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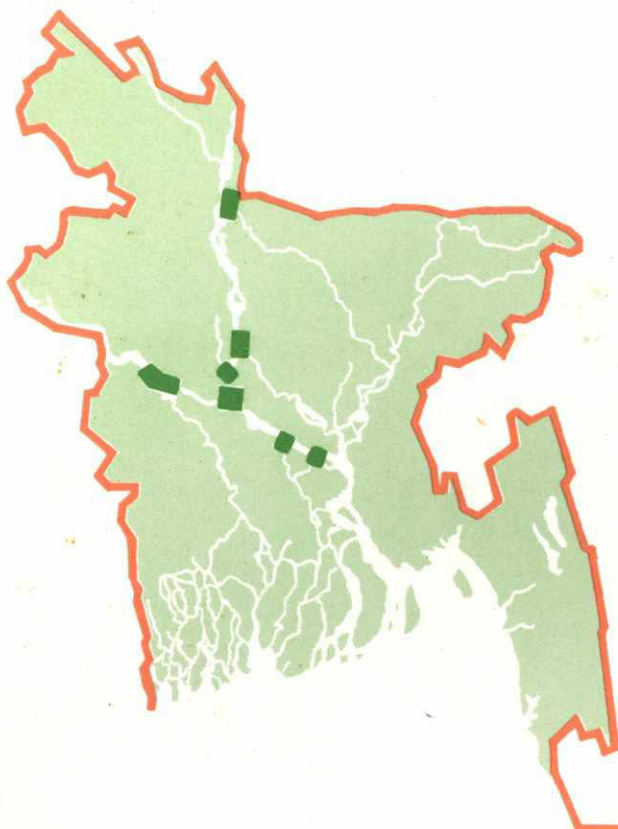
# GOVERNMENT OF BANGLADESH FLOOD PLAN COORDINATION ORGANIZATION

## FAP 24 RIVER SURVEY PROJECT

17

### 2° Interim Report

General Project Report



DELFT HYDRAULICS  
DANISH HYDRAULIC INSTITUTE  
OSIRIS  
HYDROLAND  
APPROTECH

Project ALA/90/04 — Commission of the European Communities

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## 2° Interim Report

General Project Report No. 8.

February 1995



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# FAP 24 RIVER SURVEY PROJECT



DELFT-DHI

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February 26, 1995

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Attention : Mr. Afzalur Rahman.  
Superintending Engineer.

Subject : 2° Interim Report

Our ref : RSP/9.1/1318

Dear Sir,

With pleasure we submit herewith 10 copies of our 2° Interim Report. We are looking forward to receiving your comments.

Thanking you

Yours sincerely

Johan G. Grijzen  
Team Leader FAP 24

cc to : PMU (2 copies of report)  
CEC (1 copy of report)2

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#### Annexures :

- 1 PSD 24 User's Guide
- 2 Changed format Survey Bulletins
- 3 Training Programme

## 1. Introduction

### 1.1 Rationale

In the Terms of Reference of the River Survey Project interim reports are requested after 6, 24 and 36 months (Sections 4.4.2 and 4.4.4). Moreover a Final Report Phase 1 was envisaged after 12 months. The second interim report should cover the intermediate results of the project period between the Final Report Phase 1 and month 24 (so the second year of the project from June 93 to June 94).

However, due to various reasons the test gaugings could not be done earlier than August 1993 and the International Workshop was postponed till November 1993. As both events have an important impact on the selection of survey techniques and further planning for phase 2 of the project, it was decided to include the activities of 1993 in the Final Report Phase 1.

As a result this second Interim Report is mainly covering the first half of 1994.

The report gives a description of the ongoing activities in surveys, data processing, studies and training. Some intermediate results are summarized and the further activities are outlined in the workplans.

### 1.2 Structure of this report

Chapter 2 reviews in brief the various main activities of the River Survey Project, which are discussed in more detail in the following chapters :

Chapter 3 **Mobilisation**, dealing with the additional vessels and equipment required to increase the survey capacity for the work in phase 2 of the project

Chapter 4 **River Survey**, dealing with the various types of measurements (water-level, discharge, bathymetry, etc.) on the river.

Chapter 5 **Land Survey**, mainly dealing with the horizontal and vertical control activities

Chapter 6 **Data processing**, describing the processing of survey data and the development of an engineering database PSD 24.

Chapter 7 **Studies**, dealing with the various study topics tackled in the reporting period and presenting some results

Chapter 8 **Training**, describing the various training activities in the project period and presenting a proposal for further training



Finally a review is given of the reporting undertaken in this project (Chapter 9) and the work programme covering the further activities as outlined in the workplans of Chapter 10.

## 2 Review of the activities

### 2.1 Introduction

The proceedings of the River Survey Project during the first half of 1994 are summarized in this chapter. An overview of the key activities is presented in Figure 2.1 and all these activities are summarized in the subsequent sections.

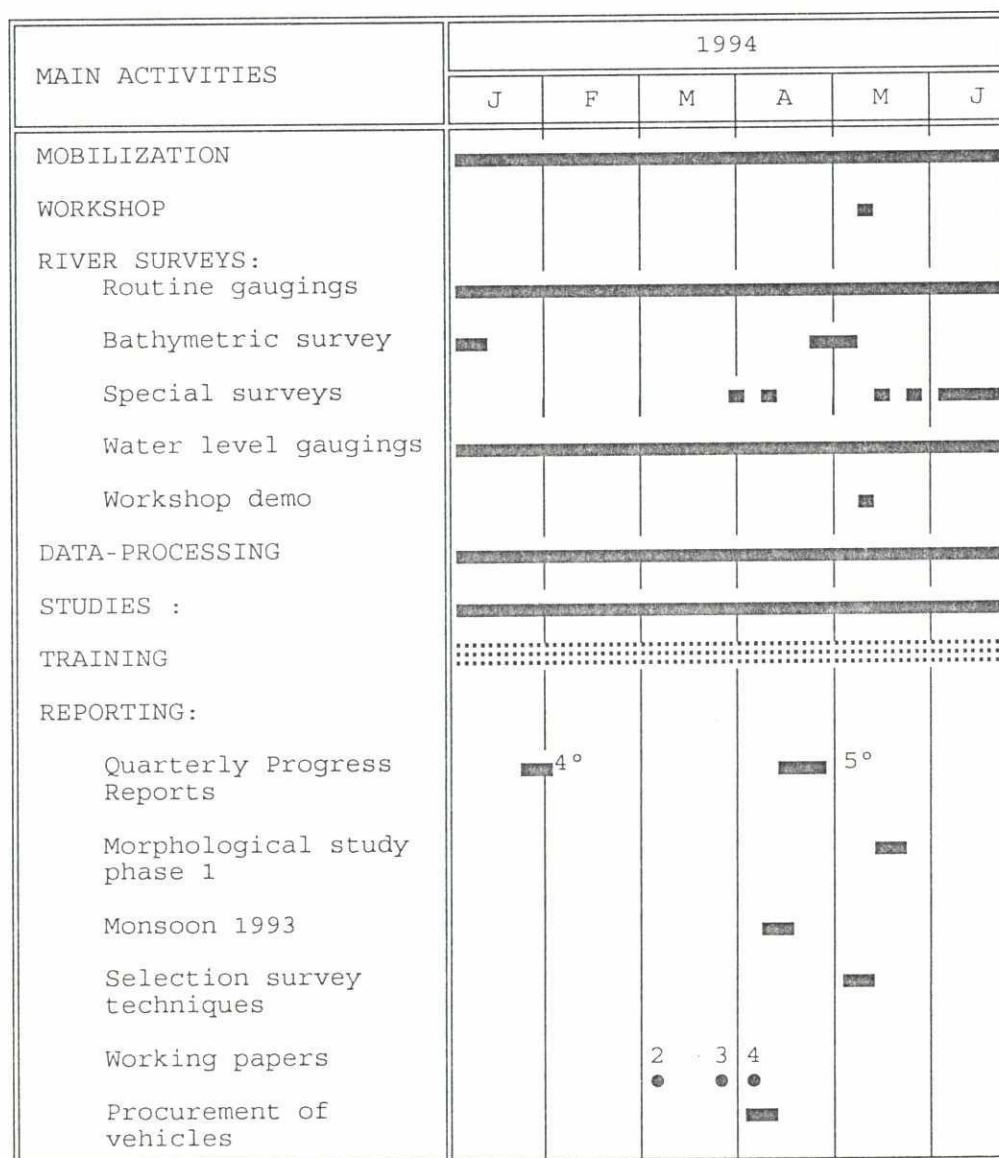


Figure 2.1 Main activities

### 2.2 Mobilisation

In the reporting period two extra survey vessels (DHB and DHE), as well as supplementary survey equipment was procured and mobilized. Mobilization was completed by the end of June 1994.

### 2.3 River survey

During May and June 1994 eight pressure type and one acoustic type of automatic water level recorder (AWLR) were installed. Shallow water platforms are constructed at safe locations, from which the upper left of the hydrograph is measured. The lower part of the hydrograph is monitored with staff gauges.

In total 32 routine gaugings of discharge, suspended load and bed-load were performed during the period January to May (lean season). The results are published in Survey Bulletins, the format of which has been revised from bulletin no. 48 onwards (see Annexure 2). Ten (10) HW routine gaugings were performed in June 1994.

Bathymetric surveys were conducted at two locations, while several special surveys were performed to collect data for use in the FAP 24 studies. These included extra discharge measurements at the Bahadurabad transect, with the objective to develop a reliable FAP 24 rating curve for this location. *// Rewrite*

### 2.4 Land survey

No particular land survey has been done during the reporting period.

### 2.5 Data processing

Most of the field measurements are computer data, which are called raw data and which need off-line data-processing. The off-line data processing comprises file conversion, plotting for quality check, subsequent data reporting and listing of files in the data catalogue. After processing the data are called processed data, which are stored in a database called Processed Survey Database, PSD 24.

Brief summaries of the results of the routine surveys are presented in Survey Bulletins. During the first half of 1994 the survey bulletins no 28 to 47 have been published in the same set-up and lay-out as used for the previous bulletins. This means that part of the detailed measurements was presented in the survey bulletin. Because the bulletins are mainly intended as a documentation of the field work and secondly as a reference for the data users, the set-up of the bulletins was changed to a more lean and systematic data presentation of key results in an easy to understand format. The revised format of the survey bulletins started from Survey Bulletin number 48, the first survey of April 1994.

The PSD 24 database was designed as an easy accessible database for study and analysis of the survey data by various users, inside and outside the project. The setup and the format of the PSD 24 was defined in spring



1994 and this database will become fully operational at the end of 1994. To facilitate the use of this PSD 24 the local area network of the personal computers in the Consultants' office has been extended to the Study Group.

## 2.6 Studies

One of the objectives of the River Survey project is to undertake special studies of the behaviour of the river system in Bangladesh based on (1) the new data that are collected during the routine surveys of the project, (2) existing data and (3) through supplementary surveys. The activities for the different study components during the reporting period are described briefly below.

### Hydrology

Progress has been made with the study of the rating curves, determination of separate rating curves for the right and the left channel near Bahadurabad, improvement of the historical discharge time series at Bhairab Bazar and Mawa and the analysis of local water level slopes. As a preliminary result the discharges determined from separate rating curves for individual channels do not deviate significantly from the discharges determined from a single rating curve. Another preliminary result is that the water level slope increases during the rising stage and decreases during the falling stage. The reported inconsistencies in the discharge time series and the rating curve at Bahadurabad, see Final Report Phase 1, has been studied by a Committee with representatives of BWDB, BUET, FPCO and FAP 24. This committee confirmed these inconsistencies and it recommended a further study and joint field measurements by BWDB and FAP 24 at Bahadurabad. In cooperation with BUET preparations have been made for special field measurements to establish the accuracy of the slope-area method.

### Morphology

The optimization of the sediment rating curve for Bahadurabad included the study of a possible seasonable effect on this rating curve. The exclusion of the dry season data did not result in a significant improvement of this rating curve. The data for the study of planforms and channel dimensions has been collected and no results from this study are available yet. A joint research programme between FAP 24 and the University of Nottingham to conduct a study on secondary current patterns in a bifurcated channel and over a braided char started in spring 1994. The first special field measurements were collected in May 1994.

As part of the topic optimization of suspended load measurements a collapsible bag sampler was ordered from Colorado State University. This bag sampler will be tested during the monsoon 1994. A Delft Bottle with a straight nozzle for suspended sediment transport measurements and a bended nozzle for bed load measurements was tested in the left channel at Bahadurabad during May.



## 2.7 Training

Training has been limited so far mainly to in-house training, due to lack of resources and lack of consensus on the issue. It is expected that a modest training programme for external organizations will become effective in March 1995.

### 3. Mobilisation

#### 3.1 General

Based on the experience gathered in phase 1 during the test gauging in August 1993, as well as during the extended phase 1 period (8 June 1992 - 31 December 1993), the configuration of survey vessels and equipment to be deployed for the remaining phase 2 period of the project was finally selected early 1994. The related mobilization activities started immediately.

In Europe, the main activities comprised the procurement of two extra survey boats (DHB and DHE) in the UK and some supplementary survey equipment in Denmark.

DHB is a "Sea Truck" type of boat modified to perform survey work. DHE is a shallow draught standard glass fibre boat. The boats were transported on cargo vessels to Chittagong, and proceeded by truck to Naryanganj, where the survey equipment was installed at a shipyard. The completion of this installation actually marked the end of the mobilization for Phase II.

Some mobilization mile-stones are shown in Figure 3.1. For more details including a description of the survey vessels and equipment involved in the River Survey Project, reference is made to the Final Report, Phase 1.

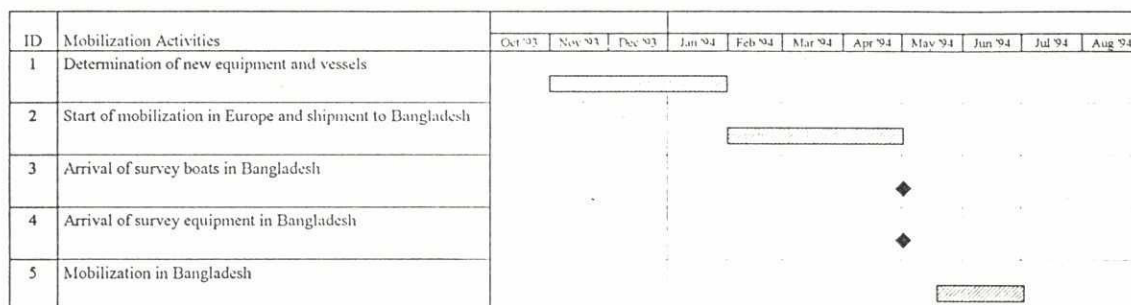


Figure 3.1 : Mobilization mile-stones in phase 2

### 3.2 Survey vessels

The two additional survey vessels for phase 2 were mobilized as follows :

- o Ms DHB is a "Sea Truck" type of glass fibre boat built for shallow water navigation and having the following main dimensions.
  - Length over all - 11,23 m
  - Beam - 3,18 m
  - Draft - 0,93 m

The Ms DHB is able to perform specialized survey operations (like the existing DHA and DHC) comprising bathymetric survey, point and depth integrated current and suspended sediment measurements, bed load sediment transport measurements and river bed sampling.

- o Ms DHE is a standard glass fibre boat also built for shallow waters and with a small front cabin making it very suitable for bathymetric surveying, as well as for some other special measurements in shallow areas requiring a small boat.

The boat has the following main dimensions :

- Length over all - 5,19 m
- Beam - 2,15 m
- Draft - 0,71 m

The survey vessels and their main features are illustrated in Figures 3.2 and 3.3 below.



DHB Features:

- o Positioning by DGPS
- o Single frequency echo sounding including sand dune tracking
- o Discharge measurements by the moving boat method using EMF and/or ADCP
- o Current velocity profiling
- o Suspended sediment transport measurements by depth integrated or singular point sampling by pumping
- o Bed-load transport sampling
- o Bed material sampling

Figure 3.2 : Features of survey vessel DHB





DHE Glasfibre Boat Features :

- o Positioning by DGPS
- o Single frequency echo sounding including sand dune tracking
- o Current velocity profiling in shallow waters

Figure 3.3 : Features of survey vessel DHE

### 3.3 Survey equipment

The additional equipment mobilized for phase 2 is listed in Table 3.1 below together with the equipment already mobilized during phase 1. As such the table states the complete survey vessel and equipment configuration deployed by the River Survey Project.

Equipment	Phase 1			Phase 2	
	DHA	DHC	DHD	DHB	DHE
DGPS Positioning system : Trimble 4000, 9 channel Trimble Navtrac, 6 channel	X	X	X	X	X
Bathymetric survey : Elac Laz 4420 (echo sounding) Simrad EA 300 P (echo-sounding) Atlas Deso 14	X	X	X	X	X
Point current measurement: Ott meter (mechanical) S4 InterOcean (electromagnetic) Braystoke propeller velocity meter	X X	X	X X		
Integrated current measurement : 300 kHz ADCP (vertical) 600 kHz ADCP (vertical) EMF (horizontal) Float tracking (horizontal)	X X X X	X* X	X	X X X	X
Suspended sediment measurement : Pump bottle sampling Depth integ. susp. sediment sampler MEX 3 Turbidity recorder	X X X	X	X	X	
Bed load sediment transport measurement : Helley-Smith trap sampler Sand-dune tracking by : Echo-sounding Delft Bottle	X X X*	X X	X X	X	X
River bed sediment sampling : Van Veen grab USBM-54	X X	X			
Side scan sonar : EG & G Model 260	X				
Communication : VHF radios Walkie talkies	X X	X X	X X	X X	X X

\* Additional equipment installed during phase 2

Table 3.1 : Capabilities and instrumentation of the River Survey Project Vessels.

The equipment in Table 3.1 should not be seen independently of one another. Very often one type of equipment is supported by another. In particular this is the case for the positioning system, which is the corner stone of all measurements in the dynamic braided rivers of Bangladesh. Also quite some of the equipment can replace each other on the individual vessels.





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In November 1993 proposals including platform design, type of sensor and recommended sites were prepared and permissions were sought for installation of AWLR's at Hardinge Bridge, Mymensingh, Kushtia/Gorai and Bhairab Bazar. Acoustic sensors were deployed and mounted on the present bridges. At Bahadurabad, Bhuyanpur (Siranganj site), Aricha, Baruria, Mawa, Tilly and Arial Khan off-take structures were constructed in the rivers in order to act as bases for the deployed pressure sensors and data loggers.

In April/May 1994 the required permissions were obtained and construction of the platforms could be undertaken. Actual installation of the recorders was initiated in May 1994 and within the reporting period 9 stations were completed; ref. Table 4.1.

At each station two staff gauges are maintained as back-up for the AWLR.

Detailed reporting on the AWLR issues is done previously in :

- o Working Paper 1  
Technical recommendations and verification of the acoustic sensor type of AWLR  
October 1993
- o Selection of Survey Techniques  
November 1993  
(this report contains Working Paper 1 as an Annexure)
- o AWLR stations  
Site selection, installation, operation and maintenance.  
(in preparation)



Pressure type :

Names of the station	River	Date of installation/ reinstallation	Location
Bahadurabad	Jamuna	30/6/94	700 m upstream of Bahadurabad ghat
Gabgachi	Jamuna	18/5/94	Mid char opposite to Fulchari
Aricha (Teota)	Jamuna	13/5/94	2 km upstream of Aricha Ghat
Bhuyanpur	Jamuna	25/5/94	Left channel opposite Sirajganj near JB
Mawa	Padma	10/5/94	Near ferry ghat
Baruria	Padma	25/5/94	6 km downstream of Aricha
Tilly	Dhaleswari	28/5/94	10 km North west corner from Manik Ganj town
Arial Khan	Off-take of Arial Khan	3/6/94	Koshabhaya 3 km downstream from off-take

Acoustic type :

Name of the Station	River	Date of Installation	Location
Mymensingh	Old Brahmaputra	29/6/94	Bridge pier no.2

Table 4.1 : Installation of Automatic Water Level Recorders.

The installation, operation and maintenance activities of the stations mentioned in Table 4.1 have been described hereafter per station :

**Station 1: Bahadurabad on the Jamuna River**

This station is located on the left bank of the Jamuna River at about 700 m upstream of Bahadurabad ghat (see Figure 4.2). Reinstallation of the pressure cell type AWLR was complete by 30 June 1994. The data collection continued up to 5 September 1994 during which the sensor elevation was 17.76 m + PWD. After that the sensor was lowered to 17.22 m + PWD on 5 September 1994. The available data record at this location continued up to 31 October 1994. The 12 hourly AWLR record was supplemented by 3 hr. manual observations.



Figure 4.2 : AWLR installation at Bahadurabad, left channel.



**Station 1a: Gabgachi on the Jamuna River**

This station is located on a mid-island of the Jamuna River opposite to Fulchari ghat. Reinstallation of the pressure cell and acoustic cell type AWLR was complete by 18 May 1994. The sensor was disengaged on 1 July 1994 due to heavy bank erosion. The available record was from 18 May to 1 July 1994. The 1/2 hour AWLR record was supplemented by 3 hr. manual observations. These observations continued.

**Station 2: Aricha on the Padma River**

This station is located at Teota on the left bank of the Padma River at about 2 km upstream from Aricha Ferry Ghat. Construction of a platform and subsequent installation of a pressure cell type AWLR was completed by 13 May 1994. The AWLR records from then on continued uninterruptedly at this station. The 1/2 hour AWLR record was supplemented by 3 hr. manual observations. The pressure sensor elevation is 2.146 m + PWD. The sensor dried up in November 1994.

**Station 3: Bhuyanpur on the Jamuna River**

This station is located on the left bank of the Jamuna River near the Jamuna Bridge site and Bhuyanpur Ferry Ghat opposite to Sirajganj. Construction of a platform and subsequent installation of a pressure cell type AWLR was complete by 25 May 1994. The 1/2 hourly AWLR records from then on continued uninterruptedly at this station until 3 August 1994. The sensor elevation was 7.78 m + PWD. As the platform was threatened by erosion, early August the recorder was dismantled. One month later the platform collapsed. The 3 hourly manual observations continued from then on.

**Station 5 : Mawa on the Padma River**

This station is located on the left bank of the Padma River at about 500 upstream from the Mawa ferry ghat. Construction of a platform and subsequent installation of a pressure cell type AWLR was complete by 10 May 1994. The AWLR records from then on continued uninterruptedly at this station. The 1/2 hour AWLR record was supplemented by 3 hr manual observations. The pressure sensor elevation is 0.849 m + PWD. A typical pressure-cell record of Mawa is shown in Figure 4.3.





Figure 4.3 Example of pressure cell record (station 5, Mawa)

#### Station 6 : Baruria on the Padma River

The station is located on the left bank of the Padma River at about 6 km downstream from Aricha. Construction of a platform and subsequent installation of a pressure cell type AWLR was complete by 25 May 1994. The 1/2 hourly AWLR records from then on continued uninterruptedly at this station until 27 June 1994. The platform collapsed after collision with a cargo boat. The pressure sensor elevation during its existence was 1.635 m + PWD. The 3 hourly manual observations continued from then on.

**Station 7 : Mymensingh Railway Bridge on the Old Brahmaputra River**

An acoustic cell type AWLR was installed on the Mymensingh Railway Bridge on 29 June 1994. The AWLR records from then on continued uninterruptedly at this station. The elevation of the acoustic sensor at this location is 13.52 m + PWD. The 1/2 hour AWLR record was supplemented by 3 hr. manual observations.

**Station 8 : Tilly on Dhaleswari River**

This station is located on the right bank of the Dhaleswari River at about 10 km upstream from Taraghat Bridge on the Dhaka-Aricha Highway. Construction of a platform and subsequent installation of a pressure cell type AWLR was completed by 28 May 1994. The 1/2 hourly AWLR records from then on continued uninterruptedly at this station until 28 June 1994. The platform collapsed after collision with a cargo boat. The 3 hourly manual observations continued from then on.

**Station 10 : Arial Khan off-take on the Arial Khan River**

This station is located on the right bank of the Arial Khan River at Koshabhaya, which is 3 km downstream from the off-take. Construction of a platform and subsequent installation of a pressure cell type AWLR was complete by 03 June 1994. The AWLR records from then on continued uninterruptedly at this station. The sensor elevation was 0.237 m + PWD. The 1/2 hourly AWLR record was supplemented by 3 hr manual observations.

Conclusions of the water-level gauging so far can be summarized as follows :

- o The applied logger-sensor system is working fine. Both pressure cell and acoustic type of sensor are functioning well.
- o A main advantage of the acoustic sensor is obviously that all parts are above the water-level, which means that repairs and maintenance can be done also during high river stages.
- o Main problems are the appropriate selection of the platform location. Catching the full range of water-levels implies a deep water platform and risks of scouring and collision with vessels.
- o A reasonable solution is to construct shallow water platforms at safe locations from which the upper half of the hydrograph is measured. The lower, easy part can be monitored with staff gauges.

### 4.3 LW routine gaugings

In the reporting period low water routine gaugings were executed as presented in the following table.

Location	Date	Bulletin no.	QPR
Bahadurabad	29 January - 1 February	28	6°
Mymensingh	30 - 31 January	29	
Sirajganj	3 February	30	
Baruria	5 - 6 February	31	
Tilly	5 - 7 February	32	
Arial Khan off-take	9 February	33	
Bhairab Bazar	10-12 February	34	
Kushtia/Gorai	14 - 15 February	35	
Hardinge Bridge	16 - 18 February	36	
Mymensingh	23 February	37	
Kushtia/Gorai	5 - 6 March	38	7°
Hardinge Bridge	7 March	39	
Bahadurabad	15 - 17 March	40	
Sirajganj	18 - 19 March	41	
Mymensingh	20 March	42	
Baruria	21 March	43	
Tilly	21 - 22 March	44	
Bhairab Bazar	24 March	45	
Arial Khan off-take	24 March	46	
Hardinge Bridge	27 - 29 March	47	
Bahadurabad	2 - 4 April	48	
Sirajganj	5 - 7 April	49	
Hardinge Bridge	8 April	50	
Baruria	8 - 10 April	51	

-Continued-

Location	Date	Bulletin no.	QPR
Bhairab Bazar	16 April	52	7°
Arial Khan Off-take	18 - 19 April	53	
Bahadurabad	26 - 28 April	54	
Sirajganj	29 April - 1 May	55	
Baruria	3 - 5 May	56	
Kustia/Gorai	11 May	57	
Hardinge Bridge	12 May	58	
Tilly	15 May	59	

Table 4.2 : LW routine gaugings till June 1994

The routine gaugings comprised

- discharge measurements
- suspended load measurements
- bed-load measurements

The measuring methods applied in the lean season of 1992/93 have been described in Survey Report 5. The methods applied in the lean season of 1993/94 are outlined in Survey Note 5.

The main results (being the total transports of water and sediments) of these surveys are summarised in Table 4.3. However, a considerable amount of detailed data have been collected, which are reported as follows :

- o Part of the survey results are presented in the Survey Bulletins which are appended to the Quarterly Progress Reports (QPR), see also the previous table. The bulletins give the executed survey programmes including the data file names and serve thereby as a hard-copy catalogue of our data base where all the collected data is stored. The actual format of the bulletins has been revised in the reporting period from bulletin no. 48 onwards, see Annexure 2.
- o The lean season measurements in the first half of 1994 will also be reported in the River Data Book for the period June 1993 to May 1995 (in preparation).





	Location	Data	Water-level (mean value) m + PWD	Discharge (average) m <sup>3</sup> /s	Total suspended sediment transport (average) kg/s
1	Bahadurabad	29/1 - 1/2/1994 15 - 17/3/94 2 - 4/4/94 26 - 28/4/94	13.51 13.38 15.29 15.48	3998 4104 10544 10240	518 521 5894 3380
2	Sirajganj	3/2/94 18 - 19/3/94 5 - 7/4/94 29/4 - 1/5/94	7.65 7.58 9.28 9.69	4431 4496 8758 11827	1600 334 2653 3508
3	Aricha	No measurements			
4	Hardinge Bridge	16 - 18/2/94 7/3/94 27 - 29/3/94 8/4/94 12/5/94	5.94 5.57 4.95 5.02 5.09	936 754 156 526 237	11 10 2 3 3
5	Baruria	5 - 6/2/94 21/3/94 8 - 10/4/94 3 - 5/5/94	2.27 2.06 3.30 3.71	6242 5107 10196 12183	464 325 2157 3807
6	Mawa	No measureemnts			
7	Mymensingh	30 - 31/1/94 23/2/94 20/3/94	6.7 6.55 6.44	14 13 7	0.10 2.3 0.8
8	Tilly	5 - 7/2/94 21 - 22/3/94 15/5/94	3.56 3.38 5.41	17 17 106	0.14 0.25 63
9	Kushtia/Gorai	14 - 15/2/94 5 - 6/3/94 11/5/94	4.19 4.18 4.11	16.87 3.37 7.37	0.42 0.02 0.10
10	Arila Khan Off-take	9/2/94 24/3/94 18 - 19/4/94	1.39 1.52 2.13	171 201 115	4 3 21
11	Bhairab- Bazar (Tidal)	10/2/94 24/3/94 16/4/94	1.53 1.74 2.51	1406 1133 2857	1-59 3-26 127

Table 4.3 : Stage-discharge-sediment transport results, LW routine gaugings till June 1994

#### 4.4 HW routine gaugings

The HW routine gaugings to be covered in the reporting period include the measurements carried out in June 1994 only as presented in the following table.

Location	Data	Bulletin no.	QPR
Bahadurabad	2 - 8 June	60	8°
Hardinge Bridge	5 - 6 June	61	
Sirajganj	8 - 12 June	62	
Baruria	12 - 15 June	63	
Mymensingh	16 June	64	
Tilly	16 June	65	
Kushtia/Gorai	19 June	66	
Hardinge Bridge	20 - 21 June	67	
Bahadurabad	24 - 26 June	69	

Table 4.4 : HW routine gaugings till June 1994

All measurements have been carried out following the recommended method.

Results of the HW routine gaugings are briefly summarized in Table 4.5 and will be reported in the River Data Book for the period June 1993 to May 1995 (in preparation).

Location	Date	Water-level (mean value) m + PWD	Discharge (average) m <sup>3</sup> /s	Total suspended sediment transport (average) kg/s
1 Bahadurabad	2 - 8/6/94	18.24	29,526	24,671
	24 - 26/6/94	18.57	34,650	18,825
2 Sirajganj	8 - 12/6/94	12.32	27,793	16,104
4 Hardinge Bridge	5 - 6/6/94	6.91	494	8
	20 - 21/6/94	7.88	1,600	105
5 Baruria	12 - 15/6/94	6.11	29,057	14,893
7 Mymensingh	15/06/94	9.04	454	153
8 Tilly	16/6/94	6.70	313	161
9 Gorai off-take	19/6/94	5.56	63	4

Table 4.5 : Stage-discharge-sediment transport results, HW routine gaugings in June 1994

The recommended method is described in for instance the 1° Interim Report (Volume II, Annexure 4). For a description of the equipment used, please refer to the same report, Volume II, Appendix 1A and the Final Report, Phase 1.

## 4.5 Bathymetry

Two bathymetric surveys have been executed in the reporting period, as depicted in the following table:

Locations	Survey periods
Arial Khan off-take	1 - 10 January
Jamuna - Ganges confluence	19 April - 6 May

Table 4.6 : Bathymetry surveys in first half of 1994

The results of the bathymetric surveys are presented in a separate Survey Report No. 11 (in preparation).

## 4.6 Special surveys

In the reporting period the following special measurements were executed:

Location	Period	Type of survey	Related study topic
Bahadurabad	31 March - 1 April	Reconnaissance and turbulence measurements	4.1 and 9.2
Aricha	12 - 13 April	Turbulence measurements	9.2
Bahadurabad	15 - 19 May	Site selection and bifurcation	4.1
Bahadurabad	27 - 29 May	Testing Delft Bottle	9.3
Bahadurabad	23 June 1994	Weekly discharge measurements	1.1
Bahadurabad	27 June 1994	Slope and discharge measurements	1.4, 1.1 3.8, 9.2
Bahadurabad	28 June 1994	Weekly discharge measurements	1.1

Table 4.7 : Special measurements during the first half of 1994

The purpose of these special surveys are briefly described in the following.



-Continued-

Period	Field measurements
March 1994	<p>Routine gauging of discharge and sediment transport using the proposed survey method for the dry season 93/94 was performed at :</p> <p>Kushtia Gorai 6th  Hardinge Bridge 7th  Bahadurabad 16-17th  Sirajganj 18-19th  Mymensingh 20th  Baruria 21st  Tilly 22nd  Arial Khan off-take 24th  Bhairab Bazar 27-29th  Hardinge Bridge 27-29th</p> <p>o A special survey comprising turbulence measurements at different locations at Bahadurabad was executed from 31 March to 01 April. Also a reconnaissance survey was made, for the location of planned bifurcation measurements.</p>
April 1994	<p>Routine gauging of discharge and sediment transport using the proposed survey method for the dry season 93/94 was performed at :</p> <p>Bahadurabad 2-4th  Sirajganj 5-7th  Hardinge Bridge 8th  Baruria 8-10th  Bhairab Bazar 6th  Arial Khan off-take 18-19th  Bahadurabad 26-28th  Sirajganj 29th-1st May</p> <p>o Bathymetric survey at Jamuna/Ganges confluence 19th April - 6th May with a survey boat rented from BIWTA</p> <p>o Special survey of turbulence measurements at Aricha on 12 and 13 April</p>

-Continued-

Turbulence measurements

The objective is to measure the turbulence structure of the flow velocity in x, y and z components using the ADCP and the S4.

Flow and sediment distribution at a bifurcation

Special measurements near Bahadurabad on the flow and sediment distributions at a bifurcation, to provide data for the studies undertaken by the University of Nottingham.

Testing Delft Bottle

The objective was to test the Delft bottle as a valid tool for collecting bed load samples. Comparative measurements were performed with the Helley-Smith bed-load sampler.

Weekly discharge measurements

The objective is to develop a reliable FAP 24 rating curve for the Bahadurabad transect for the year 1994. In order to achieve this objective, discharge measurements were to be executed weekly at Bahadurabad. As the weekly discharge measurements **have to been seen** within the operational framework, the execution of the weekly discharge measurements were adjusted in time in order to fit into the routine gauging schedule.

Slope determination

The objective was to apply an indirect method for discharge calculation. To serve this purpose three WL gauges were installed in each channel at Bahadurabad. In this context discharge measurements were executed close to the locations of the WL gauges.

**4.7 Chronology of survey activities**

A chronology of the survey activities in the reporting period is given in the table hereafter.

Period	Field measurements
January 1994	Routine gauging of discharge and sediment transport using the proposed survey method for the dry season 93/94 was performed at Bahadurabad and at Mymensingh.  Bathymetric survey was performed at the Arial Khan off-take.
February 1994	Routine gauging of discharge and sediment transport using the proposed survey method for the dry season 93/94 was performed at Sirajganj, Baruria, Tilly, Arial Khan off-take, Bhairab Bazar and Mymensingh.

Period	Field measurements																								
May 1994	<p>Routine gauging of discharge and sediment transport using the proposed survey method for the dry season 93/94 was performed at:</p> <table> <tr> <td>Sirajganj</td><td>1st-2nd</td></tr> <tr> <td>Baruria</td><td>4-5th</td></tr> <tr> <td>Hardinge Bridge</td><td>12th</td></tr> <tr> <td>Mawa (workshop demonstration)</td><td>11th</td></tr> <tr> <td>Gorai</td><td>11th</td></tr> <tr> <td>Tilly</td><td>15th</td></tr> </table> <ul style="list-style-type: none"> <li>o Special measurements at Bahadurabad at a bifurcation with the UoN.</li> <li>o Slope measurements from 15th to 19th with BUET.</li> <li>o Delft Bottle tests from 27th to 29th.</li> </ul>	Sirajganj	1st-2nd	Baruria	4-5th	Hardinge Bridge	12th	Mawa (workshop demonstration)	11th	Gorai	11th	Tilly	15th												
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Gorai	11th																								
Tilly	15th																								
June 1994	<ul style="list-style-type: none"> <li>o Routine gauging of discharge and sediment transport using the proposed survey method for the wet season 1994 was performed at : <table> <tr> <td>02 - 06</td><td>Bahadurabad</td></tr> <tr> <td>05 - 06</td><td>Hardinge Bridge</td></tr> <tr> <td>09 - 12</td><td>Sirajganj</td></tr> <tr> <td>14 - 15</td><td>Baruria</td></tr> <tr> <td>15</td><td>Mymensingh</td></tr> <tr> <td>16</td><td>Tilly</td></tr> <tr> <td>19</td><td>Kushtia/Gorai</td></tr> <tr> <td>20 - 21</td><td>Hardinge Bridge</td></tr> <tr> <td>24 - 26</td><td>Bahadurabad</td></tr> </table> </li> <li>o Special measurements : <table> <tr> <td>23</td><td>Three times extra discharge measurements were executed at Bahadurabad.</td></tr> <tr> <td>27</td><td></td></tr> <tr> <td>28</td><td></td></tr> </table> </li> </ul>	02 - 06	Bahadurabad	05 - 06	Hardinge Bridge	09 - 12	Sirajganj	14 - 15	Baruria	15	Mymensingh	16	Tilly	19	Kushtia/Gorai	20 - 21	Hardinge Bridge	24 - 26	Bahadurabad	23	Three times extra discharge measurements were executed at Bahadurabad.	27		28	
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24 - 26	Bahadurabad																								
23	Three times extra discharge measurements were executed at Bahadurabad.																								
27																									
28																									

Table 4.8 : Chronology of survey activities

## 5. Land survey

The land survey work consists of various activities such as :

- o positioning of the DGPS reference stations
- o (control) levelling of reference levels including construction of new bench-marks
- o zero control levelling of water-level stations (both AWLRs and staff gauges)
- o topographical work

Most of the preparatory land survey work like positioning of the DGPS reference stations and levelling of reference levels was carried out during the mobilization period as well as during phase 1 of the project.

During the present reporting period no particular land survey has been done.

The zero control levelling of all the water-level stations is a continuous work. In this way the zero-level of each water-level station is checked on a monthly basis.



## 6 Data Processing

### 6.1 Introduction

Most of the field measurements generate computer data, which are called raw data and which need off-line data processing. The off-line data processing comprises file conversion, plotting for quality check, subsequent data reporting and listing of files in the data catalogue. After processing the data are called processed data, which will be stored in a database called Processed Survey Database of FAP 24 (PSD 24), see Section 6.4 and Annexure 1.

The following types of surveys are supplying data to the data processing center at FAP 24:

- o Transect surveys (Section 6.2)
- o Bathymetric surveys (Section 6.3)
- o Water-level recordings
- o Sediment sampling

For each type of data collected by the survey teams, a unique method of processing is required, some of which use standard methods, while others use techniques which have been developed specifically for procedures unique to FAP 24 operations.

Brief summaries of the results of the routine surveys are presented in Survey Bulletins. The survey bulletins no 28 to 47 covering the first quarter of 1994 have the same set-up and lay-out as used for the previous bulletins. This means that only a part of the detailed measurements is presented in these bulletins. The bulletins are mainly intended as a documentation of the field work and secondly as a reference for the data users. Therefore, the set-up of the bulletins was changed to a more lean and systematic data presentation of key results in an easy to understand format. The revised format of the survey bulletins started from Survey Bulletin number 48, the first survey of April 1994. Examples of the old and new format are given in Annexure 2.

### 6.2 Transect surveys

Transect flow data from the last monsoon and dry seasons have been processed using the FAP 24 offline software package specifically developed for the project. The offline software reads the raw ASCII formatted data which come from the survey vessels, and then performs the necessary computations to calculate cross-sectional area, total discharge and sediment transport properties. For sediment transport calculations, the additional input of laboratory sediment analysis is also required. The laboratory sediment analysis is also performed at FAP 24.

