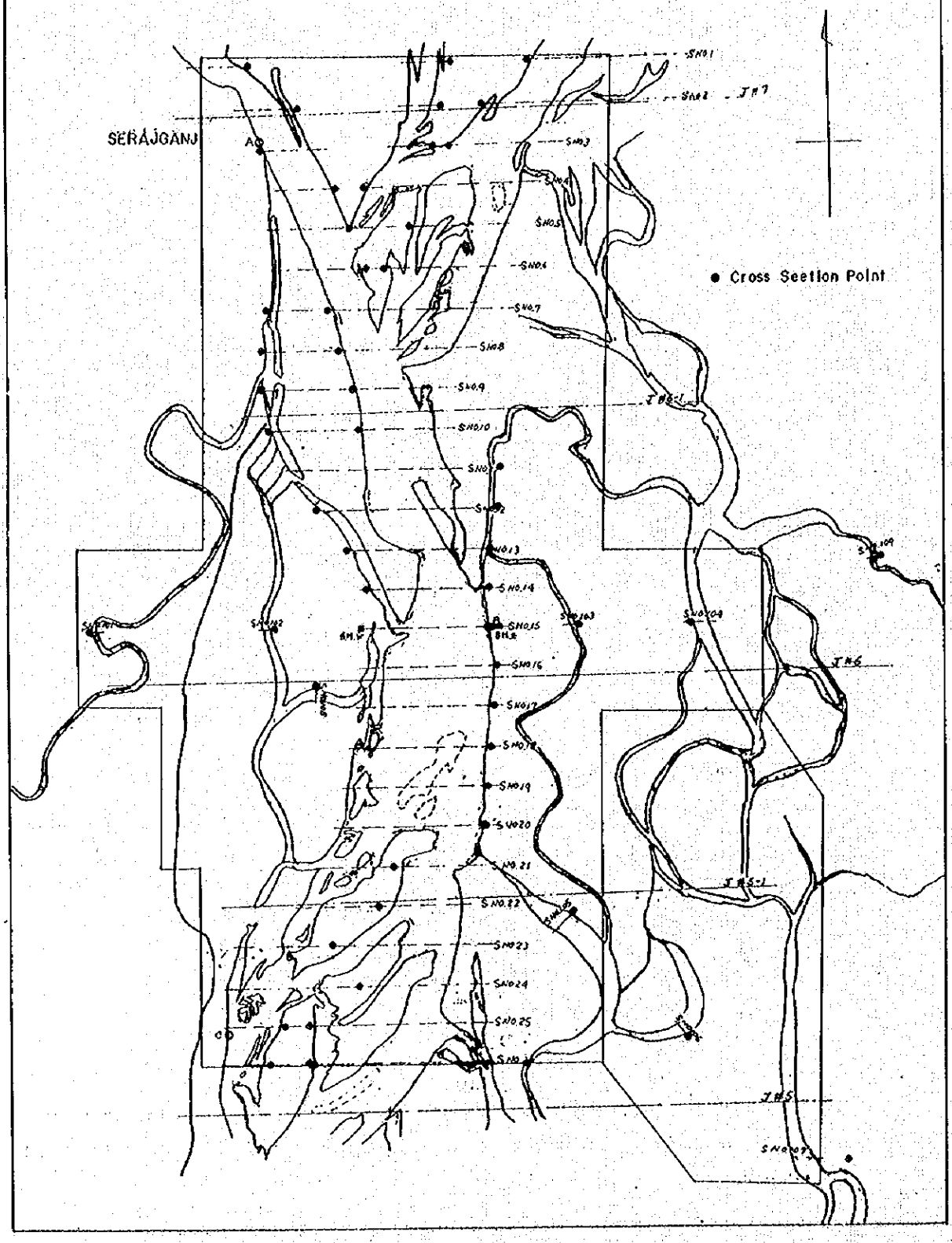
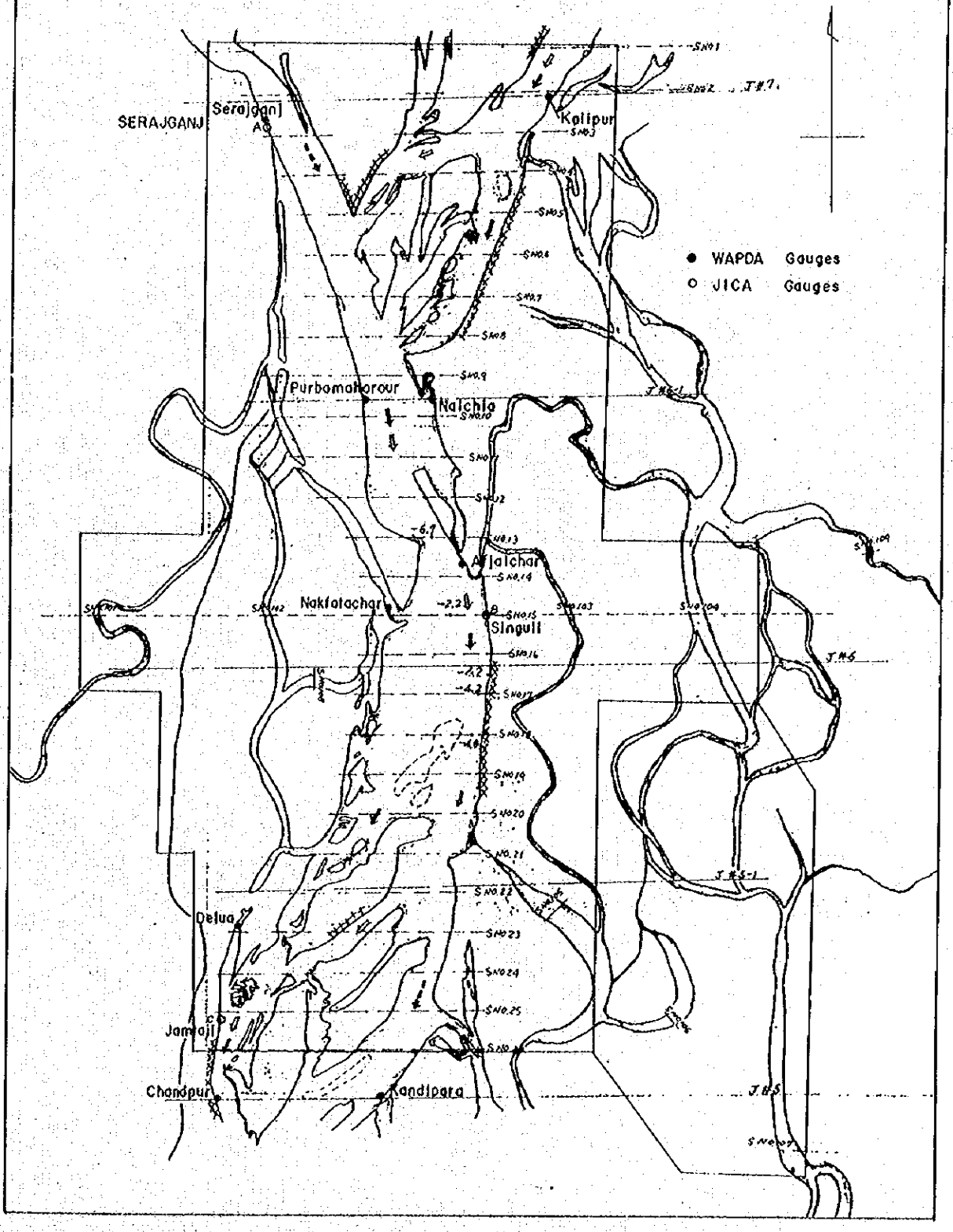


Fig. 9 LOCATION OF SERAJGANJ AREA
GAUGING STATION



2 m between.

The relations between the main and branch streams is as shown in Fig.-9, and almost the same, when the results of the first survey results during the annual flooding in 1973 and the second survey results during the water falling in January to February, 1975.

In Fig.-9;

Main stream in 1973's survey

" 1975's survey

Branch streams in both 1973 and 1975

Rapid currents which were caused by crumbling at the time of the cross sectional survey in 1975.

As regards the water depths, the central part of the narrowest place of 1 km in length along the No. 13 course of 2 km distance in the upper stream is the deepest, that is -6.7 m, and a part of about 1 km from the left shore of S - No. 15 course as shallow as -2.2 m. But the stream changes its river course toward the left shore and become deeper around 100 m from the left shore and 16 km downward from the bridge axis and it shows the depth of 4.2 m.

It is 4.2 m around 200 m from the left shore in S - No. 17 course, and in S - No. 18 course, it is as deep as -4.8 m around 400 m from the left shore. It is getting shallower in the down stream beyond this area. Even in the first survey, it is -7.1 m in depth and 3 km in width around S - No. 15. It is noticed that almost the same places are deep.

3-4. Making of Cross Sectional View

Making the utilization of the results of cross sectional survey on the spots, the cross sectional views have been plotted into the section myler of 26 sheets of the main stream respectively in 1/100 in lengthwise, 1/20,000 in crosswise scales.

Eight shees of the middle small rivers respectively in 1/100 and 1/1,000 scales.

