

GOVERNMENT OF PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANIZATION

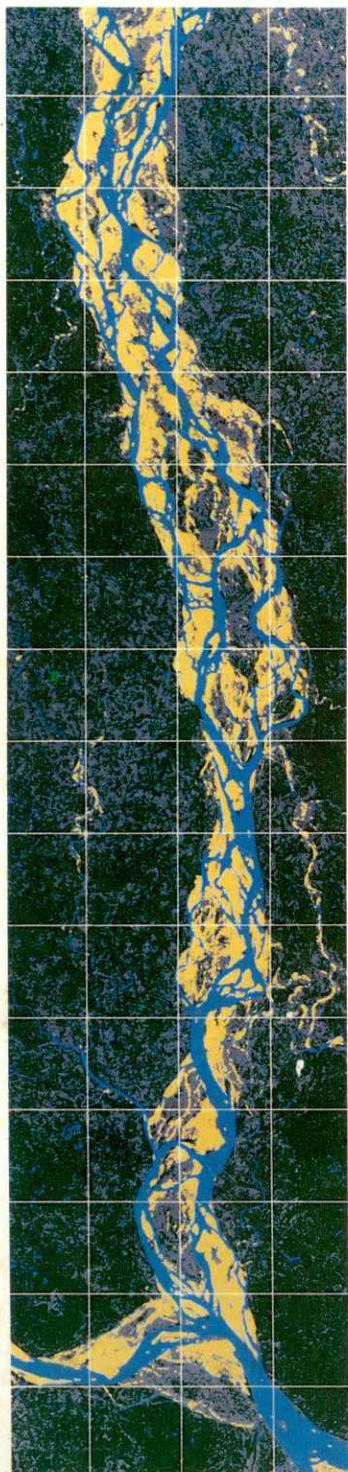
FEDERAL REPUBLIC OF GERMANY

KREDITANSTALT FÜR
WIEDERAUFBAU (KfW)

FRENCH REPUBLIC

CAISSE FRANCAISE DE
DEVELOPPEMENT (CFD)

31



BANK PROTECTION AND
RIVER TRAINING (AFPM)
PILOT PROJECT
FAP 21/22



TEST
AND
IMPLEMENTATION
PHASE

PROGRESS REPORT
NO. 26

OCTOBER TO DECEMBER 1999



JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE
CONSULTING CONSORTIUM FAP 21/22

RHEIN-RUHR ING.-GES.MBH, DORTMUND/GERMANY

COMPAGNIE NATIONALE DU RHONE, LYON/FRANCE
PROF.DR. LACKNER & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS

In association with:

BANGLADESH ENGINEERING &
TECHNOLOGICAL SERVICES LTD. (BETS)
DESH UPODESH LIMITED (DUL)

2498²

**BANK PROTECTION AND RIVER TRAINING
(AFPM) PILOT PROJECT
FAP 21/22**

TEST AND IMPLEMENTATION PHASE

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6

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FAP 21/22**

PROGRESS REPORT NO. 26

Table of Contents

	Page
1 GENERAL	
1.1 The Project	1
1.2 The Report	2
1.3 Personnel Deployment	2
1.4 Important Dates and Events	2
2 BANK PROTECTION COMPONENT (FAP 21)	
2.1 Preliminary Remark	4
2.2 Test Site I at Kamarjani	
2.2.1 General	5
2.2.2 Monitoring of the Test Structures	8
2.3 Test Site II at Bahadurabad	
2.3.1 Introduction	9
2.3.2 Monitoring of the Test Structures	15
2.4 Test Site III	
2.4.1 Introduction	16
2.4.2 Selection of Test Site	17
2.4.3 The Structure	17
2.4.4 Execution of Works	19
2.5 Reporting	
2.5.1 Introduction	19
2.5.2 Status of Works	20
3 RIVER TRAINING (AFPM) COMPONENT (FAP 22)	
3.1 Preliminary Remark	21
3.2 Test Site I at Katlamari	
3.2.1 The Test Structures	22
3.2.2 Monitoring of the Test Structures	22
3.3 Test Site II at Kundarapara	
3.3.1 The Test Structures	22
3.3.2 Monitoring of the Test Structures	23
3.4 Reporting	23

List of Figures	Page
Fig. 1: Test Site I - Kamarjani; - Adaptation Works - Adaptation of Test Structure; General Project Layout	7
Fig. 2: Test Site II - Bahadurabad; General Layout of Test Structure (1996/97)	12
Fig. 3: Definition sketch of the Revetment Test Structure	13
Fig. 4: Test Site III - Ghutail; Revetment Structure; Layout Map	18

List of Tables

Table 1: Bathymetric surveys at Kamarjani Test Site from October to December 1999	8
Table 2: Details of Revetment Composition	14
Table 3: Bathymetric surveys at Bahadurabad Test Site from October to December 1999	15
Table 1.1-1: Bank Protection Test Structures - FAP 21 Expatriate Professional Staff Activities during the Period 10/99 to 12/99	24
Table 1.1-2: Bank Protection Test Structures - FAP 21 Local Professional Staff Activities during the Period 10/99 to 12/99	25
Table 1.1-3: Bank Protection Test Structures - FAP 21 Local Support Staff Activities during the Period 10/99 to 12/99	26
Table 1.2-1.1: Bank Protection Test Structures - FAP 21 Work Plan as per Letter to Proceed of May 1993	27
Table 1.2-1.2: Bank Protection Test Structures - FAP 21 Work Plan Revision No. 1 as per proposal of September 1996	28
Table 1.2-1.3: Bank Protection Test Structures - FAP 21 Work Plan Revision No. 2 as per proposal of May 1999	29
Table 1.2-2: Bank Protection Test Structures - FAP 21 Work Plan Revision No. 1 as per proposal of May 1999 Fielded up to December 31, 1999	30
Table 1.2-3.1: Bank Protection Test Structures - FAP 21 Staffing Schedule as per Letter to Proceed of May 1993	31
Table 1.2-3.2: Bank Protection Test Structures - FAP 21 Staffing Schedule Revision No. 1 as per proposal of 1995	32
Table 1.2-3.3: Bank Protection Test Structures - FAP 21 Staffing Schedule Revision No. 2 as per proposal of September 1996	33
Table 1.2-3.4: Bank Protection Test Structures - FAP 21 Staffing Schedule Revision No. 3 as per proposal of May 1999	34
Table 1.2-4: Bank Protection Test Structures - FAP 21 Revision No. 3 as per proposal of May 1999 Staffing Schedule - Expatriate Professional Staff; Fielded up to December 31, 1999	35