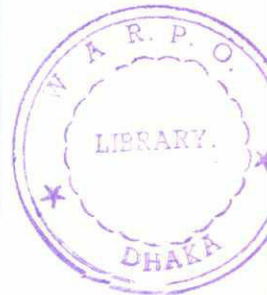
The software computes the discharge flow from ADCP/EMF data using a modified moving boat method or alternatively by the standard velocity-area

method using the S4 (or ADCP) current meter profiles. For a description of the standard method procedures, refer to the 1st Interim report, section 3.1.2 (DELFT/DHI, 1993a).

The modified moving boat method uses the combined ADCP/EMF and differential GPS positioning system to get a detailed measurement of the cross-section velocity field. Due to specific limitations of the instrumentation, some gaps in the velocity field exists (see Figure 6.1).

The magnitude of the gaps depends on various ADCP characteristics such as frequency, sensor angle and bin height and the level at which the sensors are mounted. With the two ADCP's in use in the River Survey Project the following surface gaps are met :

Vessel	Figure kHz	Sensor angle	Bin height (m)	Surface gap (m)
DHA	300	20°	0.5	2.7
DHB	600	20°	0.25	1.7



The bottom gap is for both ADCP's equal to 5% of the depth.

The first ADCP was installed on the DHA (September 1992). The measuring range of this ADCP covers the vertical between a level of 2.7 m below the free surface down to a level of 5% of the depth above the bottom. The EMF measures the velocity at a depth of installation, mostly chosen to be 0.5 m below the free surface to fill-in the area near the surface where the ADCP cannot measure. In the upper layer, the offline software computes the velocity as either a constant velocity from the EMF measurement, a constant velocity from the first ADCP bin data, or a power fit from the entire ADCP profile. Normally the EMF value is used for the computation of the upper layer velocity. In the bottom layer, the software computes the velocity as either a power fit or constant fit from the last ADCP value. Normally a power fit is used to compute the flow velocity in the lower layer. When the survey vessel approaches the bank, there is another gap in the data where it becomes too shallow for the vessel to travel, or it becomes too shallow for the ADCP to measure. In this area, the field surveyors report the remaining distance to the bank and the software uses the bank distance to make a triangular depth averaged approximation in the section. In the triangular area, the flow velocity is approximated using the adjacent EMF and top adjacent ADCP data, the zero velocity at the bank, and then depth averaging over the area. Figure 6.1 shows the detail of the various transect measurement zones.

Beginning in July of 1994, a new 600 kHz ADCP is deployed on the DHB vessel, which can measure closer to the surface and closer to the bottom. It will also have a finer bin resolution. The offline software has been modified to handle this increased data flow from the new ADCP.

The transect and profile data are processed using the offline software, whereafter the Survey Bulletins are produced, which document the particulars of the processed data.

Some examples of output of the offline software package are contained in Annexure 2.



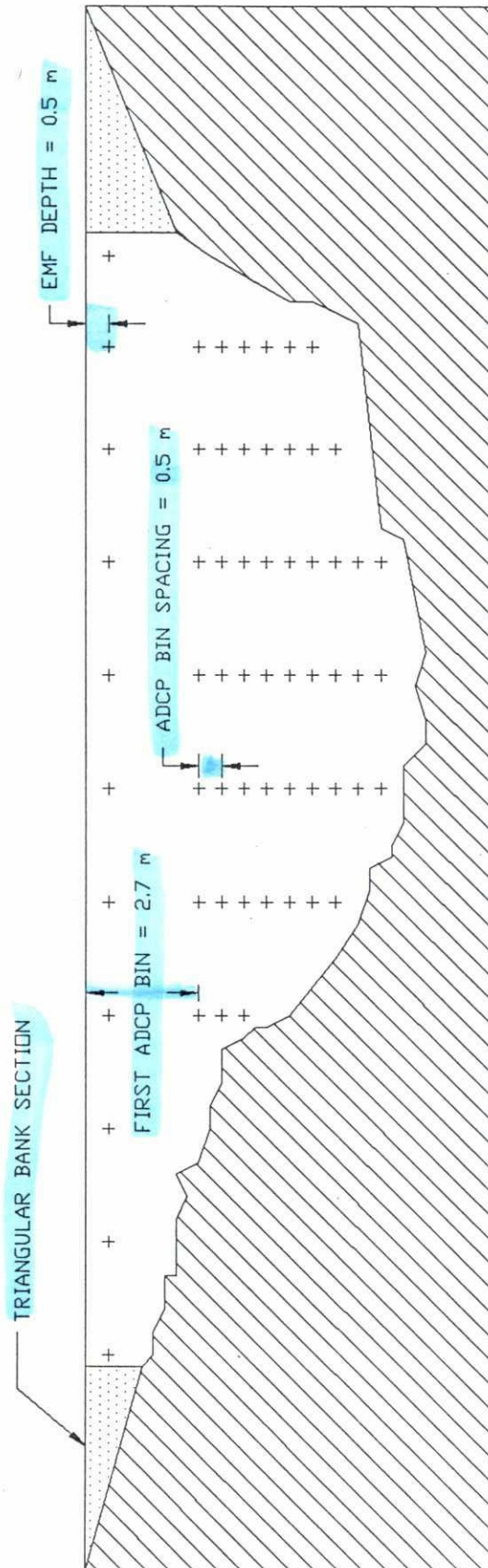


Figure 6.1 : Transect measurement detail



### 6.3 Bathymetric surveys

Bathymetric sounding charts and contour charts have been produced for all the surveys up to the present period.

Bathymetric plots are produced at the FAP 24 office using 3 main software routines. First of all, the Consultant's utility program SCAN is used to produce a map of the echosoundings. This program serves a dual purpose in that it is used for the visual inspection of the data for quality checking procedures and it also produces the final sounding chart after quality checking. Another utility software program, m21dig, from the Mike 21 software package, is used for the interpolation of the prepared raw data into a discretized fixed grid. The fixed grid data is then plotted using a contour plotting utility, t2plot, also from within the Mike 21 software package.

The raw data is prepared for interpolation by applying error checking and datum reference conversion procedures. **Error checking is done partly automatically and partly manually.** Error checking software routines, which have been developed at FAP 24, are used to locate data spikes and/or other suspicious data which can be either automatically filtered or discarded. While some items can be automatically edited, other data must be visually inspected to determine whether it is reasonable or not. Figure 6.2 shows an example of a contour chart produced at FAP 24.

*Fig- will only compare as the contours are not clear. Bank level should also be indicated.*

### 6.4 PSD 24

**Raw data come in from the field on magnetic tapes.** Multiple backup copies of the raw data tapes are made, and then the data are processed. After processing all of the **processed data is backed up to DAT tape for archiving.** The current rates of data storage requirements, excluding the backup tapes, are approximately **3 gigabytes per year for the raw data, and one gigabyte per year for the processed data.** It has not been feasible to store all the raw data on-line (on the hard disk). This huge amount of data has made it difficult for the users to get quick access to the data, since it must be retrieved from the backup tapes, and has also put an **enormous demand on the computer resources** at FAP 24. Therefore, the PSD 24 database was developed as an easy accessible database for study and analysis of the survey data by various users, inside and outside the project. It consists of a number of smaller, more easily understandable, post-processed files. This data base is much smaller in volume than the raw database, making it possible to keep all the PSD 24 data on-line for convenient study group access. The file specifications have been defined, a new catalogue system based on the PARADOX software package is being prepared, and the operation of the new database is expected to be on-line by the end of 1994. **A draft PSD 24 User's Guide is contained in Annexure 1.** To facilitate the use of this PSD 24 the local area network of the personal computers in the Consultants' office has been extended to the Study Group.

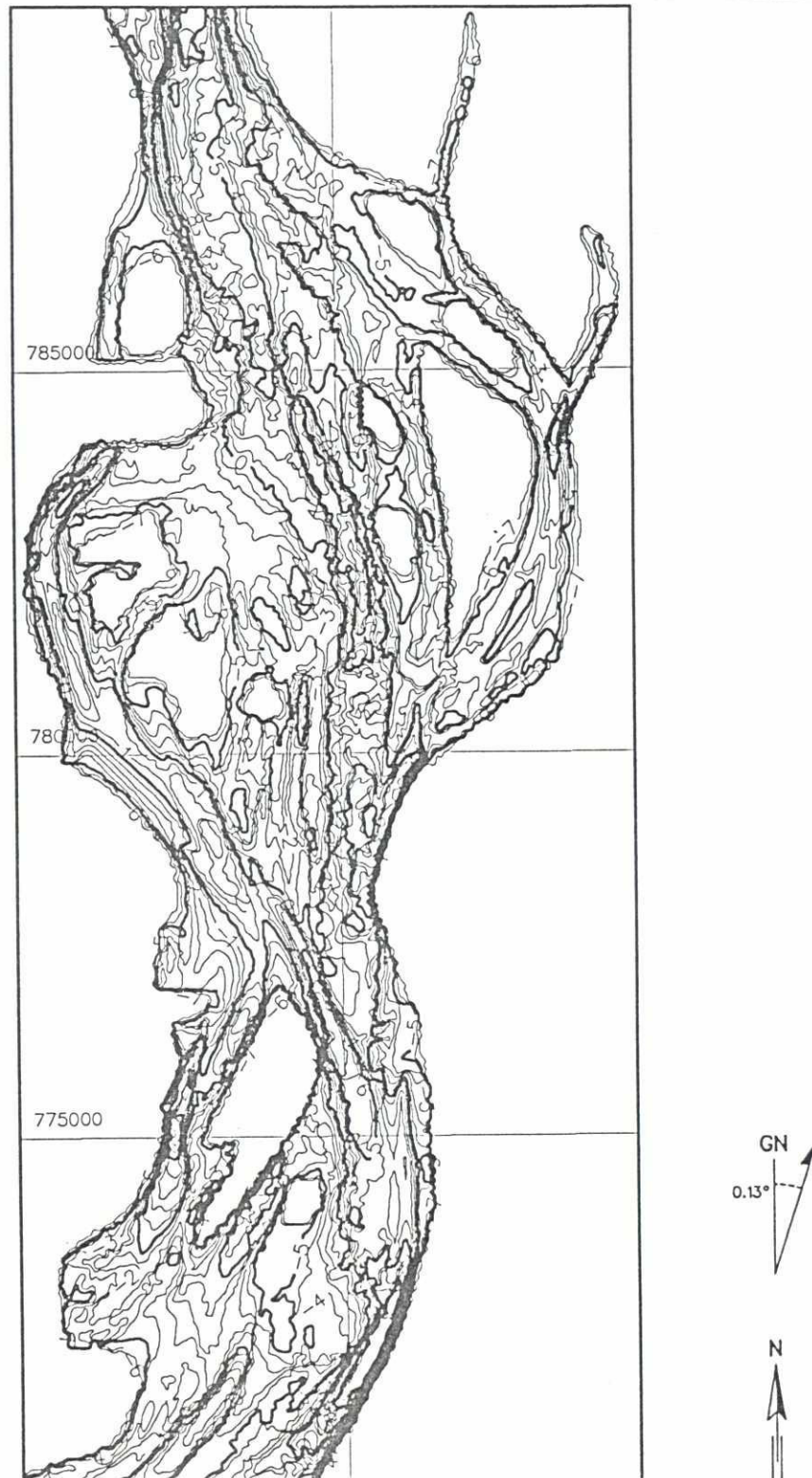


Figure 6.2 : Bathymetric map for Jamuna River at Bahadurabad (September 1993)



## 7. Studies

### 7.1 Introduction

One of the objectives of the River Survey Project is to undertake special studies on the behaviour of the main river system of Bangladesh based on (1) existing data and on (2) new data that were collected during the routine and special surveys under the project. The studies during phase 2 of the project are described as follows in the ToR:

- "(...) Undertake a programme of studies to investigate key characteristics of the behaviour of the river system. The river studies would address aspects of the main river system that are essential for the planning of projects under the Flood Action Plan. ... The studies will be undertaken in response both to the demands of ongoing FAP studies and to the possible effects of planned Flood Action Plan projects on river regimes.*
- (...) The following will give an indication of the possible studies that the Consultant may be requested to undertake:*
- o further refinement of the rating curves and estimation of peak flood flows at different flooding conditions,*
  - o further refinement of the profiles of the water surfaces at different discharges for the main rivers at different times of the year, as well as at different stages of implementation of various components of FAP,*
  - o quantitative assessment and evaluation of river response with respect to implementation of various FAP projects,*
  - o behaviour at the confluence of the Ganges and the Brahmaputra and the effect on the outlet of the Hurasagar,*
  - o the characteristics of overland flow during flood stages,*
  - o resistance and bed forms at various times of the year."*

The above list was reviewed and updated based on the findings of phase 1 studies and other input in the selection of study topics for phase 2 (DELFT/DHI, 1993b). The programme presented in that report was followed with only minor modifications during the reporting period. Those modifications are:

- o The study topic 'Effect of tectonics on planform characteristics', has been deleted, as it was considered to be too remote from the scope of the River Survey Project.*
- o The timing of some topics has been changed, among others to obtain an optimal integration of the study topics with the results of the special surveys.*

The possibility of a regular updating of the study programme has been envisaged already in the ToR: *"The first of these (studies) will be identified during the Preliminary phase of the project; others will be identified during the surveys and Studies phase."*

Some preliminary results of the studies performed in the period January to July 1994 are presented in the following sections. The results of the continued analysis of rating curves and the **analysis of local water-level slopes are presented in Section 7.2, sediment rating curves for Bahadurabad station in Section 7.3, planforms and channel dimensions in Section 7.4 and offtakes and bifurcations in Section 7.5.** The progress with the selection of measurement sites is reported in Section 7.6 and the optimization of measurement techniques in Section 7.7.

## 7.2 Hydrology

### 7.2.1 Introduction

Hydrological studies during Phase 1 resulted in methodologies for establishing rating curves and data quality checking. Further analyses were performed during the first half of 1994 (part of phase 2 studies): rating curve analysis (Sub-section 7.2.2), separate rating curves for the right and the left channel at Bahadurabad station (Sub-section 7.2.3), **inconsistencies in the Bahadurabad rating curve** (Sub-section 7.2.4), improved historical discharge time series at Bhairab Bazar and Mawa, (Sub-section 7.2.5), the analysis of local water-level slopes (Sub-section 7.2.6).

### 7.2.2 Rating curve analysis

In preparing rating curves, discharge data determined from gauging are plotted against the measured stage. Any shifts in the rating curves or uncertainties in the gauging data are best detected by frequent gauging. As an aid to the detection of anomalies, measured water-levels were plotted as a function of cross-sectional area and of mean flow velocity. Figures 7.1 and 7.2 show as an example the water-level/area and the water-level/mean flow velocity curves for Bahadurabad for 1973. This type of analysis can be used :

- o To identify causes of changes in the slope of a rating curve.
- o To identify errors; for example from the graph in Figure 7.2 it is evident that **several points which combine a low flow velocity at high stages suggest errors in the data.**
- o To extrapolate a rating curve; after extrapolating the water-level/area and the water-level/mean flow velocity curves separately, the rating curve itself may be extrapolated.

*V. Important comment of Mr. J. G. B. for the statements*

*?  
How far can be extrapolated.  
Validity of extrapolation*



(Note that parts of the cross-sections where little or no flow occurs, for example the higher parts of chars as high flows, need to be excluded).

In Figure 7.1 the solid horizontal line shows the break points in the rating curve determined in the hydrological study phase 1 (DELFT-DHI, 1993c). Two horizontal dashed lines are drawn in that graph, the lowest of these is the stage for the average low discharge of 4,000 m<sup>3</sup>/s, the second line is the stage at bank-full discharge.

Stage-area curves were plotted to investigate the anomalous flow data at Bahadurabad for the recent years. In the stage-area curve a significant difference or shift in the cross-sectional area for a given water-level can be observed between 1987 and 1990 (see Figure 7.3). Similar analysis was made considering all the gauging data, which seems to confirm that the stage-area data are different before and after the extreme flood in September 1988 (see Figure 7.4).

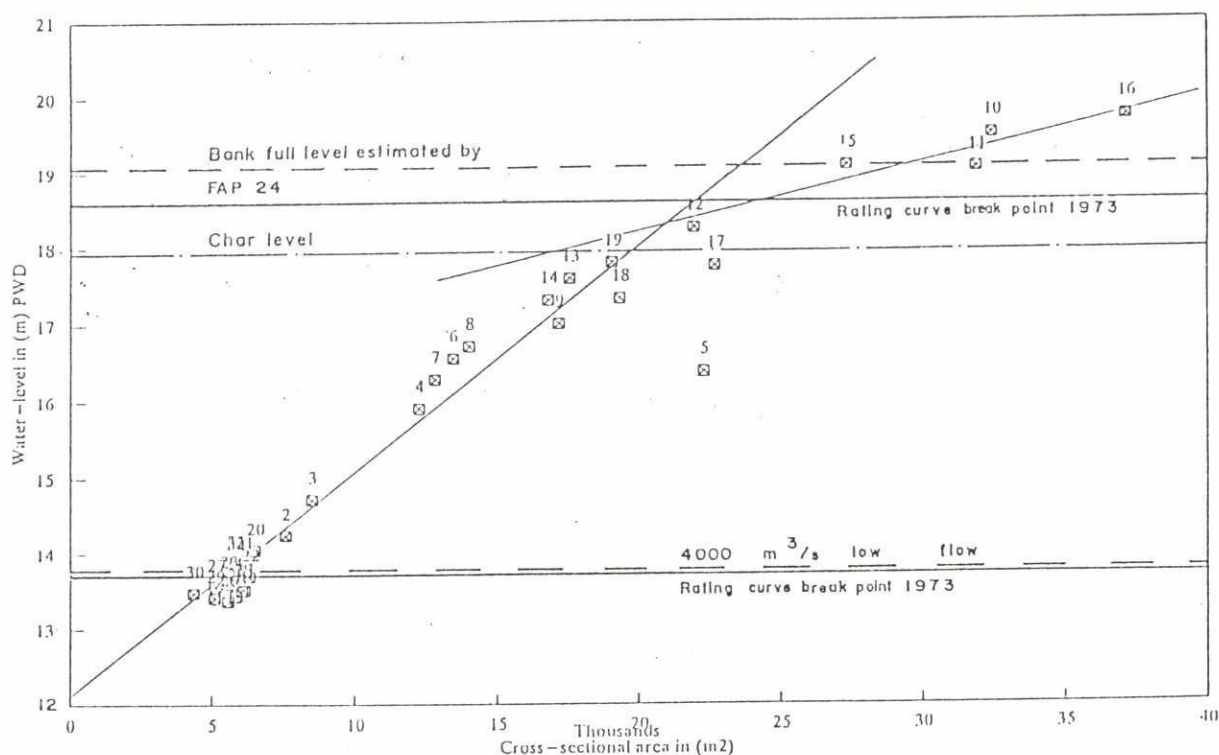


Figure 7.1 The cross-sectional area as function of the stage for Bahadurabad data, 1973

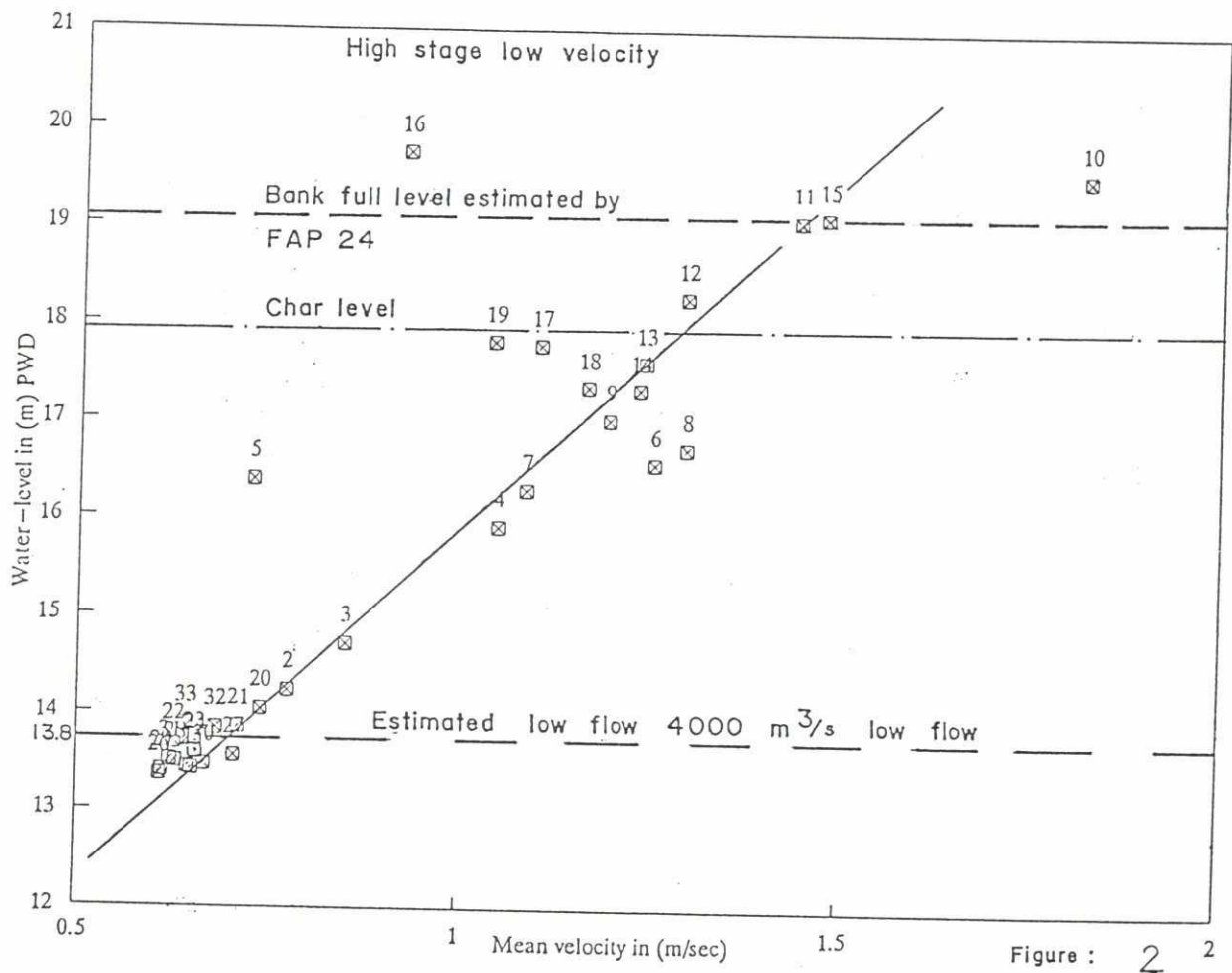


Figure 7.2 The mean flow velocity as a function of the stage for Bahadurabad data, 1973

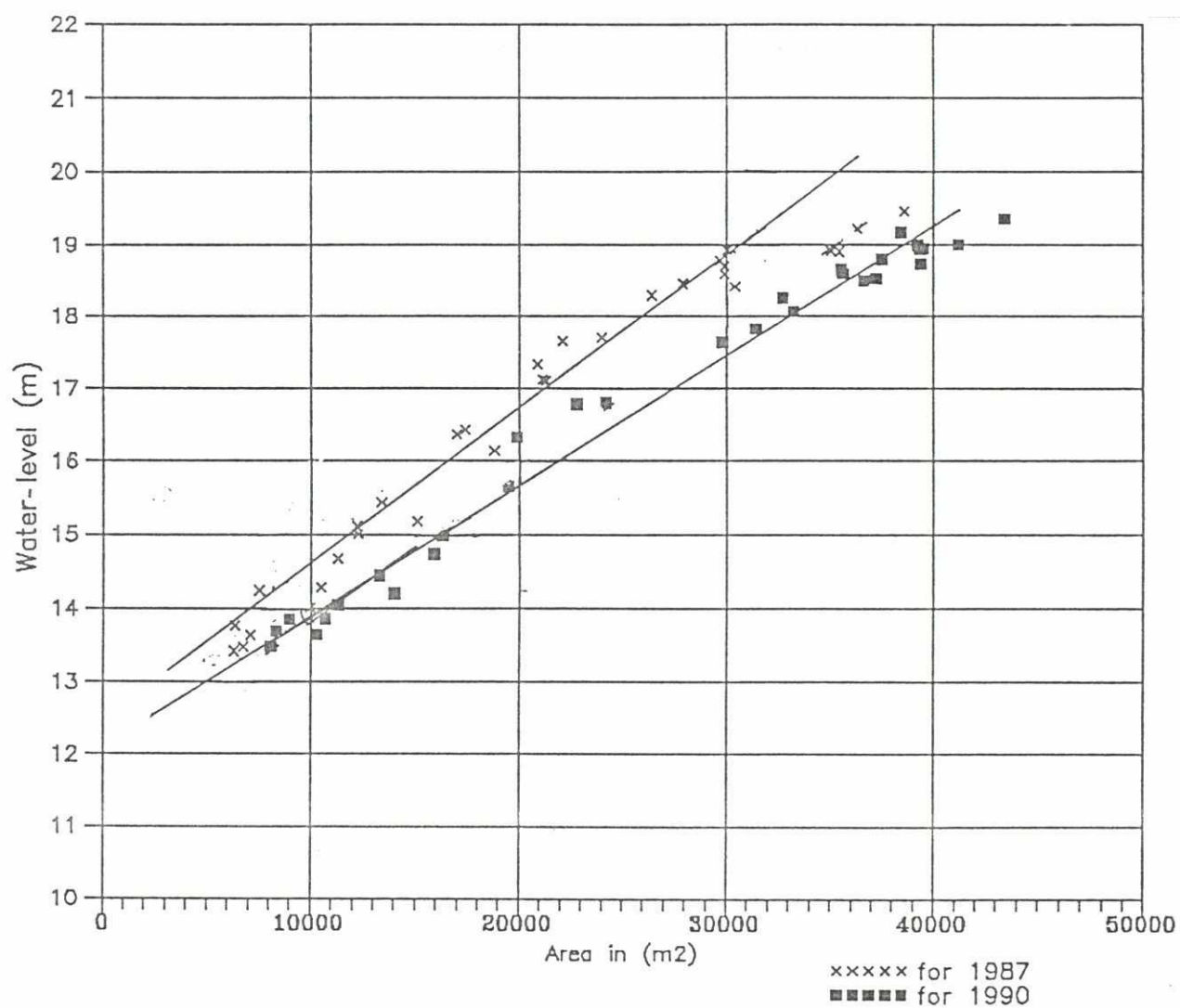


Figure 7.3 Cross-sectional area as function of the water-level for Bahadurabad data, 1987 and 1990

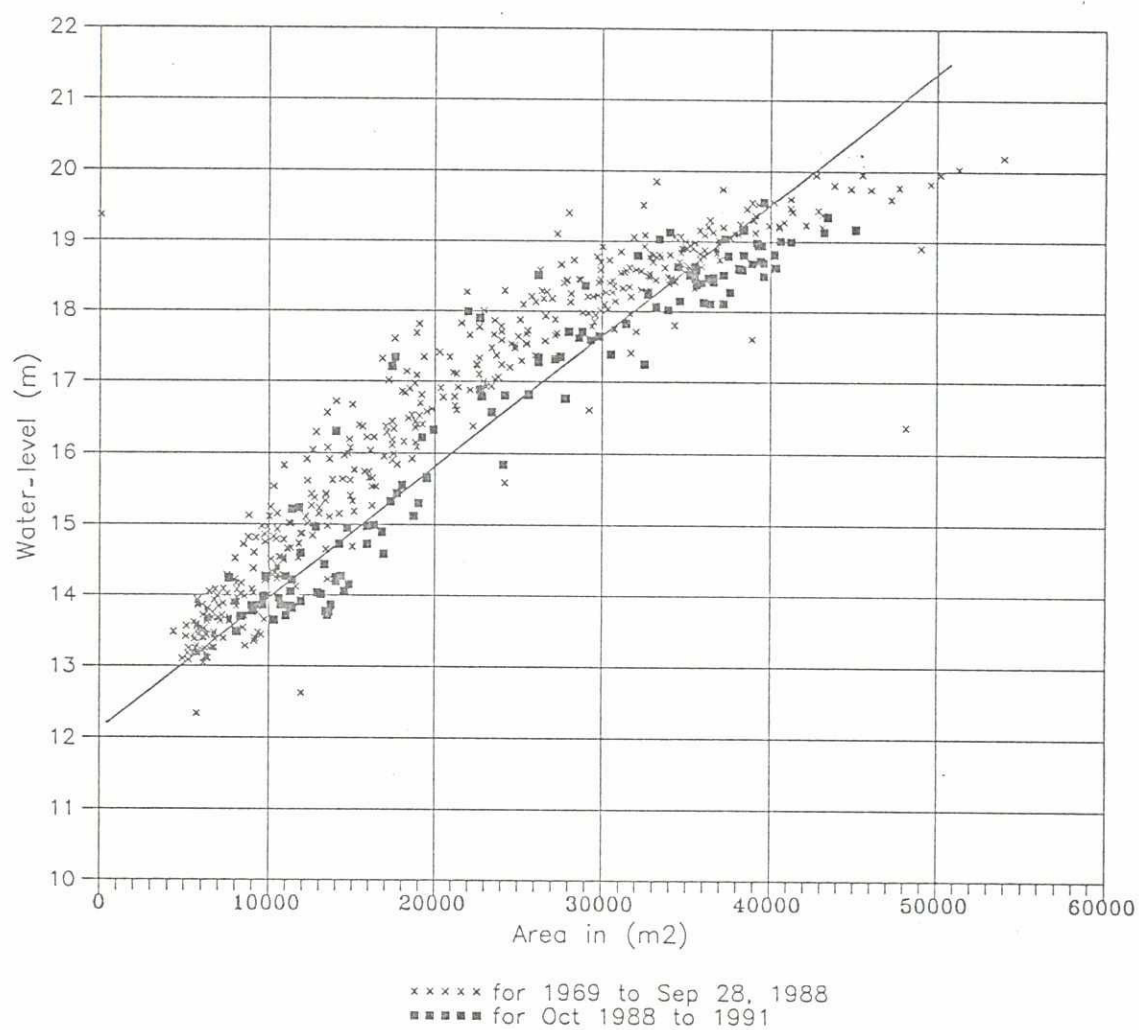


Figure 7.4 Cross-sectional area as function of the water-level for Bahadurabad data for the period 1969 to 1991.



### 7.2.3 Separate rating curves at Bahadurabad

Possible improvements by applying separate rating curves for the left channel and for the right channel at Bahadurabad station were investigated. This is an alternative approach for the present procedure with a single rating curve based on the total observed discharges and the water-levels in the left and right channel together. The discharge time series were generated separately for left channel and right channel for the year 1987 considering the respective rating curves and water-levels. These two time series were added to obtain the total discharge time series. The comparison between time series based on a single rating curve and the time series based on separate rating curves was made. The monthly mean, annual mean and maximum discharges do not show significant differences, see Tables 7.1(a) and 7.1(b). The same analysis will be performed with the FAP 24 data measured in the hydrological year 1994.

Type of discharge data	Separate rating curves (m <sup>3</sup> /s)	Single rating curve (m <sup>3</sup> /s)	Per-cent difference (%)
Annual mean	21,806	21,725	0.4
Annual maximum	71,101	71,309	-0.3

Table 7.1(a): Comparison between discharge time series on annual values (1987).

Month	Monthly mean sep. rating curves (m <sup>3</sup> /s)	Monthly mean single rating curve (m <sup>3</sup> /s)	Per-cent difference (%)
April	9.570	8.980	6.1
May	12.840	12.280	4.4
June	25.580	24.870	2.8
July	49.560	50.480	-1.9
August	53.230	53.750	-1.0
September	43.910	44.560	-1.5
October	43.910	44.560	-1.5
November	12.060	11.760	2.5
December	6.980	6.940	0.6
January	5.140	5.000	2.6
February	4.430	4.280	3.3
March	6.521	6.220	4.7

Table 7.1 (b): Comparison between monthly mean discharges determined from different rating curves (1987)

#### 7.2.4 Inconsistencies in the Bahadurabad rating curve

Following the findings reported by DELFT/DHI (1993c) regarding possible inconsistencies in the discharge time series and the rating curve at Bahadurabad after the flood in 1988, a meeting was convened by the Director General of the River Research Institute in December 1993. The inconsistencies in the rating curves of the pre- and the post 1988 period were illustrated by five different sets of analyses which include:

- o the analysis of the Q-h curve during the pre- and post-1988 period at Bahadurabad,
- o the analysis of the flood volume in the pre- and post-1988 period at Bahadurabad, Hardinge Bridge and at Baruria together with an analysis of the water-levels measured during that period,
- o the water-balance covering the Bahadurabad-Hardinge Bridge-Baruria network,
- o the water-level analyses at specific discharges, and

- o the differences in field measurements between FAP 24 and BWDB.

The meeting formed a committee with Prof. Jahiruddin Chowdhury of BUET as convenor. Its other members included the Team Leader FAP 24, the Superintending Engineer FPCO (member secretary), the Director Surface Water Hydrology I and the Director Surface Water Hydrology II. The terms of reference of this committee was stated as to *"review the causes of shift in the rating curve at Bahadurabad after the 1988 flood and suggest appropriate measures to resolve the crisis"*.

A series of about 8 committee meetings took place under the auspices of FPCO, where elaborate discussions and further analyses of data were presented. These further analyses were made by FAP 24, UNDP hydrological advisory services BGD/88/054, Surface Water Hydrology Directorates of BWDB, and Surface Water Modelling Center. They include :

- o rainfall analyses,
- o dry-season and flood-season flow analyses,
- o differences in observed Q and discharge time-series obtained from rating curves,
- o differences in on-line and off-line measurements of FAP 24,
- o effects of extrapolation of flood flows during extreme events,
- o maximum and minimum water-level analyses,
- o trend analyses of annual flows,
- o changes in channel parameters (such as width, depth and area) after the 1988 flood,
- o correlation between mean velocity and water-level,
- o generation of discharge time-series by the General Model.

The Project Adviser of FAP 24 made definite contributions by his comments and suggestions on findings of the committee. After careful study, the committee members agreed in a meeting on 7 March 1994 that *the discharge data at Bahadurabad for the three hydrological years 1989-90, 1990-91 and 1991-92 are not consistent with the data before 1989-90*. The committee also recommended the followings actions:

- o a scientific study to identify the causes of inconsistency,
- o extensive joint measurements by BWDB and FAP 24 at Bahadurabad,
- o determination of the significance of a datum error on discharge data by BWDB Hydrology Directorate.



The above conclusions and recommendations of the committee were later approved in the 8th FAPMCC meeting held on 18 April 1994.

In accordance with the recommendations, FAP 24 increased the frequency of measurements (about once in a week) at Bahadurabad, especially during the monsoon season (July to October) of 1994, some coinciding with the discharge measurement dates of BWDB.

#### 7.2.5 Improved historical discharge time series at Bhairab Bazar

The FAP 24 Hydrological Study Phase 1 (DELFT/DHI 1993c) found considerable variation in the observed discharges in the Meghna River at Bhairab Bazar. The study revealed that traditional curve fitting techniques did not give satisfactory results for establishing rating curves for Bhairab Bazar. The variability in the gauging data can probably be attributed to the following sources: backwater effects, tidal effects, unsteady flow effects and uncertainties in the gauging data.

An analysis to make a correction for backwater effects has been carried out for the rating curve data of some selected years. Firstly, a neighbouring water-level station was selected from which the fall (stage difference) or gradient could be calculated. The closest water-level stations downstream of Bhairab Bazar on the main channel are Narsingdi and Badyer Bazar. They are respectively 42 km and 68 km downstream of Bhairab Bazar (FAP 9B, 1991). An alternative station at Dilalpur, 20 km upstream of Bhairab Bazar, was chosen for calculating the fall. Figures 7.5 and 7.6 show the gauging data for 1988 and 1989 with the fall calculated from the readings at Dilalpur and Bhairab Bazar. For the 1988 data, the data can be quite clearly grouped according to the fall. The gaugings with the largest fall for a given stage have the largest discharges, as expected. The 1989 data show the same pattern. If the fall decreases then the discharge for the same stage decreases also. There are some small deviations from this pattern, which may be caused by uncertainties in the gauging data.

Based on these initial analyses the gauging data for Bhairab Bazar were corrected for constant fall. This can be performed conveniently with the HYMOS package. Once the gauging data have been corrected for constant fall the gauging points should lie closer to a single curve. The gauging data without and with a correction for a constant fall are shown in Figures 7.7 and 7.8 for 1988 and Figures 7.9 and 7.10 for 1989. Backwater effects the rating curve clearly in 1988 and a definite improvement is achieved for the gauging points at the higher stages. The improvement is not significant for the 1989 data. Nevertheless, these initial investigations suggest that a correction for the constant fall will be useful for the rating curve at Bhairab Bazar. The rating curves for 1990 onwards will be established by constant fall method considering the Dilalpur as an auxiliary station. Alternatively, a set of





rating curves for various falls may be produced. If this analysis shows the same improvements for the more recent years, then these data can be used to generate new discharge time series.