3-5. Comparison of Survey Results

3-5-1. Observation Value of Water Guage and River Slope

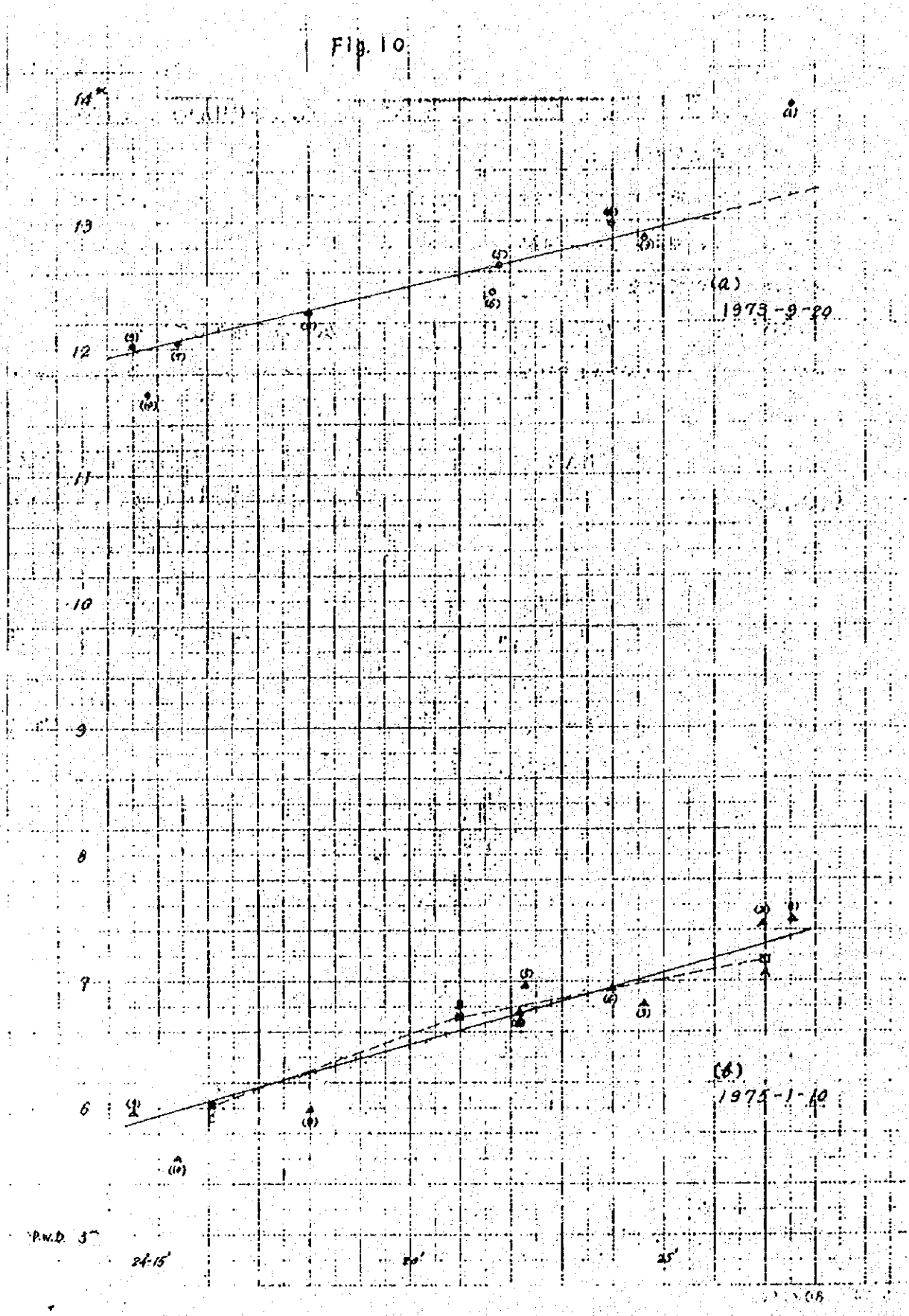
The following table shows PWD elevation observation values and observation values on 10th January 1975;

No.	Place Names	Latitude	20 Sep. 1973	10 Jan. 1975
1	Kalipur	24"-27!55	13.90 m	7.46 m
2	Sirajganj	27.0		7.44
3	Nalchia	24.63	12.86	6.82
4	Purabamahonpur	24.00	12.97	6.93
5	Afzalchar	21.81	12.65	6.81
6	Nakfatarchar	21.67	12.44	6.76
7	Dighalichar	15.40	12.02	
8	Dellia	18.00	12.28	5.97
9	Chandpur	14.50	12.02	5.97
10	Kandipara	14.83	11.64	5.59
11	Bantarpur	23°-58!40	10.13	
12	Charbharenga	59.03	10.44	
A	Serajganj	24°-27.0		7.16
B	Singuli	21.0		6.74
C	Jantail	16.1		6.06

These observation values have been plotted in vertical axis and horizontal axis as shown Fig.-10, (a) and (b).

As shown Fig.-10, (a), the river slope of each water guage approximately 1:20,000 except Kalipur and Kandipara, and the slope from four places such as Dighalichar, Chandpur, Bantarpur and Charbharenga is 1:17,000. The river width around Kalipur is about 7 km, and the current is reticulate, and it changes meander. Therefore, it can not be imagined that the water volume will increase sharply. Rather we think the elevation value is about 60 cm lower.

Fig. 10



The water level of Kandipara is about 40 cm lower than the water guages of other places, and it has been excepted.

In Fig.-10 (b), the scope which excludes the observation values of Singuli, Afzalchar and Nakfatacha is approximately 1:17,000.

The observation values of Singuli, Afzalchar and Nakafatachar show that the water levels of these places seem to be 20 cm higher, because the river width during the water falling around Afzalchar become narrow sharply in the area of about 1 km.

3-5-2. Cross-Section of BWDB

The cross Section is of five survey lines in J#5, J#5-1, J#6, J#6-1 and J#7, and the survey point and control point was connected by survey in order to meaure the azimuth and distance of these survey lines, but J#7 (3L) is a measurement on the aerial photos, and the above-mentioned survey lines are included in the topographic maps.

The following table shows the comparison of the information materials and the present survey results;

J#5	JICA	4L	270°-27'-54"	5L	270-14-43 3L
	WAPDA				270-54-00
			107,567 m		16474.050 m
			107,287		16613.711
			+ 0,280		-139.661
J#5-1	JICA	4L	267°-57'-09"	5L	268-17-35 3R
	WAPDA				270-00-00
			158,729 m	(113907.615)	13748.286 m
				13763,278	
				+143,737	
J#6	JICA	1L	270°-18'-15"	2L	270-10-10 3L
	WAPDA				271-22-00
			166,333 m		18995,059 m
			166,418		18913,992
			-0,085		+81,0067
J#6-1	JICA	3L	268°-35'-33"	2L	268-36-16 1L
	WAPDA		269-20-00		
			11598,611 m		608,003 m
			11664,466		609,283
			-65,855		-1,280
J#7	JICA	3L	269°-45'-39"	2L	269-15-39 1L
	WAPDA				
			14303,358 m		137,524
			14271,065		
			+32,293		

Notes: JICA angle is grid azimuth, and 3R shows No. 3 on the right shore.

3-5-3. Comparison of Sections of Cross Sectional Survey

The comparison of BWDB Cross Sectional survey on the main stream of Jamuna river in 1974, and the results of the present cross sectional survey in 1975 is shown in Fig.-12 to 15.

1) J#5

This course has been eliminated from the comparison because the parts of the main stream were not included in the survey area.

2) J#5-1 (Fig.-12)

Confidence in comparison is high, because this course has been made survey of almost on the same survey line as S - No. 22 this time. The main stream was running in the west according to the first survey in September 1973 and BWDB survey in March 1974, but the present survey in January 1975 shows it has moved to the east. (refer to Fig.-9) Its reason is that the main stream gets close to the east on the left shore up to 8 km in the upper parts, it was affected by the big flood in the rainy season in 1974.

3) J#6 (Fig.-13)

This is located in the down stream about 1.2 km from the bridge axis. The main stream gets closer to the left shore, and it is noticed that this stream has invaded about 200 m deeper into the shore than the 1974 survey.

4) J#6 (Fig.-14)

The current of the main stream is the same, but it retracts about 400 m in the east of the bar, and crumblings are noticed around the dike.

5) J#7 (Fig.-15)

This course is almost the same as S - No. 2. There are not many changes on the side of Serajganj, but there occur crumbling in the eastern part of the bar.