Table 1.2-5:	Bank Protection Test Structures - FAP 21 Staffing Schedule Revision No. 3 as per proposal of May 1999 Local Professional Staff - Fielded up to December 31, 1999	36
Table 2.1-1:	Studies on Recurrent Measures - FAP 22 Expatriate Professional Staff Activities during the period 10/99 to 12/99	37
Table 2.1-2	Studies on Recurrent Measures - FAP 22 Local Professional Staff Activities during the period 10/99 to 12/99	38
Table 2.2-1	Studies on Recurrent Measures - FAP 22 Work Plan as per proposal of August 1996	39
Table 2.2-2	Studies on Recurrent Measures - FAP 22 Work Plan as per proposal of August 1996 Activities fielded up to December 31, 1997	40
Table 2.2-3	Studies on Recurrent Measures - FAP 22 Work Plan as per proposal of December 1997	41
Table 2.2-4	Studies on Recurrent Measures - FAP 22 Work Plan as per proposal of December 1997 Activities fielded up to December 31, 1999	42
Table 2.2-5	Studies on Recurrent Measures - FAP 22 Staffing Schedule as per proposal of August 1996 and December 1997	43
Table 2.2-6	Studies on Recurrent Measures - FAP 22 Staffing Schedule as per proposal of August 1996 and December 1997 Expatriate Professional Staff - Fielded up to December 31, 1999	44
Table 2.2-7	Studies on Recurrent Measures - FAP 22 Staffing Schedule as per proposal of August 1996 and December 1997 Local Professional Staff - Fielded up to December 31, 1999	45

List of Annexes

Annex A	FAP 21 / Test Site I - Water Level
Annex B	FAP 21 / Test Site I - Bathymetric Survey and Flow Velocities
Annex C	FAP 21 / Test Site I - Differential Models
Annex D	FAP 21 / Test Site I - Change of Bankline
Annex E	FAP 21 / Test Site I - Photographs
Annex F	FAP 21 / Test Site II - Water Level
Annex G	FAP 21 / Test Site II - Bathymetric Survey and Flow Velocities
Annex H	FAP 21 / Test Site II - Differential Models
Annex I	FAP 21 / Test Site II - Cross-Section end of October 1999
Annex K	FAP 21 / Test Site II - Change of Bankline
Annex L	FAP 21 / Test Site II - Photographs
Annex M	FAP 21 / Test Site III - Detailed Layout and Cross-Sections
Annex N	FAP 21 / Test Site III - Bathymetric Survey and Flow Velocities
Annex O	FAP 21 / Test Site III - Differential Models
Annex P	FAP 21 / Test Site III - Cross-Sections
Annex Q	FAP 21 / Test Site III - Photographs

1 GENERAL

1.1 THE PROJECT

The Project FAP 21/22 consisting of the two components

- Bank Protection Pilot Project (FAP 21) and
- River Training and Active Flood Plain Management Pilot Project (FAP 22)

was awarded by the Flood Plan Coordination Organization (FPCO) represented by the Kreditanstalt für Wiederaufbau (KfW) to the joint venture Rhein-Ruhr Ingenieur-Gesellschaft mbH as lead partner, Compagnie Nationale du Rhône, Prof. Dr. Lackner & Partners and Delft Hydraulics in association with Bangladesh Engineering and Technological Services Ltd. (BETS) and Desh Upodesh Ltd. (DUL).

As per Terms of Reference the Consultancy Services are to be performed in two phases, a Planning Study Phase (Phase I) followed by a Test and Implementation Phase (Phase II) for the FAP 21 component.

The Consultancy Agreement was signed on October 14, 1991. The date of commencement was fixed on December 01, 1991.

The Inception Report was issued on March 21, 1992 and the Interim Report on July 16, 1992. The Draft Final Planning Study Report for the FAP 22 component was presented on December 19, 1992 and that for the FAP 21 component on January 18, 1993.

A joint mission of KfW and Caisse Française de Développement (CFD) had carried out from January 26 to February 07, 1993 the Project appraisal of Phase II. The Mission together with FPCO agreed with the overall concept for the Test and Implementation Phase of the FAP 21 component which started on June 01, 1993 after the "Letter to Proceed" had been issued by FPCO on May 15, 1993.

After a meeting held on June 21, 1993 the FAP Review Committee of the Ministry of Irrigation, Water Development and Flood Control recommended the Draft Final Planning Study Report of both the components for approval by the Technical Committee.

The Final Planning Study Report FAP 21/22 was presented on June 30, 1993 and approved by the FAP Technical Committee of the Ministry of Irrigation, Water Development & Flood Control on August 09, 1994.

With effect of January 01, 1996 the responsibilities of the client passed to the Water Resources Planning Organization (WARPO) of the in 1995 renamed Ministry of Water Resources.

The Bank Protection Pilot Project (FAP 21) consists of the construction of a Groyne Test Structure and a Revetment Test Structure at different test sites. The subcontract for the Groyne Test Structure at Kamarjani Test Site was awarded to the Consortium: The Engineers Limited and Corolla Corporation (BD) Ltd. on September 07, 1994. The actual construction works on site started on October 01, 1994 and were substantially completed end of April 1995. The subcontract for the construction of the Revetment Test Structure at Bahadurabad Test Site was awarded to the Joint Venture The Engineers Ltd.-Corolla Corporation (BD) Ltd. and Monico Ltd.-Boskalis International on September 30, 1995. The execution of works started in December 1995 but had to be suspended in January 1996 for various reasons. The construction works were resumed in November 1996 and substantially completed end of May 1997.

With reference to the suspension of works on the Revetment Test Structure early 1996 and the incomplete adaptation / repair works at the Groyne Test Structure, the Consultant recommended in July 1996 an extension of the monitoring period of the FAP 21 component by one year up to end of 1999 which was approved by the Ministry of Water Resources in March 1997. Hence, work plan and staffing schedule were adapted accordingly up to December 31, 1999.

During the review mission of KfW and AFD (new name of the French donor agency with effect from April 1998) it was agreed between the donors, WARPO and BWDB in July 1998 to implement a third FAP 21 test site at Ghutail about 4 km downstream from Test Site II. Based on the Consultant's technical and financial proposal of December 1998 and May 1999 a subcontract was awarded to the Consortium: The Engineers Limited and Corolla Corporation (BD) Ltd. on June 23, 1999 for the construction of another Revetment Test Structure. The order to commence with the fabrication of needed cc-blocks was issued the same day and the actual construction works started on December 17, 1999. Necessary extension of Consultant's contract was approved by the Client and the Donors, and work plan and staffing schedule were adapted up to December 31, 2000.

The River Training and Active Flood Plain Management Pilot Project (FAP 22) was formally finalized by holding an international experts discussion from November 02 to 04, 1993 on the new concepts presented in the Final Planning Study Report. Based on the recommendations of the Experts a combination of two different recurrent measures was built in the dry season 1996/97 at Katlamari Test Site and monitored during the flood season 1997. Early January 1998, however, it emerged that the investigations at Katlamari could not be continued due to the morphological development in the test site area. Therefore, a new test site had to be selected which was finally found at Kundarapara, about 5 km east of Kamarjani Test Site. However, all activities had to be stopped in March and June 1998 respectively due to permanent problems with the local population in that area. Finally, it was decided to resume the tests under FAP 22 in connection with the implementation of the third FAP 21 test site.