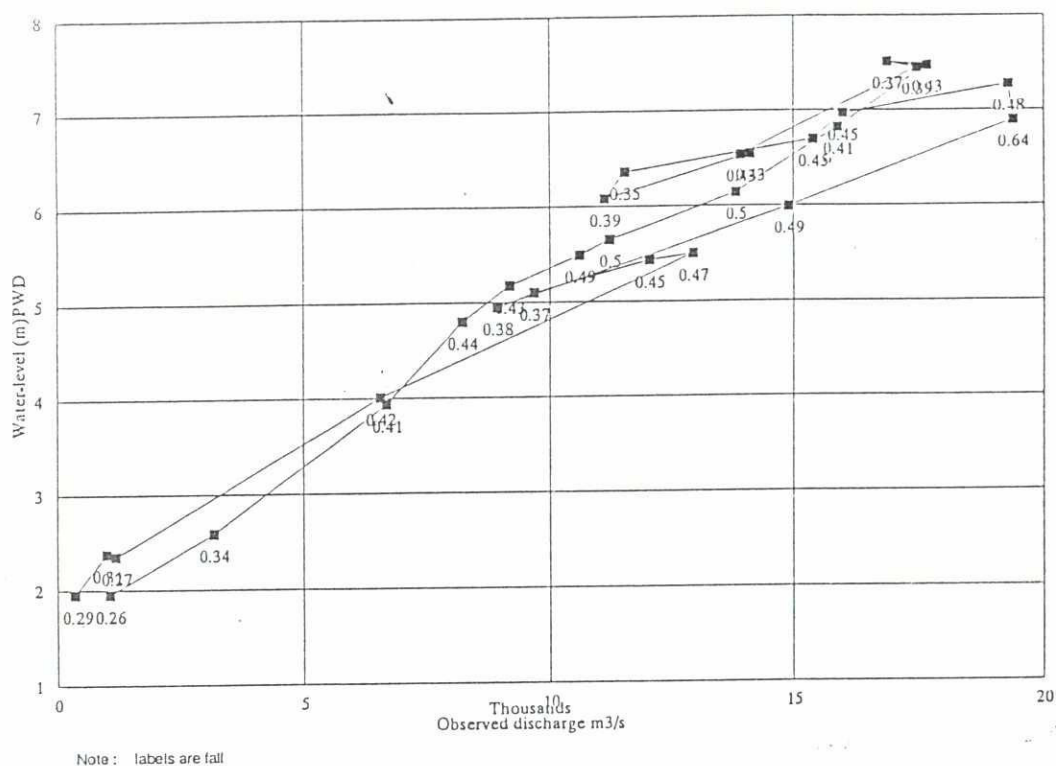


Figure 7.5 Observed discharge as function of the water-level for Bhairab Bazar, 1988, with the fall indicated

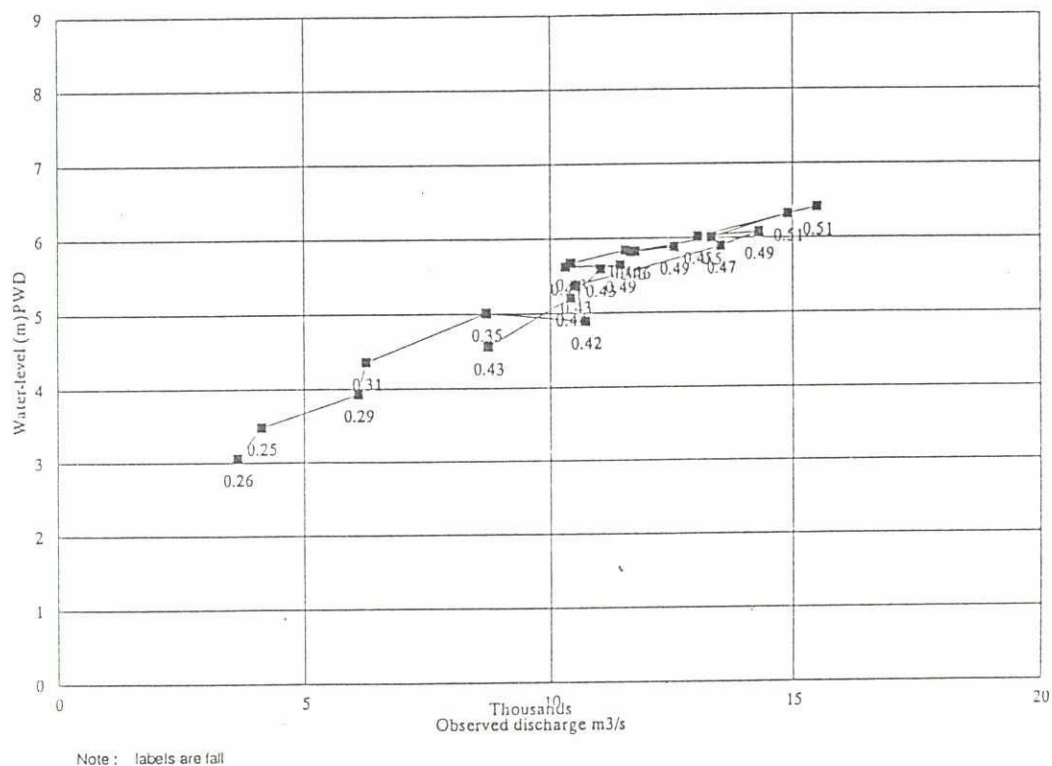


Figure 7.6 Observed discharge as function of the water-level for Bhairab Bazar, with the fall indicated

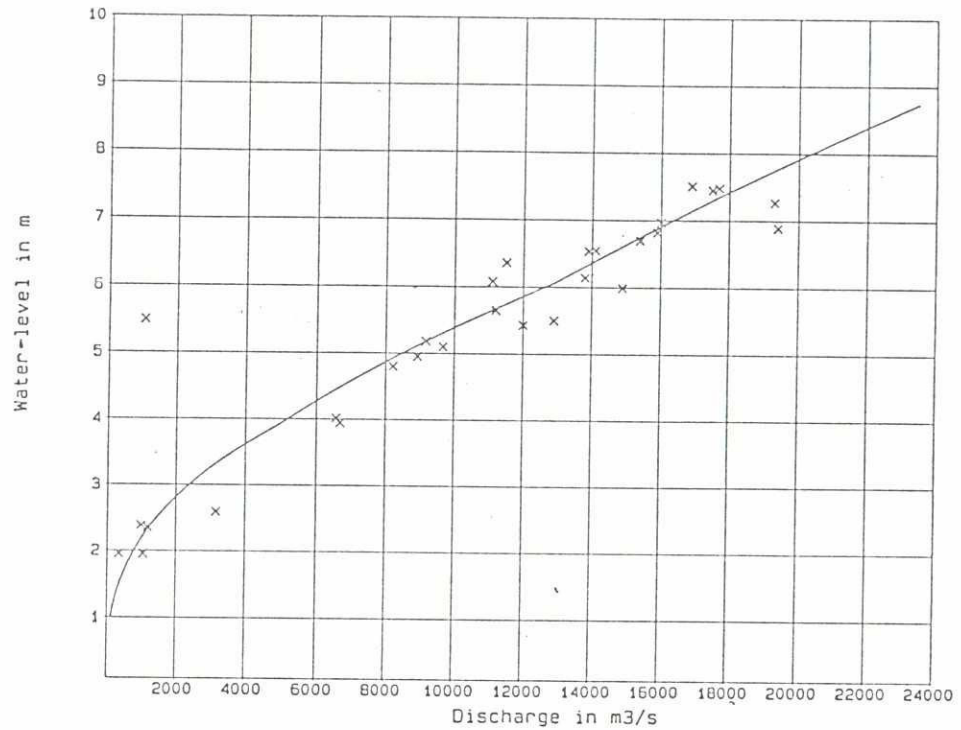


Figure 7.7 Rating curve for Bhairab Bazar, 1988, without correction

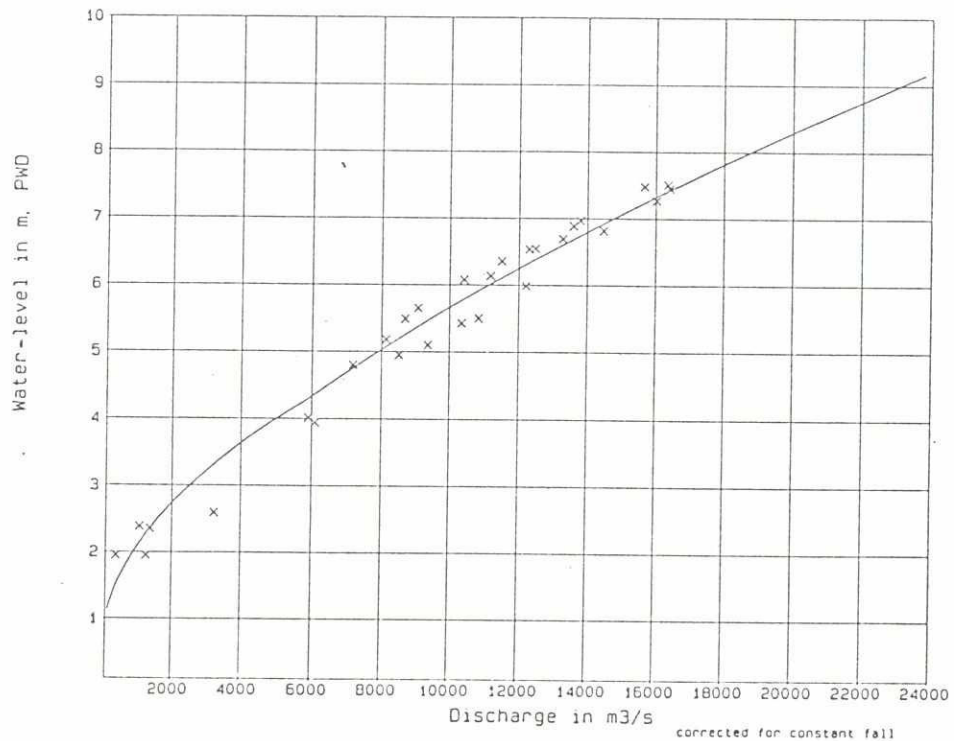


Figure 7.8 Rating curve for Bhairab Bazar, 1988, with correction based on constant fall

River Survey Project FAP 24

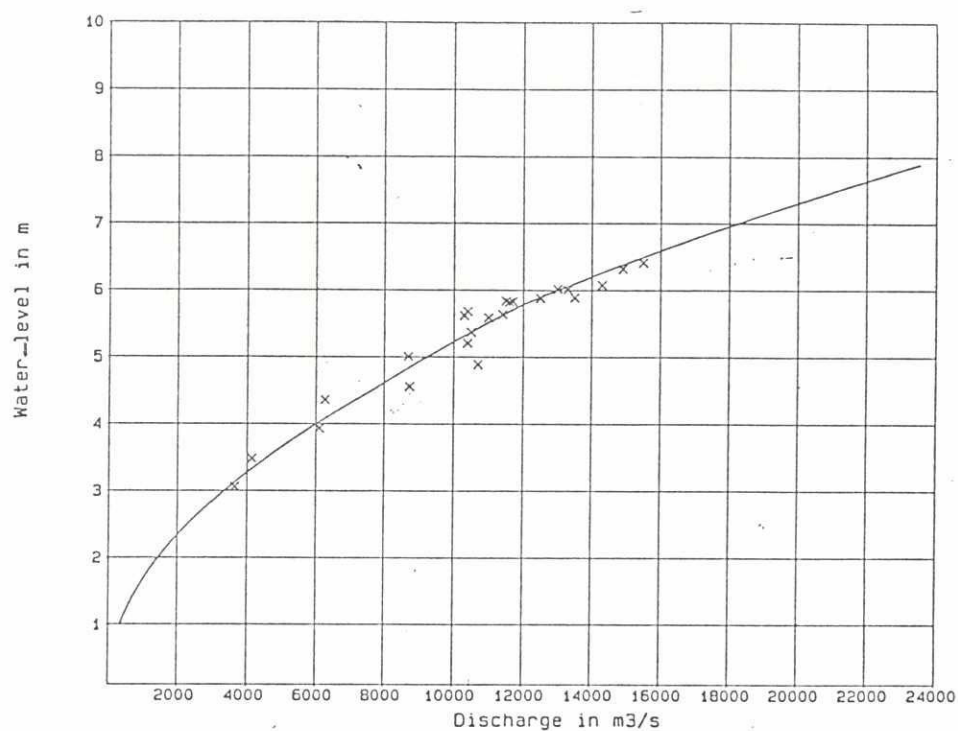


Figure 7.9 Rating curve for Bhairab Bazar, 1989, without correction

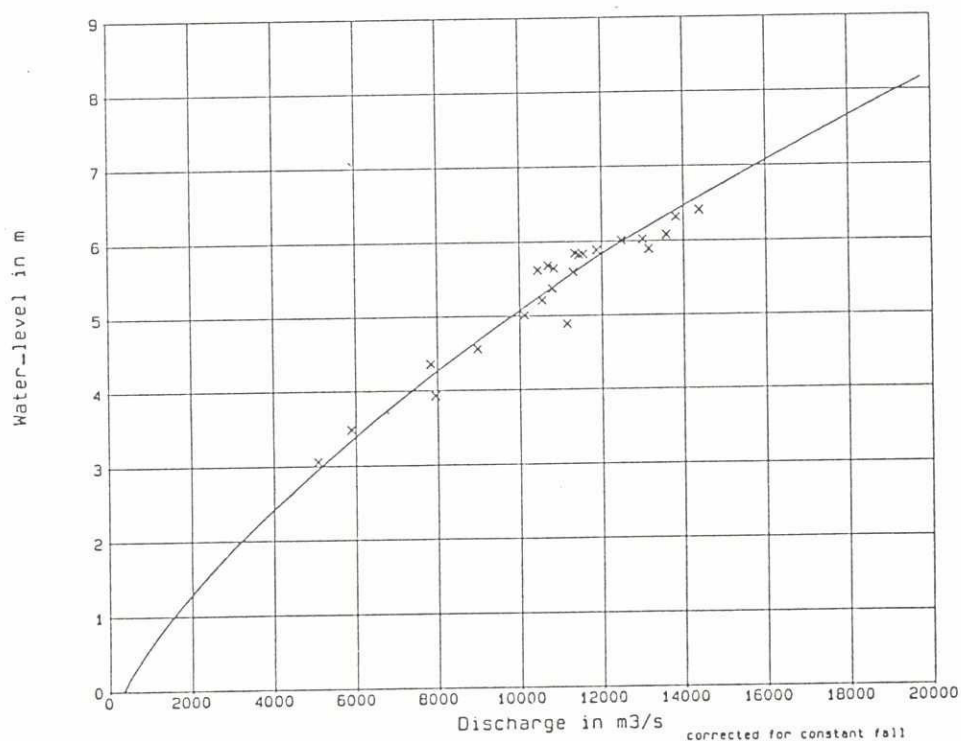


Figure 7.10 Rating curve for Bhairab Bazar, 1989, with correction based on constant fall



### 7.2.6 Local water-level slopes

The water-level slope is an important indicator of the hydraulic behaviour and sediment transport capacity of a river. During phase 1 of the hydrological study (DELFT/DHI 1993c) the overall water-level profiles and water-level slopes were studied for the major rivers. To show the local variation in the slope, water-level profiles are drawn for the 20.4 km reach at Bahadurabad along the Jamuna River. The analysis is made with the FAP 24 data from the stations along the left channel at Bahadurabad, see Figure 7.11. The data quality was checked by making a correlation between the upstream station and the downstream station and plotting the hydrographs of the upstream and downstream stations. Slopes have been determined considering three water-levels in the rising limb and three in the falling limb of the hydrograph. The water-level slope upstream of Bahadurabad varies from 8.4 to 5.4 cm/km from August to December 1993 and downstream of Bahadurabad it varies from 9.1 to 5.5 cm/km from July to December 1993, see Figure 7.12. The analysis reveals that the water-level slope increases in the rising stage and decreases in the falling stage. A more detailed analysis is ongoing.

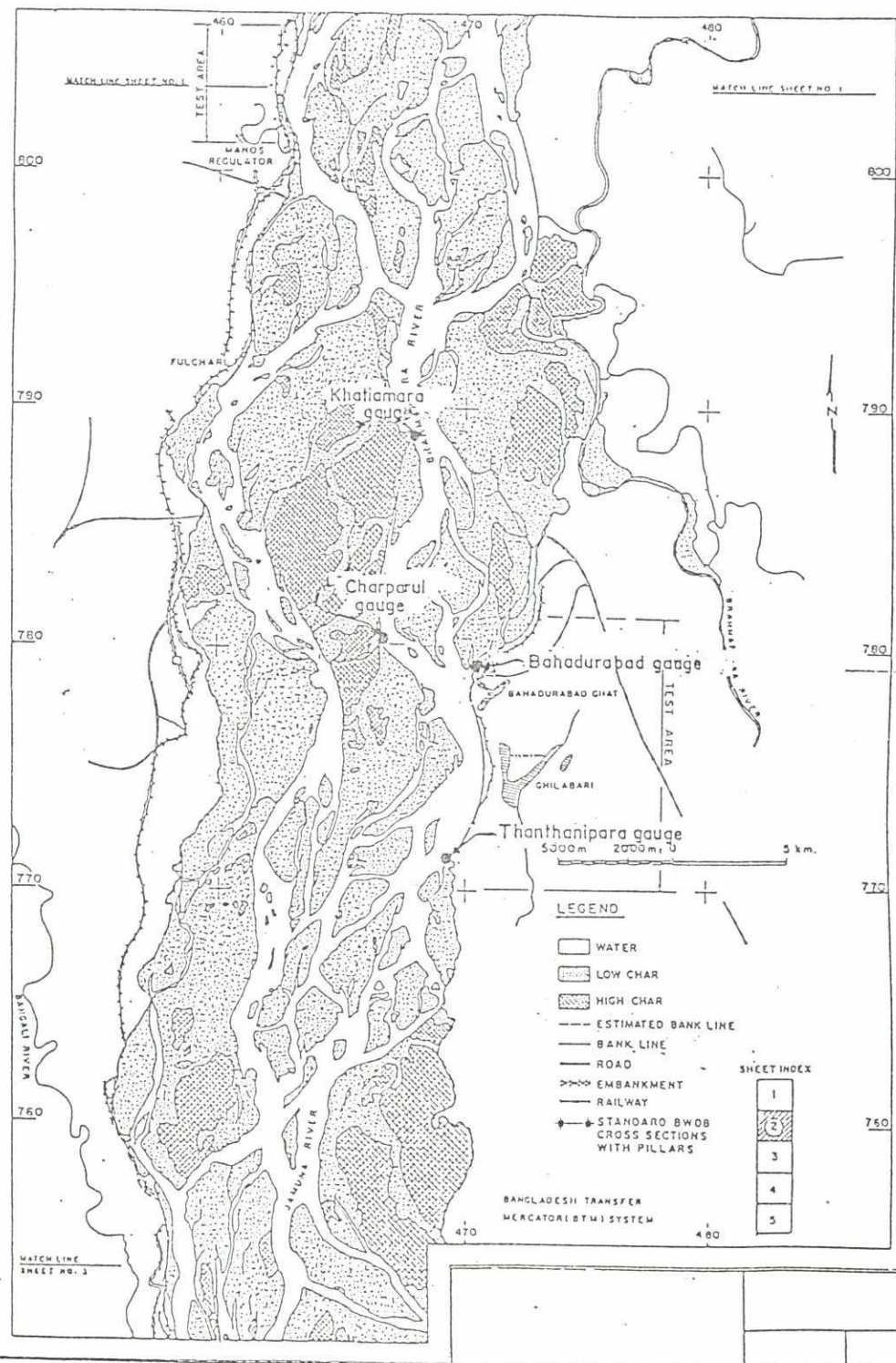


Figure 7.11 Map with water-level gauges near Bahadurabad

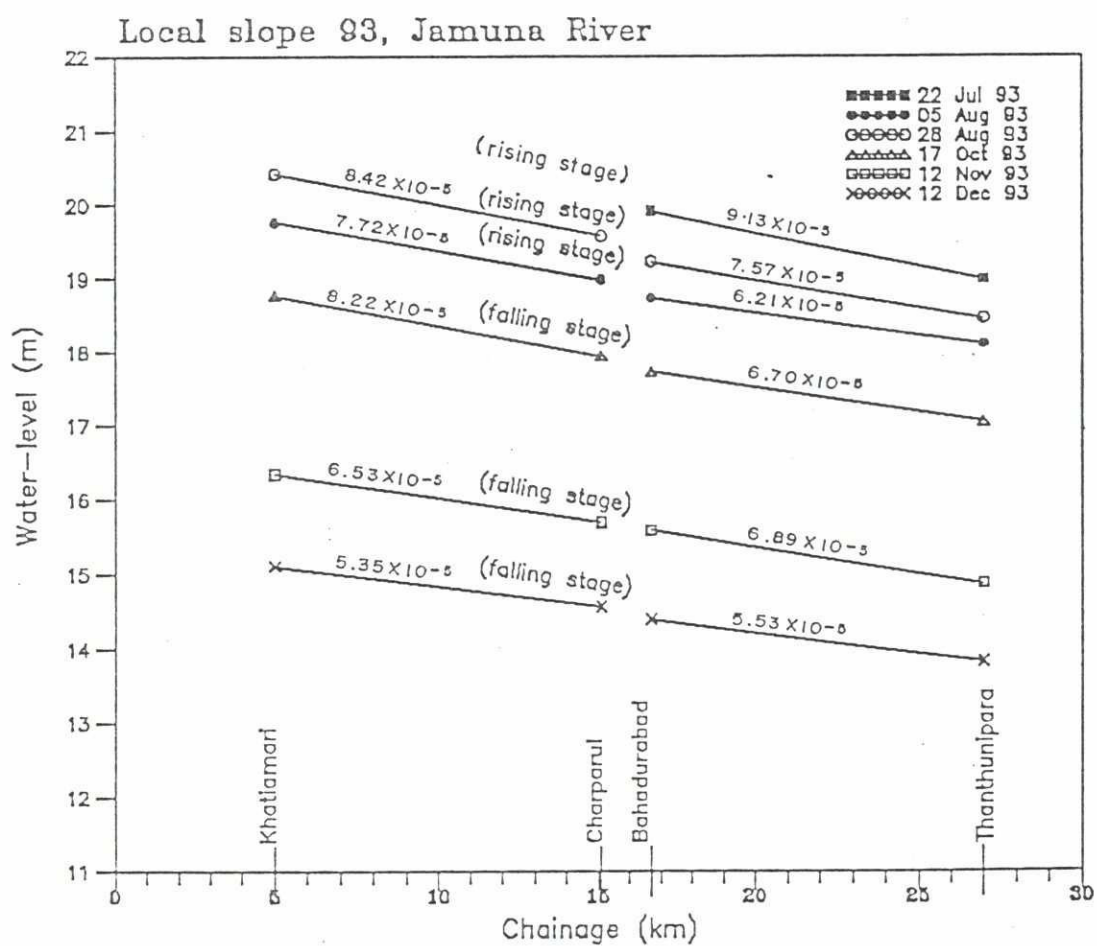


Figure 7.12 Local water-level slope as a function of the chainage and the water-level, 1993.



## 7.3 Sediment rating curves

### 7.3.1 Introduction

The sediment rating curves, which were determined in the past by different studies, were based on data series as long as available without splitting them up in shorter data series, for example in series of data collected during the flood with the water-level above or below bankfull level, the pre-monsoon, the monsoon or the post monsoon season. It is possible that the season has a significant effect on the sediment transport. It is well known that most of the sediment is transported during the monsoon season. Therefore it was decided to check the sensitivity of the overall rating curves for the season.

Another parameter which can have some effect on the sediment transport is the planform of the river at the location of the sediment measuring station: in a widening, in a contraction or in a uniform section of the river.

The power law approximation of the sediment rating curves reads as:  $S = A \cdot Q^B$ , where  $S$  is sediment discharge (suspended bed material, bed load or total load) and  $Q$  is water discharge. For a particular river the value of coefficient  $B$  depends on the typical planform of the river. In the rating curves for the total sediment transport in the main rivers like the Ganges, Padma and Jamuna, the value of  $B$  varies between 1 and 1.7. But in previously determined rating curves the coefficient  $B$  for the Ganges River at Hardinge Bridge is 2.5. The value of  $B$  for the Padma River at Baruria is 2.8. These values of  $B$  are high and indicate a steep slope of the rating curve.

Attempts were made to improve the sediment rating curve for Bahadurabad station by considering the influence of the season (see Sub-section 7.3.2). The conclusion and the recommendations are presented in Sub-section 7.3.3.

### 7.3.2 Rating curve at Bahadurabad

During phase 1 of the River Survey Project sediment rating curves were derived using all the available data of the stations along the main river system for the period 1966-1970 and 1976-1988. In the past various studies have found that the sediment data collected during the period 1966-1970 seem to be more reliable than the sediment data collected during the period 1976-1990. This was confirmed by the River Survey Project (DELFT/DHI 1994).

The planform of the river near Bahadurabad station does not show a particular widening or contraction, therefore it was not necessary to determine the effect of the planform on the sediment rating curve for Bahadurabad station. The analysis was focused on the influence of the



season on the sediment rating curve. Therefore the data for the dry seasons were excluded from the total data series and new rating curves were determined for the remaining data points. Next the combined effect of the dry season and the flow over the flood plain was determined by excluding the data of the dry seasons and the data during periods with the water-level higher than the bankfull level from the complete data series. Again new rating curves were determined from the shorter data series.

The rating curve for the suspended bed material load reads:

$$S = A * Q^B$$

in which,

S = suspended bed material transport in tons/day

Q = discharge in m<sup>3</sup>/s.

The results of this analysis are presented in Table 7.2.

Condition	Period	A	B	R <sup>2</sup>
exclusion dry season data	1976-1988	0.33	1.35	0.64
exclusion dry season and above bankfull flow data	1976 - 1988	0.65	1.28	0.61
exclusion dry season and above bankfull flow data	1966 - 1970	1.08	1.30	0.54
all data series	1966 -1970	0.22	1.46	0.86
all data series	1976 - 1988	0.46	1.32	0.72

Table 7.2 Optimization of the sediment rating curve for suspended bed material transport in the Bahadurabad station.

It can be observed that after elimination of dry period data and above bankfull data, the correlation between S and Q has dropped from R<sup>2</sup> = 0.72 for all data to 0.61 and from R<sup>2</sup> = 0.86 for all data to 0.54 for the data series 1976-1988 and 1966-1970 respectively. These correlation coefficients indicate that the monsoon (without over bankfull) data are widely scattered.

A comparison of the suspended bed material rating curves for the Jamuna River at Bahadurabad for different seasonal conditions are shown in Figure 7.13. It is indicative that after deletion of the dry period and even the above bankfull discharges, the overall sediment rating did not change for the sediment series 1976-1988. There is a slight decrease in the sediment transport for the data series 1966-1970 after disregarding the data from dry periods and periods with over bankfull discharge.

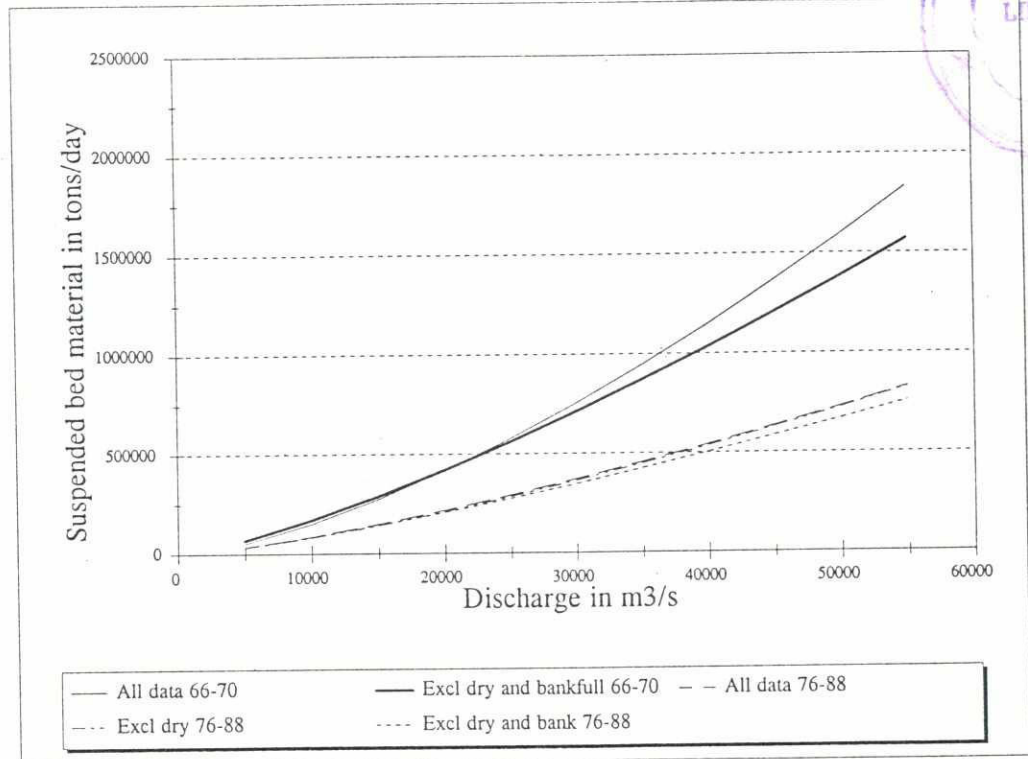


Figure 7.13: Sediment rating curves Jamuna River at Bahadurabad

### 7.3.3 Conclusion and recommendations

The exclusion of dry season data does not make any significant difference in sediment transport rating curves.

The exclusion of over-bankfull data gives reduced transport from the corresponding rating curve.

There is a considerable drop in the exponent B from 1.46 to 1.30 for the period 1966-70. This values means that the exponent n of the general sediment transport formula ( $s = \mu u^n$ , where s is sediment transport per meter width and u is the average velocity in a vertical) approximately dropped from 4.4 to 4.0, Nevertheless the n values are within the range suggested for this type of rivers.

Overall it can be said that no significant improvement of the sediment transport rating curve could be achieved from exclusion of dry season and over bankfull discharges.

Apparently, there is a significant drop in sediment transport from the period 1966 - 70 to 1976 - 88. The reason for this drop is not known. But this may be studied later on.

It is recommended to consider other separations of the total data series to try to improve the sediment rating curves.

FAP 24 has conducted a sediment gauging survey upstream of the Hardinge Bridge and Baruria and more surveys will be conducted during the monsoon 1994. After processing these data an analysis will be made to improve the sediment rating curves for those stations in a similar way as has been presented here for Bahadurabad station.

## 7.4 **Planforms and channel dimensions**

### 7.4.1 Introduction

In general the dimensions of the channels in rivers which are assumed to be in an equilibrium on a graded time-scale, may be related to flow parameters such as bankfull discharge, sediment discharge, characteristic sediment size and valley slope of the river. These relationships can be used for predicting channel behaviour. The analysis of the channel dimensions of the major rivers like the Jamuna, the Ganges, the Padma and the Meghna Rivers is planned as part of the studies in phase 2 of the River Survey Project. The analysis will be done against the background of the relative "youth" of the river system and the importance of geomorphological "remnants".



At present the first results of two approaches to determine the geometric dimensions of a channel are presented in Section 7.4.3. The first empirical approach is an application of the formulas of the regime theory and the other approach is the analytical method according to Chang (1979). Both approaches will be examined more in depth during the course of the study.

Because of the stochastic character of channel dimensions a large database with cross-sectional data of river channels is required for a successful analysis (Sub-section 7.4.2). Some tentative conclusions and recommendations are presented in Sub-section 7.4.4.

#### 7.4.2 Data

For a study of the channel dimensions a database is needed filled with accurate data and long time series of yearly cross-sections. FAP 24 has collected a large number of cross-sections surveyed by the BWDB in the rivers Jamuna, Ganges and Padma since 1964/65. These are stored in a database, which will be developed further by checking the quality of the data and by expanding it with new cross-sections. Quality checking of those cross-sections data include checking the vertical control by comparing each cross-section for different years, and the horizontal control includes a perpendicularity correction by comparing the cross-section with satellite imagery.

According to our experience it can be rather complicated to locate the exact alignment of the BWDB standard cross-sections of the main rivers (for example for the Jamuna river) on a topographic map or on a satellite image because of lack of accurate and detailed information on pillars and monuments of a cross-section.

The bathymetric surveys and the routine gauging of FAP 24 will provide additional and reliable information which can be used in the analysis of channel dimensions.

#### 7.4.3 First results for the Jamuna River

The regime theory was published by Lacey (1930) for rivers and irrigation channels on the Indian sub-continent. Recently Klaassen and Vermeer (1988), have applied those formulas on the data of the cross-sections in the Jamuna river. The values of the empirical coefficients in those formulas, which relate the bankfull depth and width of a channel to the discharge for the secondary channels of the Jamuna River, were determined. Their findings are:



$$h = 0.23 * Q_b^{0.32} \quad (7.1)$$

$$B = 16.1 * Q_b^{0.53} \quad (7.2)$$

in which:

$h$  = average depth of a single channel (m)

$B$  = width at the water-level in a single channel (m)

$Q_b$  = discharge in a single channel under bankfull conditions ( $m^3/s$ )

It should be mentioned that in the relevant graphs the scatter of the data of the individual cross-sections around the curves as defined by these formulas (7.1) and (7.2), is considerable. However, the analysis of the cross-sections of the Jamuna river by FAP 1 has confirmed the validity of these formulas for a first estimation of the width and the depth of the channels. In that study also a large scatter of data points was found (FAP 1, Draft final report, Annex 2).

In a preliminary analysis 98 BWDB cross-sections, out of which 147 individual channel sections of the Jamuna river were identified, were analyzed by FAP 24. The water-level corresponding to a bankfull discharge of approximately 44,000  $m^3/s$  was taken as reference level and secondary channels carrying more than 15% of the total discharge were considered. The procedure followed for the estimation of the discharge was almost the same as the procedure followed by Klaassen and Vermeer (1988). The definition of a secondary channel was slightly changed: channels which are separated by a submerged char with its highest point less than 0.5 m below the bank-full water-level are considered as two individual channels (see Figure 7.14). The results are presented in Figures 7.15 and 7.16. From those figures one can observe that the depth according to eq. (7.1) fits well with the average of the data points, but the width according to eq. (7.2) is higher than the average tendency based on the data points. The considerable scatter in these data points will be analyzed in more detail during the continuation of the study.

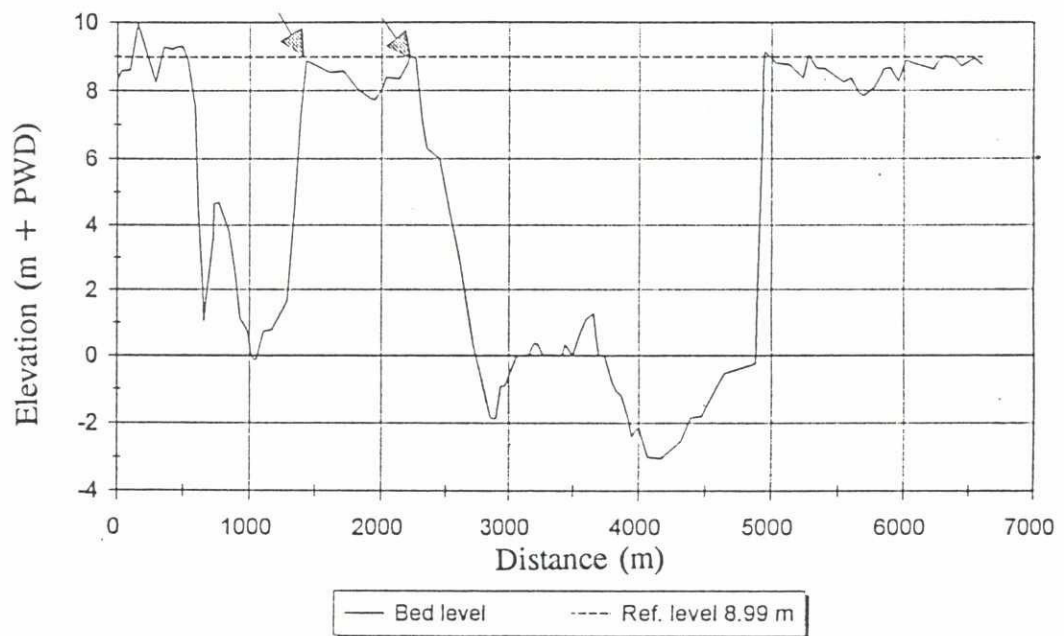


Figure 7.14 : Cross-section J#2-1R of the Jamuna River as surveyed in 1969

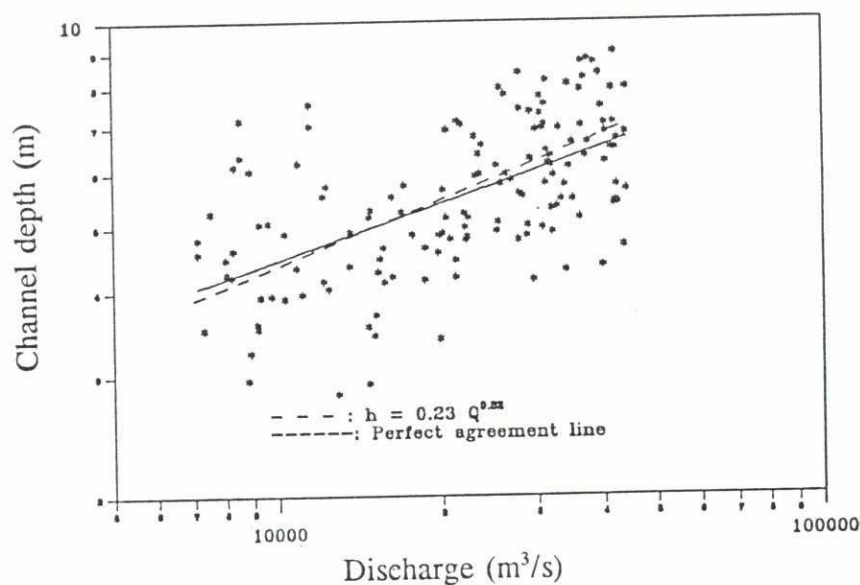


Figure 7.15 : The average depth of a single channel as a function of the discharge in that channel under the condition of bankfull discharge in the Jamuna River

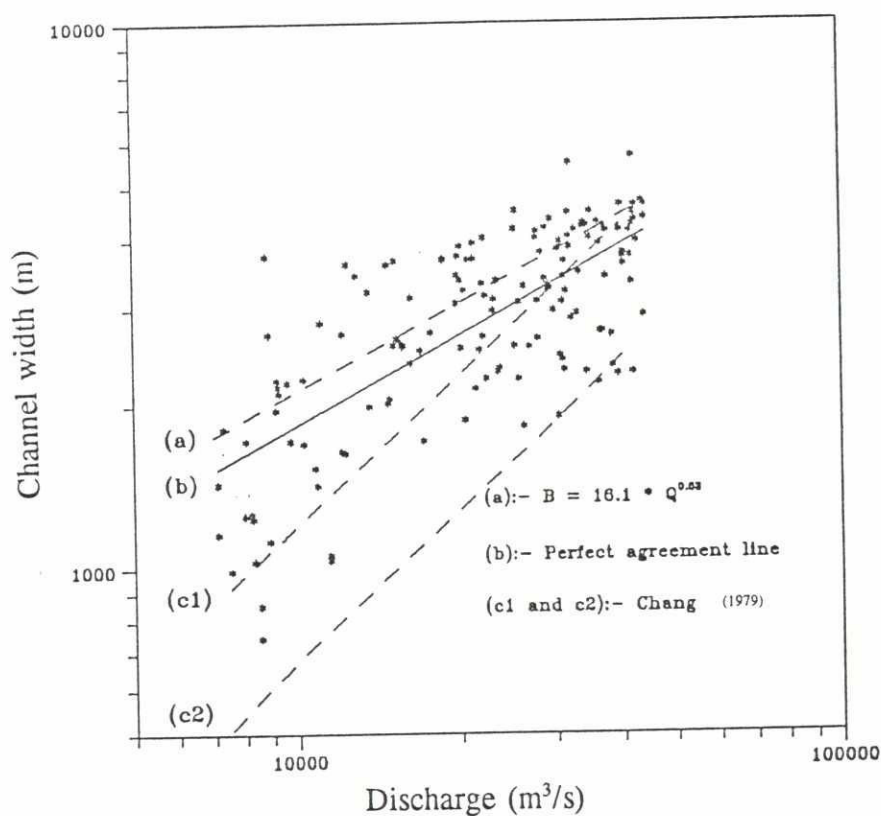


Figure 7.16 : The width of a single channel as a function of the discharge in that channel under the condition of bankfull discharge in the Jamuna River

Chang (1979), developed a design graph based on an optimal hypothesis, to determine channel width and depth as a function of slope, grain size and bank-full discharge. Considering the water-level slope ranging from  $5.5 \times 10^{-5}$  to  $8.5 \times 10^{-5}$  in the Jamuna River and the grain size ranging from 0.15 to 0.30 mm, the upper and lower limit of the width were determined for different bankfull discharges with the help of a design graph. The results are presented in Figure 7.16. From this figure it is seen that within the range of  $Q$  the variation of the width is about two folds and that the range of variation of width computed from Chang (1979) is laying below the line of perfect agreement. It is noted here that perpendicularity correction for the width could minimize the difference of the data points and the computed range of width. Furthermore this preliminary validation of the Chang method for the Jamuna River will be elaborated in more detail as the study progresses.

#### 7.4.4 Recommendation

Further and more detailed analysis is planned with more consistent FAP 24 data and selected consistent BWDB cross-section data (see DELFT/DHI 1994). In the continuation of the study also other analytical methods to predict channel dimensions will be examined for a better understanding of the river processes in Bangladesh.



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## 7.5 Offtakes and bifurcations

A joint study programme between FAP 24 and the University of Nottingham in the United Kingdom has started in the spring of 1994 to conduct a study on secondary current patterns in a bifurcated channel and over a braided bar. In a later phase of the study also the sediment distribution at the bifurcation and the outflowing channels will be included.

The main objectives of the proposed study are:

- o To define the secondary flow pattern at a simple bifurcation-confluence in a large braided river.
- o To examine the influence of changing stage on the secondary flow pattern.
- o To evaluate the extent to which secondary currents influence the uniformity of boundary shear stress on the bed and the banks of the river.
- o To investigate the distribution of sediment transport which enters into the bifurcated channel from the main channel.

In this study the analysis of field measurements of the flow pattern in a bifurcation and two outflowing channels play an important role. During a field visit in May 1993 an asymmetric bar in the Jamuna river was selected approximately 4 to 5 km south of Bahadurabad (see Figure 7.17). This bar has a length of about 5 km and its width ranges from 1 to 2 km. The maximum height of the bar is about 1 m below the average bankfull level. The left channel of the bar is 1,100 m wide and has a maximum depth of 15 m (7 m below SLW) in May, and the right channel of the bar has a width of 600 to 800 m with a maximum depth of about 8 m (in May 1994).