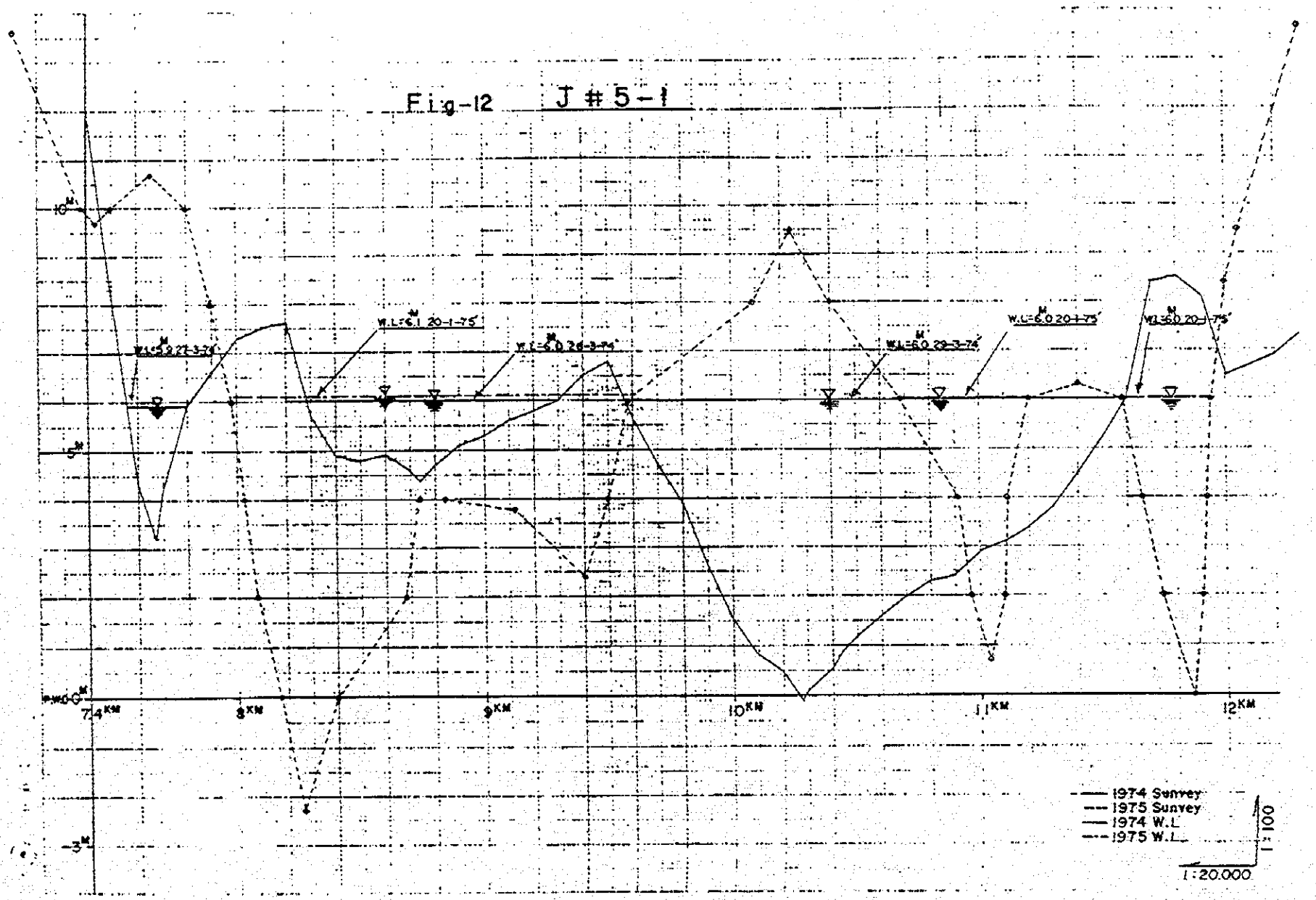
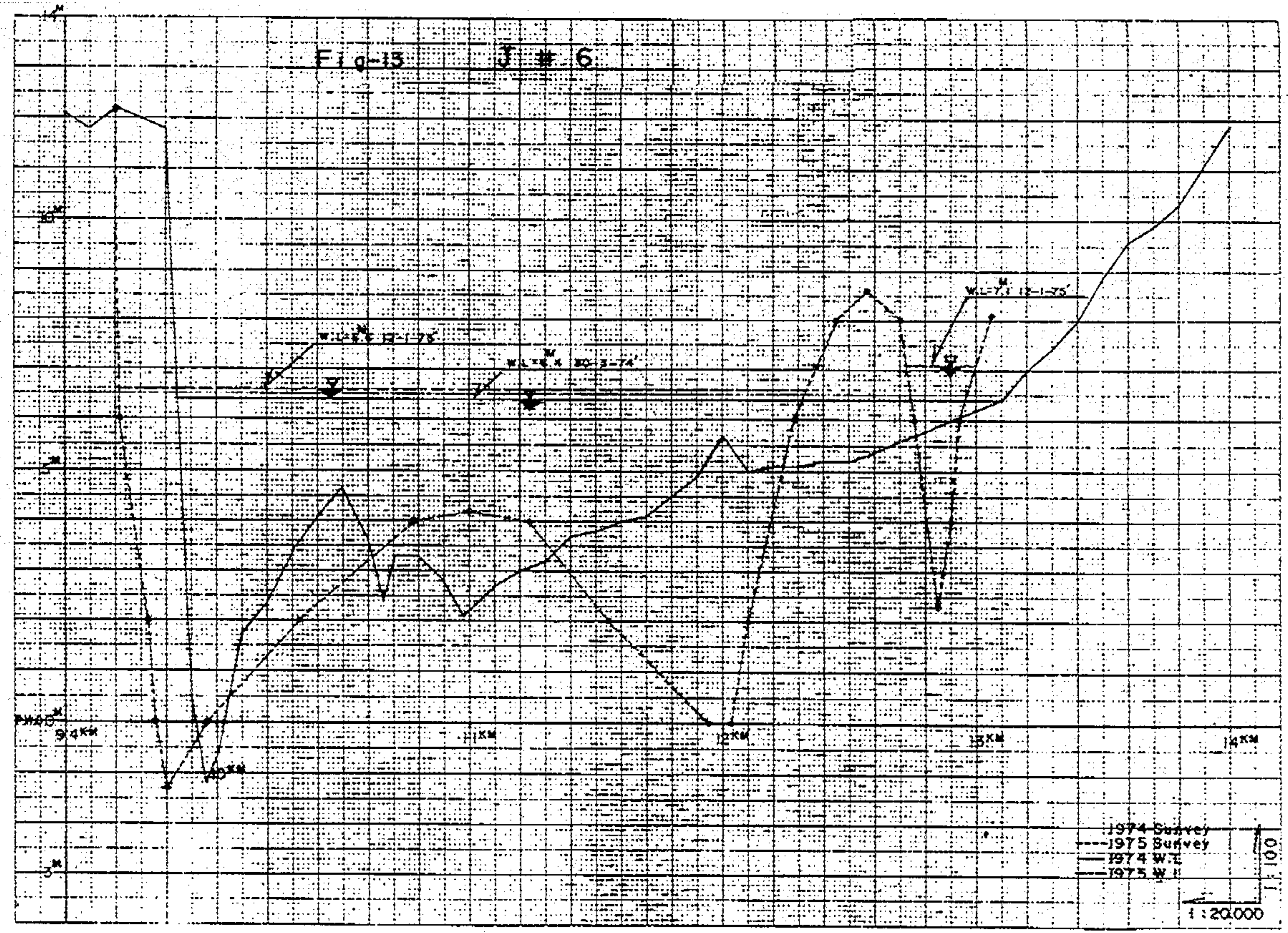


Fig-12 J # 5-1
10M
5M
-3M
W.L=5.9 27-3-74
W.L=6.1 20-1-75
W.L=6.0 26-3-74
W.L=6.0 29-3-74
W.L=6.0 20-1-75
W.L=6.0 20-1-75
7.4KM
8KM
9KM
10KM
11KM
12KM
1974 Survey
1975 Survey
1974 W.L
1975 W.L
1:100
1:20.000

Fig-13 J#6


10KM
11KM
12KM
13KM
14KM
1974 Survey
1975 Survey
1974 W.L
1975 W.L
1:100
1:20,000

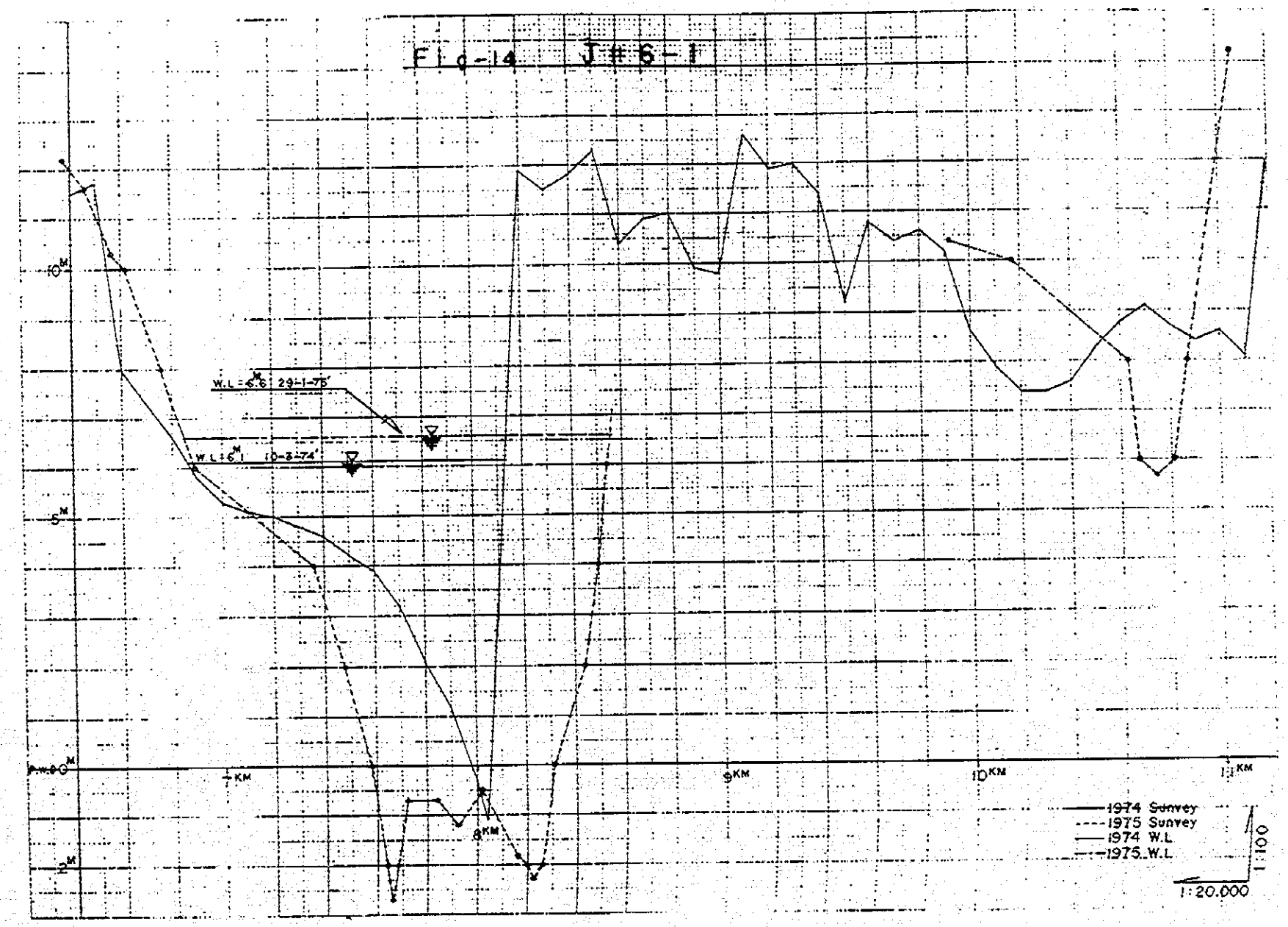


Fig-14 J#6-1
10M
5M
P.W.D.0M
2M
W.L=6.6M 29-1-75
W.L=6.1M 10-8-74
7KM
8KM
9KM
10KM
11KM
1974 Survey
1975 Survey
1974 W.L
1975 W.L
1:100
1:20.000