1.2 THE REPORT

As per Section 12.01 and Appendix 1 of the Consulting Agreement as well as according to the Work Plan of the Test and Implementation Phase (Table 1 of Attachment 1 to "Letter to Proceed") a Progress Report is due at the end of December 1999. This report is the Progress Report as indicated above and spells out the work progress of Consulting Services and Construction Works in the period from October to December 1999.

This report presents for the two components of the pilot project a description in brief of the activities performed during this period.

1.3 PERSONNEL DEPLOYMENT

After issue of the "Letter to Proceed" the expatriate Consultants and their local counterparts took up their assignment. The personnel deployment during the period under review is shown in Table 1.1-1, 1.1-2 and 1.1-3 for the FAP 21 component and in Table 2.1-1 and 2.1-2 for FAP 22.

1.4 IMPORTANT DATES AND EVENTS

15.05.1993	Letter to Proceed
01.06.1993	Start of Test and Implementation Phase
12.06.1993	Subcontract for the construction and installation of the Filter Test Rig
21.06.1993	Meeting of FAP Review Committee on Draft Final Study Report FAP 21/22
30.06.1993	Submission of Final Study Report FAP 21/22

14.07.1993	Subcontract for Physical Model Tests
23.07.1993	Collapse of Manos Regulator at Kamarjani Test Site
08. to 12.08.1993	Visit of Members of the German Parliament
18.09.1993	Submission of Final Invoice Phase I
28.09.1993	Subcontract for topographic and hydrographic survey at Kamarjani Test Site
31.10.1993	Subcontract for subsoil investigations at Kamarjani Test Site
02. to 04.11.1993	Experts Discussion FAP 22
10.02.1994	Coordination meeting for Kamarjani Test Site with FPCO and BWDB
23.02.1994	Issue of Tender Documents for Kamarjani Test Site
28.02.1994	Submission of Experts Recommendations FAP 22
20.03.1994	Pre-bid meeting for Test Site I
17.04.1994	Tender opening for Kamarjani Test Site
08. to 20.06.1994	Technical Assessment of Procurement Arrangements of the Consultant by Dr. Friedrich von Raumer on behalf of FPCO/KfW/CFD
14. to 20.06.1994	Review Mission of KfW/CFD
18.06.1994	Submission of Consultants Report on the results of the Experts Discussion FAP 22
09.08.1994	Approval of Consultants Final Study Report by the FAP Technical Committee
04.09.1994	Order to Commence construction works at Kamarjani Test Site
07.09.1994	Subcontract signed for construction works at Kamarjani Test Site
22.09.1994	Submission of Tech. Report No.1 on Physical Model Tests
22.09.1994	Submission of Tech. Report No.2 on Morphological Prediction for Test Areas
26.09.1994	Coordination meeting for Kamarjani Test Site with FPCO and BWDB
28. to 03.10.1994	KfW mission for definition of Kamarjani Test Site location and discussions on import of geotextile material
01.10.1994	Start of Construction Works at Kamarjani Test Site.
12. to 17.02.1995	Review Mission of KfW/CFD
26.02.1995	Submission of Technical Report No. 3 on Filter Stability Investigation
16.04.1995	Issue of Tender Documents for Test Site II
18.04.1995	Submission of Technical Report No. 4 on Falling Apron Investigation
15.05.1995	Pre-bid meeting for Test Site II
20. to 25.05.1995	Audit of the Project (Test Site I at Kamarjani)
30.05.1995	Completion of construction works at Kamarjani Test Site
11.06.1995	Tender opening for Test Site II
31.08.1995	Order to Commence construction works at Bahadurabad Test Site
10.09.1995	Coordination meeting for Bahadurabad Test Site with FPCO
20. to 26.09.1995	KfW mission for definition of Bahadurabad Test Site location
30.09.1995	Subcontract signed for construction works at Bahadurabad Test Site
01.12.1995	Start of construction Works at Bahadurabad Test Site
01.02.1996	Suspension of Construction Works at Bahadurabad Test Site
12.03.1996	Submission of Technical Report No. 5 on Additional Model Tests
20.03.1996	Submission of letters of FORCE MAJEURE to WARPO for both Test Sites
22.04.1996	Proposal for Final Implementation of Revetment Test Structure at Test Site II
26.06 to 03.07.96	Review Mission of KfW/CFD
18.07.1996	Proposal for Modification of Consulting Services
05.09.1996	Submission of Report on Extended Studies on Recurrent Measures (FAP 22)
30.09.1996	Submission of Report on Monitoring and Adaptation 1995 at Test Site I
29.10.1996	Proposal for location of FAP 22 Test Site (Katlamari)
13. to 17.11.1996	Technical Review Mission of KfW/CFD
26.11.1996	Resumption of construction works at Bahadurabad Test Site

24.12.1996	Start of construction works at Katlamari Test Site (FAP 22)
02.03.1997	Approval of extension of the monitoring period up to December 31, 1999
20.03.1997	Completion of construction works at Katlamari Test Site (FAP 22)
31.05.1997	Completion of construction works at Bahadurabad Test Site
20. to 29.06.1997	Technical Assessment of Procurement Arrangements of the Consultant by Dr. Friedrich von Raumer on behalf of WARPO/KfW/CFD
11. to 19.07.1997	Audit of the Project (Test Site I and II)
14. to 21.07.1997	Technical Review Mission of KfW/CFD
14.09.1997	Submission of Technical and Financial Proposal for Consultancy Services and Construction of Low Cost and Recurrent Measures (FAP 22)
06.01.1998	Approval of modified Proposal of September 1997 for Consultancy Services and Construction of Low Cost and Recurrent Measures (FAP 22)
07.02.1998	Start of construction works at Kundarapara Test Site
05.05.1998	Submission of Technical Report No. 6 on Additional Model Tests
14. to 23.07.1998	Technical Review Mission of KfW/AFD
23.12.1998	Proposal for modification of Consulting Services for Test Site III
01. to 07.03.1999	Technical Review Mission of KfW/AFD
31.05.1999	Proposal for modification of Consulting Services for Test Site III (Revision 1)
23.06.1999	Subcontract signed for construction works at Third Test Site
23.06.1999	Order to commence with fabrication of cc-blocks for Third Test Site
17.12.1999	Start of construction works at Ghutail Test Site
23.12.1999	Approval of extension of the construction and monitoring period up to December 31, 2000

2 BANK PROTECTION COMPONENT (FAP 21)

2.1 PRELIMINARY REMARK

The Consultant's services of the Test and Implementation Phase (Phase II) comprise all engineering and management tasks relating to the planning and execution of test structures at two test sites, their monitoring, adaptation, repair measures during subsequent years and handing over to the Client at the end of the contract period.

After submission of the Draft Final Planning Study Report a joint mission of KfW and CFD has carried out the project appraisal to proceed into Phase II of the Project. The Mission agreed to the overall concept of Phase II proposed by the Consultant the essence of which is the construction of permeable groynes and of various types of revetments at two different test sites in two successive seasons.