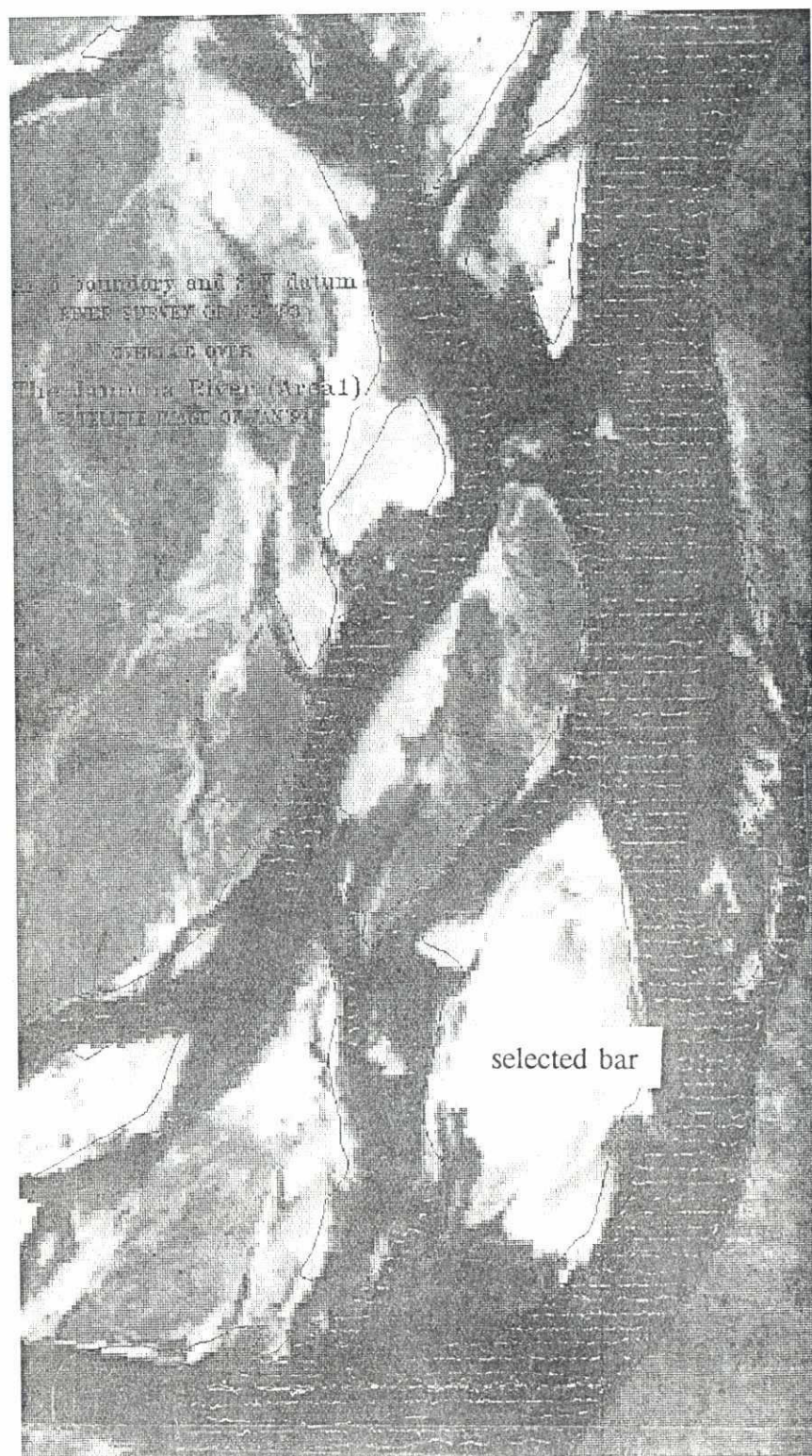


Figure 7.17 Location of the selected bar near Bahadurabad (ISPAN/FAP 19)

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For the field measurements 16 cross-sections were selected around this bar. A bankline survey was conducted during the field trip. Special secondary flow measurements were conducted in the left channel in various transects.

A programme for additional field measurements was defined with the following elements:

- o Transect survey
- o Bankline survey
- o Sediment transport measurements

The additional surveys are planned for mid June, August and during falling stage at the end of September 1994. The transect measurements which were made on 18 and 19 May will be repeated reasonably close to the original locations. The sediment measurements will be done at transect 3, 4 and 6, on the same transect line in the opposite channel.

Besides these activities related with bifurcations also the off-takes will be studied, starting with the off-take of the Gorai from the Ganges River. This part of the study will be taken up in the second half of 1994.



## 7.6 Selection of cross-section measurement sites

A meeting was held January 1994 to discuss the cross-sectional survey methodology of BWDB. Among others, the Director River Morphology of BWDB and FAP 24 Team Leader participated in the discussion. It covered the following subjects:

- o definition and network of river cross-sections,
- o methods of measurements and related accuracy,
- o data elaboration and validation,
- o documentation and dissemination of information.

It may be mentioned that BWDB regularly surveys a considerable number of river cross-sections covering all major rivers (DELFT/DHI, 1994), which are useful for morphological studies. After lengthy discussions, it was felt that there is considerable scope for further improvement of the accuracy of these measurements. Accordingly, a joint set of conclusions and recommendations were charted as described below.

Positioning. The present definition of standard cross-sections based on geographical coordinates of monuments (estimated from old maps where the monuments were identified based on site description) and alignments is not adequate. This was observed during analyses of cross-sectional data by several investigators/consultants. The situation should be improved by using, for example, global positioning system and maintaining a proper record of the shifting of monuments. At the same time a formal definition of the chainage of the monuments will facilitate the determination of cross-sections and river parameters.

Measurement methods. Accurate measurements of a cross-sectional profile in a wide and braided river like Jamuna need considerable effort. This involves a strenuous job of surveying the land part and the water part, and the integration of the two. Surveying one cross-section within about 5 days seems inadequate. It should be considered whether the number of the standard cross-sections can be reduced in order to measure some key cross-sections with a greater accuracy. The emphasis should not only be on quantity but also on the quality of data.

Cross-sectional alignment. Initially, the cross-sections were aligned perpendicular to the channel alignment. Due to planform changes in the meantime, the channel alignment might have changed, although the cross-sections remained fixed. For morphological computations a perpendicular cross-section is preferred, although a fixed cross-section has the advantage that it allows the study of developments in time. Therefore, the present practice of measurements have to be adapted. This can be done either by making some additional measurements such as measuring perpendicular cross-sections in second-order channels together with original measurements, or making some additional measurements parallel to the original alignment.



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Data elaboration and validation. While the collected data are elaborated to make them useful, **no effort is made yet to validate the data**. There are several ways to do this which include different kinds of **quality-checks** such as **comparison with** the previous years' data to ensure realistic values.

Documentation and dissemination. The reporting and publication of survey results should continue for proper dissemination to users and be improved by inclusion of the following information.

- o Description and value of the primary network bench-mark from which the monument is connected.
- o Benchmark levels of the monuments.
- o Geographical coordinates of the monuments.
- o Closing error of levelling from one bank to the other.
- o Description of the shifting of monuments, if any.
- o Angle between the cross-sectional alignment and main flow direction in each channel.

It is proposed that FAP 24 will participate during some measurement campaigns to assist BWDB with measurements and positioning of monuments. This is scheduled to take place during the dry-season of 1994/1995.

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## 7.7 Optimization of hydraulic measurements

### 7.7.1 Introduction

Hydraulic measurements are difficult, expensive and time consuming. Therefore, optimization of survey equipment and methods is necessary. This is especially true for frequent survey work. So the optimization will focus on routine surveys of both the BWDB (see also the study topic on sustainable techniques) and the River Survey Project.

Optimization means basically measuring of data of an acceptable accuracy at minimum cost. However, mostly optimization is limited to some components such as

- o minimum network (number of stations)
- o minimum duration (time per station and frequency)
- o ease of operation
- o accuracy of instruments and method
- o desired accuracy (objective of measurement)

Unfortunately, the results of the optimization are not universal and are not applicable for all rivers in the world. The results are depending strongly to the local conditions.

With the availability of modern survey equipment in FAP 24, the capacity of the project is enormous to make detailed measurements as a basis for optimization of equipment and methods. Therefore, a separate study topic on the optimization of hydraulic measurements, topic 9.2, has been selected.

### 7.7.2 Objective

The objective is to optimize hydraulic measurements of water-level, water-level slope, flow velocity, flow direction and discharge by different equipment and methods. Attempts will be made to assess the accuracy of measurements against varying sampling-intervals (in time and space) and sampling cost. The relevant questions in this regard can be listed as follows:

1. In space dimensions, at how many points in a vertical and at how many verticals in a cross-section, should one measure to obtain a representative flow-sampling ? This is a question to be answered to optimize the velocity-area method. Another question is what is the optimal network density ?
2. In the time dimension, what should be the sampling duration at a point ? For this one should know the turbulence structure and its time-scale. It is also important to know, how many times in a year one should measure and what should be the distribution in time for obtaining a representative seasonal picture.

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3. What are the characteristics and the accuracy ranges of the various instruments ? Comparison of survey data collected by different instruments is required here. (ADCP-S4-EMF-OTT)
4. The slope-area method for discharge estimation is an inexpensive method to estimate often missing discharges or to replace other methods. How accurate is this method ? Also relevant in this regard is the applicability of float-tracking in estimating stream-lines.
5. In what respect differs the traditional method (velocity-area) from the moving-boat method in Bangladesh conditions and what are their accuracies ?
6. The near river-bed flow profile is difficult to measure, but it is important to know this profile for estimation of sediment transport. Therefore, with the help of some careful measurements, it is necessary to verify the existing extrapolation formulas so that they can be used afterwards.
7. Flow-vectors differ in their magnitude and direction over the depth and over the width. But it is not always possible to measure flow-directions at the measuring points. Therefore, it is necessary to know what errors can be made by not including direction measurements.
8. There are existing models of boundary layer flow for flat-bed or with ripples. Over the dune-length, the boundary layer flow varies. It is necessary to know to what extent these models are applicable for Bangladesh rivers in order to optimize flow measurements.

### 7.7.3 Approach

To answer the above questions, the following approaches are necessary.

- o Using the routinely collected discharge observation data by different methods, questions 1, 3, 5 and 7 will be treated simultaneously to optimize space dimension, equipment and method, and measurements of flow directions. Resolution of flow vectors will be made in perpendicular and in parallel components to determine the secondary flow-structure.
- o Question 2 will be answered by making special time-series measurements of flow velocity at different locations at different depths during different part of the year. The measured vectors will be resolved in x, y and z components to determine turbulent structure in all three different directions.



Autocorrelation and Fourier analyses technique will be applied to determine the turbulence structure (amplitude and phase).

- o In order to answer question 4 special measurements of water-level, cross-section and float tracking will be made. Slope-area method of discharge determination will be carried out together with BUET.
- o Questions 6 and 8 will be treated together. Special measurements of near-bed velocity profile will be measured together with bed-load measurements. Their results will be utilized to optimize velocity-profile measurements.

#### 7.7.4 Progress

Two types of special measurements were initiated during the reporting period, one of them relates to the indirect measurements of discharge at Bahadurabad and the other relates to the measurements of turbulence structure at Bahadurabad and at Aricha. Here, the progresses of these two measurements are summarized.

##### **Indirect method of discharge determination at Bahadurabad**

This subject primarily aims at establishing the effectiveness of the slope-area method for estimating discharges at Bahaduabad. The method is often applied for the determination of discharge during extreme events and is cost-effective compared to conventional methods. If found suitable, on certain occasions, the conventional discharge measurements can be reduced. It is designed together with IFCDR of BUET and is scheduled to take place during the monsoon season of 1994. The method is based on measurements of water-level slope and cross-sectional parameters in a convergent channel reach (ISO, 1983). The first field visit took place in 15-16 May 1994, with participation of Prof. J.U. Chowdhury of IFCDR, and a channel reach of about 10 km was selected. Detailed measuring programmes are designed which include water-level gauging, monthly measurements of cross-sectional parameters, etc. The measurements will take place from June to October, 1994.

##### **Turbulence measurements at Bahadurabad and at Aricha**

Turbulence is generated by the action of flowing water along its boundary. This boundary may be bank or river-bed. Different kinds of turbulence are generated, which include micro-turbulence to large scale eddies. Their structure is also important for sediment transport. To measure a representative field situation, different parameters are measured by integrating over time. The question is what should be this integrating time. And to answer that one should know the turbulence structure. To this end, a study programme is designed and first measurements were executed at Bahadurabad and at Aricha. The

Present status of survey?



Turbulence characteristic according to the discharge and sediment load. Only dry season may not give a representative figure. will be different condition of sediment load.

measurements at Bahadurabad were made on 30 March - 1 April, 1994 at three locations representing nearly accelerating, decelerating and uniform flow conditions at different water depths. The measurements near Aricha at the confluence were made at 5 locations, including one in the Ganges River. At each location flow velocity using measurements were made during 40 minutes using ADCP, EMF and S4. With the ADCP velocity verticals were measured in three orthogonal directions x, y and z, with the EMF point integrating measurements were done near the surface in two orthogonal directions x and y and with the S4 point integrating measurements were executed at mid-depth in x and y directions. The results of these measurements will be reported later.

## 7.8 Optimization of sediment measurements

### 7.8.1 Introduction

Sediment measurements in natural rivers are difficult, expensive and time-consuming. Therefore, optimization in sediment measuring techniques is necessary. The River Survey Project mobilized different sediment sampling instruments to test the instruments and methods aiming at optimization. The objectives of this study as spelled out in DELFT/DHI (1992 and 1993b) are to recommend certain instruments and methods, which will provide accurate sediment transport data in the natural conditions of Bangladesh. During phase 1 of the project test measurements were made applying several sediment measuring techniques, which include optical turbidity recording, point-integrating sampling using a pump bottle system, depth-integrating sampling, Helley-Smith bed-load sampling, dune tracking, etc. The results are reported in DELFT/DHI (1993d and 1994b). In particular, the report on the Selection of Survey Techniques (DELFT/DHI, 1993d) contains detailed study results. During the reporting period the River Survey Project extended their range of sediment samplers by procuring a Delft Bottle sampler and two collapsible bag depth integrating samplers. Suitability and accuracies of these different instruments and methods are also reviewed by Van Rijn (1986) for different flow conditions but their applicability has to be studied for conditions in the rivers of Bangladesh.

Distinction is made between suspended load (which contains suspended bed material load and wash load) and bed load. The following optimization will be made during phase 2 of the project. In choices of instruments and methods distinction is made between indirect methods based on flow velocity and suspended sediment concentration determination and direct methods based on actual transport measurements.



### 7.8.2 Suspended load measurements

#### 1. *Indirect method: Choice of instrument and method:*

- depth-integrating by bottle sampler,
- depth-integrating by collapsible bag sampler,
- point-integrating with pump-bottle system
- instantaneous optical turbidity recording at points,
- instantaneous acoustic turbidity recording at points, verticals and cross-sections, or of ADCP back-scatter data.

These different methods, except depth-integrating collapsible bag sampler and instantaneous acoustic turbidity recording at points, were tested and results were presented in several project reports (DELFT/DHI, 1993d, 1994b). The depth-integrating collapsible bag samplers were ordered from Colorado State University and they will be tested during the monsoon 1994. The acoustic turbidity recordings are only used in a qualitative way. ADCP back-scatter profiles were used so far to indicate the relative distribution of suspended sediments. The applicability of ADCP back-scatter profiles and optical turbidity records in determining the suspended sediment concentration will be tested during a special survey in the monsoon season of 1994.

*What are the results of the survey?*

#### 2. *Direct method: use of straight-nozzle Delft Bottle*

The straight-nozzle Delft Bottle was tested in the Bahadurabad left channel during the last week of May 1994. The results and analyses will be reported later.

#### 3. *Optimization of the number of points in a vertical*

On the optimization of the number of points in a vertical, test measurements and analyses were done during phase 1 of the project. The analyses are based on the transports computed by Straub and Chinese methods from 2-point samplings at 0.2 and 0.8 depths at Bahadurabad and they are compared against integrated transports computed from 6-point sampling (DELFT/DHI, 1994b), giving a good agreement between the Straub method and the Chinese method. However, these comparisons were made considering only the sampled zone. The effects of high concentration in the unsampled zone have to be studied. This will be done with the help of the modified Einstein method (Colby and Hembree, 1955) or using the Vanoni distribution.

#### 4. *Optimization of the density of verticals accross a transect*

On the optimization of density of verticals over a cross-section it was demonstrated that at Bahadurabad the theory of Colby (Guy and Norman, 1976) can be used. The Colby theory gives an index based on  $(v^2/h)_{\max}$  normalized against the mean value of the same, where  $v$  is the mean flow velocity and  $h$  is the water depth. In addition,  $q_s/q^n$



is used as a criteria, where  $q_s$  is suspended sediment transport,  $q$  is water discharge and  $n$  is an exponent determined from the data set. This comparison again depends on computations based on the sampled zone only. Effects of the unsampled zone have to be verified. Applicability of these principles has to be tested for other locations. In the FAP 24 survey practice ADCP back-scatter profiles are used for a qualitative indication of sediment concentration variability over a transect, indicating the location of verticals where sediment measurements are most necessary.

#### 5. Optimization in the distribution of measurements over the season

The hydrologic cycle in this region has a distinct seasonal character with high sediment input during the wet monsoon season and low sediment input during the dry months. Uncertainty and variability in discharge and sediment transport are very prominent during the wet months. Therefore, it should be studied whether the same frequency of measurements is necessary to apply uniformly over the year or whether measurements should be more frequent during the wet season and less frequent during the dry months. This will be done by time-series analyses of seasonal records.

#### 6. Optimization in the near-bed concentration measurements; direct measurements versus theoretical profile fitting

Near-bed measurements of suspended sediment are very difficult, but the concentration is very high in this zone. Therefore, exclusion of this zone causes underestimation of the sediment transport. Direct measurements in this region can be made by the Delft-Bottle and compared with computations from theoretical profile distributions.

#### 7.8.3 Bed load measurements

##### 1. Indirect method: Choice of instruments and method

##### - Dune tracking

The dune tracking method was found to be suitable for application during high flow regime with a flow velocity  $\geq 3$  m/s. There is uncertainty, however, concerning the contribution of the suspended load to the movement of the dunes (study topics 9.4).

As discussed earlier the theoretical methods are the modified Einstein method or the use of sediment transport predictors (the subject is treated extensively in study topic 2.2). By comparing the theoretical results with the river conditions the most applicable theory is sought. The question in how far these theories may replace measurements in the future will be addressed.

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## 2. Direct method: Choice of instrument and method

- Helley-Smith trap sampler
- Bend-nozzle Delft Bottle

The Helley-Smith trap sampler and dune tracking methods were tested and results were reported. It was noted that in low-flow regimes with mean velocity  $\leq 1.2$  m/s, the Helley-Smith trap sampler can be used. At higher velocities the sampler becomes unstable with the danger of scooping of the bed material.

The bend-nozzle Delft-Bottle was used in near-bed situations at Bahadurabad during the last week of May 1994. The results will be reported later.

### 7.8.4 Bed-material distribution over a cross-section

Bed-material (in sizes and sand-silt percentages) varies over the cross-section. It is necessary to determine how that does relate to local flow conditions and water depth.

### 7.8.5 Relative distribution of bed load and suspended load

Bed load measurements are difficult and expensive, therefore, it is necessary to obtain a relation between bed load transport and suspended load transport.

### 7.8.6 Distinction between bed-material load and wash load

A significant portion of suspended sediment consists of wash load in the main river system of Bangladesh. It is necessary to see the textural difference in these types of sediment transports between the two, and the seasonal distribution and contribution of wash load. Theoretically, the surface sediments consist of only wash load. Therefore, a size distribution of surface water sediments may indicate the textural properties of wash load.



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## 9. Reporting

The reporting activities of the River Survey Project are reflected in the "list of RSP reports", included in this chapter.

The following categories of reports and notes are distinguished :

- A General Project Reports (inception, interim, and final reports)
- B Quarterly Progress Report
- C Survey Reports (Special Campaign and River Data Books)
- D Study Reports
- E Study Notes
- F Working Papers
- G Various
- H Workshop contribution (6-8 November 1993)
- I Lecture notes

This list is updated regularly and published in the Quarterly Progress Report.

## 8. Training

In the first half of 1994 the training activities of the River Survey Project can be summarized as follows:

- o In-house training on river dynamics
- o In-house training on AUTOCAD and FORTRAN 77
- o On 11 May a workshop was organized in Bhagaykul for the operational level officials of BWDB. The workshop consisted of lectures given by the survey staff of RSP and a visit to the DHA, where explanations were given on the use of the FAP 24 equipment. The newly installed AWLR in Mawa and a DGPS reference station in Bhagyakul were visited.
- o A lecture was given on sediment transport measurements and data elaboration in the Ganges - Brahmaputra River System by FAP 24 at the SWH internal workshop at Bhagyakul on 5 July 1994.
- o Mr. Joynal Abedin Mollah, Executive Engineer, BWDB joined the River Survey Project as a trainee on July 23, 1994.

Training has so far attracted only modest attention (except in-house training), mainly because of lack of resources under the FAP 24 contract and because of lack of consensus on the issue. Several proposals for training of BWDB staff and staff of other organizations were developed, the latest in November 1994 and contained in Annexure 3. It is expected that this training programme will become effective in March 1995.

## List of RSP reports

(Update February 1995)

### A. GENERAL PROJECT REPORTS

1. River Survey Project, FAP 24  
*Inception Report*  
22 August 1992
2. River Survey Project, FAP 24  
*Revised Inception Report*  
20 October 1992
3. River Survey Project, FAP 24  
*1° Interim Report*  
Volume I : Main Report  
February 1993
4. River Survey Project, FAP 24  
*1° Interim Report*  
Volume II : Annexures on survey work  
February 1993
5. River Survey Project, FAP 24  
*1° Interim Report*  
Volume III : Annexures on studies, etc.  
February 1993
6. River Survey Project, FAP 24  
*Draft Notes on Planning*  
June 1993
7. River Survey Project, FAP 24  
*Final Report Phase I*  
August 1994
8. River Survey Project, FAP 24  
*2° Interim Report*  
February 1995





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**B. PROGRESS REPORTS**

1. River Survey Project, FAP 24  
***1° Quarterly Progress Report***  
September - November 1992
2. River Survey Project, FAP 24  
***2° Quarterly Progress Report***  
December 1992 - February 1993
3. River Survey Project, FAP 24  
***3° Quarterly Progress Report***  
March - May 1993
4. River Survey Project, FAP 24  
***4° Quarterly Progress Report***  
June - August 1993
5. River Survey Project, FAP 24  
***5° Quarterly Progress Report***  
September - November 1993
6. River Survey Project, FAP 24  
***6° Quarterly Progress Report***  
December 1993 - February 1994
7. River Survey Project, FAP 24  
***7° Quarterly Progress Report***  
March - May 1994
8. River Survey Project, FAP 24  
***8° Quarterly Progress Report***  
June - August 1994
9. River Survey Project, FAP 24  
***9° Quarterly Progress Report***  
September - November 1994
10. River Survey Project, FAP 24  
***10° Quarterly Progress Report***  
December 1994 - February 1995  
(in preparation)

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**C. SURVEY REPORTS**

1. River Survey Project, FAP 24  
***Additional Survey, September 1992***  
31 October 1992
2. River Survey Project, FAP 24  
***Report on Land Survey: Water-level gauging***  
June 1993
3. River Survey Project, FAP 24  
***Test Gauging Report***  
Survey Procedures and Data Presentation  
October 1993
4. River Survey Project, FAP 24  
***Selection of Survey Techniques***  
May 1994
5. River Survey Project, FAP 24  
***Phase 1***  
***Dry season 1992/93***  
December 1993
6. River Survey Project, FAP 24  
***AWLR Stations***  
***site selection, installation and O&M***  
(not yet published)
7. River Survey Project, FAP 24  
***Transfer of bench-mark levels across***  
***Jamuna River at Bahadurabad***  
December 1993
8. River Survey Project, FAP 24  
***Flood season 1993*** (3 Volumes)  
July 1994
9. River Survey Project, FAP 24  
***Bathymetric pilot surveys on Jamuna River at Bahadurabad in 1993***  
August 1994
10. River Survey Project, FAP 24  
***River Data Book***  
June 1993 to May 1995  
(in preparation)

11. River Survey Project, FAP 24  
*Bathymetric Surveys Lean Season 1993/94 and Flood Season 1994*  
March 1995

**D. STUDY REPORTS**

1. River Survey Project, FAP 24  
STUDY REPORT 1  
*Selection of Study Topics for Phase 2*  
September 1993
2. River Survey Project, FAP 24  
STUDY REPORT 2  
*Hydrological Study Phase 1*  
June 1993
3. River Survey Project, FAP 24  
STUDY REPORT 3  
*Morphological Studies Phase 1*  
March 1994
4. River Survey Project, FAP 24  
*Study Programme*  
February 1995

**E. SURVEY NOTES**

1. River Survey Project, FAP 24  
*Proposal for Additional Survey Bahadurabad*  
July 1992
2. River Survey Project, FAP 24  
*Anwasha Survey*  
Technical Guidelines  
September 1992
3. River Survey Project, FAP 24  
*Proposal Additional Field Tests*  
December 1992  
28 November 1992



4. River Survey Project, FAP 24  
*Programme outline for Test Gauging*  
August 1993
5. River Survey Project, FAP 24  
*Survey procedure for the routine gaugings  
in the dry season 1993/94*  
January 1994
6. River Survey Project, FAP 24  
*Survey procedure routine gaugings  
monsoon season 1994*  
June 1994

**F. WORKING PAPERS**

1. River Survey Project, FAP 24  
*Technical Recommendation and Verification  
of the Acoustic Sensor type of AWLR*  
October 20, 1993
2. River Survey Project, FAP 24  
*Qualitative impact assessment of FAP implementation*  
January 1994
3. River Survey Project, FAP 24  
*Bed Load Measurements for phase 2*  
March 1994 (1° Draft)  
In preparation
4. River Survey Project, FAP 24  
*Tidal and backwater effects at Bhairab Bazar*
5. River Survey Project, FAP 24  
*Water-level slopes*

**G. VARIOUS**

1. River Survey Project, FAP 24  
*Reporting Format*  
(Regularly updated)

2. River Survey Project, FAP 24  
***Morphological Processes in The Bangladesh River System***  
A Compilation of Papers  
October 25, 1993
3. River Survey Project, FAP 24  
***Towards an Improved Understanding  
of the Rivers in Bangladesh***  
(RSP brochure)
4. River Survey Project, FAP 24  
***Procurement Report Vehicles***
5. River Survey Project, FAP 24  
***Travel Report (M.B. Butts)***  
***Hydrology***  
March 1994
6. River Survey Project, FAP 24  
***Note on training and Institutional strengthening***  
April 1994
7. River Survey Project, FAP 24  
***River bathymetry assessment by radar remote sensing***  
September 1994
8. River Survey Project, FAP 24  
***Note on Discharge and sediment distribution at  
Bifurcations and Off-takes***  
November 1994
9. River Survey Project, FAP 24  
***Proposal for training Programme***  
November 1994
10. River Survey Project, FAP 24  
***Travel Report (M.B. Butts)***  
***Hydrology***  
February 1995
11. River Survey Project, FAP 24  
***Remote sensing for morphological assessment and radar remote sensing pilot  
project***  
February 1995

**H. WORKSHOP CONTRIBUTIONS 6-8 NOV'93**

1. Klaassen, G. J  
*On prediction methods for alluvial rivers  
with particular reference to planform changes*
2. Olesen, K. W.  
*2-D mathematical modelling of bifurcations*
3. Mosselman, E and Wensink, G.J.  
*River Bathymetry observation with radar remote sensing*
4. Iversen, C.  
*Survey techniques selected by FAP 24*
5. River Survey Project, FAP 24  
Kuehl, S.A. and Allison M.A.  
*Subaqueous delta of the Ganges - Brahmaputra river  
system and the holocene sediment budget :  
Implications for floodplain subsidence and sedimentation*
6. *Executive Summary  
Selection of study topics for phase 2*

**I. LECTURE NOTES**

1. *On Sediment Transport and Hydraulic Roughness*
2. *River Dynamics*  
Lecturer : G. J. Klaassen
3. *River Hydraulics*  
Lecturers S. Mahmood & P. van Groen
4. *Advanced River Processes*  
By G. J. Klaassen

## 10. Workplan

### 10.1 Introduction

Detailed work programmes for the FAP 24 studies have been elaborated at length in the report "Study Programme", issued in February 1995. This report covers in detail the various study topics and special surveys undertaken during the 1994 flood season and executed/planned during the 1994/1995 lean season. For briefness these discussions are not repeated in this Interim Report and both documents could be read jointly.

The training programme is discussed in detail in Annexure 3. The first training sessions are scheduled for March/April 1994.

A detailed workplan covering the survey activities during the period July 1994 until the flood season of 1995 is presented in Figure 10.1 for the 1994 flood season and in Figure 10.2 for the 1994/1995 lean season.

Some key activities are briefly described in the following sections.