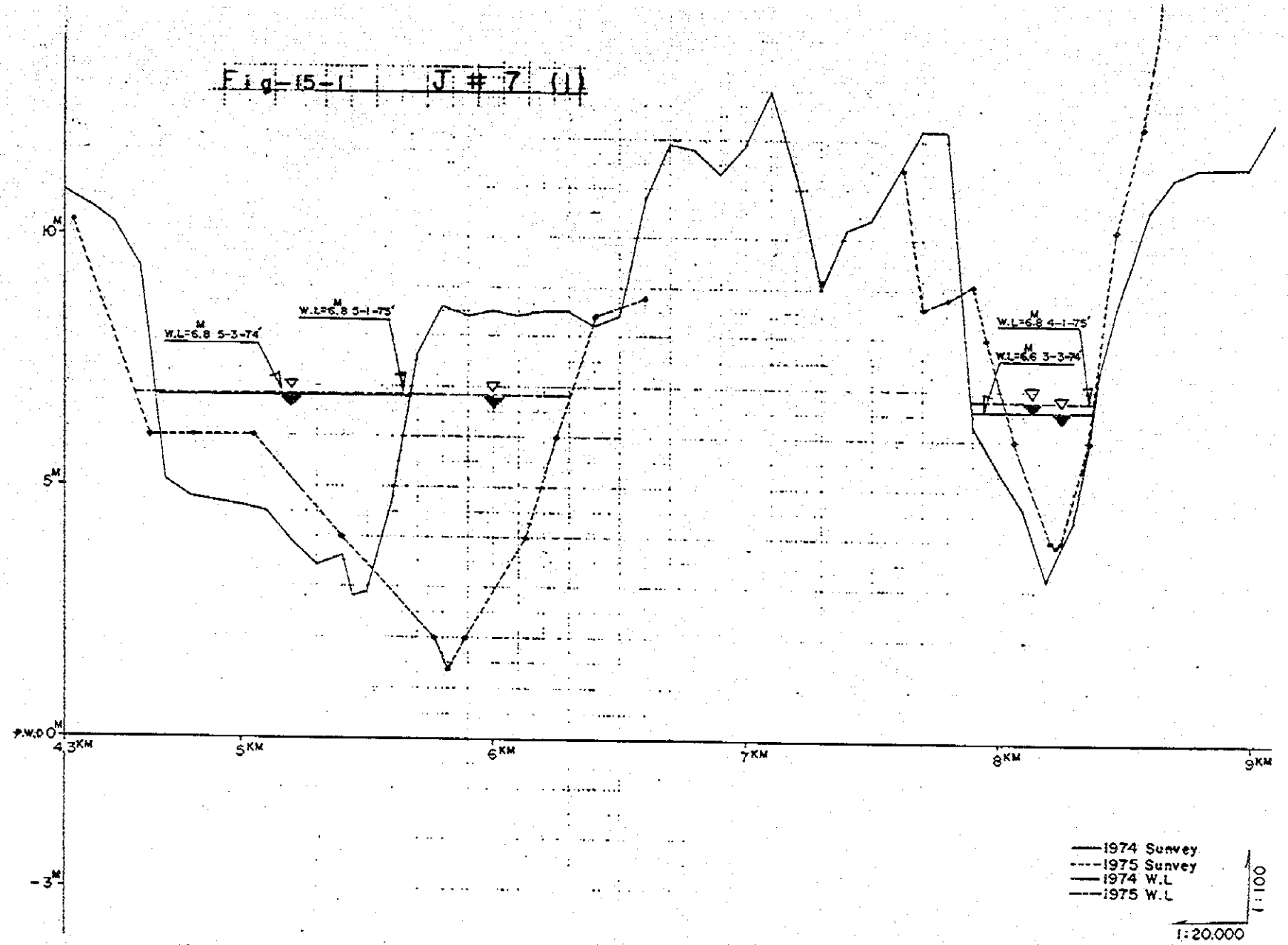


Fig-15-1 J # 7 (1)
10M
5M
P.W.D 0M
-3M
4.3KM
5KM
6KM
7KM
8KM
9KM
W.L=6.8 5-3-74'
W.L=6.8 5-1-75'
W.L=6.8 4-1-75'
W.L=6.6 3-3-74
1974 Survey
1975 Survey
1974 W.L
1975 W.L
1:100
1:20.000

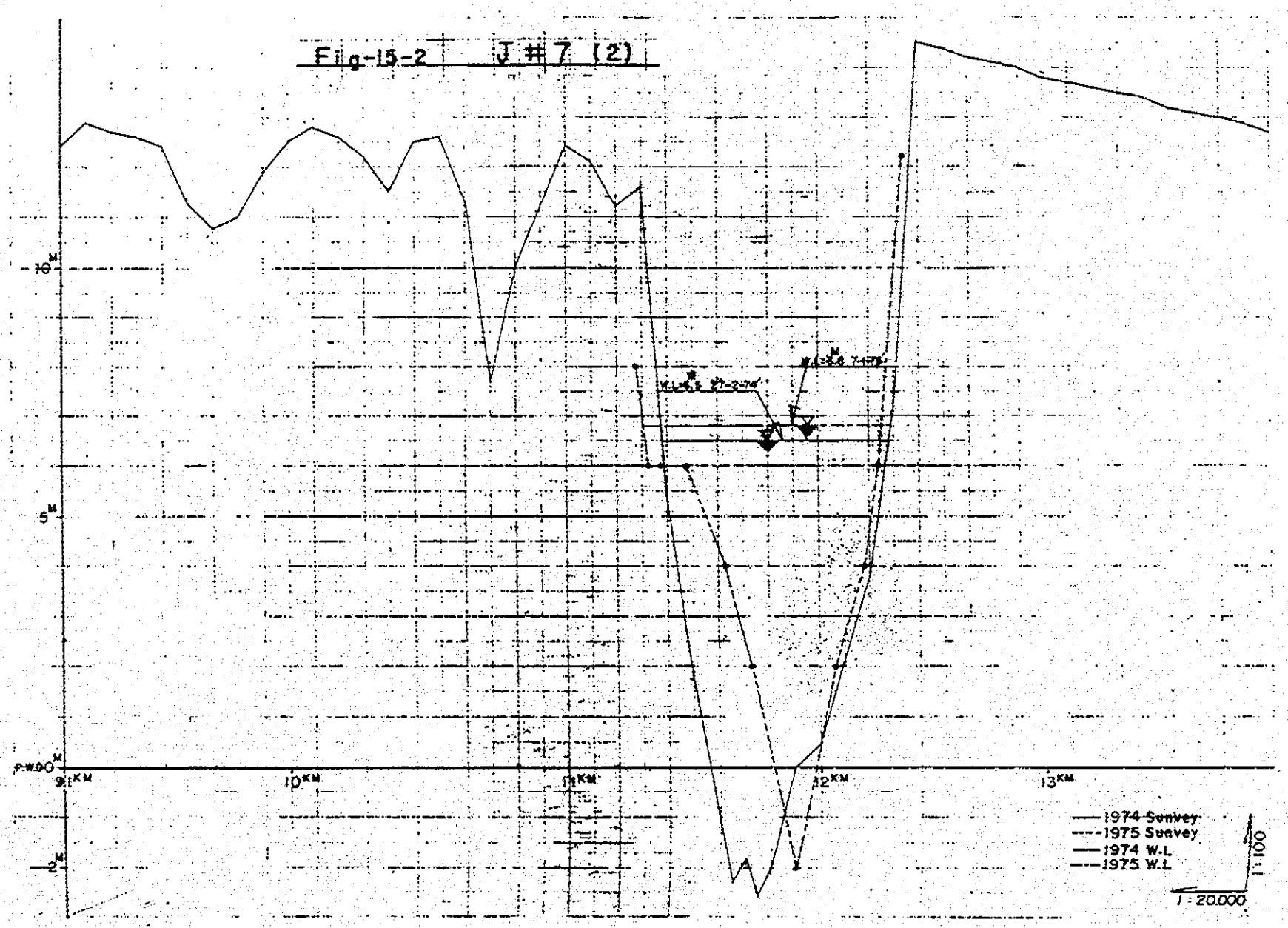


Fig-15-2 J #7 (2)
10M
5M
P.W.90M
9KM
10KM
11KM
12KM
13KM
1974 Survey
1975 Survey
1974 W.L
1975 W.L
1:100
1:20,000

CHAPTER IV CROSS SECTIONAL SURVEY OF ACCESS ROADS AND PLANNED RAILWAY ROUTE

CHAPTER IV. CROSS SECTIONAL SURVEY OF ACCESS ROADS AND PLANNED RAILWAY ROUTE

4-1. Working Plan (refer to 2-1)

In accordance with the memorandum of the general survey conference on 4th December 1974, a plan was made on the area which was divided into two, that is, one is the district to be surveyed centering on Dacca as a base, and the other the district for the purpose of centering on the base camp as a base. What was specially attantioned was to establish the raltions of height by connecting with BM (Bench Marks), and also to measure its cross section, on the basis of high water level, even if it is impossible to obtain this standard.

The working plan was made on the field and recognized at the survey supervisory committee.

4-2. Access Road Survey

The survey point of access road is located along the Dhaleswari, a branch of the Jamuna river (refer Fig.-2, S - No. 109), and the present survey shows that it has changed into a dry river, but in the rainy season, it will join the Lohajang river, and join the Dhaleswari river again through Mirzapur. During the flooding period in 1974, the whole area was almost inundated except villages according to a report. The survey of points and water levels have been made as accurately as the survey of other cross sectional ones.

4-3. Survey of Planned Railway Route

River cross sectional survey was conducted six in districts and at nine points from Dacca to Tangail shown as below;

1) A Putiajani (Lohajang in plan name)
2) B Futjani (Futjani in plan name)
3) C Lohajang (Bansi in plan name)

4) D-1 Shimultali

D-2 Bangshi (no plan name)

D-3 Latifpur

5) E-1 Baimail

E-2 Turag (Turag in plan name)

6) F Tungi (Tungi in plan name)

Figure-16 shows the relations between the high water level in 1974, and the mean ground level and water level clarified in the survey. From this fact, it may be considered that the H.W.L. slope is about 1:11,000 and W.L. about 1:8,300. However, W.L. has some points which do not connect with the river and the condition of branches have not been surveyed in details, and it is only approximate value.

Comparing H.W.L. with M.G.L., it is about 1:11,000 in A-C in the west, and in D-F in the east, 1:83,000. Difference in slope can be noticed up to the tableland extending to the provincial boundaries of Dacca and Tangail. And also there is a difference of about 1.2 m in M.G.L. too.

The effects caused by the flood in 1974 were about more than 50 cm in the west, and in the east about 1.6 m to 2.2 m. This is higher than M.G.L.