However, the remaining lead time of the programme as presented in the Draft Final Planning Study Report for additional studies, final design, procurement, subcontracting and preparation of construction was found to be too short in view of the administrative and technical difficulties identified by the Consultant and the Mission. There seemed to be unacceptable risks that the construction of the test works at the first test site could not be completed successfully during the dry season 1993/94 which in turn would have led to major cost increases and endangered the achievement of meaningful test results.

A mutual understanding between all parties concerned had been reached on a postponement of the start of the construction period and of the end of the Project by one year. Moreover, it was decided to reduce the magnitude of the test works on the two selected test sites in order to reserve funds for further improvement of the test structures or, if necessary and possible, for the construction of new

structures. Since in July 1998 remaining funds of about DM 8.4 million were estimated taking into account costs for monitoring and maintenance of the first two test structures until the end of the Project, all parties concerned came on request of the client to an agreement to utilise the contract amount up to 100 % and to implement a third test site.

The Table 1.2-1.1 is showing the Work Plan and Table 1.2-3.1 the Staffing Schedule of the Test and Implementation Phase as per "Letter to Proceed" of May 15, 1993. Table 1.2-1.2 and 1.2-1.3 present revisions of the Work Plan of September 1996 and May 1999 respectively. Necessary modifications of the Staffing Schedule adjusted to the revised Work Plans and approved by the client and the donors are shown in Table 1.2-3.2 to 1.2-3.4. Table 1.2-2 is indicating the actual progress of works and Table 1.2-4 and Table 1.2-5 the actual deployment of the expatriate and local professional staff respectively during the period under review.

2.2 TEST SITE I AT KAMARJANI

2.2.1 General

Initially, the test structure comprised 6 groynes, each of them a combination of an impermeable and a permeable section with increasing permeability towards the river of which 3 groynes (G-1 to G-3) were partly constructed off-shore and on-shore while the other ones G-B1, G-B2 and G-A were built on the flood plain. All six structures launch from and were built against an embankment constructed under the authority of the Bangladesh Water Development Board (BWDB).

The main components of the groyne test field are the groynes G-1 to G-3, whereas G-B1, G-B2 and G-A which were built upstream and downstream respectively from the main groynes are intended to supplement the functioning and effects of the latter.

The "Order to Commence" the construction works was issued on September 04, 1994 and the works were substantially completed in April 1995.

The structure was "tested" by the river for the first time during the flood season 1995 which was marked by five flood peaks of which three represent events with more than 10 years re-occurrence and a maximum water level on July 10, 1995 corresponding to a situation of about 25 years re-occurrence.

The first four flood peaks contributed to three major damage events within the test site area:

- destruction of the impermeable groyne head of groyne G-2 and loss of piles of the permeable section;
- breach of the main embankment about 80 m downstream from groyne G-2, and
- collapsing of the impermeable part of groyne G-3 at the downstream side and destruction of the impermeable groyne head.

The initial findings of damage causes and the results of additional physical model tests performed in November/December 1995 at the River Research Institute at Faridpur had identified improvement and adaptation measures which had to fulfil mainly the following conditions:

- to substantially reduce the magnitude of return currents and vortices within the groyne field in particular along the main embankment, and
- to improve the transition between the permeable and impermeable part of the groynes with the aim to further limit the development of severe return currents, turbulences and vortices.

For the design of adaptation and repair measures, the design parameters as per original design of the groyne structure were being maintained. Only the downstream part of the impermeable groyne heads received substantially increased launching aprons.

Since the main river attack during the monsoon season 1996 was expected downstream from groyne G-A threatening the main embankment near the Manos river estuary, a new supplementary groyne G-A/2 was built 200 m downstream from G-A. However, the execution of the adaptation and repair works was hampered by the political situation in the country in 1995 and the first quarter 1996 with the result that the works could not be completed in time due to the rising water level. Especially, groyne G-2 remained incomplete because the gap between the remaining pile structure built in 1995 and the relocated main embankment could not be closed by driving further piles as per design.

During the flood season 1996 the river banks in the area of Kamarjani continued to be eroded and also the Groyne Test Structure came under attack again due to the attraction of the flow by the scour hole in front of the groynes. However, due to the adaptation of the structure and the morphological development in the test site area no damages to the structure occurred during the monsoon season 1996 except to the main embankment which was slightly damaged by wave erosion in those areas where the upper part was only protected by grass sods. Repair works were carried out in November 1996 and the grass sod protection was replaced by brick mattressing. Further repair works of the pile structure of groyne G-2 was carried out by driving 23 Nos. steel piles ϕ 711 mm and 32 m length as well as by construction of 12 Nos. of reinforced in-situ concrete piles between the toe of the relocated main embankment and the pile structure left over and intact after the monsoon 1995.

From September 1997 to end of January 1998 ten additional physical model tests were performed in the River Research Institute in Faridpur, the objective of which was (1) to investigate the causes of damages observed in 1995 and (2) to gain more information/knowledge of the behaviour of the groynes/groyne field in order to be in a position to formulate design rules at the end of the Project in 1999 and to work out guidelines and manuals for their application.

During the monsoon season 1998 no damages to the test structure occurred. Hence, no adaptation and repair works were necessary in the dry season 1998/99.

Also during the monsoon season 1999 no damages have been observed. Only more or less slow bank erosion continued downstream from the test structure in the area from Rasulpur to Balashi ghat as well as severe erosion at Kamarjani Bazar, about 4 km upstream from the groyne field.

The general layout of the test structure after the execution of adaptation and repair works is shown in Fig. 1.

CONTROL POINT SCHEDULE			
Location	ID - No. of Control Point	Co-ordinates BM (FAP 24)	Elevation (m PWD)
Neer Comp	FAP 21.03	461,479.517 802,817.795	+ 21.920
G-A/2	No. 24.33	(to be established)	
G-A	No. 24.31	461,763.470 803,328.440	+ 23.335
G-3	No. 24.29	461,922.160 803,595.130	+ 23.258
G-2	No. 24.26	462,003.780 803,684.190	+ 23.446
G-1	No. 24.24	462,071.690 804,125.130	+ 23.390
G-B/1	No. 24.22	462,106.970 804,374.750	+ 23.404
G-B/2	No. 24.20	462,142.470 804,626.130	+ 23.954

LEGEND

Homehead
Banker PI
Bankline
Control points

NOTES

- All measurements in meters
- Levels refer to 10.00 m PWD
- Reference Drawings
- AD - KA - 002 Cost Section of Main Embankment
- AD - KA - 003 Main Embankment, Details of Riverfront
- AD - KA - 010 Graphe G-1, General Layout Plan
- AD - KA - 020 Graphe G-2, General Layout Plan
- AD - KA - 030 Graphe G-3, General Layout Plan
- AD - KA - 040 Graphe G-4, General Layout Plan
- AD - KA - 050 Graphe G-A/2, General Layout Plan