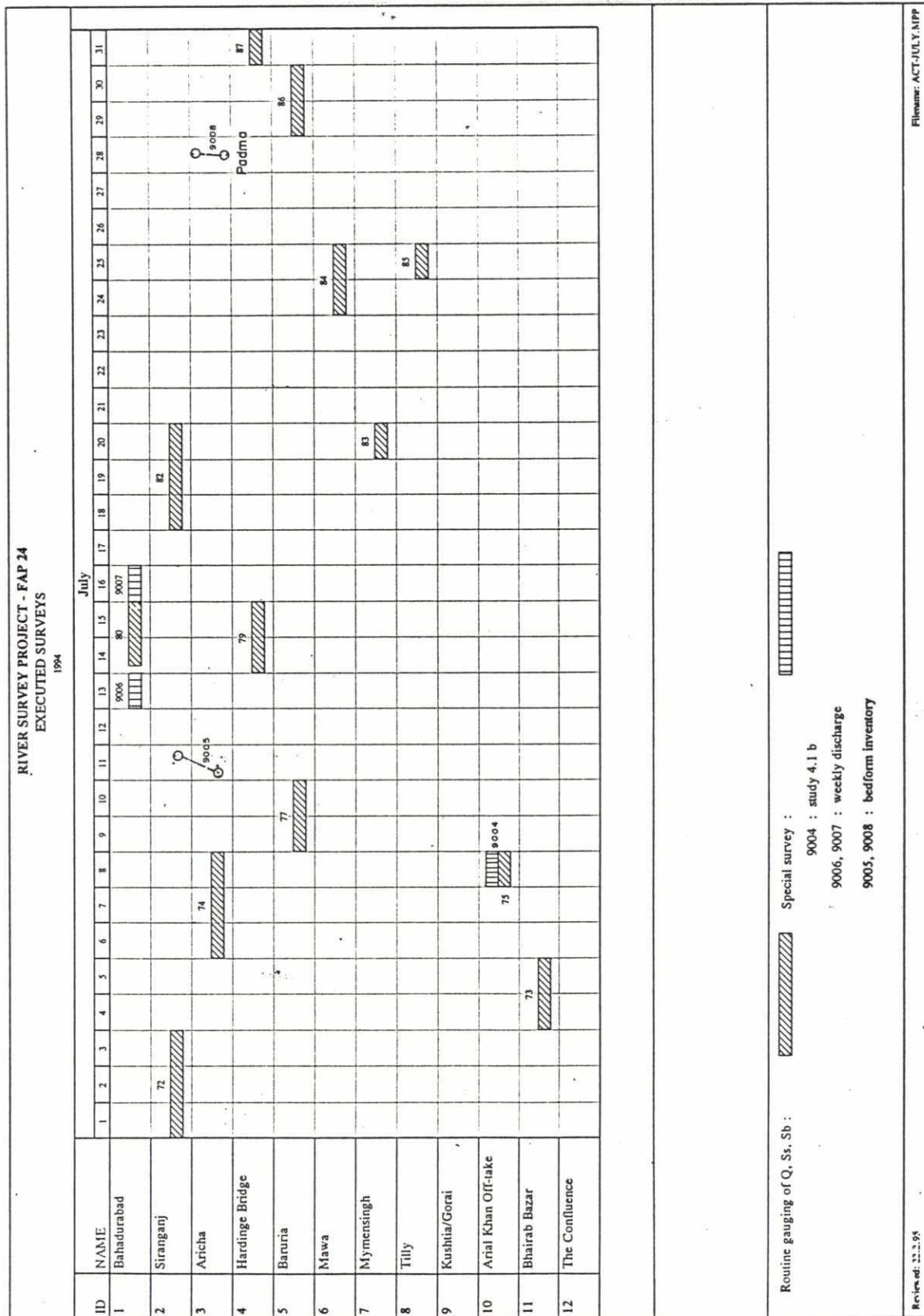


Figure 10.1a : Survey workplan July 1994

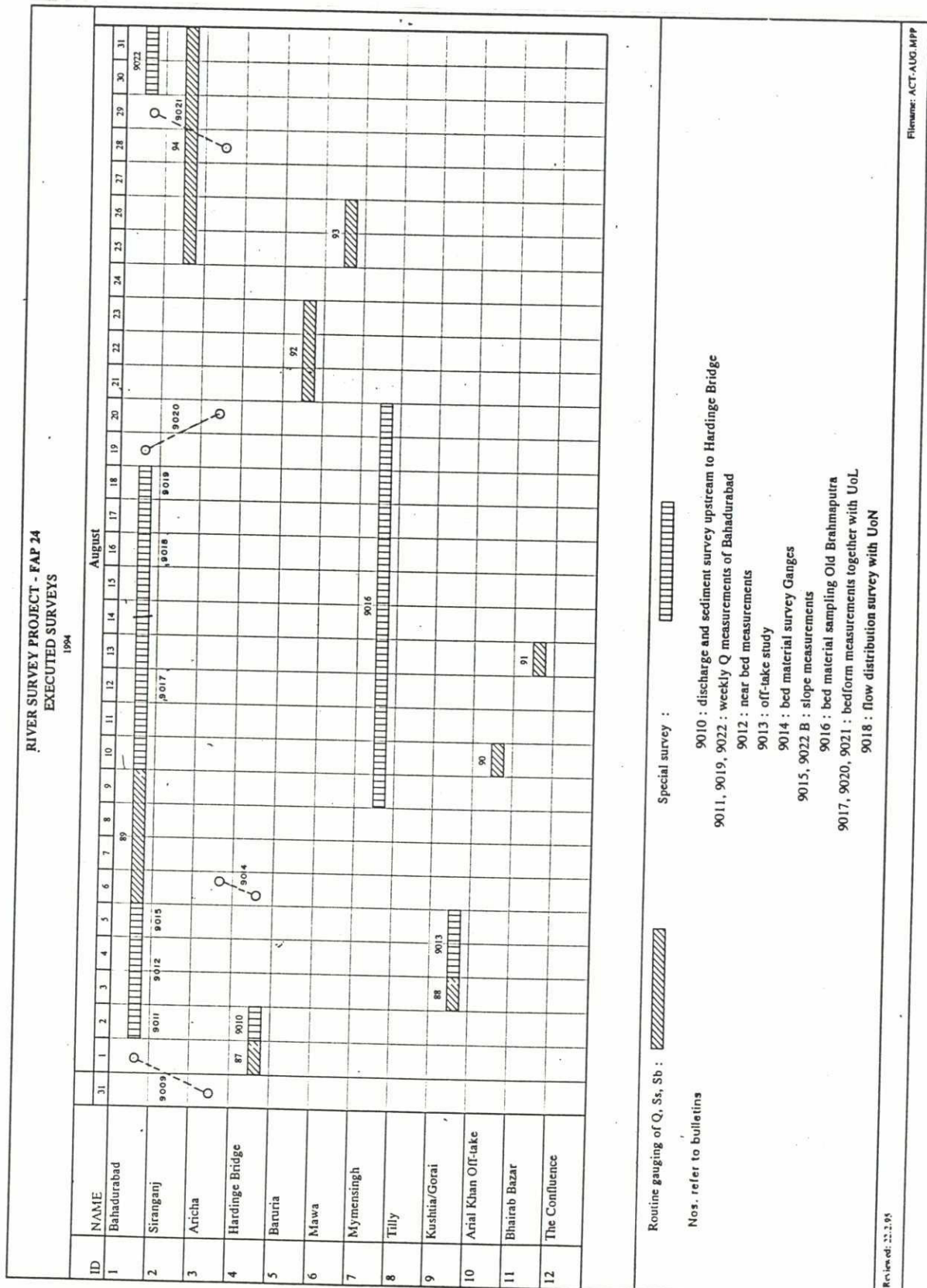


Figure 10.1b : Survey workplan August 1994

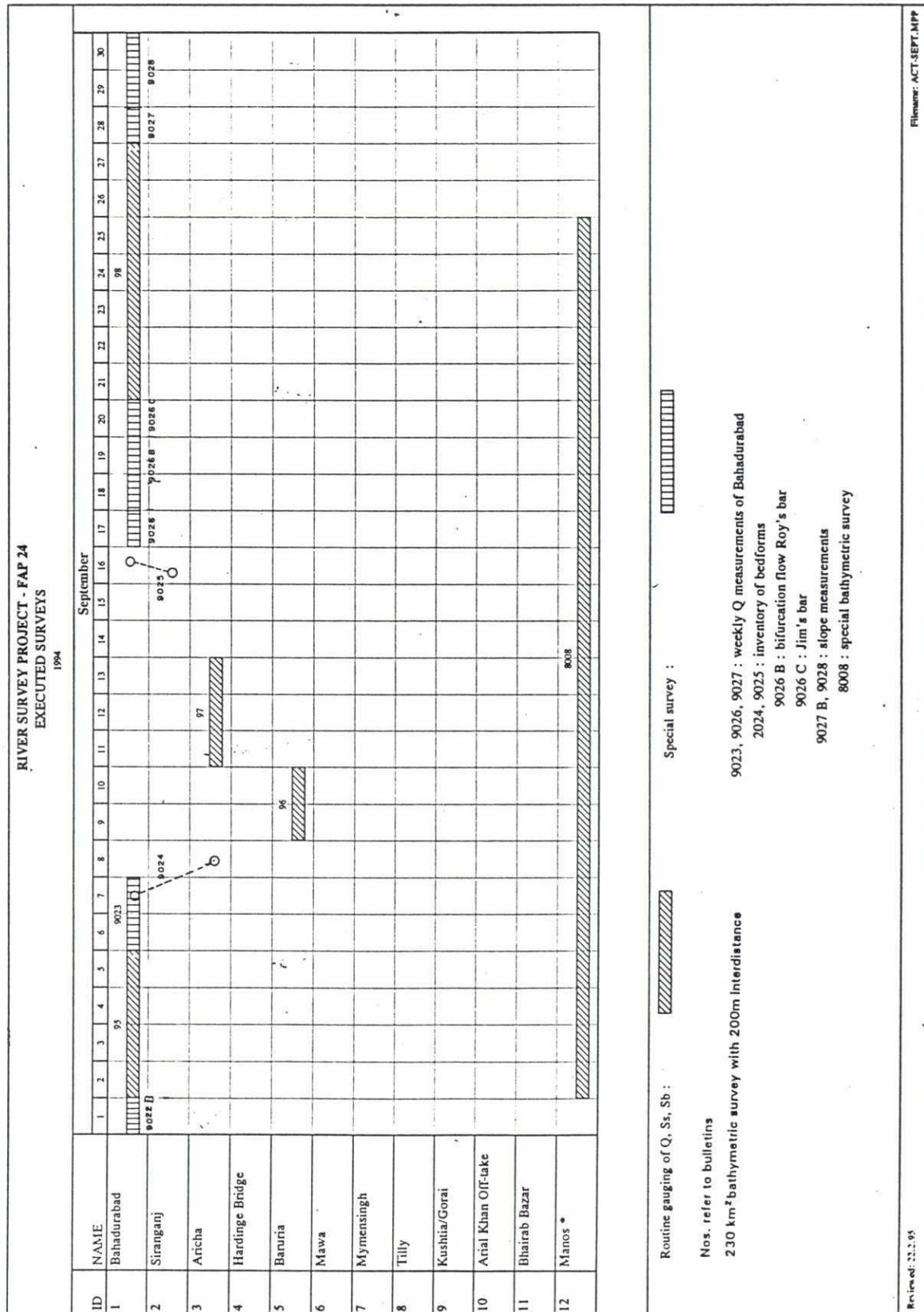


Figure 10.1c : Survey workplan September 1994



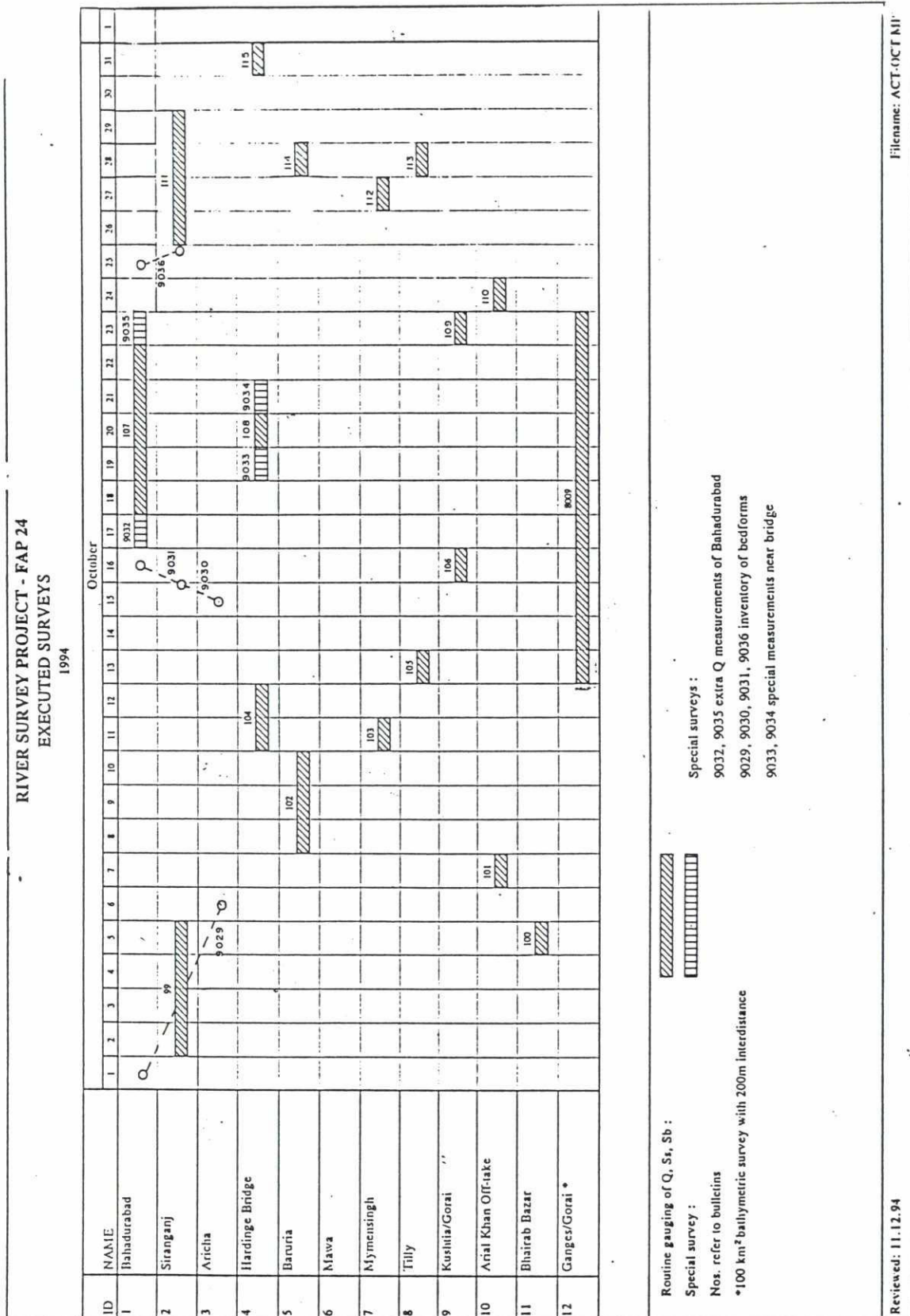


Figure 10.1d : Survey workplan October 1994



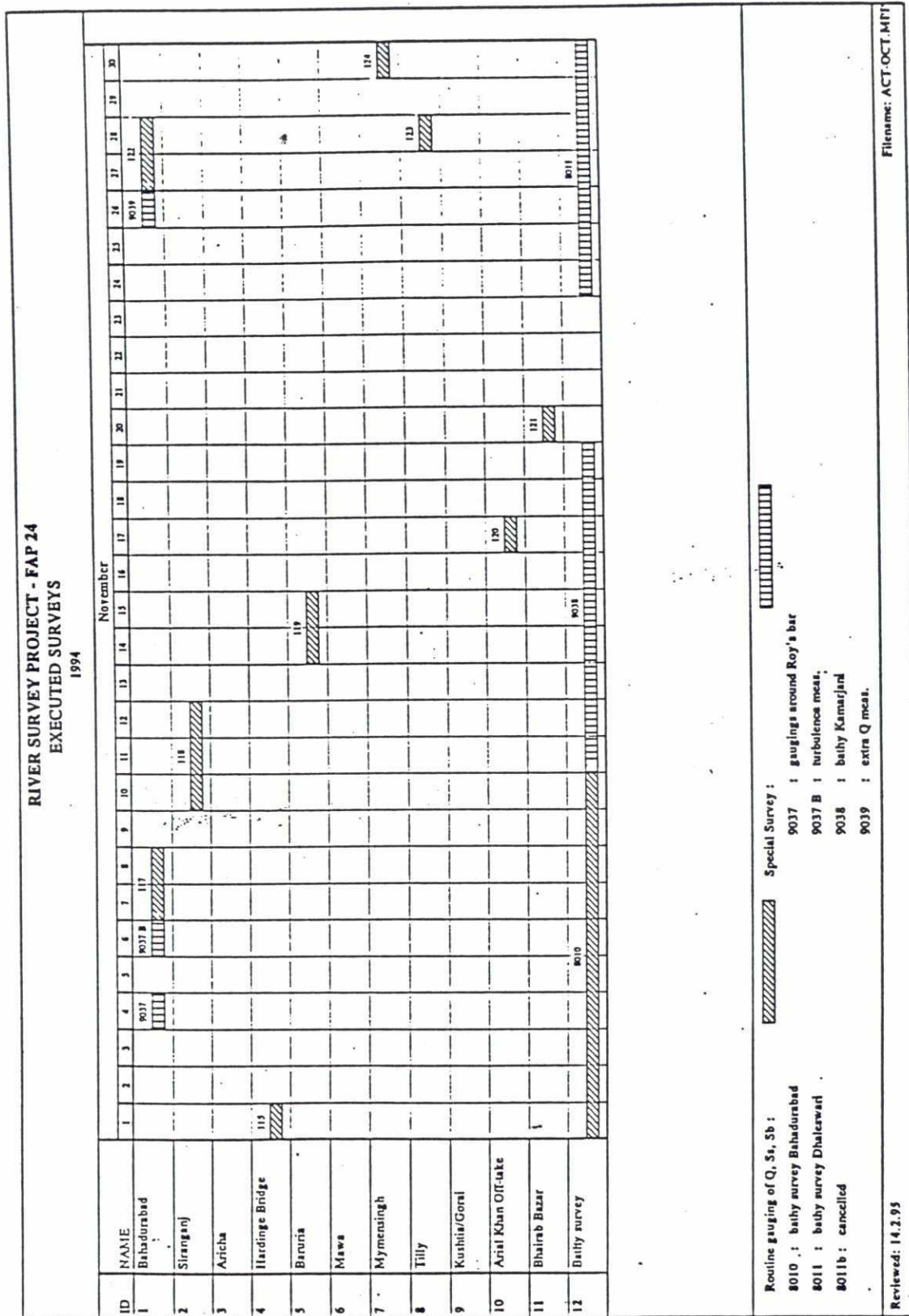


Figure 10.2a : Workplan lean season 1994/95 (executed November 1994)

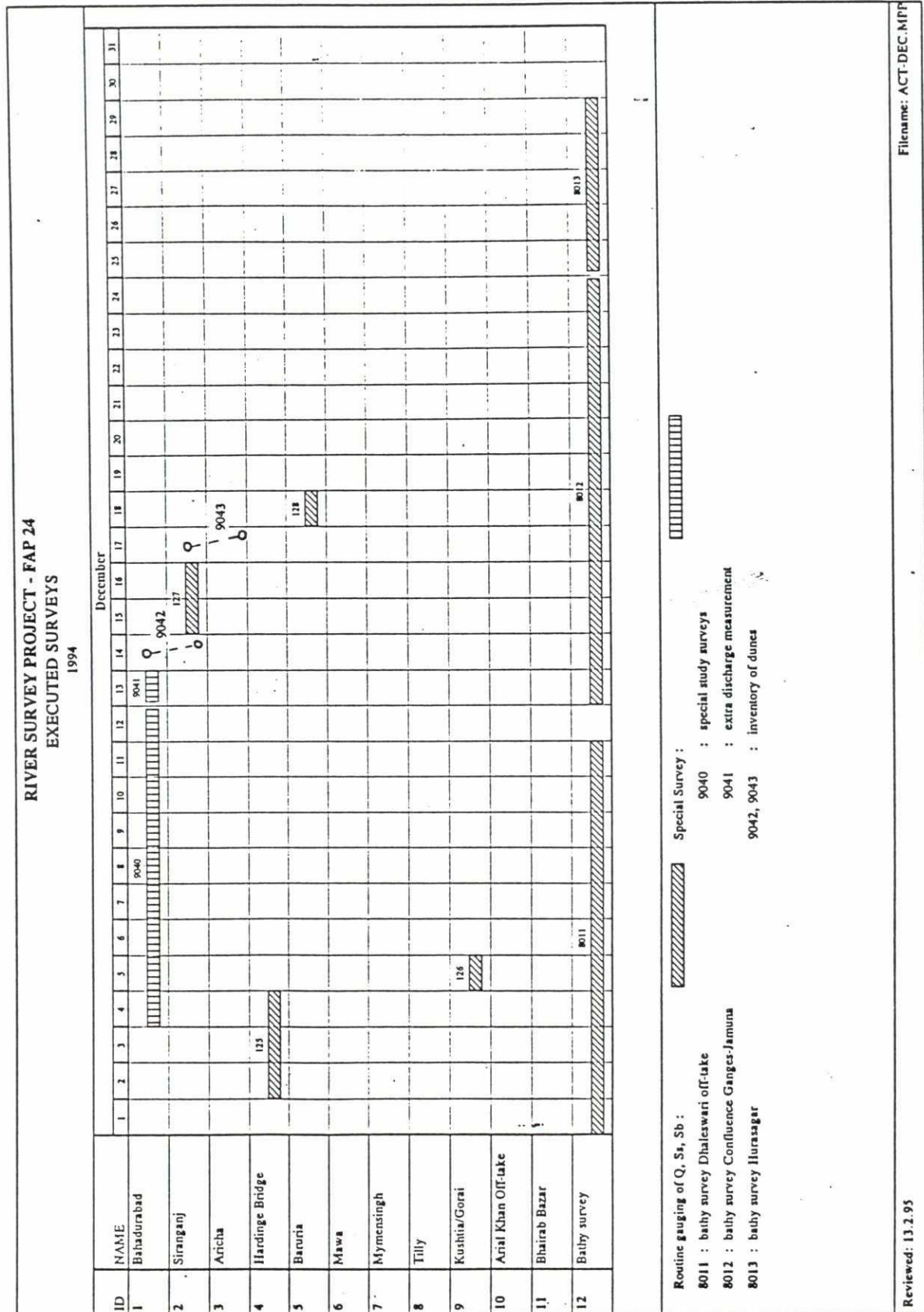


Figure 10.2b : Workplan lean season 1994/95 (executed December 1994)

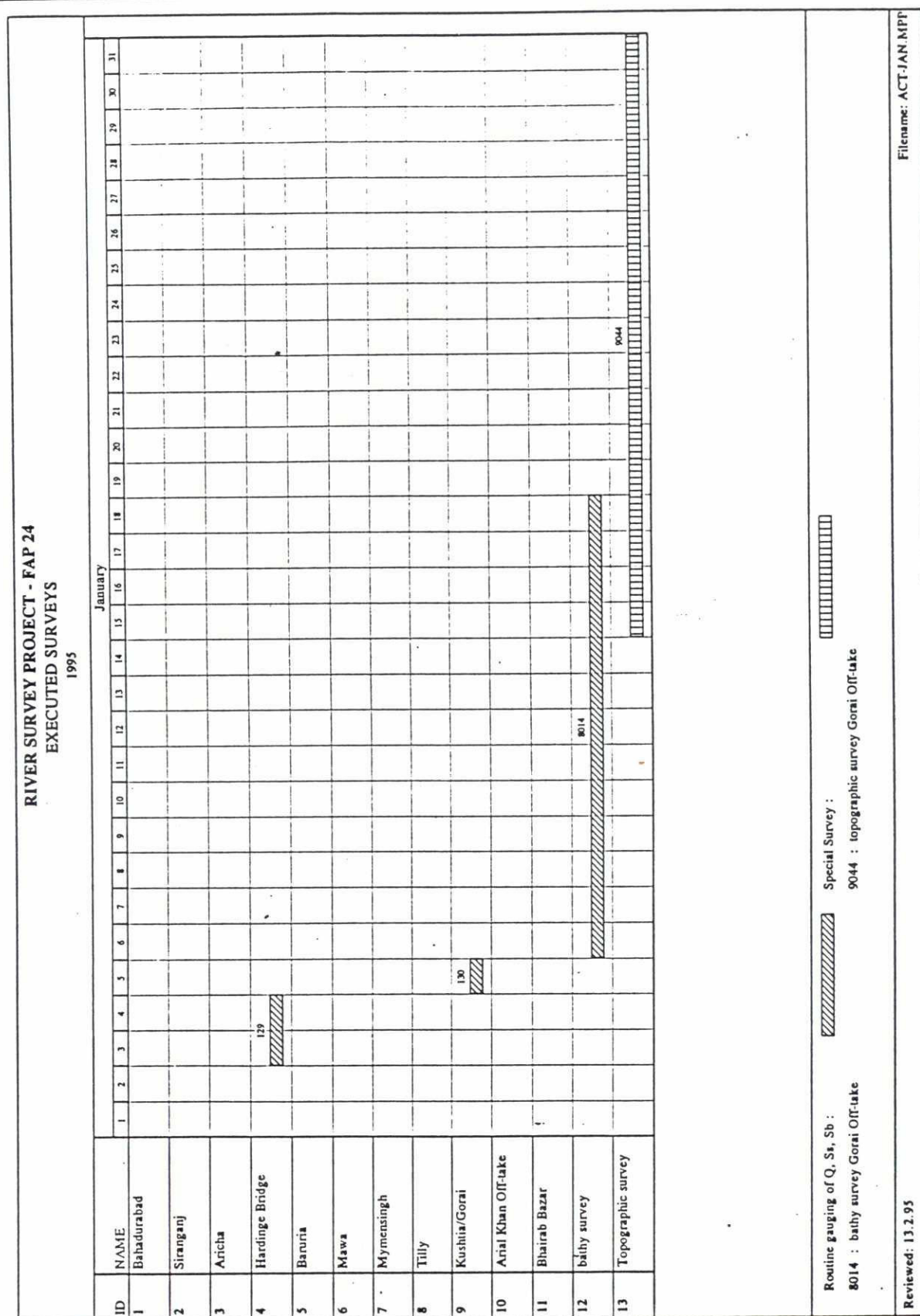


Figure 10.2c : Workplan lean season 1994/95 (executed January 1995)



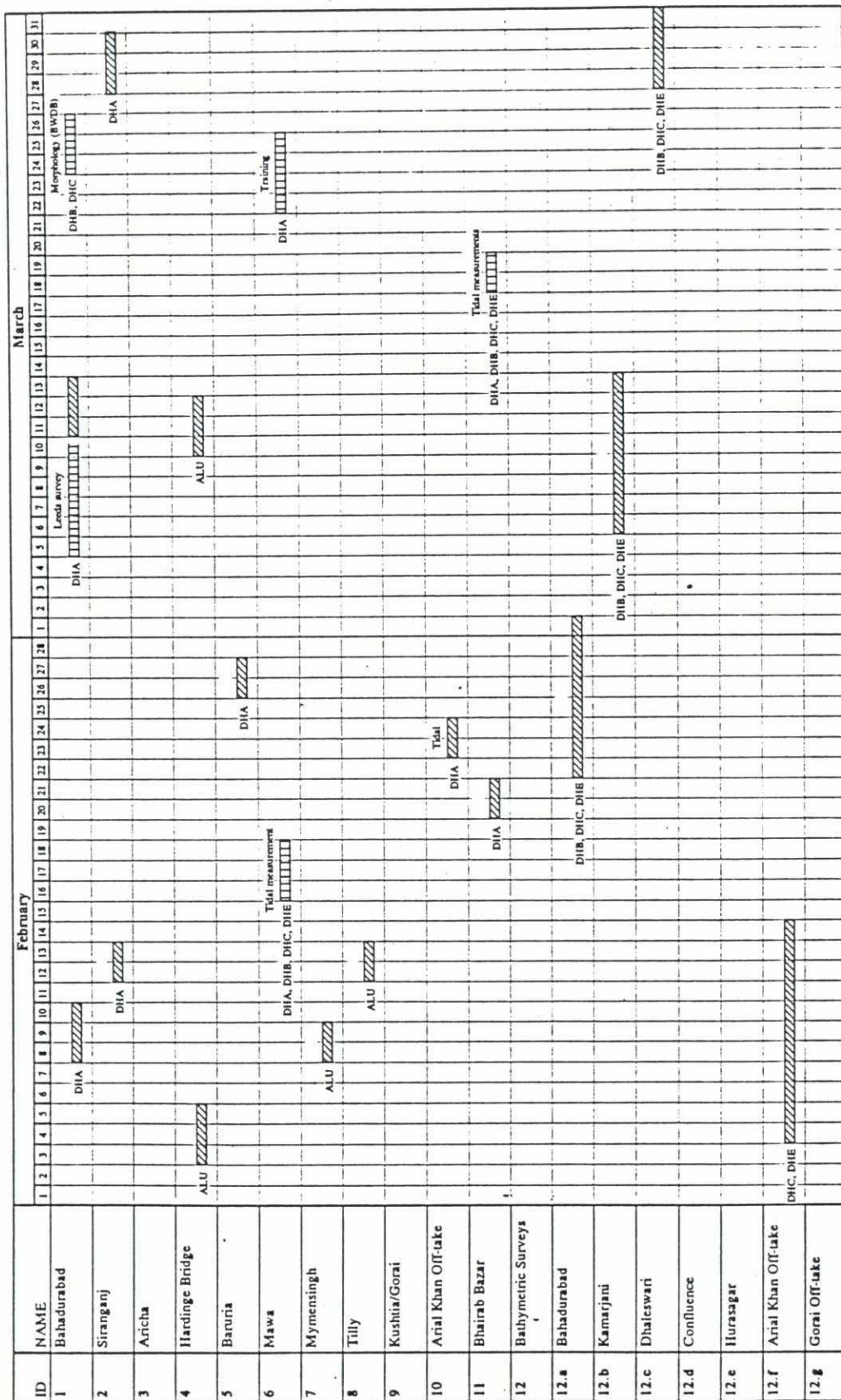


Figure 10.2d : Workplan lean season 1994/95 (Planned February/March 1995)



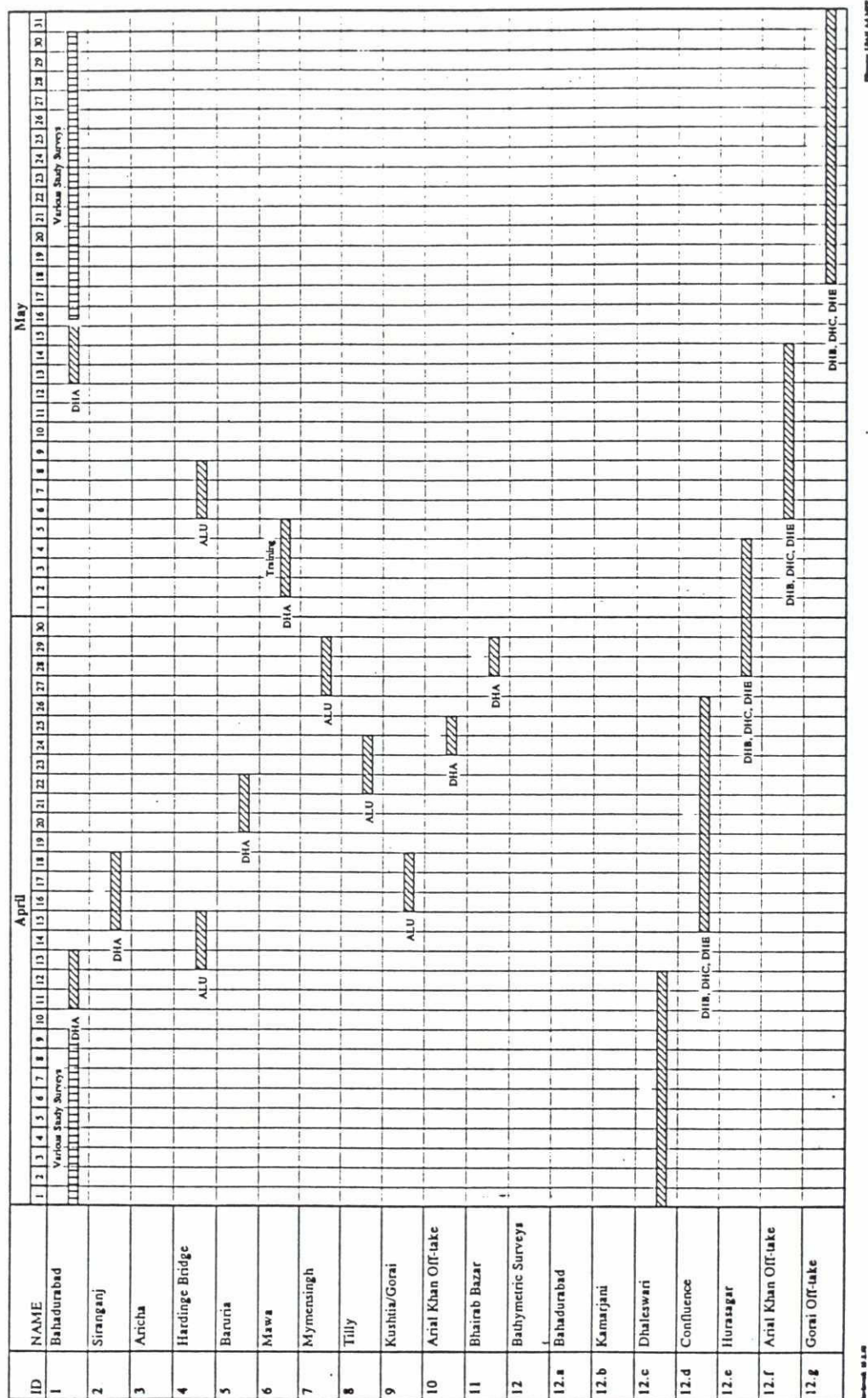


Figure 10.2e : Workplan lean season 1994/95 (Planned April/May 1995)

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## 10.2 Automatic Water Level Recorders (AWLRs)

According to the Contract, one water-level recorder had to be installed in phase 1 at Bahadurabad and another 11 during phase 2 covering the remaining stations.

In order to test an alternative instrumentation of the originally proposed water-level pressure transducers, the consultant installed by the end of May 1993 one pressure cell station just upstream of Bahadurabad Ghat and, by the beginning of July, a combined acoustic and pressure cell type recorder at Gabgachi in the right channel of the Jamuna River opposite Bahadurabad Ghat; ref. Section 4.2.

The installation of the remaining 10 stations started in May 1994 and by the end of June 1994 7 stations were in operation. The last three will be installed in the coming months. The target is to have all of them in operation by mid August 1994.

## 10.3 Routine gaugings

The survey workplan for 1994 comprises routine gaugings with flow and sediment transport measurements (including suspended load and bed load) at all the 11 locations.

The number of measurements accomplished during the lean season 1993/94 and the month of June 1994 are summarized in Chapter 4 of the present report.

## 10.4 Bathymetry

The locations and frequency of measurements are given indicatively in the contract.

The measurements were originally scheduled to start in phase 2. However, in order to obtain some operational experience and to collect some bathymetric data for study purposes as early as possible, it was agreed to include some bathymetric pilot surveys at Bahadurabad already during the flood season of 1993 as described in the Final Report, phase 1 (DELFT/DHI 1994c).

Together with the river morphologists a special bathymetric programme has been prepared for phase 2 considering aspects such as :

- o Sounding area, density and frequency
- o Contour (water line) measurements
- o Topographic methods
- o Connections with remote sensing techniques

The programme is a combination of the contractual surveys to be carried out in the seven sites just before and after the flood season and some special surveys directly related to the study programme. The special surveys include

monitoring of planform characteristics and channel dimensions through measurements over the different seasons; ref. study topic 3. The actual changes of the river bathymetry are then studied by comparing the maps of the same areas. For this reason it has also been decided to extend the existing survey area at Bahadurabad northwards covering the main channel towards the Teesta confluence.

Study topic 4 dealing with off-takes and bifurcations also requires extensive bathymetric surveying, initially focussing on some bars near Bahadurabad and the Gorai off-take from the Ganges River.

Further details are provided in Chapter 7.

### **10.5 Recommended extension of the project period**

As also mentioned previously it is recommended to maintain a phase 2 period of three years, which indicatively implies an extension of the project by 5 months (the duration of the transition period) consisting of about 3 months of surveying and 2 months for reporting and demobilization.

The main purpose of the extension is to catch the flood of 1996, thus compensating for the reduced flood measurements of 1993, a very moderate year, and for the dry years (1992 and 1994) encountered so far.

Considering that the River Survey Project should focus on floods, it seems rather logical not to terminate the project just before the flood of 1996 but there after.

The matter of a project extension has been discussed intensively with the Client's Representatives and is still subject to further clarification.



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## *Annexures*

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ANNEXURE 1

# **PSD 24 User's Guide**

**DRAFT**

**December 1994**

## Contents

- 1 Overview of the PSD 24 Database System
- 2 Description of PSD 24
- 3 Database Filename Conventions
  - 3.1 Transect survey
  - 3.2 Bathymetry
  - 3.3 Water-level
- 4 Database Directory Structure
- 5 File Specifications and Printouts
  - 5.0 Coordinate System Definitions
  - 5.1 ADCP/S4/EMF file
  - 5.2 Echosounder file
  - 5.3 Sedimentation file
  - 5.4 Suspended sediment concentration file
  - 5.5 Suspended sediment size file
  - 5.6 Bed material size file
  - 5.7 Bed load size file
  - 5.8 Iso-velocity file
  - 5.9 Survey Bulletin transect plot data file
  - 5.10 Bathymetry file
  - 5.11 Water-Level file
- 6 Paradox Catalogue System
- 7 Administration of Database Files
  - 7.1 ADCP/S4/EMF file
  - 7.2 Echosounder file
  - 7.3 Sedimentation file
  - 7.4 Script file
  - 7.5 Transect Plot Data file
  - 7.6 Mike 21 Iso-velocity Plot Datafile
  - 7.7 Mike 21 Bathymetry Plot Data
  - 7.8 Bed load, Bed material and Suspended sediment size
  - 7.9 Suspended Sediment Concentration
- 8 Administration of Paradox Catalogue System



# PSD 24 User's Guide

**DRAFT**

## 1. Overview of the PSD 24 Database System

The "Processed Survey Data" engineering database, "PSD 24", is a DOS/Windows based file system installed at FAP 24. The database is composed of 2 main components. The first component is the processed datafiles. The second component consists of a catalogue system which lists all the files and file specific information for quick file identification and query searches.

The PSD 24 files are processed from the raw data on either UNIX and DOS computers, and then copied to the PSD 24 Server which is accessible to the internal Study Group via an ethernet LAN (Local Area Network). The files are DOS formatted with the exception of the Mike21 bathymetry and iso-velocity files. The PSD 24 files residing on the PSD 24 Server are considered as the master copy and are read-only accessible. The file catalogue system for the DOS based PSD 24 is kept on Paradox 4.5 for Windows. The Paradox based catalogue lists the vital file specifics for each datafile within the PSD 24 and allows the user to perform a search for any file that meets the user specified criteria.

## 2. Description of PSD 24

PSD 24 contains the processed engineering datafiles produced from the field survey measurements. There are 3 basic data file categories, each category containing the following filetypes:

### a) Transect survey data

<u>File Type and Content</u>	<u>File Format</u>	<u>Filename extension</u>
1) ADCP/S4/EMF data	Quattro	.ase
2) echosounder data	Quattro	.ech
3) sediment transport data	Quattro	.sed
4) susp. sed conc.	Quattro	.ssc
5) susp. sed. size	Quattro	.ssz
6) bedload sediment analysis	Quattro	.bdl
7) bed material analysis	Quattro	.bdm
8) survey bulletin transect plot data	Quattro	.trs
9) iso-velocity plot data	Mike 21	.dt2 and .ct2

### b) Bathymetric survey data

1) fixed grid bathymetry data	Mike 21	.dt2 and .ct2
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### c) Water level survey data

1) gage level readings	ASCII	.wl
2) AWLR's	Quattro	.wl

### 3. Database Filename Conventions

#### 3.1 Transect Survey Filename Convention

Filenames for the transect survey data will retain the same name structure as the raw data except that the extension will be used to identify the different types of PSD 24 files.

Example File Name: B2AL1T08.ECH

*B* = Survey Location  
*2* = 1992 (year)  
*A* = 10 or October (month)  
*L* = 21 (day)  
*1* = Vessel No. 1  
*T* = Transect (*B* = bathymetry)  
*08* = Sequence No.

Survey Station	Code
Aricha	A
Bahadurabad	B
Baruria	U
Bhairab-Bazar	Z
BWDB	V
Hardinge Bridge	H
Kushtia	K
Mawa	M
Mymensingh	Y
Offtake Arial Khan	O
Serajganj	S
SWMC	W
Tilly	T

#### File Extension Filetype

.ASE	ADCP/S4/EMF data (Quattro)
.ECH	echosounder data (Quattro)
.SED	sediment transport data (Quattro)
.SSC	suspended sediment concentration analysis (Quattro)
.SSZ	suspended sediment size analysis (Quattro)
.BDL	bedload sediment analysis (Quattro)
.BDM	bed material analysis (Quattro)
.TRS	survey bulletin transect plot data (Quattro)
.DT2 & .CT2	iso-velocity plot data (Mike 21)

### 3.2 Bathymetry Filename Convention

Bathymetry files will be named similarly to the transect data with some exceptions.

=====

Example File Name: B2AL1.DT2 and B2AL1.CT2

=====

*B = Survey Location = Bahadurabad*  
*2 = Year = 1992*  
*A = Month = 10 or October*  
*L = Starting day = 21*  
*1 = Vessel No. 1*

=====

The .DT2 and .CT2 extensions are required for use with the Mike 21 plotting and editing software. The .DT2 file contains the data and the .CT2 file contains the file header information.

### 3.3 Water Level Filename Convention

Water level files will be named similarly to the transect data with some exceptions.

=====

Example File Name: B21C1.WL

=====

*B = Survey Location = Bahadurabad*  
*2 = Year = 1992*  
*1 = Starting Month = 1 January*  
*C = Ending month = 12 December*  
*1 = Type of measurement (1=staff gauge, 2=AWLR)*

=====

#### 4. Database Directory Structure

The files will be stored in directories which are unique to the specific file category (transect, bathymetry or water level) and unique to the date of the survey and the survey location. To illustrate, consider the following directory tree:

<u>Home</u>	<u>Category</u>	<u>Year</u>	<u>Mon</u>	<u>Loc</u>	<u>Day</u>	<u>Filename</u>
p:\psd24	\transect	\1992				
		\1993				
		\1994	\mar			
			\apr	\baru		
				\baha	\02	
					\03	\b4431t02.ase
						\b4831t02.ech
						\b4831t02.siz
						\b4831t02.sed
p:\psd24	\bathy	\1992				
		\1993				
		\1994	\may			
			\jun	\aric		
				\baha	\02	
					\25	\b46y1.ct2
p:\psd24	\wlevel	\1992				
		\1993				
		\1994	\apr			
			\may	\b1		
				\b2	\01	
					\02	\b46d.wl

The transect survey station names have been abbreviated in the directory tree as follows:

aric =	Aricha
baha =	Bahadurabad
baru =	Baruria
bbaz =	Bhairab-Bazar
bwdb =	BWDB
hard =	Hardinge Bridge
kush =	Kushtia
mawa =	Mawa
myme =	Mymensingh
aria =	Offtake Arial Khan
sira =	Sirajgang
swmc =	SWMC
till =	Tilly



## 5. File Specifications and Printouts

### 5.0 Coordinate System Definitions

In general, the following definitions describe the coordinate system used in PSD24.

**left bank** = If an observer is facing downstream, the left bank is on the observers left side.

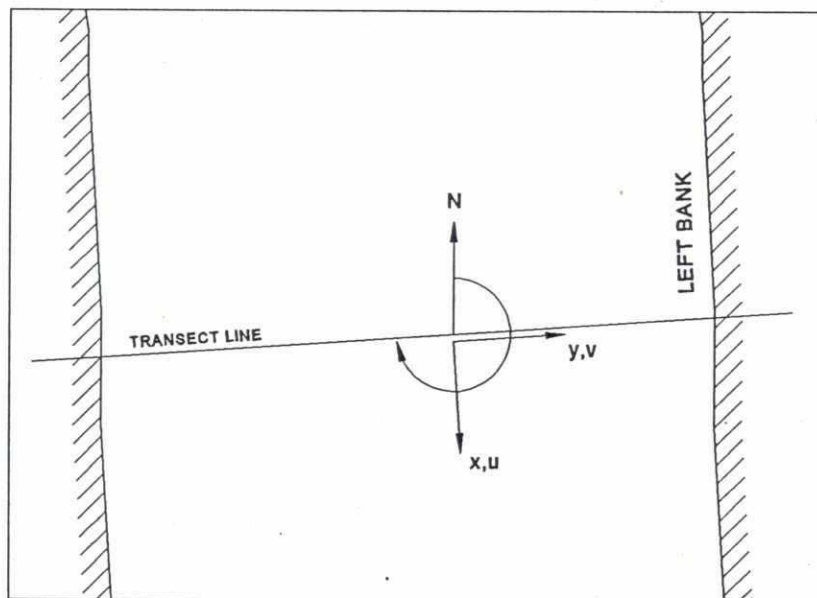
**right bank** = If an observer is facing downstream, the right bank is on the observers right side.

**transect angle** = The angle from a vector pointing to the north clockwise to a vector pointing from the left bank to the right bank.

**x, u directions** = Positive is downstream and perpendicular to the transect alignment.

**y, v directions** = Positive is perpendicular to (x, u) pointing to the left bank (right hand coordinate system)

**z, w directions** = Positive is Up.



Definition sketch of coordinate system.

## 5.1 ADCP/S4/EMF file (.ase file)

This file contains processed ADCP, S4 and EMF data. In general, the file has 5 main sections. The sections are as follows:

### 1) Main File Header Block

Contains file information describing the overall transect, i.e. date, start and end positions, stage level, width, area, discharge, # of stationary profiles, # of Moving boat ADCP profiles, etc.

	A	B	C	D
1	b4431102.ase			
2	*****			
3	FAP24-River Survey Project			
4	Flow Velocity File.	Creation date:	1994-09-18	
5	*****			
6	date	(yyyy-mm-dd)	1994-04-03	
7	location		Bahadurabad	
8	raw data filename		b4431102	
9	starting position	(m)	469519.40	776425.70
10	ending position	(m)	470638.40	776429.90
11	total dist. transect	(m)	1119.01	
12	left bank dist.	(m)	20.00	
13	right bank dist.	(m)	100.00	
14	pos. of left bank	(m)	470658.40	776430.00
15	transect angle lt->rt	(deg)	269.78	
16	water level	(m+pwd)	15.29	
17	total width	(m)	1239.01	
18	area	(m2)	7794.04	
19	discharge	(m3/s)	6320.26	
20	# of verticals		8.00	
21	# of S4 verticals		0.00	
22	# of ADCP verticals		8.00	
23	# of MANUAL verticals		0.00	
24	# of ADCP profiles		124.00	

### 2) Stationary Profile Header Block

Contains summary information for each stationary profile. Vertical number labels are appended with an "A" for ADCP, or an "S" for S4.

	A	B	C	D	E	F	G	H	I
26	*****								
27	Stationary Current Meter Flow Data								
28	vert#	dist. lt. bk.	easting	northing	width	depth	depth	qx	qy
29		(m)	(m)	(m)	(m)	(m+PWD)	(m)	(m3/s/m)	(m3/s/m)
30	1A	174.00	470484.40	776430.80	430.90	10.64	4.65	3.75	-0.96
31	2A	430.90	470227.50	776430.10	165.49	7.99	7.30	9.53	-2.41
32	3A	596.39	470062.00	776432.20	222.31	5.54	9.75	8.75	-2.27
33	4A	818.70	469839.70	776428.90	109.11	9.59	5.70	3.19	-1.06
34	5A	927.81	469730.50	776452.80	60.34	7.04	8.25	0.99	-0.45
35	6A	988.14	469670.20	776442.90	51.52	6.69	8.60	3.48	0.46
36	7A	1039.67	469618.70	776436.60	92.31	6.99	8.30	5.22	0.51
37	8A	1131.98	469526.40	776434.20	107.03	9.99	5.30	0.37	-0.17



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### 3) Stationary Profile Data Block

Contains the flow data for each vertical

	A	B	C	D	E	F	G	H
39	*****							
39	vert#	depth	speed	dir	u-vel	v-vel	w-vel	backscatter
40		(m)	(m/s)	(deg)	(m/s)	(m/s)	(m/s)	(dB)
41	1A	0.50	0.68	218.17	0.53	-0.42		
42	1A	2.66	1.03	182.71	1.03	-0.05	-0.01	80.70
43	1A	3.16	0.95	185.05	0.95	-0.09	-0.01	82.27
44	1A	3.66	0.86	188.60	0.85	-0.13	0.00	83.90
45								
46	2A	0.50	1.27	195.45	1.22	-0.34		
47	2A	2.66	1.28	191.86	1.25	-0.27	-0.01	77.09
48	2A	3.16	1.25	192.47	1.22	-0.28	-0.01	77.87
49	2A	3.66	1.21	192.64	1.18	-0.27	-0.02	78.56
50	2A	4.16	1.15	193.26	1.12	-0.27	-0.02	79.32
51	2A	4.66	1.10	194.08	1.07	-0.27	-0.02	80.21
52	2A	5.16	1.03	194.79	1.00	-0.27	-0.02	81.18
53	2A	5.66	0.95	195.42	0.92	-0.26	-0.02	82.39
54	2A	6.16	0.85	195.38	0.82	-0.23	-0.03	83.69

### 4) Moving Boat Profile Header Block

Contains summary information for each moving boat profile. Moving boat vertical number labels are appended with a "T", meaning "transect".