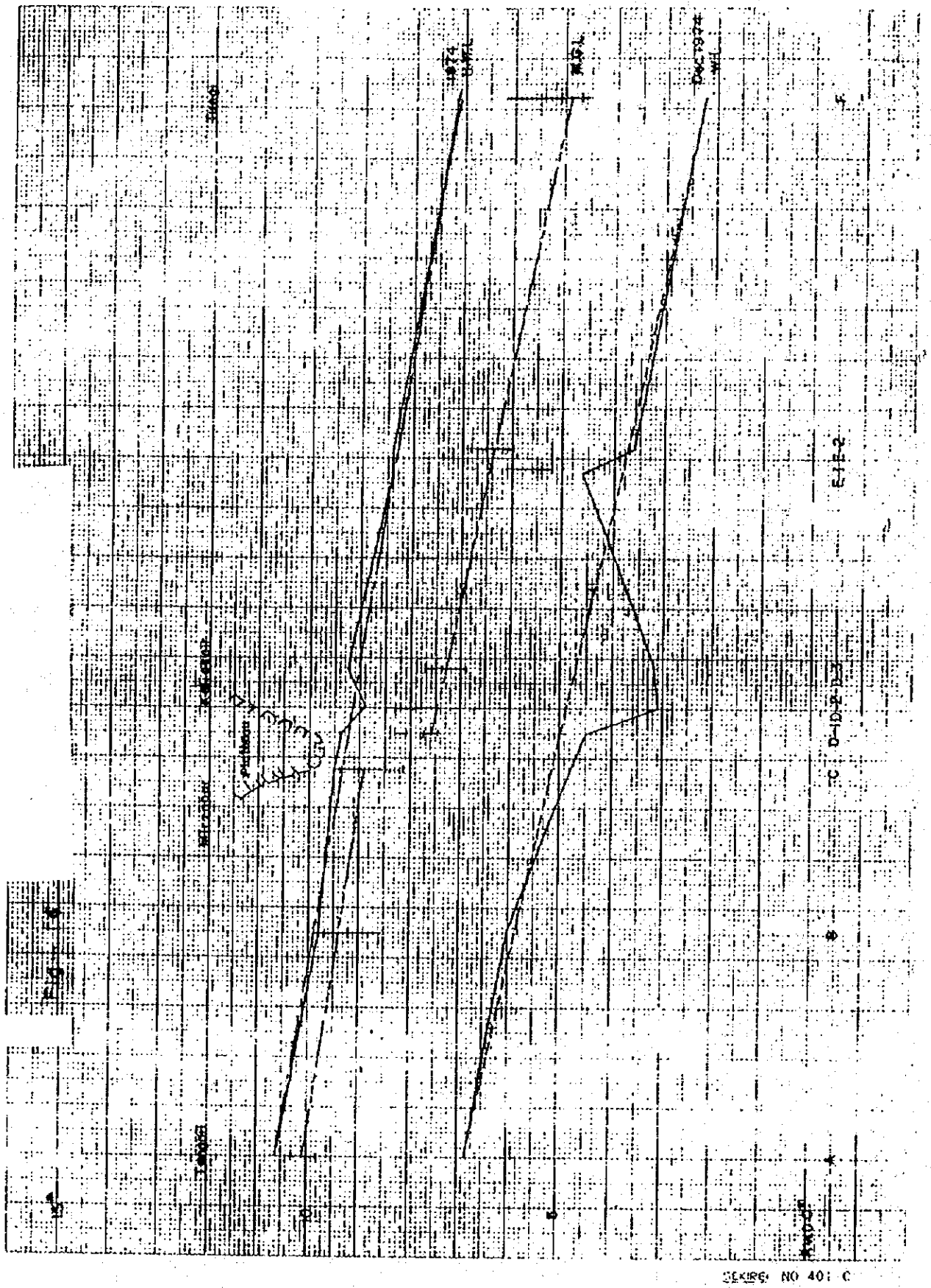
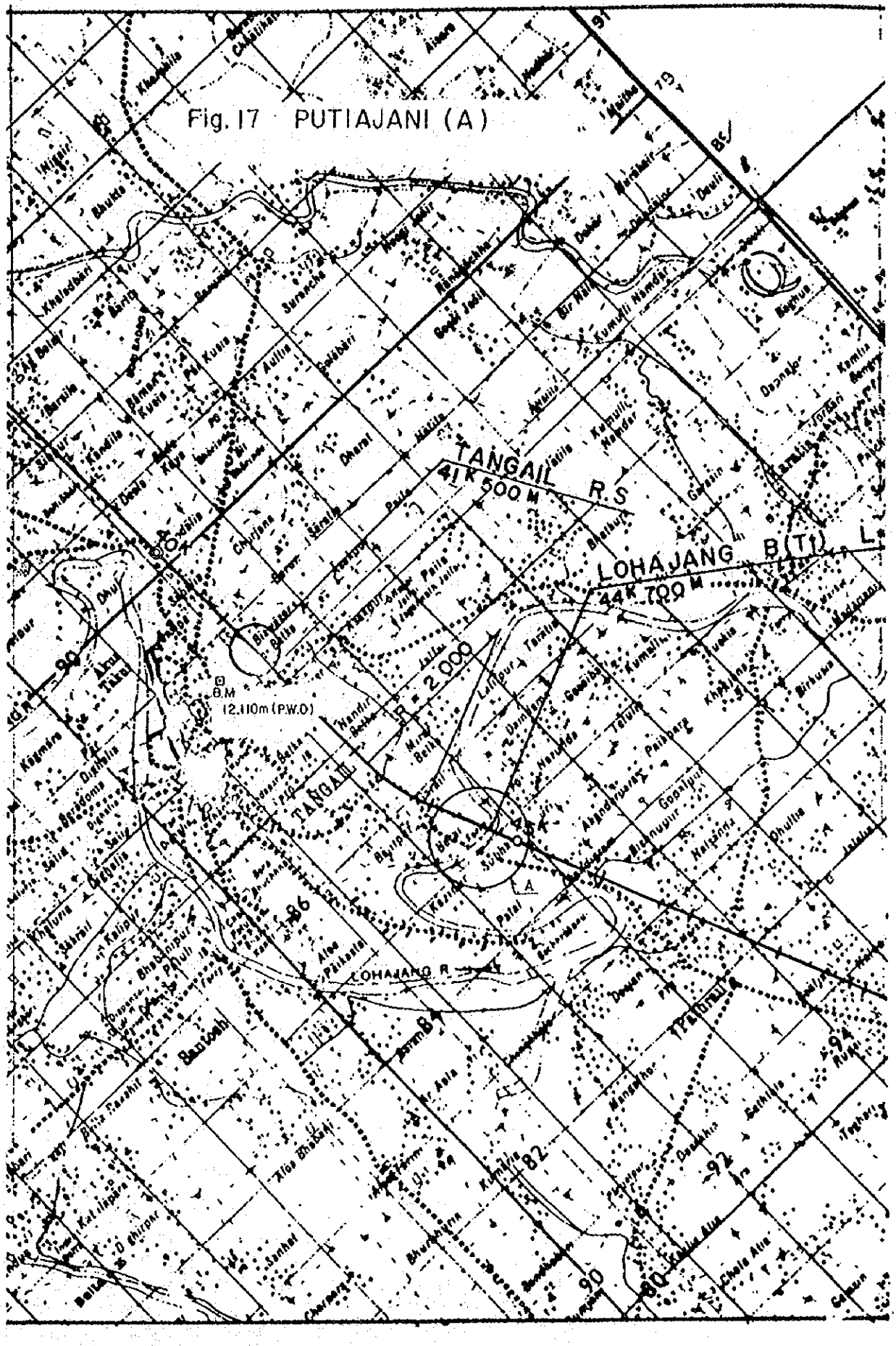


Fig. 17 PUTIAJANI (A)



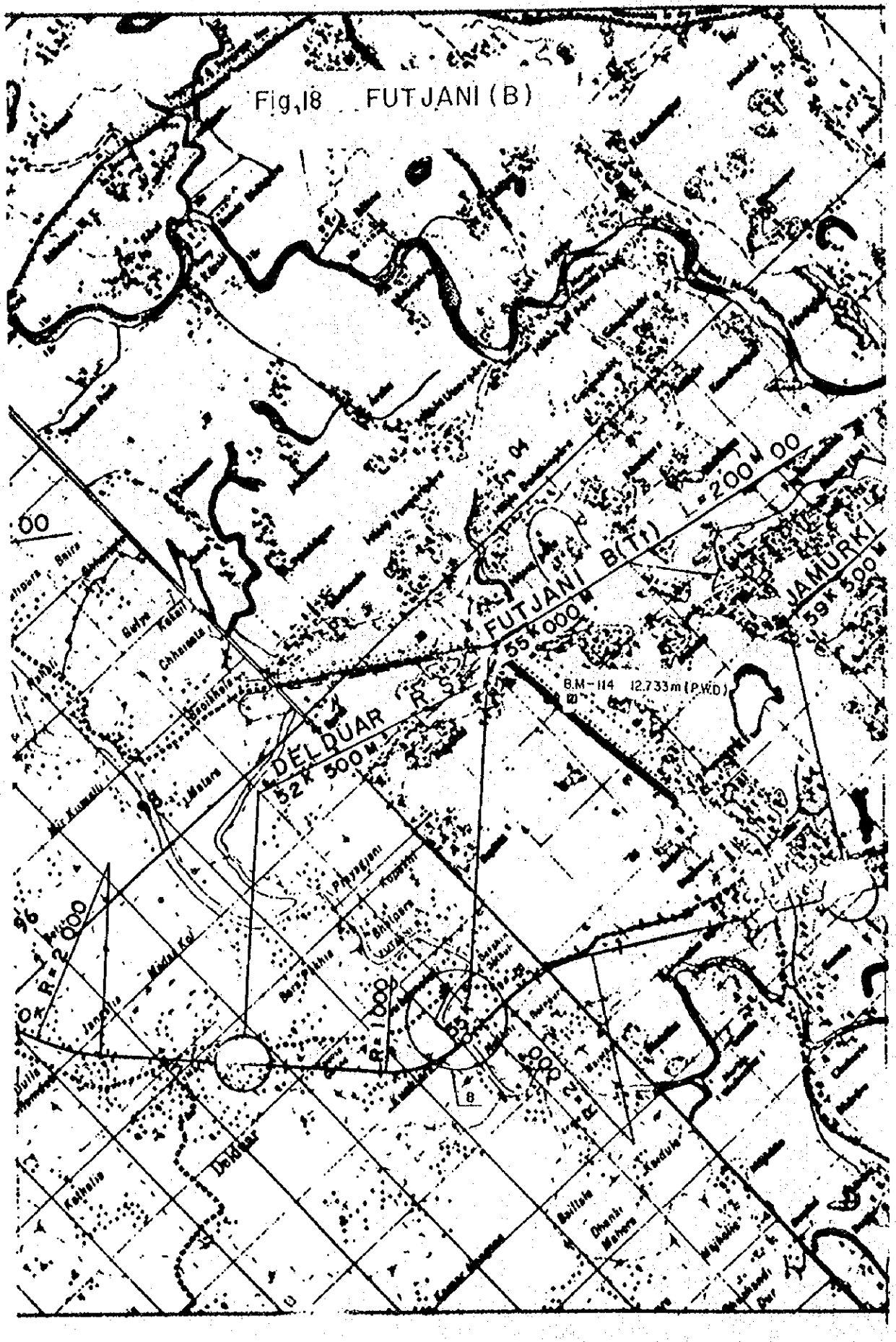


Fig.18 FUTJANI (B)