0 50 100 150 m
Scale 1 : 2000

REVISION	DATE	NAME	DESCRIPTION	APPROVED
3	27.1.97	AMOR	AT BUILT DRAWING (Adaptation work)	
2	8.8.96	AMOR	AS BUILT DRAWING	
1	28.9.96	AMOR	Revised near G-A/2	

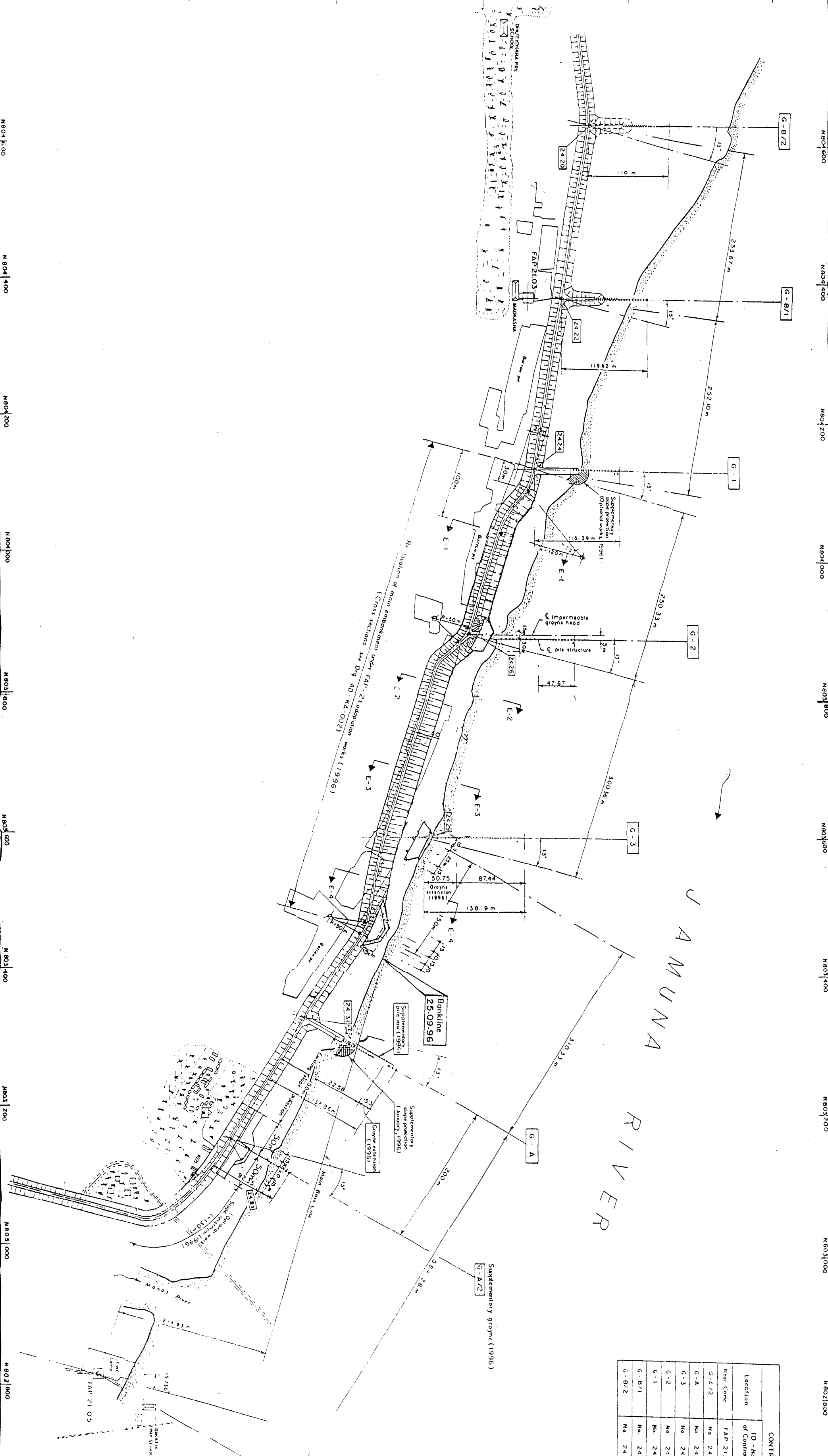
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION WATER DEVELOPMENT & FLOOD CONTROL
FLOOD PLAN COORDINATION ORGANIZATION (FPCO)

BANK PROTECTION PILOT PROJECT FAP - 21

TEST SITE 1 KAMARJANI
ADAPTATION WORKS
GENERAL PROJECT LAYOUT

SCALE 1 : 2000
FIGURE NO. 1

DATE	NAME	SCALE	FIGURE NO.	REVISION
27.1.97	AMOR	1 : 2000	1	3



2.2.2 Monitoring of the Test Structures

Since the final objective of the bank protection pilot project is to develop and optimise design criteria, cost-effective construction and maintenance methods which will serve as future standards appropriate for the prevailing conditions at the Jamuna and other rivers of Bangladesh, regular monitoring, preventive maintenance and adaptation of the works is a must after installation of the test structure. Hence, monitoring started immediately after completion of the works in 1995. The following activities have been performed during the period under review:

(1) Bathymetry

Bathymetry surveys were done to detect and record planform and riverbed changes and their influence on the stability of the test structure. The activities during the months of October to December 1999 are shown in Table 1. All the surveys were finally processed in the office in Dhaka and the results are shown in contour charts.

The results of the main surveys during the period under review are given in Annex B.

Date	Survey Area		
	October 1999	November 1999	December 1999
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13			
14			
15			
16			main survey
17	main survey		main survey
18	main survey		main survey
19	main survey	main survey	
20	main survey	main survey	
21		main survey	
22		main survey	
23		main survey	
24			
25			
26			
27			
28			
29			
30			
31			

Table 1: Bathymetry surveys at Kamarjani Test Site from October to December 1999

(2) Topographic Measurements

The topographic measurements were done by using Electronic Distance Measurement (EDM) equipment & levelling instrument. During the period under review the following works were performed:

02/10	bankline from 1.0 km upstream from Kamarjani Bazar to 2.2 km downstream from the test structure
02/10	char in front of the test structure
23/10	char in front of the test structure and further upstream
24/10	bankline from 2.0 km upstream to 1.0 km downstream from Kamarjani Bazar
29/11	water level gauge at G-A shifted and zero value measured at 15.12 m+PWD
20/12	water level gauge at G-A shifted and zero value measured at 14.33 m+PWD
22/12	char in front of the test structure
23/12	char in front of the test structure and at Kundarapara

(3) Measurement by the Monitoring System

The monitoring system is located at groyne G-2 and recording water level information, wave heights and periods, test pile inclination and acceleration, wind speed and direction as well as other meteorological data like temperature, precipitation and relative humidity. Data are shown in the monthly reports on monitoring of the test structures.