	A	B	C	D	E	F	G	H	I
119	*****								
120	Moving Boat ADCP Current Meter Flow Data								
121	vert#	dist. ft. bk.	easting	northing	width	depth	depth	qx	gy
122		(m)	(m)	(m)	(m)	(m+PWD)	(m)	(m <sup>3</sup> /s/m)	(m <sup>3</sup> /s/m)
123	1T	68.76	470589.63	776432.17	67.89	12.44	2.85	1.63	0.06
124	2T	77.35	470581.04	776432.87	8.60	12.24	3.05	2.69	0.07
125	3T	85.29	470573.10	776433.13	8.00	12.04	3.25	2.81	0.09
126	4T	93.29	470565.10	776432.77	8.00	11.54	3.75	3.80	0.05
127	5T	102.09	470556.30	776432.10	9.60	11.49	3.80	4.11	0.26
128	6T	110.89	470547.50	776431.22	8.00	10.99	4.30	4.90	-0.15
129	7T	119.12	470539.28	776430.75	8.20	10.84	4.45	3.95	-0.31
130	8T	127.65	470530.75	776430.47	8.50	10.89	4.40	4.70	-0.55
131	9T	136.37	470522.03	776430.50	8.70	10.64	4.65	5.42	-0.21
132	10T	145.90	470512.50	776430.80	10.40	10.54	4.75	4.89	-0.11
133	11T	155.79	470502.60	776431.02	9.00	10.74	4.55	5.03	-0.85
134	12T	164.68	470493.71	776431.11	8.90	10.59	4.70	5.16	-0.94
135	13T	173.03	470485.36	776430.99	8.40	10.54	4.75	4.98	-1.09
136	14T	181.00	470477.40	776429.24	8.01	10.59	4.70	5.19	-0.41
137	15T	190.40	470468.00	776428.60	10.20	10.19	5.10	4.89	-0.35
138	16T	198.99	470459.42	776427.72	7.80	10.29	5.00	4.84	-0.79
139	17T	206.57	470451.84	776427.25	7.60	10.44	4.85	5.40	-0.87
140	18T	215.38	470443.03	776427.08	8.70	10.59	4.70	4.58	-0.42
141	19T	223.30	470435.10	776426.20	8.00	10.89	4.40	4.51	-0.72
142	20T	232.90	470425.50	776426.80	10.40	10.64	4.65	5.13	-0.56
143	21T	241.65	470416.75	776429.30	7.00	10.09	5.20	4.96	-0.63
144	22T	250.90	470407.50	776430.20	11.00	10.54	4.75	4.95	-0.26
145	23T	261.56	470396.83	776431.52	9.70	10.19	5.10	4.42	-0.46
146	24T	271.04	470387.35	776432.61	9.50	9.84	5.45	5.41	-1.64
147	25T	280.53	470377.85	776433.60	9.50	10.49	4.80	4.62	-0.31



### 5) Moving Boat Profile Data Block

Contains the flow data and ADCP backscatter data for each vertical.

	A	B	C	D	E	F	G	H
247	vert#	depth	speed	dir	u-vel	v-vel	w-vel	backscatter
248		(m)	(m/s)	(deg)	(m/s)	(m/s)	(m/s)	(dB)
249	1T	0.50	0.91	168.50	0.90	0.18		
250	1T	2.66	0.71	192.93	0.69	-0.16	-0.02	79.88
251								
252	2T	0.50	0.82	174.15	0.82	0.08		
253	2T	2.66	0.90	182.35	0.90	-0.04	0.01	79.88
254								
255	3T	0.50	0.98	177.10	0.98	0.05		
256	3T	2.66	0.78	178.89	0.78	0.01	0.00	80.74
257								
258	4T	0.50	1.07	179.36	1.07	0.01		
259	4T	2.66	1.10	179.17	1.10	0.01	-0.02	81.60
260	4T	3.16	0.75	177.47	0.75	0.03	-0.09	83.57

### 5.2 Echosounder file (.ech file)

This file contains processed echosounder data. In general the file has 2 main sections.

The sections are as follows:

#### 1) Main File Header Block

Contains file information describing the overall transect, i.e. date, start and end positions, stage level, width, area, mean depth, hydraulic radius, channel asymmetry, etc.

	A	B	C	D
1	b4431t02.ech			
2	*****			
3	FAP24-River Survey Project			
4	Echosounder File	Creation date:	1994-10-02	
5	*****			
6	date	(yyyy-mm-dd)	1994-04-03	
7	location		Bahadurabad	
8	raw data filename		b4431t02	
9	starting position	(m)	469519.4	776425.7
10	ending position	(m)	470638.4	776429.9
11	total dist.transect	(m)	1119.0	
12	left bank dist.	(m)	100.0	
13	right bank dist.	(m)	20.0	
14	pos. of left bank	(m)	470738.4	776430.3
15	transect angle lt->rt	(deg)	269.8	
16	water level	(m+pwd)	15.3	
17	total width	(m)	1239.0	
18	area	(m2)	7631.2	
19	hydraulic radius	(m)	6.1	
20	wetted perimeter	(m)	1245.6	
21	mean depth	(m)	6.2	
22	channel asymmetry		1.5	
23				



## 2) Echosounder distance/depth data block

	A	B
24	*****	
25	dist. lt. bk.	depth
26	(m)	(m)
27	0.0	0.0
28	100.4	1.9
29	101.4	1.9
30	103.2	2.1
31	104.1	2.2
32	105.2	2.2
33	106.1	2.2
34	107.1	2.2
35	109.3	2.2
36	110.4	2.3
37	111.5	2.4

## 5.3 Sedimentation file (.sed file)

This file contains processed ADCP backscatter radiation and MEX turbidity data. Also starting with April 1994 surveys, these files contain sediment transport computations based on laboratory analysis of sediment sample data. In general the file has 3 main sections.

The sections are as follows:

### 1) Main Header Block

Contains file information describing the overall transect, i.e. date, start and end positions, stage level, width, area, discharge, # of vertical profiles, # of MEX profiles, etc.

	A	B	C	D
1	b4431t02.sed			
2	*****			
3	FAP24-River Survey Project			
4	Sedimentation File.	Creation date:	1994-10-02	
5	*****			
6	date	(yyyy-mm-dd)	1994-04-03	
7	location		Bahadurabad	
8	raw data filename		b4431t02	
9	starting position	(m)	469519.4	776425.7
10	ending position	(m)	470638.4	776429.9
11	total dist transect	(m)	1119.0	
12	left bank dist.	(m)	100.0	
13	right bank dist.	(m)	20.0	
14	pos. of left bank	(m)	470738.4	776430.3
15	transect angle lt->rt	(deg)	269.8	
16	water level	(m+pwd)	15.3	
17	total width	(m)	1239.0	
18	area	(m2)	7624.1	
19	discharge	(m3/s)	6148.6	
20	# of verticals		8.0	
21	# of MEX profiles		1.0	
22				

## 2) Vertical Profile Header Block

Contains summary information for each stationary profile.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
26	Sedimentation Data															
27	vert#	dist. h. bk	easting	northing	width	depth	depth	disch	dep. ave conc	sed trans	susp sed	wash load	bedload	d50susp	d50bedload	d50bed
28		(m)	(m)	(m)	(m)	(m+wd)	(m)	(m <sup>3</sup> /s/m)	(mg/l)	(g/s)	(g/s)	(g/s)	(g/s)	(mm)	(mm)	(mm)
29	1A	254.0	470484.4	776430.8	510.9	10.6	4.7	3.2	82.3	982.9	132.4	834.3	16.2	n/a	0.224	n/a
30	2A	610.9	470227.5	776430.1	167.5	8.0	7.3	9.4	636.0	1697.0	1000.9	882.5	13.6	n/a	0.343	n/a
31	3A	678.4	470060.0	776432.1	216.5	5.7	9.6	8.7	140.6	992.5	265.7	719.0	7.7	n/a	0.329	n/a
32	4A	895.0	469843.4	776428.0	114.5	9.6	5.7	3.1	41.0	124.0	12.5	108.9	0.5	n/a	0.299	n/a
33	5A	1009.6	469728.7	776423.2	59.5	6.7	8.6	0.9	24.2	54.7	1.5	19.2	0.0	n/a	n/a	n/a
34	6A	1059.1	469670.2	776442.9	49.6	6.7	8.6	3.4	45.1	54.7	7.5	47.2	0.0	n/a	0.205	n/a
35	7A	1116.8	469621.6	776436.5	95.2	7.1	8.2	5.2	131.2	226.5	64.3	162.2	0.0	n/a	0.219	n/a
36	8A	1212.0	469526.4	776434.2	27.0	10.0	5.3	0.4	69.6	4.1	0.6	3.5	0.0	n/a	n/a	n/a

## 3) Stationary Profile Sedimentation Data Block

Contains the sedimentation data for each vertical

	A	B	C
36	ADCP Sedimentation Data		
37	vert#	depth	backscatter
38		(m)	(dB)
39	1A	2.7	80.7
40	1A	3.2	82.3
41	1A	3.7	83.9
42			
43	2A	2.7	77.1
44	2A	3.2	77.9
45	2A	3.7	78.6
46	2A	4.2	79.3
47	2A	4.7	80.2
48	2A	5.2	81.2
49	2A	5.7	82.4
50	2A	6.2	83.7
51			
52	3A	0.5	
53	3A	2.7	72.2
54	3A	3.2	72.5
55	3A	3.7	73.2
56	3A	4.2	73.9
57	3A	4.7	74.6
58	3A	5.2	75.4

## 4) MEX Turbidity Data Block

Contains the MEX turbidity data for each vertical.

	A	B	C
110	MEX 3 Turbidity Meter Sedimentation Data		
111	vert#	depth	turbidity
112		(m)	(%)
113	3B	0.5	7.9
114	3B	2.0	12.5
115	3B	3.9	12.7
116	3B	5.9	12.4
117	3B	7.8	13.5
118	3B	9.1	16.6

#### 5.4 Suspended sediment concentration file (.ssc file)

This is a Quattro file containing the suspended sediment concentration laboratory results for all verticals measured in a given transect survey.

	A	B	C	D	E	F	G
1	<b>Suspended Sediment Concentration</b>						
2	<b>FAP 24 - River Survey Project</b>						
3	Location:	Bahadurabad					
4	River:	Jamuna					
5	Channel Number:	1					
6	Date:	Apr-3-1994					
7	Sample Type:	Pump Bottle					
8	Channel Width:	1156.23					
9	Lt. Bank Easting:	4444444					
10	Lt. Bank Northing:	6666666					
11							
12	<b>Vertical</b>	<b>Sample</b>	<b>Sample</b>	<b>Total</b>	<b>Suspended Sediment Concentration</b>		
13	<b>No.</b>	<b>No.</b>	<b>Depth</b>	<b>Depth</b>	<b>Wash</b>	<b>Bed Material</b>	<b>Total</b>
14			<b>(m)</b>	<b>(m)</b>	<b>Load (mg/l)</b>	<b>Load (mg/l)</b>	<b>(mg/l)</b>
15	1	a234	1	6.00	1.23	5.67	6.90
16	1	a123	2	6.00	2.34	4.56	6.90
17	1	a432	3	6.00	3.45	3.45	6.90
18	1	a567	4	6.00	4.56	2.34	6.90
19	1	a123	5	6.00	5.67	1.23	6.90

#### 5.5 Suspended sediment size file (.ssz file)

This is a Quattro file containing the suspended sediment size analysis for all vertical measured in a given transect survey.

(see section 5.7 for example)

#### 5.6 Bed material size file (.bdm file)

This is a Quattro file containing the bed material sediment size analysis for all vertical measured in a given transect survey.

(see section 5.7 for example)



## 5.7 Bed load size file (.bdl file)

This is a Quattro file containing the bed load sediment size analysis for all vertical measured in a given transect survey.

Sieve Analysis of Bed Load																								
FAP 14 - River Survey Project																								
Location: Bahadurabad																								
River: Jamuna																								
Channel Number: L1																								
Date: Apr-03-1994																								
Sample Type: Bed Load																								
Channel Width (m): 1728.0																								
Left Bank Easting: 470758.4																								
Left Bank Northing: 776430.1																								
Vertical Number	Sample Number	Instrument Type	Collection Period	Type of analysis	Easting Position (m)	Northing Position (m)	Total Depth (m)	Sample Depth (m)	Dist. from Left Bank (m)	Vertical Wt. (g)	D16 (mm)	D35 (mm)	D50 (mm)	D65 (mm)	D84 (mm)	Std. Dev.	Wt. Total (g)	Wt. before Sieving (g)	Wt. after Sieving (g)	Loss (g)	Transport Rate (g/m <sup>2</sup> /s)			
8	Sample No. A1183	HELLY-SMITH	130	Dry	480818.0	776435.0	8.1	8.1	1119.4	88.8	0.127	0.172	0.219	0.281	0.362	1.757	2.258	2.227	2.281	0.034	0.00028			
9	Sample No. A398	HELLY-SMITH	130	Dry	480818.0	776435.0	8.1	8.1	1119.4	88.8	0.117	0.170	0.219	0.283	0.364	1.835	1.854	1.849	1.847	0.007	0.00018			
10	Sample No. A44	HELLY-SMITH	130	Dry	480817.0	776437.0	8.8	8.8	1085.4	110.5	0.137	0.171	0.215	0.275	0.348	1.749	2.284	2.178	2.148	0.136	0.00036			
11	Sample No. A700	HELLY-SMITH	130	Dry	480817.0	776437.0	8.8	8.8	1085.4	110.5	0.105	0.157	0.195	0.242	0.301	1.864	1.884	1.847	1.847	0.037	0.00030			
12	Sample No. A357	HELLY-SMITH	130	Dry	487040.0	776439.0	5.9	5.9	888.4	180.5	0.161	0.237	0.289	0.344	0.429	1.840	21.854	21.751	21.889	0.133	0.00239			
13	Sample No. A56	HELLY-SMITH	130	Dry	464040.0	776439.0	5.9	5.9	888.4	180.5	0.167	0.197	0.219	0.265	0.336	1.691	66.531	60.533	62.471	0.942	0.00400			
14	Sample No. A129	HELLY-SMITH	130	Dry	470254.0	776439.0	8.8	8.8	888.4	180.5	0.261	0.303	0.349	0.394	0.465	1.311	57.930	50.841	50.630	0.301	0.00400			
15	Sample No. A56	HELLY-SMITH	130	Dry	470254.0	776439.0	8.8	8.8	888.4	180.5	0.269	0.313	0.352	0.367	0.462	1.311	120.620	50.508	50.573	0.016	0.01323			
16	Sample No. A91	HELLY-SMITH	130	Dry	470258.0	776439.0	7.2	7.2	812.4	223.0	0.218	0.218	0.266	0.324	0.385	0.461	1.558	87.930	50.010	50.078	0.088	0.01002		
17	Sample No. A83	HELLY-SMITH	130	Dry	470258.0	776439.0	7.2	7.2	812.4	223.0	0.254	0.358	0.352	0.400	0.488	1.388	99.930	50.433	50.430	0.003	0.04578			
18	Sample No. A90	HELLY-SMITH	130	Dry	470259.0	776439.0	6.8	6.8	738.4	278.4	0.131	0.178	0.227	0.285	0.361	1.718	139.930	60.542	60.491	0.041	0.01140			
19	Sample No. A82	HELLY-SMITH	130	Dry	470260.0	776439.0	6.8	6.8	738.4	278.4	0.132	0.178	0.227	0.281	0.366	1.718	307.000	60.015	60.016	0.004	0.02386			
Vertical Number	Sieve Size (mm)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	
8	1.000	0.001	0.002	99.998	0.001	0.002	99.998	0.001	0.002	99.998	0.001	0.002	99.998	0.001	0.002	99.998	0.001	0.002	99.998	0.001	0.002	99.998	0.001	
Sample No. A1183	0.500	0.045	2.118	57.620	0.045	2.118	57.620	0.045	2.118	57.620	0.045	2.118	57.620	0.045	2.118	57.620	0.045	2.118	57.620	0.045	2.118	57.620	0.045	
	0.250	0.864	39.571	58.299	0.864	39.571	58.299	0.864	39.571	58.299	0.864	39.571	58.299	0.864	39.571	58.299	0.864	39.571	58.299	0.864	39.571	58.299	0.864	
	0.125	0.979	43.305	14.993	0.979	43.305	14.993	0.979	43.305	14.993	0.979	43.305	14.993	0.979	43.305	14.993	0.979	43.305	14.993	0.979	43.305	14.993	0.979	
	0.063	0.170	7.523	7.470	0.170	7.523	7.470	0.170	7.523	7.470	0.170	7.523	7.470	0.170	7.523	7.470	0.170	7.523	7.470	0.170	7.523	7.470	0.170	
Pan	0.169	7.470	0.000		0.169	7.470	0.000		0.169	7.470	0.000			0.169	7.470	0.000		0.169	7.470	0.000				
11	1.000	0.001	0.001	99.999	0.001	0.001	99.999	0.001	0.001	99.999	0.001	0.001	99.999	0.001	0.001	99.999	0.001	0.001	99.999	0.001	0.001	99.999	0.001	
Sample No. A398	0.500	0.036	2.198	97.711	0.036	2.198	97.711	0.036	2.198	97.711	0.036	2.198	97.711	0.036	2.198	97.711	0.036	2.198	97.711	0.036	2.198	97.711	0.036	
	0.250	0.665	36.791	63.030	0.665	36.791	63.030	0.665	36.791	63.030	0.665	36.791	63.030	0.665	36.791	63.030	0.665	36.791	63.030	0.665	36.791	63.030	0.665	
	0.125	0.673	41.305	16.714	0.673	41.305	16.714	0.673	41.305	16.714	0.673	41.305	16.714	0.673	41.305	16.714	0.673	41.305	16.714	0.673	41.305	16.714	0.673	
	0.063	0.127	7.229	8.986	0.127	7.229	8.986	0.127	7.229	8.986	0.127	7.229	8.986	0.127	7.229	8.986	0.127	7.229	8.986	0.127	7.229	8.986	0.127	
Pan	0.148	8.985	0.000		0.148	8.985	0.000		0.148	8.985	0.000			0.148	8.985	0.000		0.148	8.985	0.000				
12	1.000	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	
Sample No. A44	0.500	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	
	0.250	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	
	0.125	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	
	0.063	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	
Pan	0.181	5.750	0.000		0.181	5.750	0.000		0.181	5.750	0.000			0.181	5.750	0.000		0.181	5.750	0.000				
Vertical Number	Sieve Size (mm)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	Material (g)	Material (%)	
7	1.000	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	0.009	99.992	0.003	
Sample No. A56	0.500	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	1.617	98.004	0.069	
	0.250	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	39.461	59.633	1.211	
	0.125	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	44.865	14.757	1.412	
	0.063	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	8.907	5.750	0.263	
Pan	0.181	5.750	0.000		0.181	5.750	0.000		0.181	5.750	0.000			0.181	5.750	0.000		0.181	5.750	0.000				

## 5.8 Iso-velocity file (.ct2 & .dt2 files)

Mike 21 type 2 file. Essentially it consists of a 2-d fixed grid matrix of u-velocities at each fixed grid component. It is necessary to use Mike21 to read this data. It is possible to export the data from Mike21 into a space separated variable file format for input into most spreadsheets programs. Once imported into the spreadsheet, the files can become very large.

(see survey bulletins for example plots)

### 5.9 Survey Bulletin transect plot data file (.trs file)

This is a Quattro file which contains all of the data which is used to produce the transect plots in the Survey Bulletins. The data is presented in columnar format. The following is a detailed definition of the contents of each column:

<u>Column#</u>	<u>Variable</u>	<u>Units</u>	<u>Description</u>
1	dist	m	echosounder dist from lt.bank
2	z	m	depth below stage level
3	dist	m	ADCP dist from lt. bank
4	a	m <sup>2</sup>	cross section area of profile
5	w	m	width of profile
6	u	m/s	velocity perpendicular to run line
7	v	m/s	velocity parallel to run line
8	qt	m <sup>3</sup> /s	total discharge for profile
9	qs	kg/s	total sed. discharge in prof.
10	qut	m <sup>3</sup> /s/m	unit total discharge
11	qus	kg/s/m	unit total sediment sediment
12	qsw	kg/s/m	unit susp. washload transport
13	qsus	kg/s/m	unit susp. sediment transport
14	qbed	kg/s/m	unit bedload transport
15	dist	m	sample distance from lt. bank
16	d50susp	mm	d50 size of suspended sediment
17	d50bedld	mm	d50 of bedload sediment
18	d50bed	mm	d50 of bed material

### 5.10 Bathymetry file (.ct2 & .dt2 files)

Mike 21 type 2 file. Essentially it consists of a 2-d fixed grid matrix of SLW water depths at each fixed grid component. It is necessary to use Mike21 to read this data. It is possible to export the data from Mike21 into a space separated variable file format for input into most spreadsheets programs. Once imported into the spreadsheet the files can become very large.

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## 5.11 Water level file

The water level files are Quattro formatted files, with the following format:

\*\*\*\*\*

Filename: b21c1.wl  
Location: Hardinge bridge  
Starting Date: 01/01/94  
Ending Date: 12/31/94  
Type of reading: Staff gauge

\*\*\*\*\*

Date (yymmddhhmm)	Level (m, PWD)
9201010000	12.33
9201010100	12.45
9201010200	12.42



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## 6. Paradox Catalogue System

All PSD 24 data files will be listed in a Paradox database table. To access the table, the user must run the Paradox program. To run the program, double-click on the Paradox icon from Windows, supply the password, "psd24", and then choose File/Open/Table, and choose the table named:

psd24.db

For each PSD 24 file, an entry for each of the following fields is kept:

- Survey bulletin number
- Filename
- Location
- Channel number
- River
- Survey type
- File contents
- File location
- Survey Date
- File Format
- Starting easting
- Starting northing
- Ending easting
- Ending northing
- Online/Offline
- Retrieve

### Query Searches in Paradox

To make a search for a particular set of data, the user may choose to run a Query. To perform a Query, choose the menu File/New/Query. Then choose the psd24.db table. The user is then presented with a menu screen showing all the fields in the table. Within each field is a checkbox and an area to enter the search string. The checkbox is used to choose which fields will be returned in the Query listing. The search string can be entered as either the entire word, or wildcard variables combined with a partial word. The search strings are not case sensitive by default.

As an example, if the user was interested to find a listing of the filenames and file locations for all of the files which contain ADCP data on the Padma River, the user would place a check in the boxes for the "Filename" and "File Location" fields, and then enter the search string "..ADCP.." under the "File Contents" field, and then enter "..Padma.." under the "River" field. Note that the search strings contain the ".." characters at each end of the string. The ".." is a wildcard, and can be used when the user is not sure on the exact spelling or format of the entire string. Also note that the search strings are not case sensitive. Once the parameters are selected, choose the menu, Query/Run. After some time, Paradox Query will return a list of all the records found which satisfied the requested search criteria. The query table can be printed, saved, deleted, re-formatted into a Paradox Report, and also can be appended with further Query search listings.

**Viewing Quattro files from within Paradox**

It is possible to view the individual Quattro formatted files from within Paradox. To view the Quattro files from Paradox do the following:

- 1) Start Quattro Pro for Windows.
- 2) Switch to Paradox using the key command "Alt-Esc".
- 3) Move the cursor to the field labelled "Retrieve".
- 4) launch the file using the key command "Shift-F2".

The user is recommended to read the Paradox User's Guide for a full description of all features available inside the Paradox system.

Editing of the Paradox database table can only be performed by the database manager.

## 7. Administration of Database Files

The following information is used to interpret the raw data and to produce the PSD24 files.

- a) Survey Bulletins.
- b) Field Survey reports.
- c) Sediment Lab data sheets and reports.
- d) Water level data.

### 7.1 ADCP/S4/EMF File (.ase file)

Run the program Psd24Ase (UNIX) for each channel transect as presented in the Survey Bulletin. For the older Survey bulletin data use the transect data which was used for the discharge calculation reported. Also included are the stationary profile files, even if they are not used for the discharge calculation.

The Psd24Ase program is used similarly to the other FAP 24 Offline software, and uses the following input specification:

```
usage : Psd24Ase
topmethodT          (if discharge based on transect data, meter or constant)
topmethodP          (if discharge based on stationary profile data, meter or constant)
left_bank_dist
right_bank_dist
firstfixno
lastfixno
pwd                 (stage level, m above PWD)
transfilename
profilename profilename ...
[-mode mode]        (stationary data to output: S4, ADCP, MIXEDS4, MIXEDADCP)
[-mancurr filename]
[-gpscorrT]         (GPS correction applied to the transect file)
[-gpscorrP]         (GPS correction applied to the profile file)
[-depthcorrT x]
[-depthcorrP x]
[-adcprotT angle]
[-adcprotP angle]
[-emfrotT angle]
[-emfrotP angle]
[-adcpfreqT frequency]
[-adcpfreqP frequency]
[-S4factor factor]
[-shift_left_right] (to manually switch the left and right bank definition)
```

The output from this file will be a DOS formatted ASCII file with the name:

transect\_filename.ase

It is then converted to Quattro format using the macro program:

p:\psd24\psd24mac.wb1



## 7.2 Echosounder file (.ech file)

Run Psd24Ech (UNIX) for each channel transect as presented in the Survey Bulletin.

The Psd24Ech program is used similarly to the other FAP 24 Offline software, and uses the following input specification:

```
usage : Psd24Ech
        Transfilename
        left_bank_dist
        right_bank_dist
        pwd
        [-ech_dist x] default 0.0
        [-depthcorr x] default 0.0
        [-shift_left_right]
```

The output from this file will be a DOS formatted ASCII file with the name:

transect\_filename.ech

It is then converted to Quattro format using the macro program:

p:\psd24\psd24mac.wb1

## 7.3 Sedimentation file (.sed file)

Run Psd24Sed (UNIX) for each channel transect as presented in the Survey Bulletin.

The Psd24Sed program is used similarly to the other FAP 24 Offline software, and uses the following input specification:

```
usage: Psd24Sed
        topmethodP
        left_bank_dist
        right_bank_dist
        firstfixno
        lastfixno
        pwd
        transfilename
        proffilename proffilename ...
        [-depthcorrP x]
        [-mode mode]
        [-gpscorrP]
        [-shift_left_right]
        [-adcprotP angle]
        [-emfrotP angle]
        [-adcpfreqP frequency]
        [-const_backscatter constant] (proportionality constant, mg/l/db, 0 for no calculation)
        [-s sedifilename] (same file used in DischTrans, files after April 1994)
        [-mancurr filename]
        [-d50 grainfilename] (same file used in DischTrans, files after April 1994)
```

The output from this file will be a DOS formatted ASCII file with the name:

transect\_filename.sed

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It is then converted to Quattro format using the macro program:

p:\psd24\psd24mac.wb1

#### 7.4 Script File

The script file used to run Psd24Ase, Psd24Ech and Psd24Sed is combined into a single file and it has the filename:

b4321

where:

b = location, Bahadurabad  
4 = year, 1994  
3 = month, March  
2 = day, 2  
1 = vessel number, DHA

#### 7.5 Transect Plot Data file (.trs file)

This is the same file as used for making the transect plots for the Survey bulletins. The first step to produce this file is to run the UNIX programs:

DischProf - if only stationary profile measurements exist.

DischTrans - if ADCP moving boat transect data was measured

The DischProf program uses the following input specification:

mode :	The data to use for the calculation : ADCP or S4.
topmethod :	The method for calculating the top layer discharge : meter or constant.
firstdist :	Distance to the first bank in meters.
lastdist :	Distance to the last bank in meters.
firstfixno :	The first fix number to use in the calculation.
lastfixno :	The last fix number to use in the calculation.
transfilename :	Name of transsect input file without extension.
profffilename :	Name of profile input file without extension. At least two files must be specified.
-s sedifilename :	Perform sediment discharge calculation. Sediment sample data are contained in the file sedifilename.
-mancurr filename :	Read manually entered current data from file.
-gpscorr :	Use GPS vessel speed data to correct ADCP current velocities.
-noproj :	Do not project currents in standard method.
-depthcorr x :	Correct the depth by x meters.
-adcprot angle :	Rotate the ADCP data by angle.
-emfrot angle :	Rotate the EMF data by angle.
-plotcross filename :	Create a file to be plotted by PlotCross program.
-plotdisch filename :	Create a file to be plotted by PlotDisch program.
-S4factor factor :	Multiply S4 data by factor.

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-adcpfreq frequency: ADCP frequency in kHz (default 300).  
-density density : density of sediment (default 1 kg/m<sup>3</sup>)

The DischTrans program uses the following input specification:

filename : The input filename without extension.  
mode : Method to use for ADCP online method  
          discharge calculation : GPS or ADCP.  
topmethod : The method for calculating the ADCP online  
            method top layer discharge : meter or  
            constant.  
btmmethod : The method for calculating the ADCP online  
            method bottom layer discharge : constant or  
            power.  
firstdist : Distance to the first bank in meters.  
lastdist : Distance to the last bank in meters.  
firstfixno : First fix number to use in calculation.  
lastfixno : Last fix number to use in calculation.  
-s sedifilename : Perform sediment discharge calculation.  
                  Sediment sample data are contained in the  
                  file sedifilename.  
-gpscorr : Use GPS vessel speed data to correct ADCP  
           current velocities.  
-noproj : Do not project currents in standard method.  
-depthcorr x : Correct the depth by x meters.  
-adcprot angle : Rotate the ADCP data by angle.  
-emfrot angle : Rotate the EMF data by angle.  
-plotdisch filename : Create a file to be plotted by the PlotDisch  
                      program.  
-adcpfreq frequency: ADCP frequency in kHz (Default 300)  
-density density : density of sediment in kg/m<sup>3</sup> ( Default 1 )  
-d50 grainfilename : Grain data are read in from the filename and  
                      written in the plotfile specified by option  
                      -plotdisch

The **-plotdisch** plot file is used as input to the DISCH.EXE (DOS) program.

The output from DISCH.EXE is a DOS formatted ASCII file with the name:

transect\_filename.trs

It is then converted to Quattro format using the macro program:

p:\psd24\psd24mac.wb1



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#### **7.6 Mike 21 Iso-Velocity Plot Data (.ct2 & .dt2 and .inp files)**

This is the Mike 21 plot file which is used to produce the Iso-velocity plots for the survey bulletin.

The output file will be Mike 21 binary formatted files with the name:

transect\_filename.ct2 , .dt2 and .inp

#### **7.7 Mike 21 Bathymetry Plot Data (.ct2 & .dt2 file)**

This is the Mike 21 plot file which is used to produce the bathymetry plots.

The output file will be a Mike 21 binary formatted file with the name:

b4321b.ct2 & .dt2

where:

b = location, Bahadurabad  
4 = year, 1994  
3 = month, March  
2 = day, 2  
1 = vessel number, DHA  
b = bathymetry

#### **7.8 Bed load, Bed material and Suspended sediment size (.bdl, bdm & .ssz)**

These files are produced by combining Quattro spreadsheets produced by the sediment laboratory. The sediment lab spreadsheets are combined, putting all samples into a single file using a Quattro macro. Different macros are used depending on when the sediment data was processed because the file formats have changed a few times since the beginning of the project.

#### **7.9 Suspended Sediment Concentration (.ssc)**

These files are produced by combining Quattro spreadsheets produced by the sediment laboratory. The sediment lab spreadsheets are combined, putting all samples into a single file using a Quattro macro. Different macros are used depending on when the sediment data was processed because the file formats have changed a few times since the beginning of the project.

## 8. Administration of Paradox Catalogue system.

The Paradox catalogue will include a record for each file entered into the PSD 24 file system. Only the database manager will have privileged access to write new information to the PSD 24 catalogue. The catalogue is contained within a file called a Table, and has the filename:

psd24.db

There are various ways of entering data into the table. The first and most direct is to open the table, and then to manually enter each data field for each record. Because of the large number of data records which will be produced, this will normally require too much manual effort. Another method of data entry is to first open the table, and then open the Paradox form named:

psd24.fsl

The form is a convenient way of entering or editing data within each file record. Manual data entry directly into the table or using the form should only be used for the bathymetry data and water level gage records or for editing existing data fields.

To facilitate semi-automatic record entry for the transect records, a FORTRAN program,

maketabl.exe

has been developed. The program 'maketabl' has the following input/output specifications:

Input:        raw transect filename  
              river channel number  
              starting and ending coordinates

Output:       Paradox PSD 24 table records for each of the 9 different transect filetypes in  
              Comma Separated Value (CSV) format for direct input into Paradox table.

The output filename is

survey\_bulletin\_number-channel number.txt

Using the input parameters and decoding the filename, the program is able to create table records for all 9 transect files, whether they exist or not. The database manager must delete the lines which do not apply to the particular transect. They should be deleted from the Paradox table using the Ctrl-Del command in Edit mode.

To import the ".txt" file into Paradox, use the Files/Utilities/Import command and import the file 'table.prn' into a temporary table. Use the delimited text format. Next use the Files/Utilities/Add command to append the temporary table to the PSD 24 table, 'psd24.db'.

The final task is to manually edit the field which indicates whether the file has been placed online to PSD 24.



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ANNEXURE 2

**Changed format  
Survey Bulletins**



Y22

Contents :

Introduction

Survey Bulletin 22 (old format)

Survey Bulletin 77 (new format)



## Introduction

Per 1st April 1994 the format of the Survey Bulletins (nos 48 and further) was changed. To illustrate this two bulletins are given hereafter as an example :

Survey Bulletin 22	(Old format)
Survey Bulletin 77	(New format)

The reason of the adaptation is manifold :

- o The old format was in fact a tentative one which could be produced with the initially available processing software.
- o In the old bulletins information was mainly presented in table form, while a more graphical presentation was desired.
- o The old format gave a lot of details in verticals, while variation of parameters over the width of the river was lacking.
- o The old format became too bulky; a more compact presentation was desired.

It took some time to develop the special software for the new bulletin format. The software enables to produce the bulletins using a high degree of automation.

The new format is chosen in such a way that the bulletins

- o Can be used annex to the Quarterly Progress Reports (Chapter 1 through 5)
- o Can be used as a catalogue for the engineering database PSD 24 (Chapter 6 and 7)
- o Can be used as part of the River Data Books (see proposed format in Final Report Phase 1).

The major changes can be appreciated by comparing the attached two bulletins no. 22 and 77. The main differences are :

- o The measuring programme has been simplified.
- o The details of the track of the survey vessels are omitted.
- o The tables concerning the details of flow and sediment concentration in the vertical are dropped.
- o A compact presentation of flow and sediment distribution over the width of the river (per channel) is added.
- o The ADCP vector plots are left out.
- o iso-velocity plots are added.

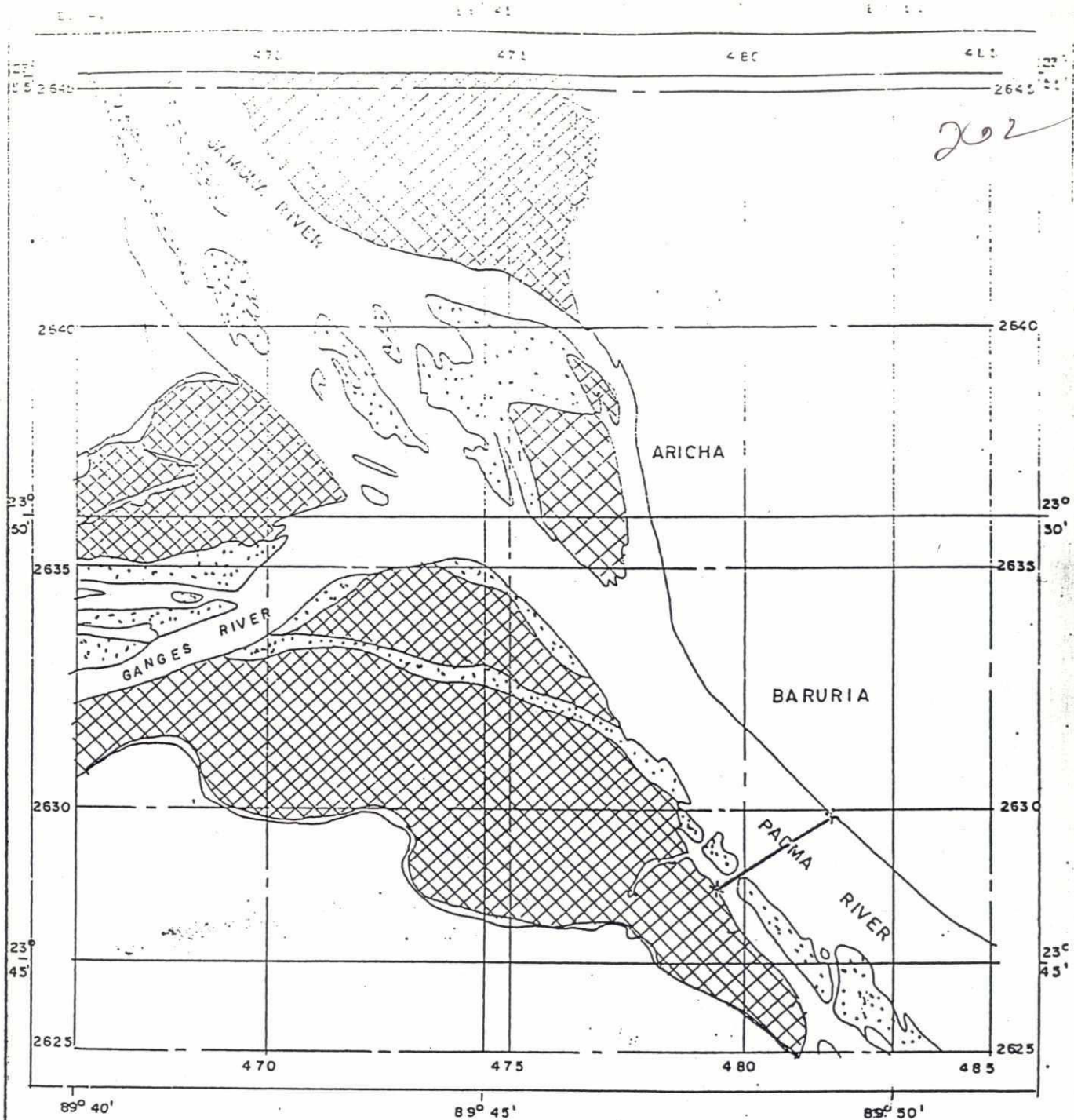
# **FAP 24 RIVER SURVEY PROJECT**

**SURVEY BULLETIN NO.22  
OCTOBER 1993**

**RIVER : PADMA  
STATION : BARURIA**

1. Survey Programme as made
2. Summary of results
3. Selected Flow and Sediment distributions
4. Location of measurements






**LEGEND:—**

- X—X Measurement Cross Section
- High land
- Unstable/Low land
- BWDB Embankment



5000 m 2500 m 0

Map is based on most recent  
Satellite image of March 1993.