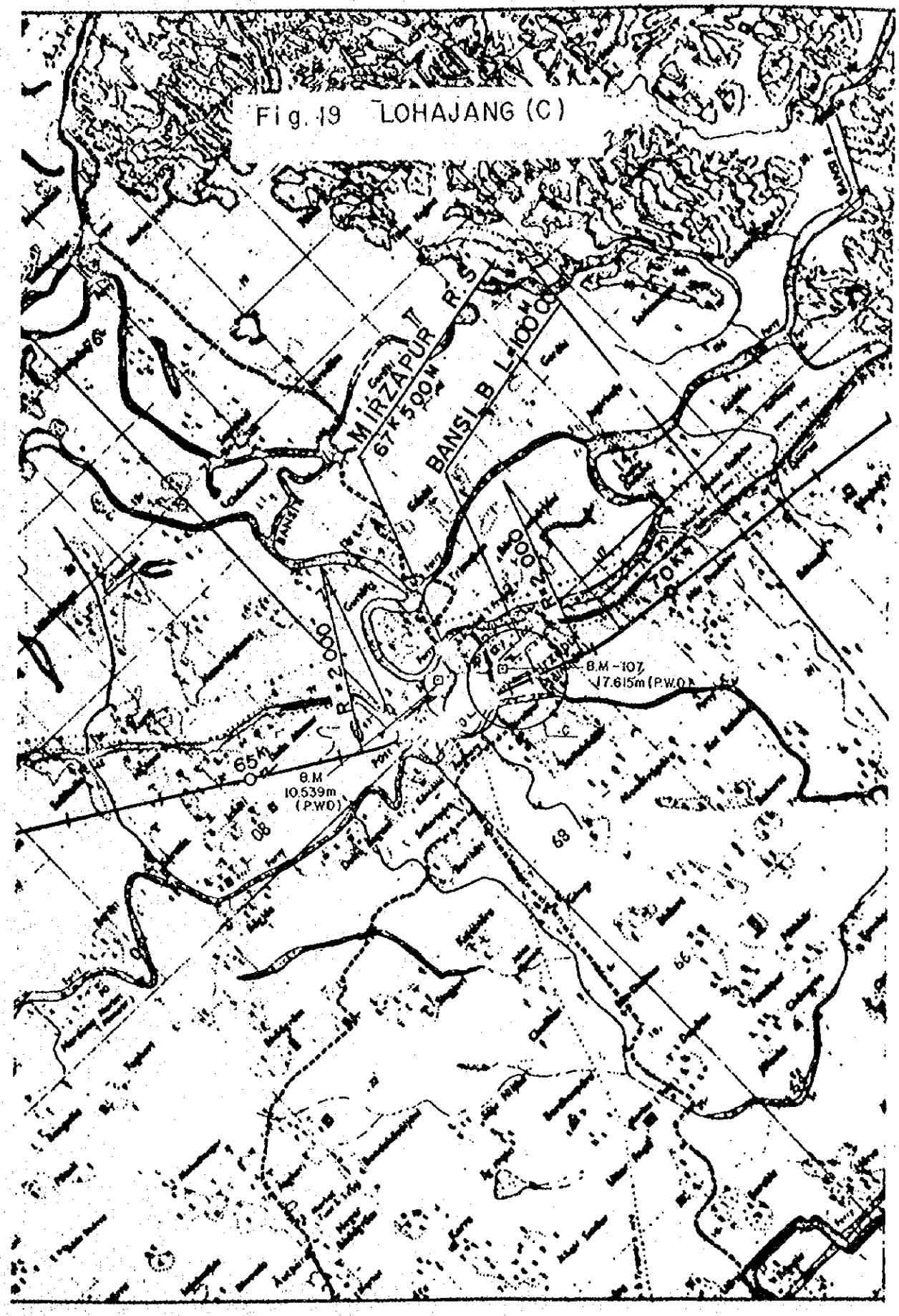


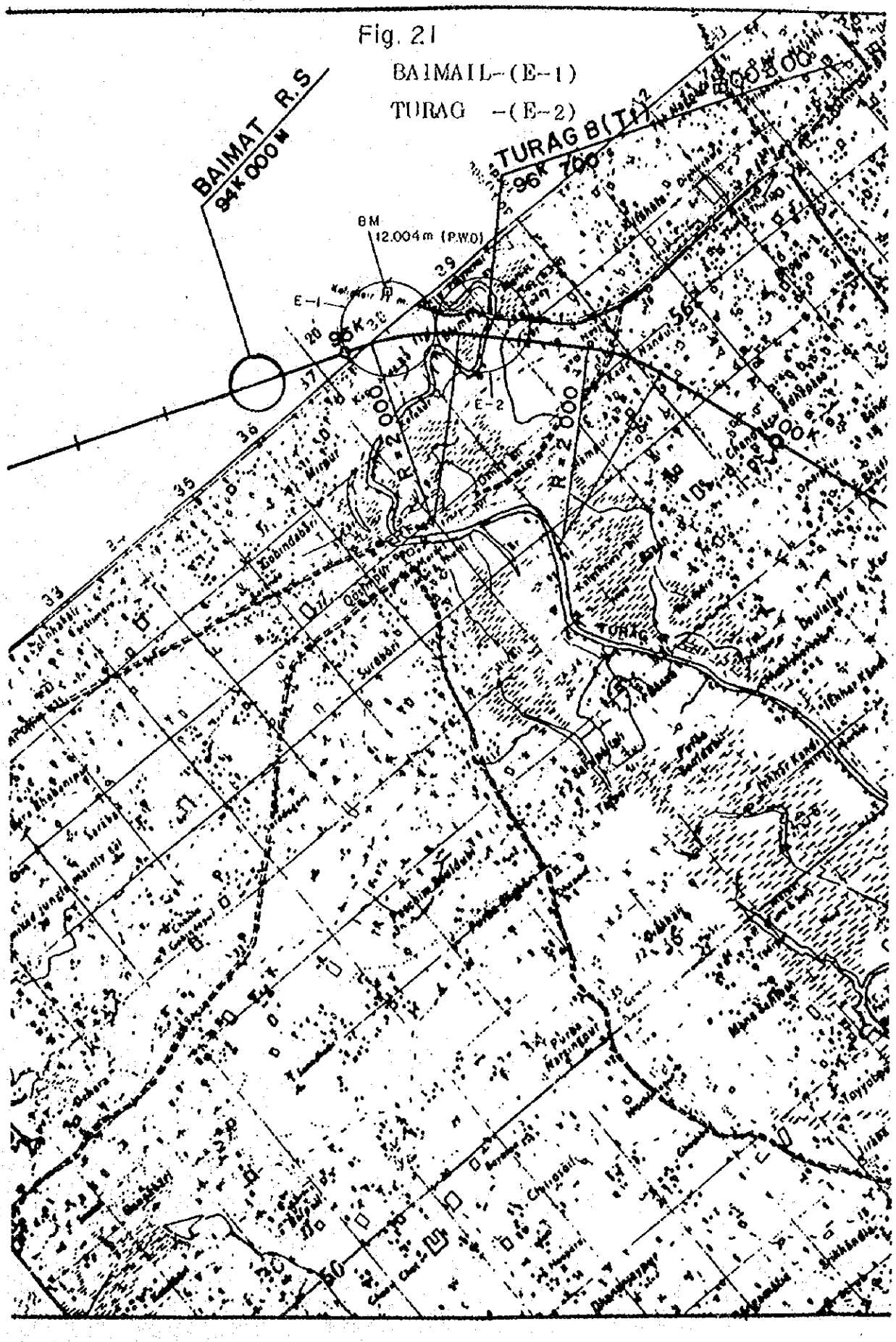
Fig. 19 LOHAJANG (C)

Fig. 20 SHIMUL/TBLI – (D-1)
BANGSHI – (D-2)
LATIFPUR – (D-3)

Fig. 21

BAIMAIL-(E-1)

TURAG -(E-2)



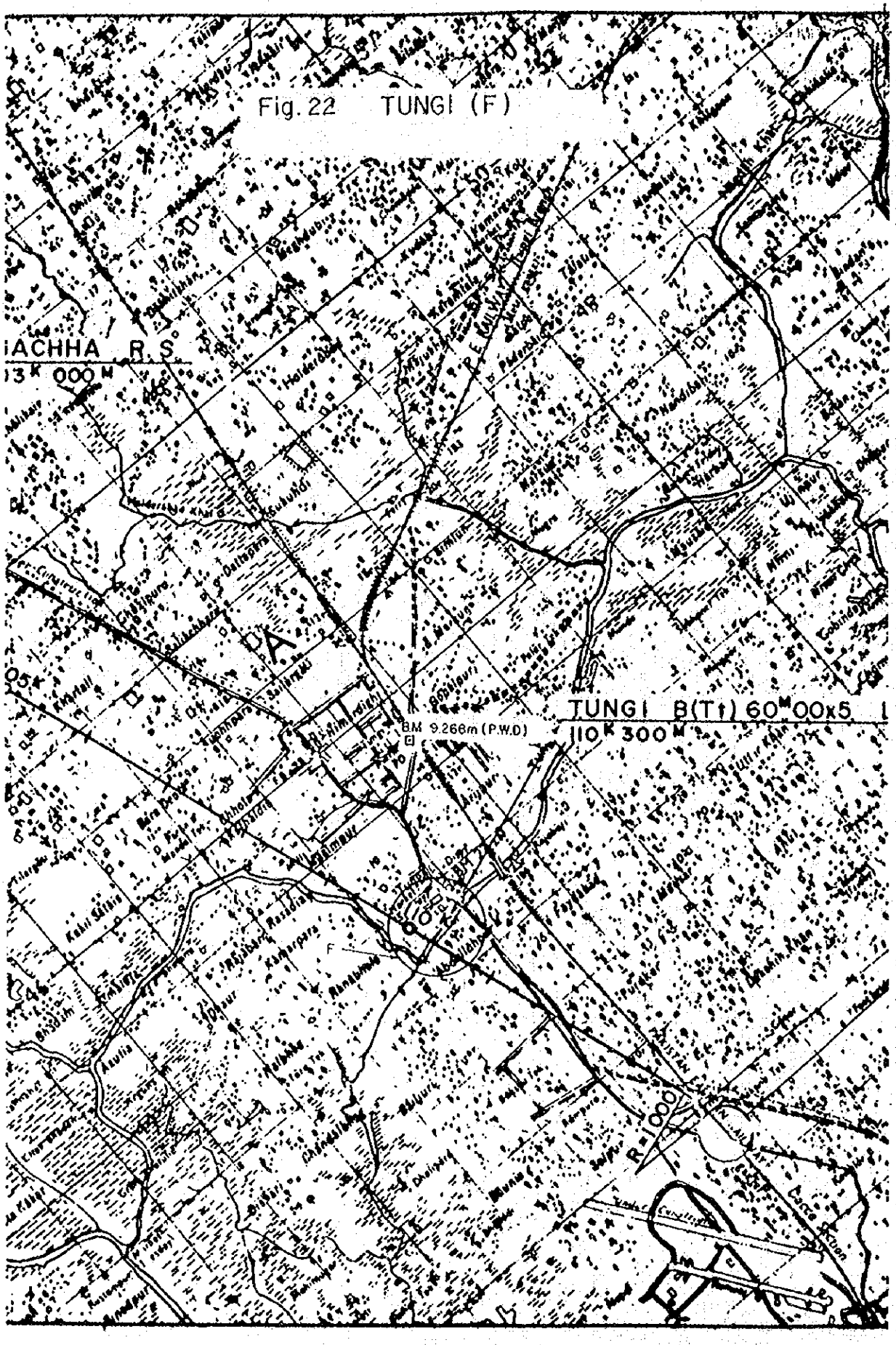


Fig. 22 TUNGI (F)

4-4. Making of Cross Sectional Chart

By utilizing the cross sectional survey on the field, the cross sectional chart has been, plotted on the section myler so that each starting point of the access road and railway route will be on the right side.