(4) Measurement of Flow Velocity and Direction

Float track measurements were continued as well as measurements with the Valeport currentmeter in the Kamarjani main channel and Kundarapara cut-off channel. Results are presented in the monthly reports on monitoring of the test structures and in Annex B.

(5) Observations

The fall of the water level, which had started after the peak on August 27, at 21.74 m+PWD continued till October 08, when a minimum of 18.81 m+PWD was measured. The last peak of the year was recorded on October 26 at 19.78 m+PWD. After that a continuous drop was observed and at the end of 1999 the water level was at 15.32 m+PWD.

The erosion at Kamarjani Bazar, which had started in the previous year, ceased in October and sedimentation was observed just as in November in the area of the estuary of the Ghagot and upstream of Rasulpur.

The Kundarapara channel continued to shift to the west. It conveyed about 58% of the total discharge, whereas about 42% ran along the Kamarjani channel.

2.3 TEST SITE II AT BAHADURABAD

2.3.1 Introduction

The construction of the Revetment Test Structure was originally planned about 4 km south of Bahadurabad Ghat based on the investigations during the Study Phase. Since, however, no substantial erosion occurred at the pre-selected test site, this area was abandoned and a more suitable one was selected in September/October 1995 at Kulkandi-village just downstream from Bahadurabad Ghat. The decision on the final location of the test structure was taken on October 11, 1995. However, end November 1995 it emerged that the Subcontractor could not mobilise the main construction equipment for dredging and under water works in time. After he had admitted his inability to do so, the Consultant informed the Subcontractor on December 05, 1995 of his failure to comply with the contractual obligations in accordance with Sub-Clause 63.1 (b) of the Conditions of Contract. On January 20, 1996 the Subcontractor was notified in accordance with Sub-Clause 46.1 of the

Conditions of Contract that the rate of progress of works was too slow to comply with the contractual Time of Completion and finally it was decided on January 31, 1996 to defer the final completion of the test structure until next dry season.

Based on the experience in 1995 and January 1996, and after identification of the main constraints preventing the completion of Works as per original schedule, a proposal for the final implementation of the Revetment Test Structure during the dry season 1996/97 was submitted in April 1996 taking into account the morphological analysis of the test area in March and May 1996 and the expected morphological development during the monsoon season 1996.

However, in August 1996 a deep channel shifted towards the bank of the selected test site and over the full length of the planned structure with severe erosion of the river bank resulting in a complete loss of the unprotected structure of 1995/96. Hence, another location of the Revetment Test Structure had to be determined and the design of the structure to be adapted accordingly. A proposal was presented to WARPO on October 19, 1996 which was discussed with the client and the donors during a review mission of the latter from November 13 to 17, 1996 with the final decision in favour of the location as shown in Fig. 2.

The start and the implementation of works was strongly affected by the land acquisition problem and the progress of works was already behind schedule at the end of 1996, because the subcontractor could only start the actual works on November 20, 1996 and concentrated till the end of the year mainly on earth works. Even after the client and the donors had decided during their meeting in November 1996 to proceed with the construction works, the concerned authorities of the Government of Bangladesh took almost another month for compensation payment to the local population after the donors had agreed to advance necessary funds.

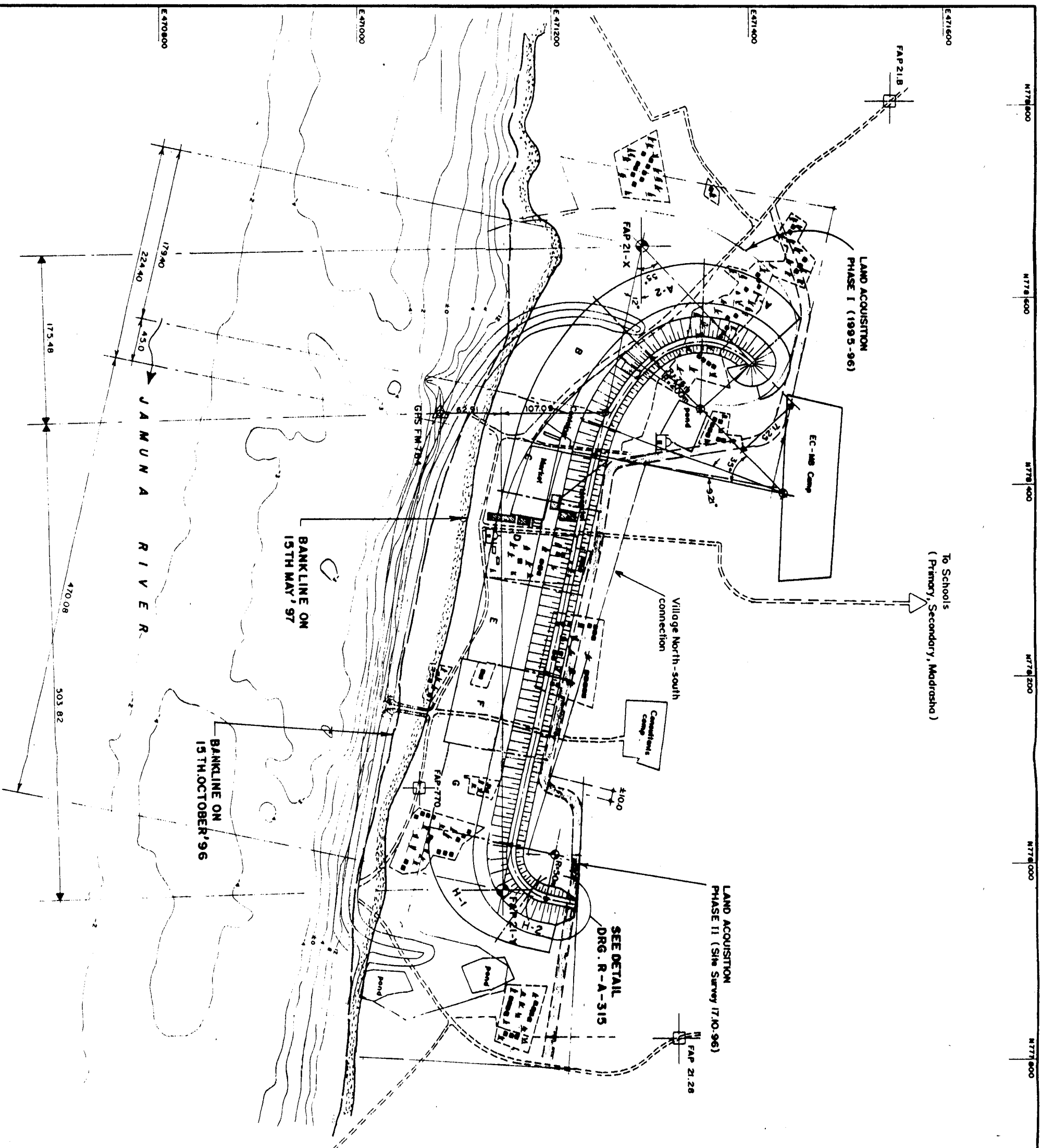
Due to the above mentioned circumstances the delay of the actual construction works accumulated to almost 2.5 months. However, the Consultant and his Subcontractor made every effort to make up for lost time and on June 15 the Client had been informed that the Revetment Test Structure was complete in all respects on June 12, 1997.