FAP 24 RIVER SURVEY PROJECT  
 Delft Hydraulics/Danish Hydraulic Institute  
 in association with Oosterveld/Hydroland  
 DELFT-DHI

Survey Bulletin No. 22 - Oct. , 1993  
 Location No.5 Padma River at Baruria

File:

Date:

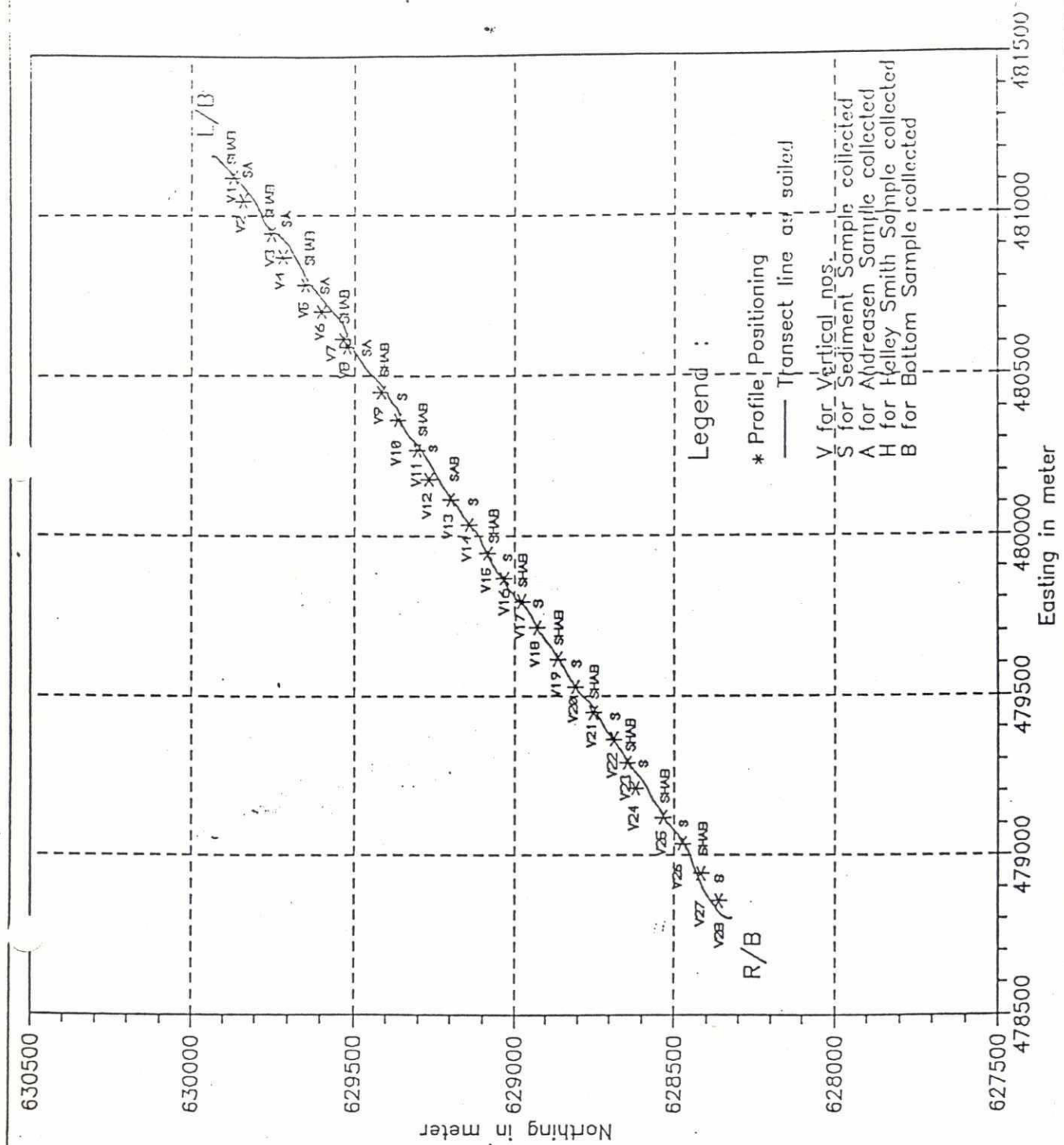
Scale:


Int:

**KEY PLAN.**

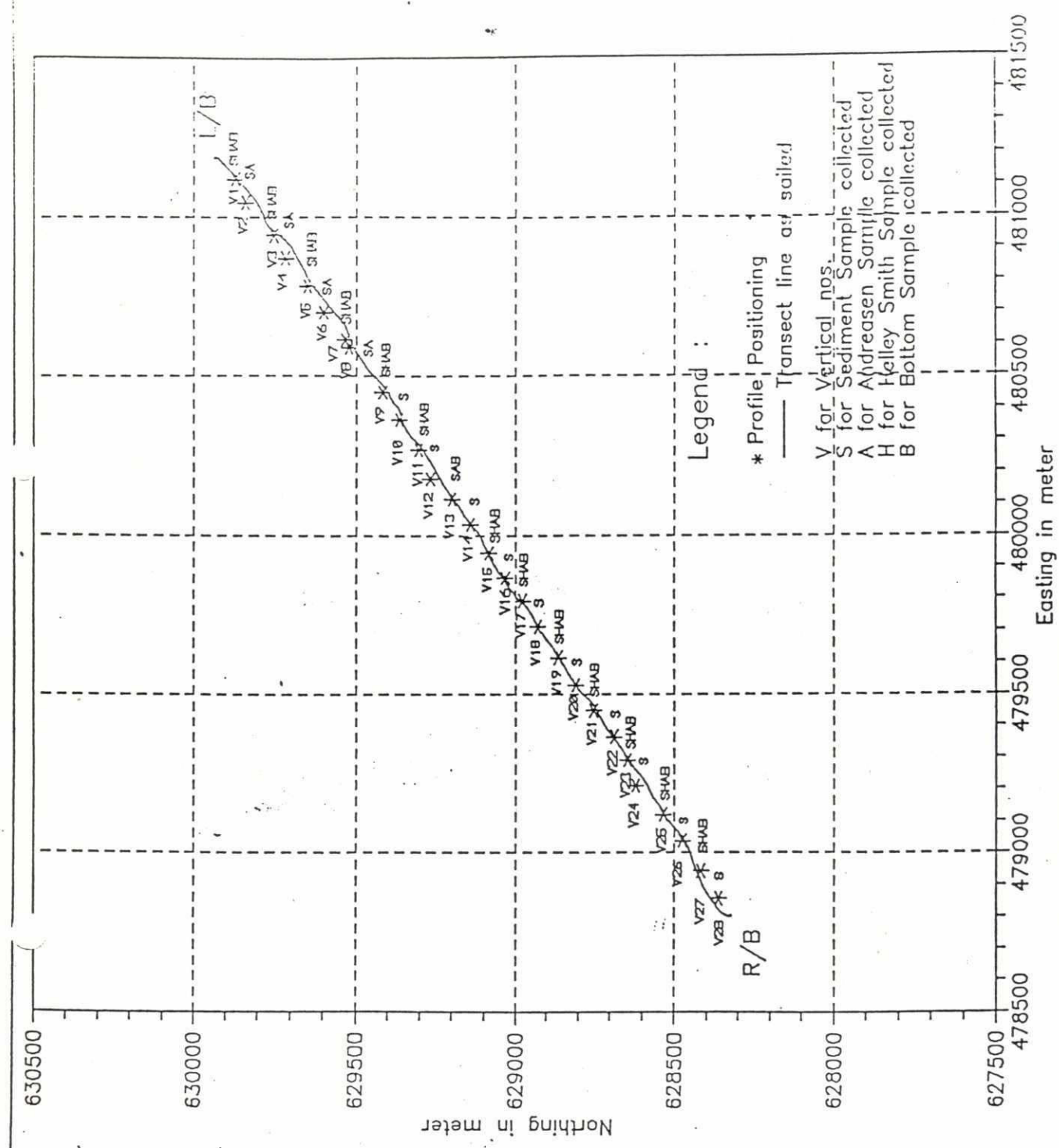
Drg.No.


266



<div>FAP 24</div> <div></div> <div>DELFT-DHI</div>		<div>RIVER SURVEY PROJECT</div> <div>Delft Hydraulics/Danish Hydraulic Institute in association with Oostvapoort/Hydroland</div>		<div>Survey Bulletin No. 22 Oct 1993</div> <div>Location No. 5 : Padma River at Baruria</div>	
<div>File:</div>	<div>Date:</div>	<div>LOCATION OF MEASUREMENTS</div>		<div>Fig.</div>	
<div>Scale:</div>	<div>Init:</div>				

5698



<b>FAP 24</b>  <b>DELFT-DHI</b>		<b>RIVER SURVEY PROJECT</b> <small>Delft Hydraulics/Danish Hydraulic Institute in association with Chuvap/Approach/Hydroland</small>		<b>Survey Bulletin No. 22 Oct 1993</b>	
				<b>Location No. 5 : Padma River at Baruria</b>	
File:	Date:	<b>LOCATION OF MEASUREMENTS</b>			<b>Fig.</b>
Scale:	Init:				



Type	Time		File Name	Ver. No.	Easting (meter)	Northing (meter)	DISCHARGE GAUGING					SEDIMENT TRANSPORT GAUGING				
	From	To					ADCP	HYDRO	EMF	S4	MEX	Suspended Sediment Samples	Andreasen Tube Samples	Helley Smith Samples	Integrated Sediment Samples	Bottom Samples
Transect	08:29:51	09:01:40	U3AJ1T01				T	T	T							
Transect	09:07:18	09:33:56	U3AJ1T02				T	T	T							
Transect	16:56:57	17:23:37	U3AJ1T03				T	T	T							
Transect	17:25:16	17:52:49	U3AJ1T04				T	T	T							
Profile	10:15:32	10:55:30	U3AJ1P01	1	481118	629871	P	P	P	P	P	6	1	2	-	1
Profile	14:48:12	15:25:00	U3AJ2P04	2	481045	629841		P		P		6	1	-	-	-
Profile	11:57:08	12:38:50	U3AJ1P02	3	480941	629753	P	P	P	P	P	6	1	2	-	1
Profile	11:03:58	11:43:48	U3AJ2P01	4	480870	629718		P		P		6	1	-	-	-
Profile	14:05:31	14:55:08	U3AJ1P03	5	480783	629650	P	P	P	P	P	6	1	2	-	1
Profile	12:58:36	13:42:43	U3AJ2P02	6	480701	629600		P		P		6	1	-	-	-
Profile	15:39:30	16:16:09	U3AJ1P04	7	480615	629534	P	P	P	P	P	6	1	2	-	1
Profile	16:17:06	16:32:04	U3AJ2P05	8	480589	629523		P				6	1	-	-	-

Table 2.1 SURVEY PROGRAMME AS MADE

Location : Padma river at Baruria  
Station No. 5  
Date of Survey : 19 Oct 93

Type	Time		File Name	Ver. No.	Easting (meter)	Northing (meter)	DISCHARGE GAUGING					SEDIMENT TRANSPORT GAUGING				
	From	To					'ADCP	HYDRO	EMF	S4	MEX	Suspended Sediment Samples	Andreasen Tube Samples	Helley Smith Samples	Integrated Sediment Samples	Bottom Samples
Transect	08:02:54	08:27:11	U3AK1T01				T	T	T							
Transect	08:30:12	08:57:48	U3AK1T02				T	T	T							
Transect	16:25:51	16:52:31	U3AK1T03				T	T	T							
Transect	16:54:52	17:21:11	U3AK1T04				T	T	T							
Profile	09:36:24	10:42:56	U3AK1P01	9	480450	629417	P	P	P	P	P	6	1	2		1
Profile	08:48:24	09:28:39	U3AK2P01	10	480364	629364		P		P		6				
Profile	12:27:11	16:16:05	U3AK1P03	11	480268	629304	P	P	P	P	P	6	1	2		1
Profile	09:44:25	10:18:57	U3AK2P02	12	480177	629267		P		P		6				
Profile	14:17:40	15:07:12	U3AK1P04	13	480113	629199	P	P	P	P	P	6	1			1
Profile	10:31:15	11:05:11	U3AK2P03	14	480034	629142		P		P		6				
Profile	11:16:32	11:50:47	U3AK2P04	16	479865	629032		P		P		6				
Profile	12:02:00	12:35:54	U3AK2P05	18	479711	628929		P		P		6				
Profile	14:17:16	14:47:33	U3AK2P06	20	479529	628808		P		P		6				
Profile	15:03:00	15:41:15	U3AK2P07	22	479364	628687		P		P		6				
Profile	10:00:52	16:38:19	U3AK2P08	24	479210	628620		P		P		6				

Table 2.2 SURVEY PROGRAMME AS MADE

Location : Padma river at Baruria  
Station No. 5

Date of Survey : 20 Oct 93

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Type	Time		File Name	Ver. No.	Easting (meter)	Northing (meter)	DISCHARGE GAUGING				SEDIMENT TRANSPORT GAUGING					
	From	To					ADCP	HYDRO	EMF	S4	MEX	Suspended Sediment Samples	Andreasen Tube Samples	Helley Smith Samples	Integrated Sediment Samples	Bottom Samples
Transect	07:39:41	08:04:34	U4AL1T01				T	T	T							
Transect	08:10:26	08:38:58	U4AL1T02				T	T	T							
Transect	17:24:16	17:48:23	U4AL1T03				T	T	T							
Profile	09:03:01	09:45:02	U3AL1P01	15	479944	629083	P	P	P	P	P	6	1	2	-	1
Profile	10:26:07	11:13:00	U3AL1P02	17	479793	628977	P	P	P	P	P	6	1	2	-	1
Profile	11:51:02	12:41:00	U3AL1P03	19	479615	628863	P	P	P	P	P	6	1	2	-	1
Profile	13:23:01	14:11:12	U3AL1P04	21	479448	628752	P	P	P	P	P	6	1	2	-	1
Profile	12:49:11	13:39:46	U3AL2P05	23	479290	628645		P		P	P	6	1	2	-	1
Profile	11:23:53	12:10:05	U3AL2P04	25	479120	628534		P		P	P	6	1	2	-	1
Profile	10:13:42	10:58:46	U3AL2P03	26	479037	628475		P		P	P	6	-	-	-	-
Profile	09:06:32	09:40:07	U3AL2P02	27	478943	628418		P		P	P	6	1	2	-	1
Profile	08:24:25	08:52:27	U3AL2P01	28	478869	628363		P		P	P	6	-	-	-	-

Date of Survey : 21 Oct 93

Type	Time		File Name	Ver. No.	Easting (meter)	Northing (meter)	DISCHARGE GAUGING					SEDIMENT TRANSPORT GAUGING				
	From	To					ADCP	HYDRO	EMF	S4	MEX	Suspended Sediment Samples	Andreasen Tube Samples	Helley Smith Samples	Integrated Sediment Samples	Bottom Samples
Transect	09:32:52	09:58:52	U3AM1T01				T	T	T							
Transect	10:03:24	13:07:11	U3AM1T02				T	T	T							
Transect	16:07:46	16:32:40	U3AM1T03				T	T	T							

Date of Survey : 22 Oct 93

Location : Padma river at Baruria  
Station No. 5



Table 2.3 SURVEY PROGRAMME AS MADE



Type Of Samples	Sample Nos.	Total Sample Nos.	Vertical No.
Point Integrated Samples	A2026.A20 .A983.A2003.A20 2	6	2
	A452.A447.A432.A436.A4 7.A4 5	6	
	A979.A998.A989.A20 3.A993.A200	6	3
	A384.A388.A400.A396.A446.A443	6	4
	A2000.A99 .A976.A2002.A20 0.A988	6	5
	A43 .A392.A438.A39 .A390.A4 6	6	6
	A20 8.A2025.A202 .A98 .A2024.A20 4	6	7
	A430.A4 4.A433.A444.A4 9.A389	6	8
	A966.A972.A204 .A2059.A978	6	9
	A952.A992.A946.A958.A965.A947	6	20
	A2043.A2046.A2047.A20 5.A20748.A968	6	22
	A95 .A990.A948.A953.A954.A944	6	2
	A2040.A2038.A2039.A2054.A2042.A2053	6	23
	A949.A980.A942.A964.A962.A940	6	24
	A263.A296.A295.A262.A260.A 00	6	25
	A957.A950.A955.A960.A96 .A963	6	26
	A378.A 06.A 0 .A259.A299.A38	6	27
	A975.A2035.A2037.A2033.A2032.A2036	6	28
	A 03.A2030.A20 9.A2034.A203 .A2050	6	29
	A385.A387.A399.A394.A398.A382	6	0
	A2055.A2058.A2057.A2045.A2049.A205	6	2
	A393.A44 .A4 8.A402.A386.A397	6	
	A2020.A2007.A2009.A2029.A967.A938	6	3
	A395.A434.A380.A435.A439.A420	6	4
	A2005.A2008.A2006.A2022.A2004.A2028	6	5
	A970.A97 .A94 .A969.A945.A999	6	6
	A2027.A982.A984.A973.A974.A977	6	7
	A995.A997.A994.A985.A986.A987	6	8

Date of Survey : 19/10/93 - 22/10/93

Table 2.4 List of Sediment Samples

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Type Of Samples	Sample Nos.	Total Sample Nos.	Vertical No.
Andreasen Tube Samples	A30	1	1
	A28	1	2
	A931	1	3
	A935	1	4
	A453	1	5
	A24	1	6
	A933	1	7
	A936	1	8
	A858	1	9
	A851	1	11
	A332	1	13
	A729	1	15
	A932	1	17
	A926	1	19
	A727	1	21
	A934	1	23
	A925	1	25
	A855	1	27
Helfey-Smith Samples	A123,A465	2	1
	A124,A463	2	3
	A48,A459	2	5
	A740,A565	2	7
	A46,A130	2	9
	A745,A101	2	11
	A706,A717	2	15
	A127,A350	2	17
	A466,A346	2	19
	A461,A43	2	21
	A353,A695	2	23
Vanveen Samples	A690,A696	2	25
	A349,A345	2	27
	DHA-1	1	1
	DHA-2	1	3
	DHA-3	1	5
	DHA-4	1	7
	DHA-1	1	9
	DHA-2	1	11
	DHA-3	1	13
	DHA-1	1	15
	DHA-2	1	17
	DHA-3	1	19
	DHA-4	1	21
	DHC-3	1	23
	DHC-2	1	25
	DHC-1	1	27

Date of Survey : 19/10/93 - 22/10/93

Table 2.5 List of Sediment Samples .

Y80

River : Padma  
ADCP/EMF Discharge

Date of Survey : 19-22 October 1993

Location : Baruria

Date	Transect	Bank		Water Level	Total Width	Area	Discharge
		From	To	(m+PWD)	(m)	(sq.m)	(cumec)

19/10/93	U3AJ1T01	Left	Right	6.56	2921	27788	39840
19/10/93	U3AJ1T02	Right	Left	6.56	2920	27918	41651
19/10/93	U3AJ1T03	Left	Right	6.51	2914	27795	39154
19/10/93	U3AJ1T04	Right	Left	6.50	2939	27884	39960

20/10/93	U3AK1T01	Left	Right	6.44	2911	27577	37595
20/10/93	U3AK1T02	Right	Left	6.44	2931	27812	39564
20/10/93	U3AK1T03	Left	Right	6.41	2910	27179	36978
20/10/93	U3AK1T04	Right	Left	6.40	3335	30111	39588

21/10/93	U3AL1T01	Left	Right	6.35	2920	27354	34945
21/10/93	U3AL1T03	Left	Right	6.33	2911	26948	37068

22/10/93	U3AM1T01	Left	Right	6.29	2924	26696	36782
22/10/93	U3AM1T02	Right	Left	6.29	2922	26707	37407
22/10/93	U3AM1T03	Left	Right	6.27	2925	26798	36409

Table 3.1 SUMMARY OF RESULTS (ADCP/EMF-discharge)



River : Padma  
S4 Velocity

Date of survey : 19 - 22 Oct 1993  
Location : Baruria

Vertical 1	
Total depth = 10.90 m	
Depth	Velocity
(m)	(m/s)
1.99	1.45
4.01	1.56
5.99	1.59
8.11	1.44
9.92	1.07

Vertical 2	
Total depth = 9.40 m	
Depth	Velocity
(m)	(m/s)
0.96	1.78
1.84	1.81
3.79	1.81
5.65	1.64
7.49	1.64
9.27	1.14

Vertical 3	
Total depth = 12.70	
Depth	Velocity
(m)	(m/s)
2.57	1.64
5.25	1.52
7.80	1.33
10.39	1.20
12.35	0.94

Vertical 4	
Total depth = 16.50	
Depth	Velocity
(m)	(m/s)
2.55	1.54
5.19	1.54
7.79	1.36
10.51	1.25
11.89	1.07

Vertical 5	
Total depth = 16.50 m	
Depth	Velocity
(m)	(m/s)
3.31	2.00
6.60	1.78
9.94	1.71
13.32	1.50
14.35	1.49

Vertical 6	
Total depth = 16.50	
Depth	Velocity
(m)	(m/s)
0.50	
2.86	2.28
5.63	2.17
8.44	2.08
11.10	1.91
14.48	1.50

Vertical 7	
Total depth = 16.20	
Depth	Velocity
(m)	(m/s)
0.50	
2.97	2.35
5.98	2.22
9.11	2.05
12.27	1.93
15.69	1.21

Vertical 9	
Total depth = 17.00	
Depth	Velocity
(m)	(m/s)
0.50	
3.04	2.01
6.12	2.05
9.21	1.85
12.15	1.74
16.75	1.21

Vertical 10	
Total depth = 13.50 m	
Depth	Velocity
(m)	(m/s)
0.50	1.84
2.75	1.95
5.29	1.99
8.29	1.73
10.59	1.85
12.24	1.65

Vertical 11	
Total depth = 14.90	
Depth	Velocity
(m)	(m/s)
0.50	1.45
2.98	1.70
5.97	1.42
8.96	1.27
11.91	1.12
14.87	1.03

Vertical 12	
Total depth = 13.80	
Depth	Velocity
(m)	(m/s)
0.50	
2.79	1.16
5.53	1.04
8.30	0.98
11.04	0.85
13.62	0.69

Vertical 13	
Total depth = 13.20	
Depth	Velocity
(m)	(m/s)
0.50	0.80
2.58	1.00
5.16	0.87
7.76	0.95
10.34	0.76
12.20	0.59

Vertical 14	
Total depth = 9.80 m	
Depth	Velocity
(m)	(m/s)
0.50	
1.84	0.85
3.52	0.73
5.35	0.74
6.99	0.70
8.90	0.50

Vertical 15	
Total depth = 7.20 m	
Depth	Velocity
(m)	(m/s)
0.50	
1.46	0.76
2.79	0.78
4.19	0.75
5.60	0.66
7.06	0.43

Qw = 34,161 (m3/s)



Table 3.2 SUMMARY of RESULTS (S4 Current)

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River : Padma  
S4 Velocity

Date of survey : 19 - 22 Oct 1993

Location : Baruria

Vertical 16	
Total depth = 6.20 m	
Depth	Velocity
[m]	[m/s]
1.22	0.81
2.49	0.77
3.74	0.73
5.01	0.55
6.08	0.45

Vertical 17	
Total depth = 6.60 m	
Depth	Velocity
[m]	[m/s]
0.50	0.76
1.29	0.68
2.65	0.74
3.78	0.74
5.09	0.65
6.46	0.48

Vertical 18	
Total depth = 6.80 m	
Depth	Velocity
[m]	[m/s]
1.16	1.32
2.30	1.11
3.53	1.01
4.61	0.88
5.92	0.71

Vertical 19	
Total depth = 6.00 m	
Depth	Velocity
[m]	[m/s]
0.50	1.26
1.23	1.18
2.44	1.24
3.58	1.27
4.81	1.12
5.93	0.95

Vertical 20	
Total depth = 5.70 m	
Depth	Velocity
[m]	[m/s]
1.22	1.42
2.32	1.27
3.51	1.37
4.58	1.23
5.67	1.02

Vertical 21	
Total depth = 6.00 m	
Depth	Velocity
[m]	[m/s]
0.50	1.36
1.12	1.23
2.22	1.47
3.32	1.39
4.43	1.31
5.57	1.08

Vertical 22	
Total depth = 5.40 m	
Depth	Velocity
[m]	[m/s]
1.12	1.26
2.23	1.38
3.26	1.24
4.29	1.15
5.22	1.08

Vertical 23	
Total depth = 5.20 m	
Depth	Velocity
[m]	[m/s]
1.05	1.14
2.09	1.40
3.14	1.54
4.15	1.31
4.99	1.07

Vertical 24	
Total depth = 5.30 m	
Depth	Velocity
[m]	[m/s]
1.03	1.71
2.13	1.62
3.09	1.46
4.19	1.37
5.12	1.02

Vertical 25	
Total depth = 5.10 m	
Depth	Velocity
[m]	[m/s]
1.02	1.31
2.04	1.47
3.05	1.42
4.08	1.25
4.61	1.21

Vertical 26	
Total depth = 4.80 m	
Depth	Velocity
[m]	[m/s]
1.00	0.96
1.93	0.99
2.88	1.32
3.82	1.28
4.35	1.21

Qw = 34,161 (m3/s)

Table 3.3 SUMMARY of RESULTS (S4 Current)

River : Padma  
Concentration

Date of survey : 19 - 22 Oct 1993

Location : Baruria

Vertical 1	
Total depth = 10.90 m	
Depth	Conc.
(m)	(mg/l)
0.50	365.82
1.99	292.57
4.01	296.25
5.99	442.94
8.11	505.88
9.92	769.74

Vertical 2	
Total depth = 9.40 m	
Depth	Conc.
(m)	(mg/l)
0.50	177.01
1.84	276.84
3.79	460.13
5.65	626.92
7.49	886.55
9.27	3396.43

Vertical 3	
Total depth = 12.70	
Depth	Conc.
(m)	(mg/l)
0.50	373.86
2.57	371.01
5.25	543.03
7.80	520.23
10.39	606.30
12.35	716.67

Vertical 4	
Total depth = 16.50	
Depth	Conc.
(m)	(mg/l)
0.50	322.70
2.55	410.00
5.19	392.91
7.79	416.00
10.51	523.46
11.89	528.14

Vertical 5	
Total depth = 16.50 m	
Depth	Conc.
(m)	(mg/l)
0.50	287.58
3.31	258.82
6.60	318.56
9.94	288.06
13.32	351.28
14.35	427.12

Vertical 6	
Total depth = 16.50	
Depth	Conc.
(m)	(mg/l)
0.50	135.03
2.86	349.15
5.63	393.42
8.44	560.89
11.10	566.93
14.48	981.37

Vertical 7	
Total depth = 16.20	
Depth	Conc.
(m)	(mg/l)
0.50	355.93
2.97	279.07
5.98	330.86
9.11	366.47
12.27	365.27
15.69	725.00

Vertical 9	
Total depth = 17.00	
Depth	Conc.
(m)	(mg/l)
0.50	631.25
3.04	452.69
6.12	454.22
9.21	585.63
12.15	680.30
16.75	1272.94

Vertical 10	
Total depth = 13.50 m	
Depth	Conc.
(m)	(mg/l)
0.50	413.07
2.75	455.32
5.29	540.57
8.29	584.62
10.59	668.67
12.24	1632.43

Vertical 11	
Total depth = 14.90	
Depth	Conc.
(m)	(mg/l)
0.50	387.50
2.98	362.58
5.97	427.97
8.96	546.31
11.91	487.74
14.87	673.53

Vertical 12	
Total depth = 13.80	
Depth	Conc.
(m)	(mg/l)
0.50	460.38
2.79	488.41
5.53	507.28
8.30	555.37
11.04	638.55
13.62	838.79

Vertical 13	
Total depth = 13.20	
Depth	Conc.
(m)	(mg/l)
0.50	337.08
2.58	389.60
5.16	369.23
7.76	386.11
10.34	425.15
12.20	494.27

Vertical 14	
Total depth = 9.80 m	
Depth	Conc.
(m)	(mg/l)
0.50	410.84
1.84	510.13
3.52	532.08
5.35	585.19
6.99	628.99
8.90	915.29

Vertical 15	
Total depth = 7.20 m	
Depth	Conc.
(m)	(mg/l)
0.50	394.12
1.46	430.34
2.79	465.71
4.19	536.23
5.60	550.00
7.06	582.66

Qs = 18,738 (Kg/s)

Table 3.4 SUMMARY of RESULTS (Suspended Sediment Concentration)



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# River : Padma Concentration

Date of survey : 19 - 22 Oct 1993

Location : Baruria

Vertical 16	
Total depth = 6.20 m	
Depth	Conc.
[m]	[mg/l]
0.50	501.41
1.22	493.49
2.49	538.27
3.74	640.00
5.01	644.59
6.08	836.48

Vertical 17	
Total depth = 6.60 m	
Depth	Conc.
[m]	[mg/l]
0.50	317.58
1.29	414.10
2.65	522.29
3.78	462.29
5.09	469.18
6.46	540.45

Vertical 18	
Total depth = 6.80 m	
Depth	Conc.
[m]	[mg/l]
0.50	476.09
1.16	509.32
2.30	602.53
3.53	701.19
4.61	609.33
5.92	1013.84

Vertical 19	
Total depth = 6.00 m	
Depth	Conc.
[m]	[mg/l]
0.50	631.58
1.23	822.35
2.44	669.12
3.58	536.36
4.81	793.30
5.93	849.69

Vertical 20	
Total depth = 5.70 m	
Depth	Conc.
[m]	[mg/l]
0.50	505.62
1.22	518.34
2.32	586.89
3.51	630.34
4.58	715.58
5.67	1560.24

Vertical 21	
Total depth = 6.00 m	
Depth	Conc.
[m]	[mg/l]
0.50	586.75
1.12	568.95
2.22	534.15
3.32	555.56
4.43	603.87
5.57	617.65

Vertical 22	
Total depth = 5.40 m	
Depth	Conc.
[m]	[mg/l]
0.50	540.96
1.12	569.33
2.23	567.86
3.26	675.31
4.29	805.78
5.22	1100.65

Vertical 23	
Total depth = 5.20 m	
Depth	Conc.
[m]	[mg/l]
0.53	541.33
1.05	559.71
2.09	648.84
3.14	716.36
4.15	867.95
4.99	1409.84

Vertical 24	
Total depth = 5.30 m	
Depth	Conc.
[m]	[mg/l]
0.50	520.31
1.03	571.95
2.13	684.47
3.09	803.85
4.19	922.50
5.12	2051.85

Vertical 25	
Total depth = 5.10 m	
Depth	Conc.
[m]	[mg/l]
0.50	597.81
1.02	620.00
2.04	642.68
3.05	771.88
4.08	1101.35
4.61	1110.81

Vertical 26	
Total depth = 4.80 m	
Depth	Conc.
[m]	[mg/l]
0.50	524.18
1.00	565.35
1.93	630.00
2.88	681.69
3.82	873.75
4.35	1189.22

Qs = 18,738 (Kg/s)

Table 3.5 SUMMARY of RESULTS (Suspended Sediment Concentration)

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Helley-Smith samples		
Vertical No.	Bed load sb in Kg/ms	
	1	2
1	0.027522	0.012719
3	0.231689	0.143640
5	0.160855	0.125219
7	0.060526	0.010636
9	0.125548	0.239474
11	0.096491	0.001370
15	0.000520	0.000096
17	0.000080	0.000309
19	0.016316	0.002368
21	0.051162	0.002231
23	0.001749	0.046573
25	0.037856	0.024671
27	0.000148	0.000703

Table 3.6 SUMMARY of RESULTS (sediment transport, bed load)

Sample No	Date	Time	D16 (mm)	D35 (mm)	D50 (mm)	D90 (mm)	Standard Deviation
DHA-1	19/10/93	10:40	0.066	0.078	0.089	0.125	1.343
DHA-2	19/10/93	12:27	0.136	0.159	0.179	0.245	1.307
DHA-3	19/10/93	14:43	0.135	0.156	0.174	0.236	1.291
DHA-4	19/10/93	16:10	0.098	0.138	0.159	0.229	1.494
DHA-1	20/10/93	10:24	0.135	0.158	0.179	0.249	1.325
DHA-2	20/10/93	13:03	0.101	0.135	0.159	0.229	1.470
DHA-3	20/10/93	14:55	0.127	0.150	0.170	0.239	1.337
DHA-1	21/10/93	09:39	0.087	0.133	0.155	0.229	1.588
DHA-2	21/10/93	10:55	0.094	0.136	0.157	0.228	1.523
DHA-3	21/10/93	12:30	0.078	0.106	0.132	0.220	1.619
DHC-4	21/10/93	14:00	0.081	0.113	0.140	0.223	1.607
DHC-3	21/10/93	13:16	0.065	0.077	0.088	0.141	1.364
DHC-2	21/10/93	12:00	0.066	0.081	0.095	0.189	1.562
DHC-1	21/10/93	09:30	0.056	0.071	0.082	0.123	1.439

Table 3.7 SUMMARY of RESULTS (grain size bed material)

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Sample No.	Date	Time	D16 (mm)	D35 (mm)	D50 (mm)	D90 (mm)	Standard Deviation
A30	19/10/93	10:45	0.006	0.015	0.023	0.100	3.569
A28	19/10/93	15:10	0.048	0.069	0.081	0.122	1.547
A931	19/10/93	12:20	0.006	0.014	0.019	0.049	2.610
A935	19/10/93	11:35	0.007	0.020	0.032	0.175	4.458
A453	19/10/93	14:33	0.009	0.030	0.076	0.207	5.413
A24	19/10/93	13:24	0.014	0.065	0.084	0.196	4.000
A933	19/10/93	16:03	0.020	0.071	0.092	0.202	3.262
A936	19/10/93	17:00	0.057	0.126	0.151	0.242	2.073
A958	20/10/93	10:24	0.016	0.071	0.122	0.227	4.661
A851	20/10/93	13:00	0.008	0.019	0.030	0.127	3.558
A332	20/10/93	14:50	0.004	0.013	0.018	0.062	3.472
729	21/10/93	09:35	0.004	0.011	0.018	0.085	3.889
A932	21/10/93	10:55	0.003	0.008	0.015	0.132	4.000
A926	21/10/93	12:30	0.013	0.042	0.077	0.203	4.124
A727	21/10/93	14:00	0.005	0.010	0.017	0.108	4.229
A934	21/10/93	13:15	0.010	0.039	0.072	0.133	4.406
A925	21/10/93	12:00	0.008	0.028	0.055	0.113	4.374
A855	21/10/93	09:30	0.007	0.016	0.023	0.078	2.795

Table 3.8 SUMMARY OF RESULTS (Grain size suspended sediment)

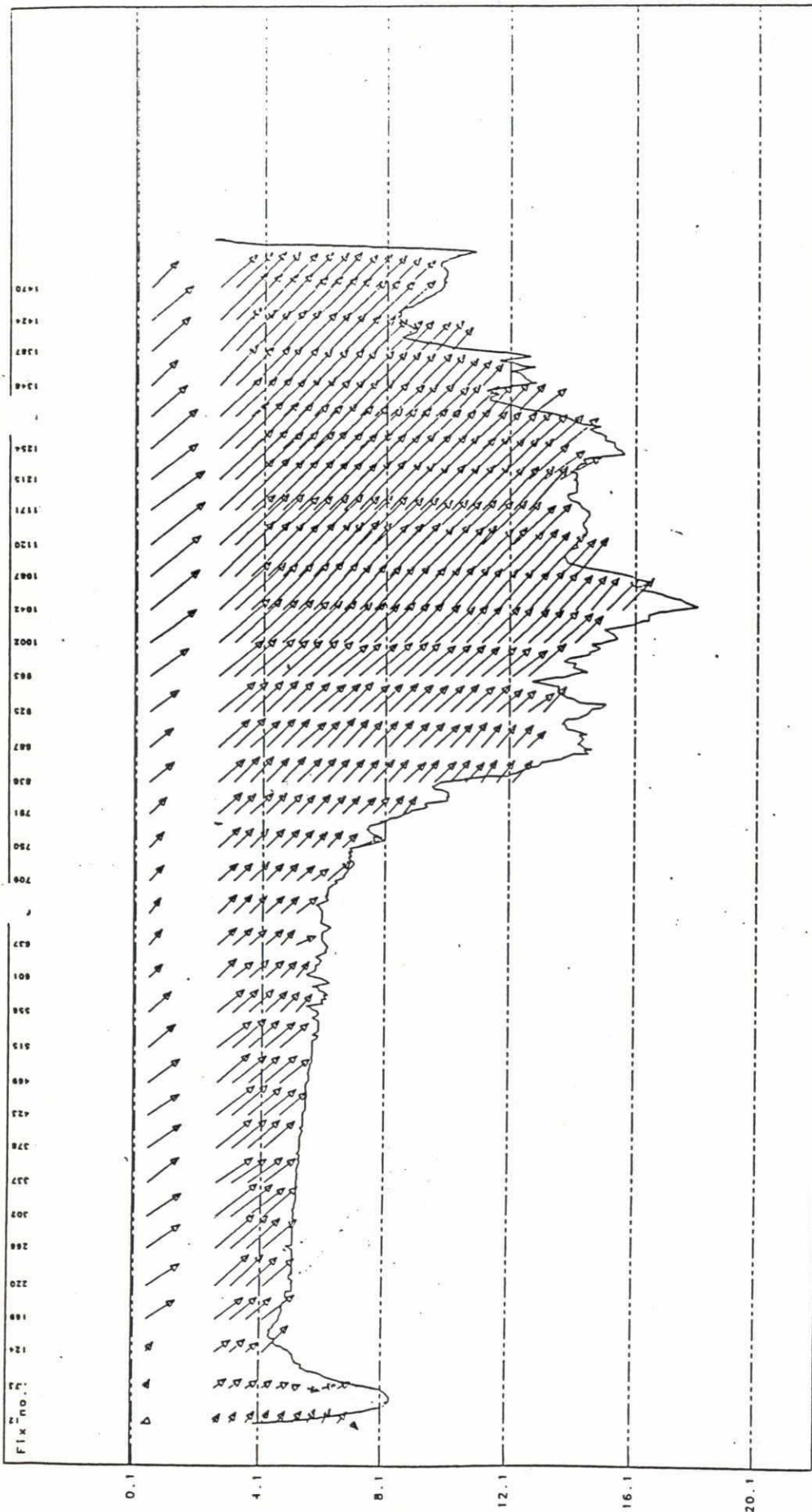


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Sample No	Date	Time	D35 (mm)	D50 (mm)	D65 (mm)	Standard Deviation
A123	19/10/93	10:40	3.000	0.092	0.105	1.382
A465	19/10/93	10:45	0.082	0.095	0.110	1.493
A124	19/10/93	12:12	0.159	0.178	0.200	1.301
A463	19/10/93	12:20	0.159	0.178	0.199	1.299
A48	19/10/93	14:33	0.154	0.173	0.196	1.314
A459	19/10/93	14:43	0.153	0.173	0.195	1.319
A740	19/10/93	16:03	0.152	0.177	0.206	1.420
A565	19/10/93	16:10	0.307	0.346	0.390	1.315
A46	20/10/93	10:05	0.160	0.183	0.209	1.345
A130	20/10/93	10:14	0.159	0.179	0.202	1.310
A745	20/10/93	12:55	0.154	0.175	0.199	1.337
A101	20/10/93	13:03	0.269	0.312	0.363	1.575
A708	21/10/93	09:31	0.222	0.277	0.332	1.631
A717	21/10/93	09:39	0.192	0.250	0.313	1.742
A127	21/10/93	10:50	0.168	0.270	0.257	1.718
A350	21/10/93	11:04	0.176	0.209	0.249	1.617
A466	21/10/93	12:21	0.107	0.134	0.164	1.643
A346	21/10/93	12:31	0.163	0.205	0.260	1.798
A461	21/10/93	13:50	0.115	0.142	0.170	1.630
A43	21/10/93	14:00	0.115	0.142	0.170	1.634
A353	21/10/93	13:05	0.300	0.340	0.385	1.327
A695	21/10/93	13:16	0.102	0.127	0.160	1.671
A690	21/10/93	11:50	0.120	0.146	0.176	1.651
A696	21/10/93	11:55	0.106	0.134	0.166	1.669
A349	21/10/93	09:30	0.225	0.284	0.339	1.797
A345	21/10/93	09:24	0.135	0.200	0.286	2.337

Table 3.9 SUMMARY of RESULTS (grain size bed load)

# FLOW DISTRIBUTION



PLOT ID. : **BARURIA**

Project : River Survey Project FAP 24  
 File : /u/124adm/data/93-oct/oct-22/93am1102  
 Drawn : Thu Jan 27 12:01:01 1994  
 Type : Cross Section  
 Init. : MN  
 Rev. : A

Appr. : Id. No.