Nine sheets of the railway route and one sheet of the road were drawn in the scales of 1/100 vertically and 1/300 horizontally.

CHAPTER V PHOTO-MOSAIC MAKING

CHAPTER V. PHOTO-MOSAIC MAKING

5-1. Working Plan

Photo mosaics are to be made soon after the photo-taking. These are divided into mosaic photos.

Photo mosaics are classified into mosaic photos which are to be made soon after taking photos, and those which are to be made after returning to Japan.

5-1-1. Mosaic Photos on the Field

The plan of mosaic work was made urgently for a general conference on the field as shown in 2-1. Making use of the contact photos taken in 1:33,000 for this purpose, mosaics were made by the feature composing method, and survey sphere, bridge axises and the cross sectional survey lines of the mainstream of the Jamuna river were inserted on these mosaics.

Necessary reprinted maps by photo reproduction were used in survey on the field.

5-1-2. Mosaic Photos in Japan

The contact photos of 1:33,000 which had been taken back to Japan were used firstly for the making of the original of mosaics by feature collection of 1:33,000, and then for reducing it into 1:50,000 in order to make negatives.

5-2. Completed Photo Mosaics

The original of the completed mosaics were stuck up on panel, and their negatives were made too. The field except the river parts is almost flat land. The photo mosaics can be used without processing as a plan.

The values of the photo maps are not changed by reduction and enlargement. Therefore, it is useful to make use of the mosaics for good reference to various planning. The plotting sphere of the present survey is 344 km^2 centered on the main stream of the Jamuna river, but its mosaic sphere

is 900 km^2. It is advisable to make use of these mosaic photos and contact photos.

CHAPTER VI TRANSPORTATION AND CAMPING

CHAPTER VI. TRANSPORTATION AND CAMPING

6-1. Transportation Plan

Success or failure in this survey depended such on how to transport all the personnel and materials and equipment all through the survey period. Particularly, according to the survey conducted prior to the departure of the team, the flood in 1974 was unprecedent in history in Bangladesh, and we had to transport all the necessary equipment and materials and foods from Japan because we anticipated critical shortage in commodities. Taking into consideration the experiences of the survey in the rainy season in 1973, special attention was given to the following on ship cargos and air cargos;

1) To send ship cargos at least three months prior to the starting of the work because of the expected number of days which are necessary procedures for customs clearance.
2) To despatch an advance party before the main survey team arrive in Bangladesh for the purpose of receiving the cargos.
3) To concentrate all the equipment and materials in Dacca, and then to transport them by the unriskiest and fastest method.

6-2. Camping

It was necessary to set a new base-camp for this survey, it was also considered as necessary to send the personnel and equipment by water to necessary survey points because in the dry season the Jamuna river was expected to be more than 4 km in width, and the sphere of survey was anticipated to be 25 km along the main stream, and about 12 to 18 km toward the cross section. Decision was made that it would be most effective to conduct the survey at a base camp which was planned to set upon the shore around the center of the survey area.

The construction of the base camp was planned under the direct management of JICA with the participation and cooperation of the survey team.

The necessary construction materials were all shipped from Japan.

The most important problems in the camp construction are; (1) how to secure the supply of fuel oil, etc., (2) how to secure medical aids in emergency.

6-3. Transportation and Camping Conditions

6-3-1. Transportation

On 22nd October 1974, one member who started from Japan for Bangladesh beforehand arrived in Bangladesh to take care of the receiving and transporting the cargos. Ninety-nine ship cargos leaving Japan on 26th August were cleared in customs in Titagon habour on 30th October, and reached Dacca station by railway on 9th November.

As regards the air cargos, fifty-six cases were planned to take in Dacca at the beginning of November according to the first plan, but because of the inefficient air-lift system, between Bangkok and Dacca, we had to negotiate with airways companies many times. And finally the cargos arriving at Dacca were on 14th November and cleared in customs on 18th. Equipment and materials necessary for photo processing were taken directly from the airport to the Survey of Bangladesh, and all these cargos stored at three places in Dacca, as planned beforehand.

The cargos to transport from Dacca to Sirjinga, a working base at the beginning, were equipment for the control point survey and leveling, and daily necessities packed in about 100 case and 30 drums of fuel oil. These cargos aboard three sea trucks left Narayanganj harbour on 25th November, going up the Megna river, Padoma river and Jamuna river, reached Sirajiganji harbour on 29th November. One sea truck of 57 foot length and two sea truck of 25 foot length were chartered on the spot, and we continued to use the latter for the survey. About 29 people consisting of 2 members of the team and 7 policemen went on board the trucks for the security of transportation and preparations for camping. And the transportation from

Sirajiganj harbour to the JICA office had been completed on a truck and jeep and two chartered trucks making a detour by land. All the equipment and materials reached the termination without any damages, and prior to the starting day of the survey operation, the unpacking, inspection and preparations of all the equipment and materials were completed, because taking into consideration the delay in the starting of operation of the survey team in the rainy season of 1973, much attention had been placed on the shipping date from Japan, procedures for customs clearance, transportation arrangements, problems on transportation, etc.

In connection with other transportation matters, the movement from Sirajiganj to the base camp, the movement of the sounding party from Dacca to the base camp and the transportation for the retreat from the base camp to Dacca, and also the transportation from Bangladesh to Japan have been described respectively in each chapter.

6-3-2. Camping

The initial plan showed that the construction of base camp would be completed by the end of November, and the survey operation would be conducted from the beginning of December at the base camp as its survey base, but inspite of the serious efforts of the JICA office, we had to estimate the completion of construction to be after the middle of December, because the decision of a base camp was made on 18th November and the first construction materials reached on 26th November respectively later than planned.

According to the survey operation flow, we had to complete sounding by the end of February in order to avoid the season of sandy storms. It was a prerequisite for this purpose to commence control point survey and leveling from the beginning of December. Therefore, we had to use the JICA office of Sirajiganji on the opposite shore about 10 km up from the base camp, and to return to the base camp after the completion of construction. This JICA office was used as a lodging house for the survey members in 1973, but has been

closed since May 1974. Therefore it was not good for immediate occupation for the purpose.

The members who were in charge of transporting the equipment and materials made prepatations of shelves or store rooms necessary for the living of the team, in addition to the repairing of tap water and electric light facilities in the office for nine members of the main party camping on 2nd December.

The survey base was shifted to the Singjuli base camp on 16th December along with the completion of the base camp, which was used until the completion of the sounding party's survey at the end of February of the following year.

The base camp was constructed directly by JICA, and has been managed since. It was used as a lodging house by other various survey teams, and particularly as a boring work base by the geological survey party.

An outline of the base camp has been shown in Fig.-23. Special attention was paid to tap water and bathing equipment, in addition to lodging, cooking and recreation. Its environment was very pleasant for living as well as survey working because it was equipped with an independent power generation for electric light and wiring.

The procurement of a large volume of fuel oils for vehicles, sea trucks and cooling and watering equipment for a period of four months was considered as a big problem for the constructon of base camp.

At the time, Bangladesh was short much in high octane gasoline, and we had many difficulties to secure the large supply of fuels for a long period although we had an official permission from the government.

At that time, land routes were closed by flooded rivers, and the transportation at the first half of period depended entirely on sea trucks. However it became to be easier because we could use helicopters in the middle of the survey. One of the helicopters were chartered in Singapore to carry the sick or injured members in an emergency and also for the necessary supplies. And its effectiveness

was made use of much because it could be applied to surveying in the last half of period.

6-4. Camp Assault Incident

The first half of the main survey operation went on smoothly being favored by the good environments such as weather, topography and lodging. However, in the last half of it, we were given much pressure psychologically and the proceeding of the operation was handicapped with a camp assault incident.

6-4-1. Situations Prior to the Incident

The survey team moved from Sirajganj to the base camp on 16th December 1974, and the JICA office on the field gave an opening ceremony on 28th December, which was participated by the assistant Parliamentary Vice-Minister of transport, provincial governor and many people concerned.

The guests made an observation on the situations of the survey operation and the equipment facilities of the camp, and the event was completed successfully under a good atmosphere. Around that time we heard of the attacks of armed groups on a police boxes in Tangail and Sirajiganj.

The policemen assigned in the area of the camp were twelve in number. In addition to the main duty of guarding the camp they were taking care of ships and boats navigating the Jamuna river and villages in the vicinity of the camp. They seemed to keep sharp eyes on native people entering the camp site without permission. Nobody of the Japanese members could anticipate the happening of an accute situation, when they were ordered to switch off the light because of shootings once at night in January. Along with the good hospitality of the native officials and inhabitants toward the bridge survey of the Jamuna river, we had made a decision that there would be no attacking on the base camp.