During the construction phase the structure was protected by a natural earth dam. This was important for the completion of the falling aprons. It remained intact for a longer period than expected and was finally washed away only in the last week of June 1997. Hence, the test structure became subjected to flow and wave attack and the falling aprons started to function. During the monsoon 1997 the structure was strongly attacked by the river and severe erosion downstream from the structure was observed. In July flow velocities up to 3.9 m/s were measured and a scour hole developed in front of Section D and E the deepest level of which was at -7.0 m+PWD. The river attack continued also in August and September just as the severe erosion downstream from the test structure which was about 100 m in September in an area about 1 km downstream from the structure.

Though the flow velocity decreased considerably in September, the depth of the scour hole in front of the structure increased and shifted to Section G and H. The deepest level was recorded at -14 m+PWD. In October 1997 a mid channel char continued to grow in front of the Railway ferry ghat. This resulted in a reduction of width and depth of the channel near the bank upstream from the Revetment Test Structure, whereas the western channel developed further and attacked the riverbank just downstream from the structure. Considerable erosion of some 50 m were recorded in October and this process continued till the end of the year. However, no damage to the structure was observed, the falling aprons functioned as expected and at the end of the year sedimentation in the area of the falling aprons of Section G and H and in the channel occurred.

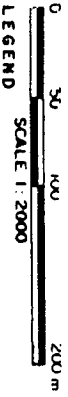
Also during the first quarter of 1998 erosion has been observed downstream from the structure up to Ghutail Bazar. When the water level started to rise at about mid March, the test structure came under attack again, but the falling aprons continued to function as expected. In June and July sedimentation occurred in front of the structure with maximum deposition of about 17.5 m along Section H-2. In August, however, fresh erosion gave way to the sedimentation process and continued along the structure till end of the year affected in the last quarter by the formation of a new char in front of the structure. During the whole year 1998 no damages to the structure caused by the river were observed.

At the beginning of 1999 a number of chars had developed in the vicinity of the test structure and a channel aimed at an angle of about 40° at Section B and C of the structure. After moderate changes of the river bed in front of the revetments and falling aprons during the first 5 months, the erosion process started to increase in June and resulted in deep scour holes up to about -5 m+PWD in the downstream area. In July the oblique channel shifted further downstream and the parallel channel in front of the revetment structure started to silt up. During the last quarter of the year when the water level continued to fall a strip of land gradually surfaced, which had a width of about 100 m in front of the structure and which the local population started to cultivate.



CONTROL POINT SCHEDULE			
No. of Control Points	Co-ordinates		Elevation (m PMD)
	Easting	Northing	
FAP 21-B	471,548.482	778,800.937	+20.246
GPS FM 764	471,086.185	778,478.880	—
FAP 21,28	471,330.663	777,813.399	+20.139
FAP 770	471,067.515	778,073.154	+20.246
FAP 21-X	471,293.485	778,654.360	—
FAP 21-Y	471,149.095	777,975.060	—

*) not existent anymore.



- LEGEND**
- Embankment
 - Road Pucca, Kacha, Footpath
 - High River Bank
 - House Pucca, Kacha B. Tinsed
 - Traverse Station B. Prior
 - Home stand
 - Mosque

NOTES

1. The topography shown on this drawing is based on J.T.W.C. survey of Oct '96 combined with topographical maps of Survey of Bangladesh.
2. Levels refer to ± 0.00 m PMD.
3. Bank line and bathymetric survey on 09/10/96
4. Reference Drawing R-A-302 Detailed Layout of Test Structure

REV.	DATE	NAME	DESCRIPTION	APPROVED
1	01.09.97	Answer	AS BUILT DRAWING	

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANISATION (WARPO)

BANK PROTECTION PILOT PROJECT FAP-21

TEST SITE II - BAHADURABAD

GENERAL LAYOUT OF TEST STRUCTURE (1996/97)