SURVEY ID. :

Positions : BTM  
 Date : 931022  
 Start Time : 10:03:24  
 End Time : 10:29:50  
 Start Position : 478812E 628311N  
 End Position : 481187E 62927N  
 Discharge : 37374.24 (m<sup>3</sup>/s)

PROFILE CURRENT VELOCITY :

Horizontal Scale : 1 : 15000  
 Vertical Scale : 1 : 200  
 Current Arrow Scale : 0.5 cm per m/s  
 Azimuth of Cross Section : 55.8 Deg North  
 Current Arrows Relative to North

# **FAP 24 RIVER SURVEY PROJECT**

## **Survey Bulletin no. 77 Routine Measurements**

**River : Padma  
Location : 5 - Baruria  
Period : 09 - 10 July, 1994**

### **Contents:**

<b>1. Location and measuring positions .....</b>	<b>1.1 - 1.2</b>
<b>2. Survey programme and key figures .....</b>	<b>2.1</b>
<b>3. Horizontal distribution of flow and sediments .....</b>	<b>3.1</b>
<b>4. Cross-sectional distribution of flow velocity .....</b>	<b>4.1</b>
<b>5. Grain size distributions .....</b>	<b>5.1</b>
<b>6. Collected data and their storage .....</b>	<b>6.1 - 6.2</b>
<b>7. PSD 24 database file description .....</b>	<b>7.1</b>

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**Prepared by**

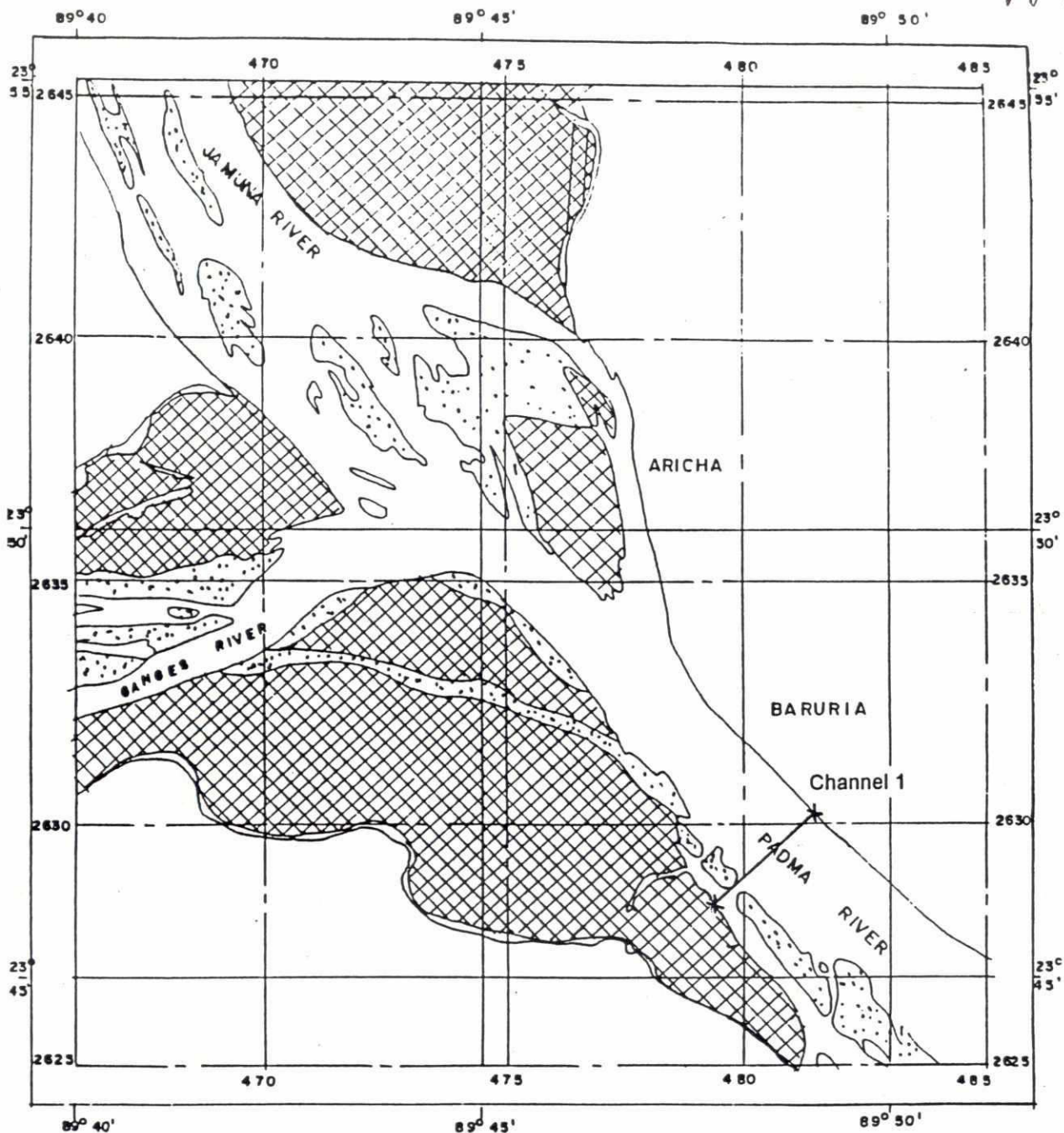
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**Checked by**

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**Approved by**





**LEGEND:-**

- X—X Measurement Cross Section
- High land
- Unstable/Low land
- BWDB Embankment



5000m 2500m 0

Map is based on Satellite image of march, 1993

**FAP 24**



DELFT - DHI

**RIVER SURVEY PROJECT**  
Flood Plan Coordination Organization

Commission of the European Communities

**Survey Bulletin 77 : 09-10 July, 1994**

**Location 5 : Padma River, Baruria**

Date : 10 Oct 1994

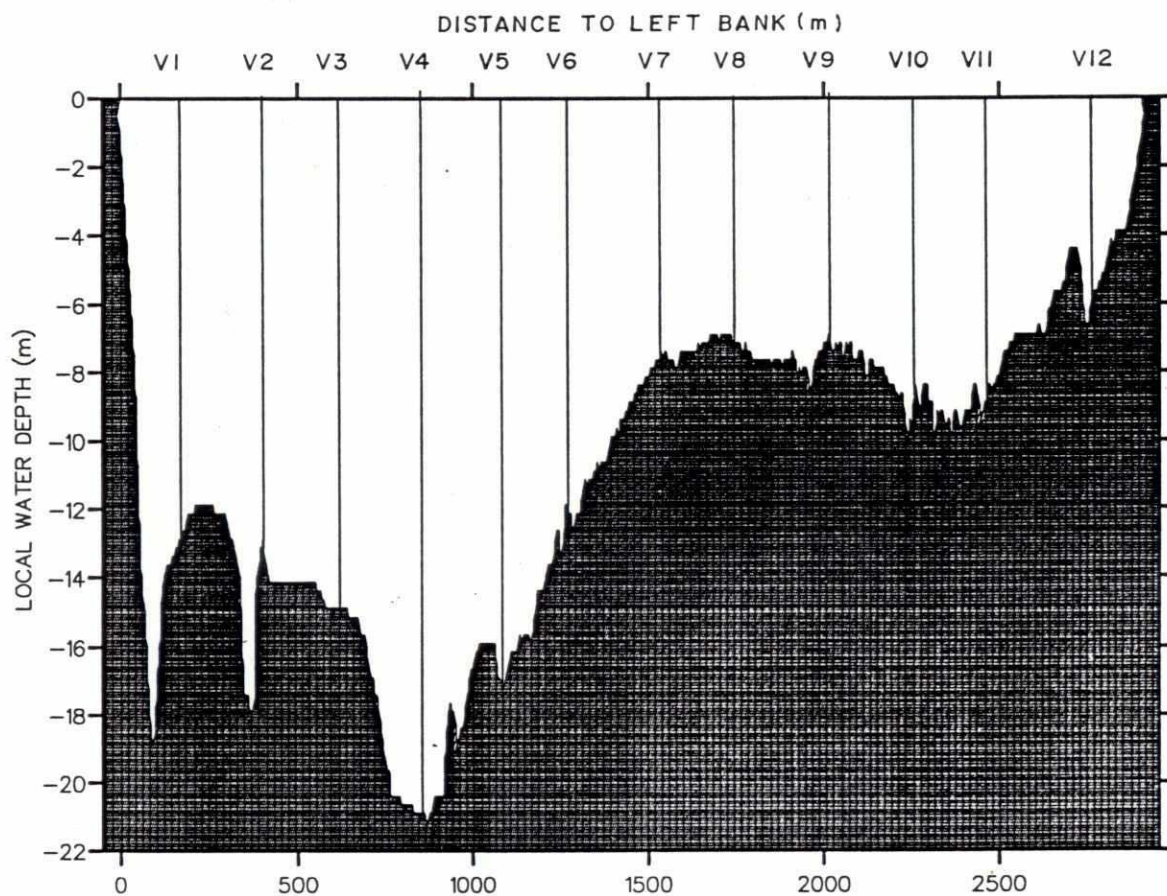
Init : mua/mk

**Location map**

page

1.1

20



Water level : 6.91 m + PWD

FAP 24



DELFT - DHI

RIVER SURVEY PROJECT  
Flood Plan Coordination Organization  
Commission of the European Communities

Survey Bulletin 77 : 09-10 July, 1994

Location 5 : Padma River, Baruria

File : U4791T01

Date : 10 Oct 1994

Init : mua/mk

Cross-sections and measured verticals  
Channel 1

page

1.2


Type of measurement	Method	No. of measurements in channel			
		1	2	3	4
Discharge	ADCP transect	8	-	-	-
	EMF transect	-	-	-	-
	Echo-Sounding	-	-	-	-
Vertical current profile	No. of verticals in channel	12	-	-	-
	ADCP	12	-	-	-
	S4 current meter	1	-	-	-
	Ott current meter	-	-	-	-
Vertical sediment profile	Pump bottle sampling	5	-	-	-
	Andreasen settling tube	-	-	-	-
	MEX turbidity meter	12	-	-	-
	Integrated bottle sampling	12	-	-	-
	Collapsible bag	-	-	-	-
Bed load	Dune tracking	-	-	-	-
	Helley-smith sampler	24	-	-	-
	Delft Bottle	-	-	-	-
Bed material	US BM-54 bed sampler	-	-	-	-
	Van Veen bed sampler	-	-	-	-

Table 2.1: Survey programme as made

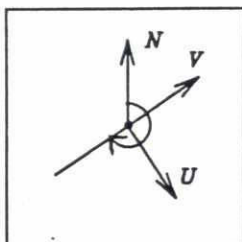
	Width (m)	Area (m <sup>2</sup> )	Stage h (m+PWD)	Discharge Q (m <sup>3</sup> /s)	Bed load transport Sb (kg/s)	Suspended Sediment transport Ss total (kg/s)
Channel 1	2899	29621	6.91	40922	42	19988

Table 2.2: Key figures

Gauge Location	Date	Water level (Daily average) (m+PWD)
Baruria	09 Jul 94	6.91
	10 Jul 94	6.90

<div><div>FAP 24</div><div></div><div>DELFT - DHI</div></div>		<div>RIVER SURVEY PROJECT</div> <div>Flood Plan Coordination Organization</div> <div>Commission of the European Communities</div>	Survey Bulletin 77 : 09-10 July , 1994	
		Location 5 : Padma River, Baruria		
File : U4791T01	Date : 10 Oct 1994	Survey programme as made and key figures	page  2.1	
	Init : mua/mk			



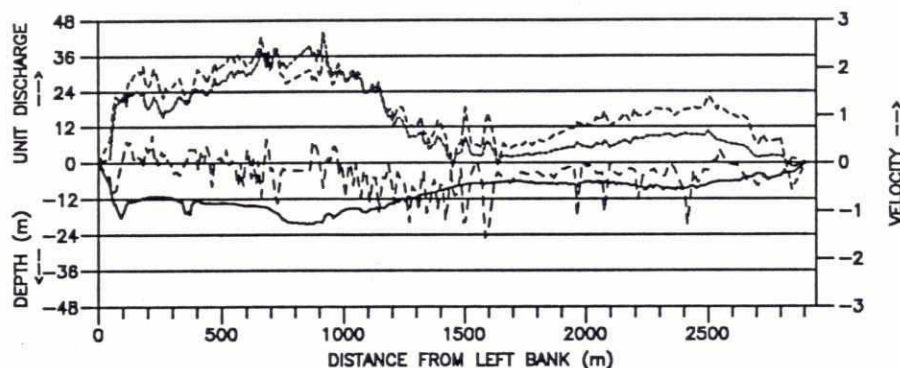


TRANSECT AZIMUTH = 236°

U - VELOCITY NORMAL TO TRANSECT (m/s)

V - VELOCITY PARALLEL TO TRANSECT (m/s)

N - MAGNETIC NORTH



FLOW

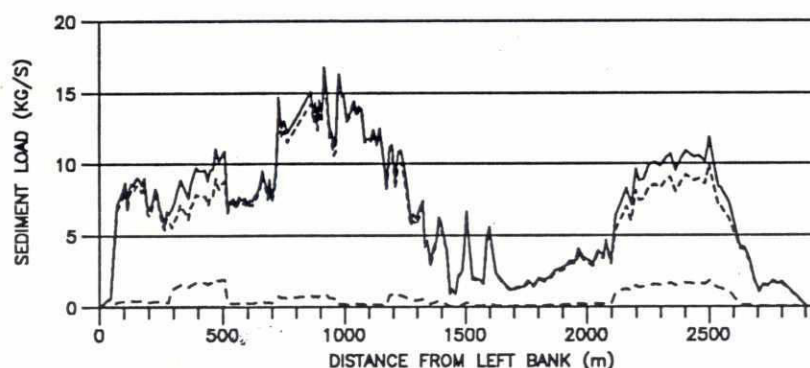
LEGEND :

- WATER DEPTH (m below STAGE)
- UNIT DISCHARGE (m³/s/m)
- U - (m/s)
- V - (m/s)

STAGE = 6.91 (m+PWD)

A = 29621 (m²)

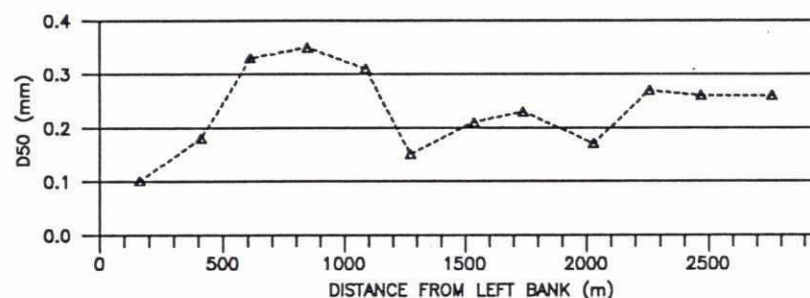
Q = 40922 (m³/s)



SEDIMENT TRANSPORT

LEGEND :

- S<sub>TOTAL</sub> 20030 (kg/s)
- S<sub>WASH LOAD</sub> 18292 (kg/s)
- S<sub>SUSP. BED</sub> 1696 (kg/s)
- S<sub>BED LOAD</sub> 42 (kg/s)



GRAIN SIZE

LEGEND :

- ◆◆◆◆ D<sub>50</sub> SUSP. (mm)
- ▲▲▲▲ D<sub>50</sub> BED LOAD (mm)
- D<sub>50</sub> BED MAT. (mm)

FAP 24



RIVER SURVEY PROJECT  
Flood Plan Coordination Organization

Commission of the European Communities

Survey Bulletin 77 : 09-10 July, 1994

Location 5 : Padma River, Baruria

File : U4791T01

Date : 10 Oct 1994

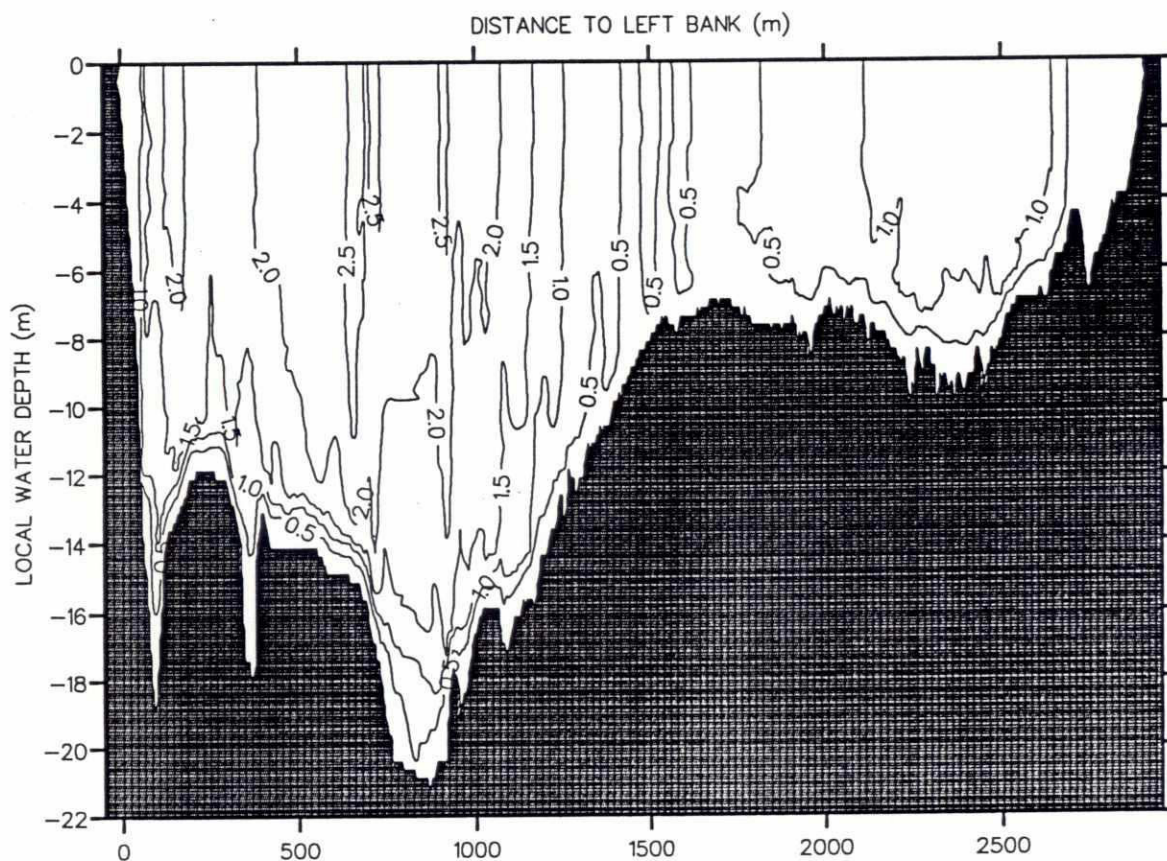
Init : mua/mk

Horizontal distribution of flow and sediments  
Channel 1

page

3.1

826



Iso-velocity contours (m/s)  
Water level : 6.91 m + PWD



RIVER SURVEY PROJECT  
Flood Plan Coordination Organization  
Commission of the European Communities

Survey Bulletin 77 : 09-10 July, 1994

Location 5 : Padma River, Baruria

File : U4791T01

Date : 10 Oct 1994

Init : mua/mk

Cross-sectional distribution of flow velocity  
Channel 1

page

4.1




200

Andreasen settling tube							
Channel	Vertical	time (YYMMDDHHMM-HHMM)	Depth	Weight percent < 0.06 mm > 0.06 mm	D10 (mm)	D50 (mm)	D90 (mm)
Sample not collected							
Table 5.1: Grain size of near bed suspended sediment (0.3 m above river bed)							

US BM-54 bed samples							
Channel	Vertical	time (YYMMDDHHMM-HHMM)	Depth	Weight percent < 0.06 mm > 0.06 mm	D10 (mm)	D50 (mm)	D90 (mm)
Sample not collected							
Table 5.2 : Grain size of bed material							

Helley - Smith								
Channel	Vertical	time (YYMMDDHHMM-HHMM)	Depth (m)	Weight percent < 0.06 mm > 0.06 mm		D35 (mm)	D50 (mm)	D65 (mm)
1	1	9407091211-1230	12.80	7.717	92.283	0.085	0.101	0.119
	1	9407091211-1230	12.80	9.592	90.408	0.085	0.101	0.120
	2	9407091255-1309	14.40	4.400	95.600	0.154	0.176	0.201
	2	9407091255-1309	14.40	3.212	96.788	0.164	0.192	0.224
	3	9407091351-1405	14.50	2.961	97.039	0.278	0.319	0.367
	3	9407091351-1405	14.50	0.337	99.663	0.301	0.342	0.388
	4	9407091428-1611	15.40	0.130	99.870	0.315	0.353	0.395
	4	9407091428-1611	15.40	0.189	99.811	0.313	0.353	0.399
	5	9407100916-0935	15.30	2.552	97.448	0.273	0.317	0.368
	5	9407100916-0935	15.30	4.848	95.152	0.267	0.311	0.362
	6	9407101142-1159	11.50	0.577	99.423	0.120	0.145	0.173
	6	9407101142-1159	11.50	0.747	99.253	0.135	0.159	0.188
	7	9407101045-1053	6.80	13.087	86.913	0.157	0.212	0.282
	7	9407101045-1053	6.80	5.491	94.509	0.165	0.210	0.272
	8	9407101010-1021	6.30	6.935	93.065	0.177	0.227	0.292
	8	9407101010-1021	6.30	7.359	92.641	0.181	0.237	0.302
	9	9407101225-1236	6.60	0.474	99.526	0.151	0.173	0.197
	9	9407101225-1236	6.60	0.470	99.530	0.153	0.174	0.199
	10	9407101426-1434	10.40	0.846	99.154	0.225	0.280	0.335
	10	9407101426-1434	10.40	0.349	99.651	0.213	0.267	0.325
	11	9407101451-1503	8.40	1.932	98.068	0.222	0.282	0.339
	11	9407101451-1503	8.40	5.258	94.742	0.182	0.239	0.302
	12	9407101521-1531	5.20	2.398	97.602	0.195	0.252	0.312
	12	9407101521-1531	5.20	1.873	98.127	0.203	0.261	0.319

Table 5.3 : Grain sizes of bed load

<div><div><div>FAP 24</div><div></div><div>DELFT - DHI</div></div><div><div>RIVER SURVEY PROJECT</div><div>Flood Plan Coordination Organization</div><div>Commission of the European Communities</div></div></div>		Survey Bulletin 77 : 09 - 10 July , 1994	
		Location 5 : Padma River , Baruria	
	Date : 10 Oct 1994	Grain size distributions	page
	Init : mua/mk		



Method	Channel	Time (YYMMDDHHMM-HHMM)	File name
ADCP & EMF transect	1	9407090758-0823 9407090827-0854 9407091638-1701 9407091719-1746 9407100753-0819 9407100916-0935 9407101605-1638 9407101641-1711	U4791T01 * U4791T02 U4791T03 U4791T05 U47A1T01 U47A1T03 U47A1T04 U47A1T05

Table 6.1: ADCP & EMF transects

\* : transect in PSD 24 data base and presented in Sections 3 and 4


Method	Channel	Vertical	Time (YYMMDDHHMM-HHMM)	Easting (m)	Northing (m)	Depth (m)	File name
Vertical current & turbidity profiles (ADCP/S4/MEX)	1	1 2 3 4 5 6 7 8 9 10 11 12	9407091211-1230 9407091255-1309 9407091351-1405 9407091428-1611 9407100916-0935 9407101142-1159 9407101045-1053 9407101010-1021 9407101225-1236 9407101426-1434 9407101451-1503 9407101521-1531	481085 480883 480715 480515 480314 480162 479945 479772 479532 479342 479172 478923	629845 629698 629588 629465 629334 629229 629077 628971 628809 628683 628557 628402	12.8 14.4 14.5 15.4 15.3 11.5 6.80 6.30 6.60 10.4 8.40 5.20	U4791P01 * U4791P02 * U4791P03 * U4791P04 U47A1P01 * U47A1P04 * U47A1P03 * U47A1P02 * U47A1P05 * U47A1P07 * U47A1P08 * U47A1P09 *

Table 6.2: Vertical profiles

\* S4 & MEX not available

Method	Channel	Vertical	No. of samples	Time (YYMMDDHHMM-HHMM)	Easting (m)	Northing (m)	Depth (m)
Suspended sediments (pump bottle)	1	4	5	9407091428-1611	480515.0	629465.0	15.40

Table 6.3: Suspended sediment - point sampled


<b>FAP 24</b>  <b>RIVER SURVEY PROJECT</b> Flood Plan Coordination Organization Commission of the European Communities	<b>Survey Bulletin 77 : 09-10 July , 1994</b>		
	<b>Location 5 : Padma River , Baruria</b>		
	Date : 10 Oct 1994	<b>Collected data and their storage (1)</b>	page 6.1
	Init : mua/mk		

Method	Channel	Vertical	No. of samples	Time (YYMMDDHHMM-HHMM)	Easting (m)	Northing (m)	Depth (m)
Suspended sediments	1	1	1	9407091211-1230	481085	629845	12.8
		2	1	9407091255-1309	480883	629698	14.4
		3	1	9407091351-1405	480715	629588	14.5
		4	1	9407091428-1611	480515	629465	15.4
		5	1	9407100916-0935	480314	629334	15.3
		6	1	9407101142-1159	480162	629229	11.5
		7	1	9407101045-1053	479945	629077	6.80
		8	1	9407101010-1021	479772	628971	6.30
		9	1	9407101225-1236	479532	628809	6.60
		10	1	9407101426-1434	479342	628683	10.4
		11	1	9407101451-1503	479172	628557	8.40
		12	1	9407101521-1531	478923	628402	5.20

Table 6.4: Suspended sediment - depth integrated



Method	Channel	Vertical	Time (YYMMDDHHMM-HHMM)	Easting (m)	Northing (m)	Depth (m)	Sample No
Helley Smith Sample	1	1	9407091211-1230	481085	629845	12.8	A51
		1	9407091211-1230	481085	629845	12.8	A63
		2	9407091255-1309	480883	629698	14.4	A46
		2	9407091255-1309	480883	629698	14.4	A47
		3	9407091351-1405	480715	629588	14.5	A31
		3	9407091351-1405	480715	629588	14.5	A62
		4	9407091428-1611	480515	629465	15.4	A695
		4	9407091428-1611	480515	629465	15.4	A122
		5	9407100916-0935	480314	629334	15.3	A905
		5	9407100916-0935	480314	629334	15.3	A696
		6	9407101142-1159	480162	629229	11.5	A908
		6	9407101142-1159	480162	629229	11.5	A1661
		7	9407101045-1053	479945	629077	6.80	A1636
		7	9407101045-1053	479945	629077	6.80	A1688
		8	9407101010-1021	479772	628971	6.30	A903
		8	9407101010-1021	479772	628971	6.30	A460
		9	9407101225-1236	479532	628809	6.60	A95
		9	9407101225-1236	479532	628809	6.60	A92
		10	9407101426-1434	479342	628683	10.4	A913
		10	9407101426-1434	479342	628683	10.4	A105
		11	9407101451-1503	479172	628557	8.40	A1646
		11	9407101451-1503	479172	628557	8.40	A108
		12	9407101521-1531	478923	628402	5.20	A77
		12	9407101521-1531	478923	628402	5.20	A1139

Table 6.5: Bed load

 <p><b>FAP 24</b> RIVER SURVEY PROJECT Flood Plan Coordination Organization Commission of the European Communities</p>	Survey Bulletin 77 : 09-10 July , 1994		
	Location 5 : Padma River , Baruria		
	Date : 10 Oct 1994	Collected data and their storage (2)	page 6.2
	Init : mua/mk		

Types of Data	Channel	Format	Filename
ADCP/S4/EMF data	1	QUATTRO	U4491T01 .ase
Echosounder data	1	QUATTRO	U4491T01 .ech
Sediment transport data	1	QUATTRO	U4491T01 .sed
Susp. sed. conc. analysis	1	QUATTRO	U4491T01 .ssc
Bed load sediment analysis	1	QUATTRO	U4491T01 .bdl
Transect plot data	1	QUATTRO	U4491T01 .trs
Iso-velocity plot data	1	MIKE 21	U4491T01 .ct2 U4491T01 .dt2

Table 7.1 PSD 24 Database file description

<div><div><div>FAP 24</div><div></div><div>DELFT - DHI</div></div><div><div>RIVER SURVEY PROJECT</div><div>Flood Plan Coordination Organization</div><div>Commission of the European Communities</div></div></div>		Survey Bulletin 77 : 09 - 10 July , 1994	
		Location 5 : Padma River, Baruria	
	Date : 10 Oct 1994	PSD 24 Database file description	page 7.1
	Init : mua/mk		



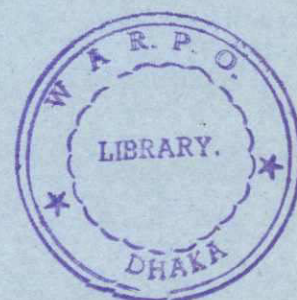
*Handwritten signature*

ANNEXURE 3

# Training Programme

PROPOSAL

November 1994



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# 1 Rationale

## 1.1 Introduction

One of the components of the River Survey Project FAP 24 consists of training. In the first phase of the project, the training consisted mainly of on-the-job training and in-house courses on river engineering. At the end of this phase a training programme for the second phase has been elaborated. During 1994 this programme has been revised a couple of times. This note presents the version of November 1994.

In this chapter, the scope of the training is given. Thereafter the proposed training programme is presented (Chapters 2-4), and in the last chapter the contractual aspects are described (Chapter 5).

## 1.2 Objectives and scope

In the ToR of the River Survey Project, the objectives and scope of the training are described as follows:

### Quote:

- o *Objectives of training (Section 3.1)*  
*'To strengthen BWDB by providing on-the-job training to professional staff from BWDB, and where applicable BIWTA and staff of associated, local consultants in the fields of river surveys and studies, so that they can continue the data collection programme in the long term and to upgrade the institutional capability in Bangladesh for river hydrological and morphological data collection and study programme'*
- o *Training phase 1 (Section 4.2 c)*  
*'In conjunction with FPCO and BWDB prepare and outline a programme for training BWDB and, where applicable, BIWTA staff and staff of associated local consultants. Initial training of all local and counterpart staff will be carried out in phase 1. Initial recommendations for upgrading of technology and equipment will be made'*
- o *Training phase 2 (Section 4.3 c)*  
*'Prepare and carry out programmes for training BWDB and, where applicable, staff of other Bangladeshi organizations, including the staff of associated local consultants and contractors in the use of modern equipment, instruments, techniques and technology so that they are able (a) to carry on with the surveys after completion of the project and (b) to upgrade the routine survey programmes being undertaken by those organizations. This would mostly take the form of on-the-job training, but would be supplemented by some training seminars and workshops.'*

### Unquote.



In the Technical Specifications (TS), the training activities are described in a slightly different way.

**Quote:**

*No formal training is included in phase 1. It is however expected that the Consultant, when assessing the data acquisition and processing performed by the local organizations, will give useful guidance and will consider the participation of local hydrographers in its field experiments.*

*The on-the-job training to be achieved during phase 2 must lead to a transfer of technology to make possible the continuation of part of the routine activities at the end of phase 2.*

*The training programme will be agreed on in consultation between FPCO, BWDB, the involved local authorities, the Consultant and the Project Adviser.*

*As the Consultant has the final responsibility of the results, the training programme has to be set up in such a way not to hamper his activities. The Consultant must therefore propose in his tender document the minimum training activities, their frequency, duration and content.*

**Unquote.**

### 1.3 Constraints

There are in fact two problems limiting the training activities:

- o There is no budget for training
- o The equipment is only temporarily imported in Bangladesh and must be taken out of the country at the end of the project

The present absence of a budget is initiated by the ToR where the following is stated under staffing for training:

**Quote:**

*'The Consultant would have to show his experience in this field and the staff he intends to employ, but he is not required at this stage to give an estimate of the number of manmonths involved.'*

**Unquote.**

At the moment, only limited on-the-job training is possible. Limited, as the training activities may not harm project results (Section 1.2, last para).

During the pre-bid meeting of August, 1991, it was decided that the project equipment is only temporarily imported. As discussed earlier (Interim Report, Annexure 5, page 5.23), this may affect the training programme. For the type of instruments, only used by the River Survey Project in Bangladesh, training at the operational level does not make sense.

## 1.4 Outline

### Target disciplines

The following disciplines may be considered for training:

- o Survey vessel crew
- o Surveyors, hydrographers
- o System analysts, data handling specialists
- o Sediment analysts
- o River engineers, hydrologists, morphologists

The main subjects of training, obviously closely related with these disciplines, are respectively as follows.

### Main subjects

- o Ship handling, maintenance, manoeuvring
- o Surveying; water-levels, bathymetry, discharge, and sediments
- o System operation and management, data storage, data processing
- o Laboratory analysis of sediments
- o Hydrological and morphological study topics

### Target organizations

- o BWDB, Hydrology
- o BIWTA
- o RRI
- o BUET
- o Approtech, Hydroland (associated local consultants)
- o Other local staff of the River Survey Project

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**Subject/organization matrix:**

In the following matrix it is indicated which subjects of training will be given to which organization:

Main subject Organization	Ship	Survey	Data	Lab	Study
BWDB	-	+	+	+	+
BIWTA	-	+	-	+	-
RRI	-	-	-	+	+
BUET	-	-	-	-	+
Approtech	-	-	+	-	+
Hydroland	-	+	-	-	-
RSP	+	-	+	+	-

Table 1.1 : Subject/organization matrix

The training for the last three groups is considered to be in-house training. Hereafter only the external training component is elaborated.

**Methods of training:**

The methods to be considered for external training depend strongly on the subjects:

- o Survey :
  - introductory training
  - special exercises in the field
  - lectures
  - on-the-job training
- o Data and Lab
  - mid term on-the-job (weeks)
- o Study :
  - long term part-time on-the-job (months, years)
  - short field visits, participation in surveys
  - seminars

Obviously, the methods chosen are strongly depending on the available resources, see Section 1.3

**Target level**

The degree of detail in which certain subjects will be handled depends on the



level of the target group. See for example the levels of personnel involved in the hydrological service.

Officers/Employees	Level
1. Chief Engineer, Hydrology	Decision Level
2. Superintending Engineer/ Director	
3. Executive Engineer/ Deputy Director	Implementation Level
4. Sub-divisional Engineer	Field Level
5. Assistant Engineers	Operational Level
6. Sectional Officers/ Assistant Director	
7. Surveyors	
8. Gauge Readers	
9. Vessel crews	
10. Survey crews	

Table 1.2 : Levels of personnel

The decision level needs general information about survey techniques, possibilities, pros and cons. This will be provided by introductory training. The objective of this training for this level is to provide the background data required for an appropriate selection of survey techniques.

The implementation level and the field level need to have more details. Especially the physical background should also be known. It is assumed that the field level will train the operational level. Therefore the field level will be the prime target level for training by the River Survey Project.

### 1.5 Organization

In the organization of the training given by the River Survey Project (RSP) to the various Organizations (BWDB, BIWTA, RRI and BUET), the River Survey Project Management Unit (RSPMU) plays a central role.

The RSPMU will mediate between the RSP and the Organizations especially regarding

- o Subjects of training
- o Selection of trainees
- o Various aspects of implementation

## 2. Survey training

### 2.1 Target

The survey training is given to BWDB and BIWTA staff. The main part of the training will be given to trainers, which are staff members at the field level: Sub-divisional engineers.

### 2.2 Methods

Methods of survey training comprise

- o Introductory training
- o Special exercises in the field
- o Lectures
- o On-the-job training

#### 2.2.1 Introductory training

It is proposed to organize introductory training for the decision level. The training consists of a combination of a few lectures on principles of measurements combined with survey demonstrations aboard the vessels.

The differences of the various available techniques to measure either water or sediment transport will be highlighted. The possibilities, pros and cons will be discussed in order to assess the sustainability in Bangladesh.

In principle, an introductory training session will take one day. It is envisaged to have two such days during the project period.

#### 2.2.2 Special exercises

Special survey training will be organized for the trainers (the field level). In the field a number of exercises have to be carried out using available equipment and vessels. Training sessions with a duration of about 4 days in combination with lectures (see below) are envisaged.

Possible training topics are:

1. Set up of AWLR station; location versus morphology; case studies; slopes and other hydraulic effects; comparison of various instruments
2. Bathymetry
3. Combined of bathymetric and topographic measurements
4. Optimization of hydraulic measurements; data density and accuracy
5. Optimization of suspended sediment measurements; effects of bed forms

6. Methods of bed load measurements including dune tracking  
Probably the training topics 1 and 2 are of special interest for BIWTA. Therefore two training programmes will be developed one on topics 1, 2 and probably 3. and a programme on topics 4 to 6.

The training programme will be further elaborated in close cooperation with the RSPMU (see also Section 1.5). Some ideas are for instance:

- o to combine the AWLR exercise with work to be done by the RSP on the selection of sites
- o to compare traditional contours with computer generated contours on bathymetric charts
- o to execute comparative measurements using a wide range of flow and sediment instruments
- o to pay ample attention to methods of on board data processing and quality checking.

It is proposed to realise both training programmes of 4 days each, one time in the 94/95 lean season and one time in the 95/96 lean season.

### 2.2.3 Lectures

Lectures will be organized as part of the introductory training for the decision level or more extensively as part of the field exercises for the trainers.

The lectures will compare different available techniques and elaborate the physical processes of water and sediment transport.

The lectures for the trainers are given in the BWDB training center in Bhagyakul. The subjects are mentioned above. The time for lecturing is included in the time mentioned under exercises.

### 2.2.4 On-the-job training

On-the-job training is possible throughout the year. It means that a very limited number of people, say 2 may board the main survey vessel of the River Survey Project (the 'DHA') to participate in the survey work. There are a few practical restrictions:

- o The training should not hamper the on-going survey work (therefore only two trainees per boat are allowed)
- o There is no extra accommodation aboard for trainees, which implies that trainees should disembark at the end of each day. This means that on-the-job training for more than one consecutive day is only feasible at survey locations with a nearby guesthouse



- o Special land transport need to be organized. Participation up to one month per year is envisaged

### 2.3 Survey training programme

An outline for the proposed training programme in phase 2 of the River Survey Project is given in the figure below.

Year	1995	1996
Subject		
SURVEY		
o Introduction	●	●
o Exercises	- -	- -
o Lectures	● - -	● - -
o On-the-job	-----	-----

Legend :

- day
- up to 4 days
- on ad hoc basis
- | end of project

Figure 2.1 : Survey training programme

Some particulars regarding this training schedule are mentioned hereafter:

- o Introductory training is given during one day per season
- o One exercise for BWDB staff and one for the combined BWDB and BIWTA staff will be organized in the lean season
- o Lectures coincide with the previous introduction and exercises
- o On-the-job training will total one month per year

The size of the training programme is given in the following table.

Type of training	Duration	No.of participants	Vessel day	
			DHA	DHE
Introductory	2 * 1 day	6	2	-
Exercises on the river	4 * 4 days	4 to 12*	8	8
On-the-job in surveys	2 * 30 days	2	-	-

\* Depending on the vessels available

Table 2.1 : Size of training

### 3 Data processing and sediment laboratory

#### 3.1 Data processing

With the processing of survey data distinction can be made between

- o processing aboard
- o processing in the office

Processing aboard is sometimes limited to quality checking, while further processing is done in the office. Sometimes full processing is done on board. The processing aboard will be included in the survey training (see previous chapter)

Training in the data processing office will be basically on-the-job training. This training will focuss on two aspects

- 1 Use of the engineering database PSD 24
- 2 Ad hoc assistance to the BWDB data processing office (as soon as the new set-up becomes operational)

#### 3.2 Sediment laboratory

The following type of analyses are executed in the sediment laboratory of the River Survey Project:

Type	Samples	Suspended load	Bed load	Bed material
o Concentration		+	-	+
o Dry sieving		+	+	+
o Wet sieving		-	-	+
o Settling tube		+	-	+

Table 3.1 : Training sediment laboratory

Training may be given on this type of analysis in the form of on-the-job training. The target organizations are BWDB, BIWTA and RRI.

The training should be limited to a few times one man during one week.



#### 4. Studies

For training on study subjects the following methods are proposed

- o Lectures
- o Seminars
- o On-the-job

As surveys and studies are strongly interrelated activities in the River Survey Project also the training on surveys and studies need to be (partly) integrated. Therefore hydraulics and morphological processes are related to measuring methods. Lectures on these subjects are part of the survey programme described in Chapter 2.

Seminars will be organized during which intermediate results of the River Survey Project will be presented.

On-the-job training on study subjects means long term active participation in some of the studies topics of the River Survey Project. Topics to be considered are for instance :

- 2.4 : Long term development of distributories
- 3.2 : Channel dimensions and regime equations
- 3.3 : Bank erosion rates
- 5.1 - 5.3 : Confluences
- 7.1 - 7.3 : Bed-form dynamics

On-the-job training on study subjects cannot be organized during normal working hours (as funds for facilities are lacking). At the moment possibilities of training during evening hours is investigated. BUET seems to be interested in this option.

The possibilities will be further elaborated in close cooperation with the RSPMU, see also Section 1.5.



## 5. Contractual and financial aspects

In the following, the required resources to realize the training programme, as proposed in the previous subsection, are summarized.

### 5.1 Manmonth

The main part of the field training will be realised by the survey team of FAP 24 besides that 2 manmonth for expats and 5 manmonth for local staff is required to be taken from the study manmonths. It means that a few per cent of the study manmonths will be spent on training. The required input fits within the available resources according to the Contract.

### 5.2 Vessel days

It is proposed that the 10 vessel days (DHA) mentioned can be paid applying the unit rates of hydrometric vessel and 8 days applying the unit rates of the hydrographic vessel, see next table. Included in these rates are the standard crew and survey staff (these are consequently not counted under manmonths). It is expected that the vessel days fit within the Contract.

	Vessel days	Unit rates	Totals in ECU
Introductory	2	3247	6,494
Exercises	8	3247	25,976
	8	2150	17,200
Grand total			49,670

Table 5.1 : Costs of vessel days