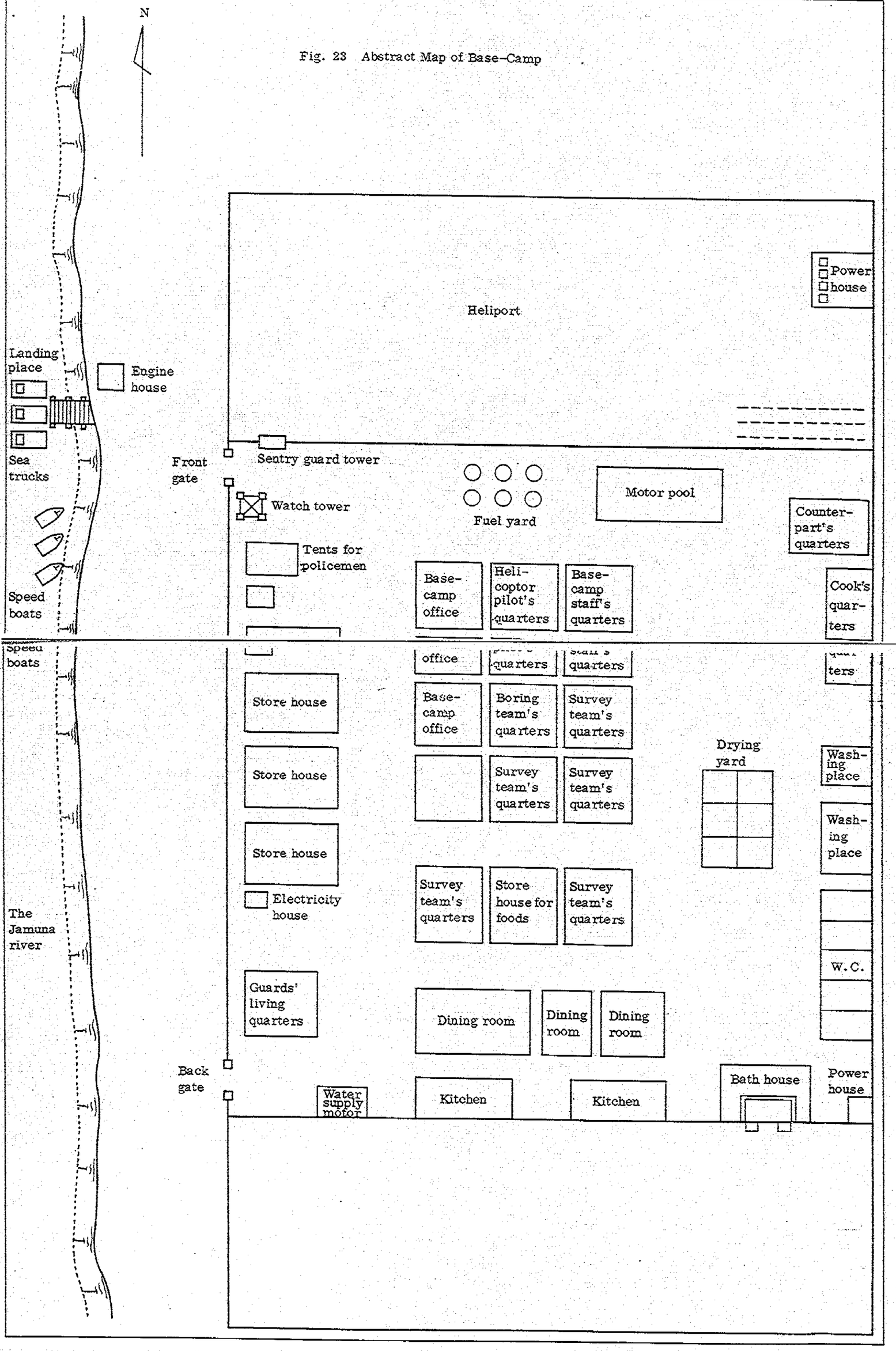
And the diffusion of cooperative spirits in the area.

6-4-2. Assault of Armed Groups

However, an attack took place on the night of 12th January 1975 on the contrary to our judgement. Armed groups started to launch an attack with shootings on the guard boxes on both the south-east and the east of the camp site. And a part of the gangs succeded in invading into the boat harbour just in front of the camp and in approaching only ten meters distance to fire on two lodging camps, large and small. The exchanges of the assaulting groups and the defending policemen continued for about two hours.

As some bullets penetrated the Japanese camp, the Japanese members and native workers lay flat on the ground until the shootings came to an end. Not only the policemen but also some natives fought with arms to stop the enemy from invading the inside. Although we found many bullet marks when we inspected all the parts of the camp site, luckily there were no damages or injuries on the personnel and equipment. The police chief submitted a report on this assault as follows;

Fig. 23 Abstract Map of Base-Camp



FOLLOWING MESSAGE HAS BEEN RECEIVED FROM BASE CAMP AT 1200 HRS 13.1.75

To
The Manager,
Jamuna Bridge Survey Office
Base Camp, Sirajganj

Sub: Base Camp Attacked by Armed Miscreants

Dear Sir,

This is to inform you that last night about 23:04 hours some miscreants attacked the Base Camp. Firstly, one LMG brush was opened from the smouth east corner of the Base Camp aiming at the Scentry Guard. On hearing of the firing we all policemen took our respective position. After the first brush the Scentry Guard replied. Simultaneously more brush firing were coming aiming at us from north and north west corner and we started firing at them. This exchange continued for nearly 2 hours. Afterward I sent 4/5 policemen to patrol the adjacent areas but they did not tread out the miscreants. Probably at that time they ran away. During the exchange none was killed nor injured. I used nearly 152 ammunition. In the next morning I marked total 46 bullet marks in different tents, sandbags and bamboos fired by miscreants.

So, I therefore, hope you will kindly make the necessary arrangements through your Organization so that I could send messages to communicate with our departmental Head. I also inform you that I am very much pleased at your co-operation and assistance during the operation.

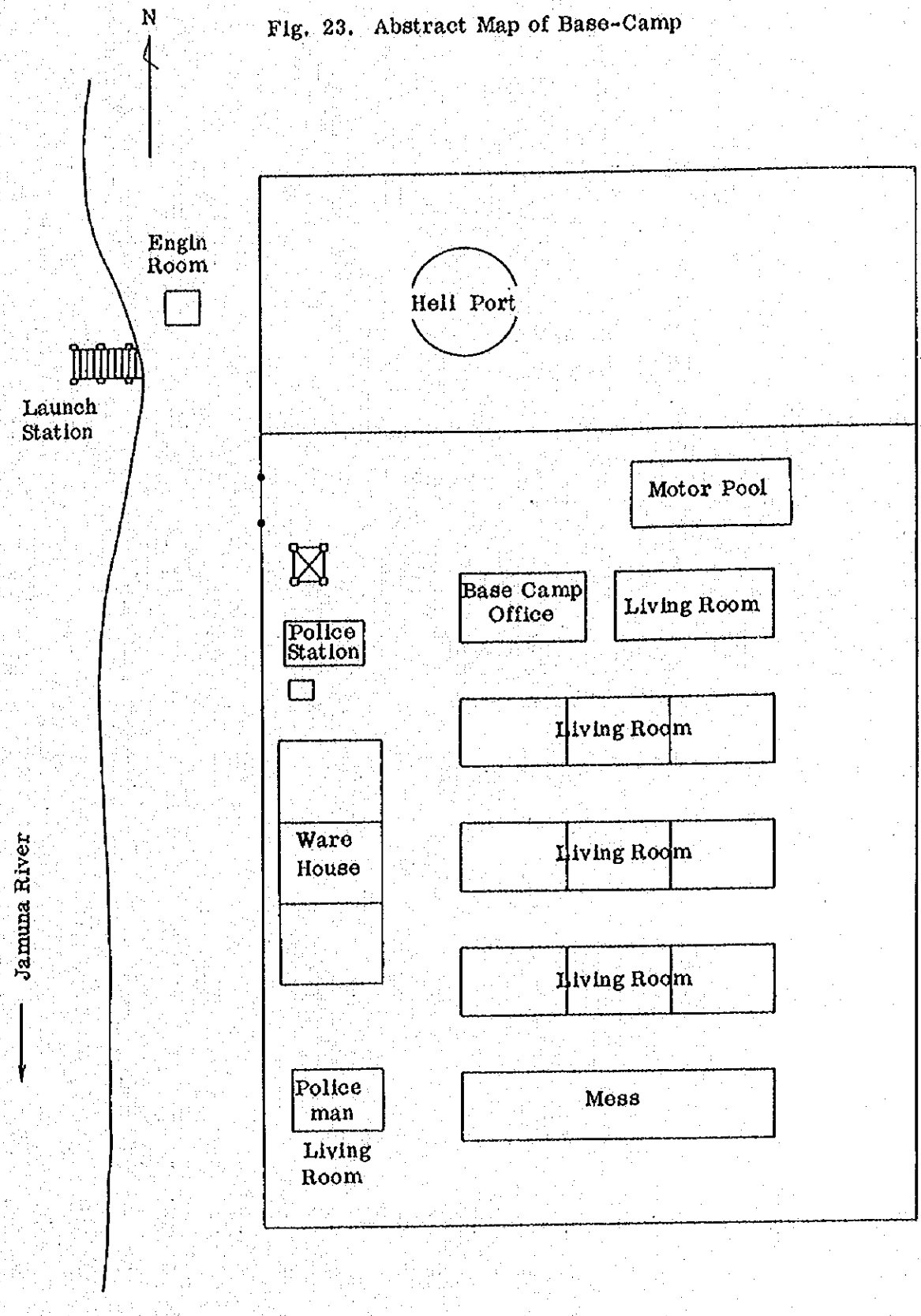
Thanking you.

Yours faithfully,
ABUL KALAM
Havildar No. 4523
H.R.T., Police Incharge
Base Camp.

c.c. File

Radio TOK 1200 asc 13.1.75

Fig. 23. Abstract Map of Base-Camp



The surveying was suspended on 13th in order to watch the development of such a situation, but it was restored on 14th because of our judgement that there would be little danger in the day time.

6-4-3. Action after the Incident

1) Consultations for Action on Incident

On 13th, Japanese Ambassador Oyamada and the project personnel on the Japanese side met at the Embassy of Japan to make a study of the general survey operation and situation of the assault for the purpose of making future policy of action.

As a result, the following articles have been confirmed;

(1) to request the Bangladesh government for the enforecement of guarding forces, and also an immediate action for the assault case,

(2) to increase the equipment to secure safety against shooting attacks, and

(3) to complete the necessary survey without suspending the work in order to shorten the period of staying at the base camp by checking survey methods.

2) Action at Base Camp

Discussions were made in details on a fundamental policy to deal with the incident. At the base camp on the night of 14th. Consultation was also made among the provincial governor, police chief and JICA office which took the initiative in making decision. As a result, a plice commander was despatched, policemen were increased more arms were supplied, and improvement of guard posts and shooting facilities were made. In addition, three thousand sand-bags were made for defence, and barbed wires of 300 m and eight units of search-lights were newly equipped in and around the camp which was enforced with trenches and coverings. This defending work was almost finished around 22nd January so that every part of the camp was covered and safety could be secured against enemy's approaching and shootings.

3) Continuation of Survey Operation

From the judgement that there woule not be dangers in the day time, we started again to conduct the operation with the maintenance of liaison methods in survey, and place limits on base returning time. And Helicopers were made use of in operation too. In order to shorten the staying period at the camp holidays were cancelled for the continuance of the work. We never met against with any incident later, the whole survey work was completed as had been planned without indjuries and damages on the personnel and equipment.

The above is the development of the assault incident. Our deep gratitude is really due to the kind consideration of Bangladesh people as well as their government.