DATE	03-11-96	SCALE	1:2,000
APPROVED			

FIGURE NO. 2

REVETMENT TEST STRUCTURE DEFINITION SKETCH

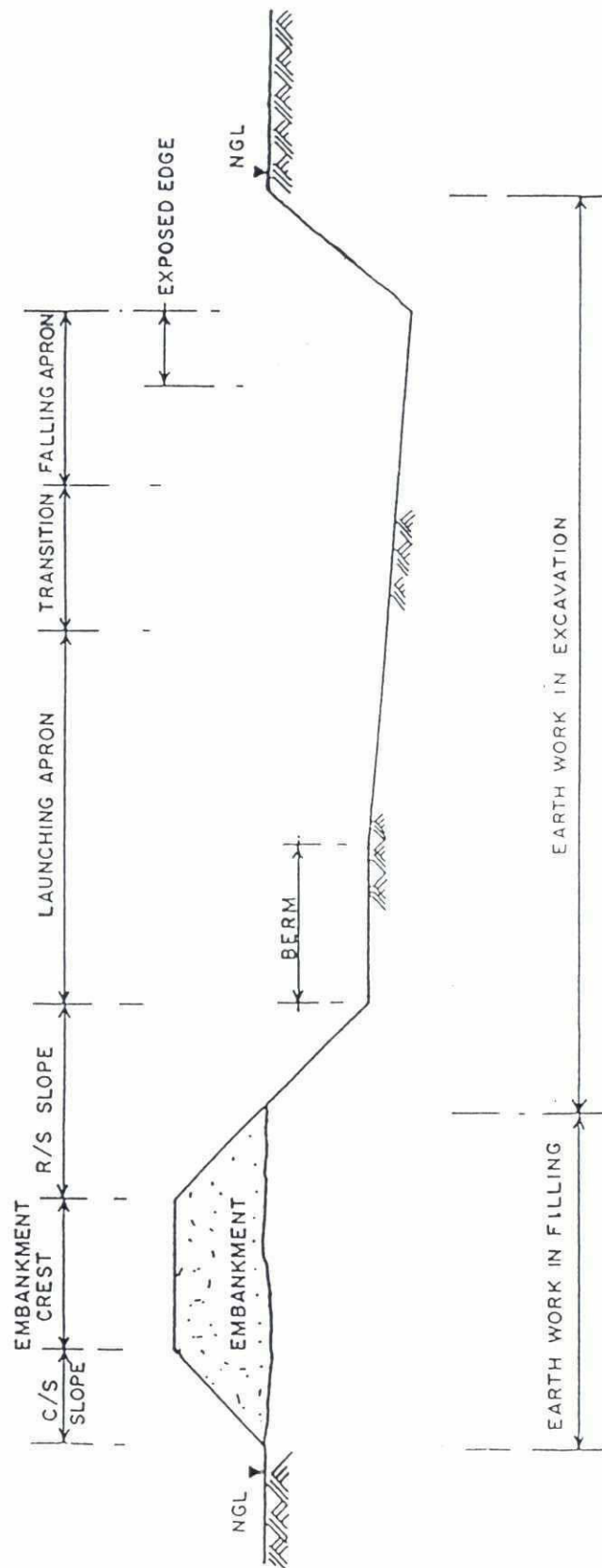


Figure 3: Definition Sketch of the Revetment Test Structure

DETAILS OF REVETMENT COMPOSITION

A. COVER LAYER

In all sections Durba grass sods laid on Geo-jute soil cover											
Test Structure	A - end	A - 1	A - 2	B	C	D	E	F	G	H - 1	H - 2
Land-sided slope	Brick mattress d = 15 cm	~ 74.70	~ 74.70	~ 99.10	~ 93.20	88.0	90.0	88.0	100.0	~ 82.75	~ 97.60
Approximate length along toe of upper slope (at berm level)	~ 87.40										
Revetment above berm level (+15.3 m to +22.0m PWD)	Brick mattress d = 15 cm	Brick mattress d = 15 cm	Wiremesh d = 23/36 cm with stone fill Grade B (D ₅₀ = 15 cm) on intermediate rubble layer (d = 25 cm)	Wiremesh mattress d = 23 cm with stone fill Grade B (D ₅₀ = 15 cm) on intermediate rubble layer (d = 25 cm)	CC - blocks D _n = 30 cm hand-laid in single, diagonal lines	CC - blocks D _n = 30 cm hand-laid in single, parallel lines	Interlocking CC-slabs (ship-lap type)	Wiremesh mattress d = 36 cm with brick fill	Interlocking CC-slabs (longue-groove type) on intermediate layer	Rip-rap Grade C (D ₅₀ = 20 cm) Top 20 cm with stone pitching (d = 50 cm)	Rip-rap Grade C (D ₅₀ = 20 cm) Top 20 cm with stone pitching (d = 40 cm)
Launching Apron at and below berm level (+14.5 m to +15.3 m PWD)		Dumped CC-blocks D _n = 30 cm	Dumped CC-blocks D _n = 35 cm	Dumped CC-blocks Edge us: D _n = 50 cm Center: D _n = 35 cm Edge ds: D _n = 40 cm	Articulated Rano- mattress d = 23/36 cm; stone fill grade B; C, D (D ₅₀ = 25 cm) with inter-connecting steel wire ropes and anchors placed at berm level	Articulated CC-block mattress with inter-connecting steel wire ropes and anchors placed at berm level	FORESHORE - mattress (collapsible block mattress with cement grout fill)	PROFIX - mattress (tubular fabric mattress with sand and sand-bitumen fill)	INCOMAT - sandflex mattress (collapsible block mattress with sand fill)	Rip-rap Grade F (D _n = 25-35-45 cm)	CC - blocks D _n = 30 cm D _n = 35 cm (mixed)
Transition between launching apron and falling apron		CC-blocks D _n = 30 cm	CC-blocks D _n = 30 cm	CC-blocks D _n = 35 cm	Geo-sand-container Type E (900 kg/No.)	CC - blocks D _n = 40 cm	CC - blocks D _n = 40 cm	Rip-rap Grade E CC-blocks, D _n = 30 cm	CC - blocks D _n = 35 cm #2		
Falling Apron (level + 14.5 m PWD)	Dumped CC-blocks D _n = 30 cm	Dumped CC-blocks D _n = 35 cm	Rip-rap, Grade E (D ₅₀ = 30 cm)	Geo-sand-container Type C (180 kg/No.)	Geo-sand-container Type E (900 kg/No.)	CC - blocks D _n = 40 cm	CC - blocks D _n = 40 cm	CC - blocks D _n = 40/45 cm (mixed)	CC - blocks D _n = 35/40 cm (mixed)		
Exposed edge of falling apron		(mixed)	Rip-rap, Grade F (D _n = 25/35/45 cm)	Geo-sand-container Type D (250 kg/No.)		CC-blocks D _n = 45 cm	CC- blocks D _n = 45 cm	Gabion socks with stone fill Grade B (D ₅₀ = 15 cm) (300 kg/No.)	CC - blocks D _n = 40 cm	Selected boulders D _n = 35-45 cm	

u1 : upstream
d1 : downstream

B. FILTER LAYER

In all sections Geo-jute Soil Saver												
Test Structure		A-end	A-1	A-2	B	C	D	E	F	G	H-1	H-2
Land - sided slope		GF-1										
Approximate length along toe of upper slope (at berm level)		~ 87.40	~ 74.70	~ 74.70	~ 99.10	~ 93.20	88.0	90.0	88.0	100.0	~ 82.75	~ 97.60
Geotextile filter mats above berm level	Spec. Type	GF-1/-5	GF-1	GF-5	GF-2	Filter III on filter II	GF-2	GF-1	GF-1	GF-1	GF-4	GF-4/-2
	Brand Name	BIDIM b7 HaTe Q22/4	BIDIM b7	HaTe O 22/4	BIDIM S 550		BIDIM S 550	DATEX AD1300	BIDIM S 390	DATEX AD1300	BIDIM S 700	HaTe E 650/K251
Geotextile filter mats of and below berm level	Spec. Type	GF-1/-5	GF-2	GF-2	GF-4	GF-2	GF-4	FORESHORE - collapsible fabric block mattress with cement grout fill)	PROFIX - mattress (tubular fabric mattress with sand and sand-bitumen fill)	GF-1 (sub-layer to INCOMAT sand flex mattress)	GF-1	GF-1
	Brand Name	BIDIM b7 HaTe O 22/4	BIDIM S 550	BIDIM S 550	HaTe K 251	DATEX AD1600	BIDIM S 700			BIDIM b 7	BIDIM S 390	BIDIM S 390

Table 2: Details of Revetment Composition

2.3.2 Monitoring of the Test Structures

Monitoring of the Revetment Test Structure started already during the construction phase in January 1997. During the period under report the following activities have been performed:

(1) Bathymetry

Bathymetry surveys are mainly done to record riverbed changes in front of the test structure and to detect their influence on the stability of the structure, in particular to find out the behaviour / functioning of the falling aprons and launching aprons, since this is decisive for the overall stability of the test structure.

The activities during the months of October to December 1999 are shown in Table 3. All the surveys were finally processed in the office in Dhaka and the results are shown in contour charts as well as differential models (see Annex G and H).

Date	Survey Area		
	October 1999	November 1999	December 1999
01			
02			
03			
04			
05			
06			
07			
08			
09			
10	main survey		
11	main survey		
12	main survey		
13	main survey		
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			main survey
25			main survey
26			main survey
27	main survey	main survey	
28	main survey	main survey	
29	main survey	main survey	
30			
31			

Table 3: Bathymetry surveys at Bahadurabad Test Site from October to December 1999

Moreover, measurements have been carried out regularly in the individual sections of the structure. The aim of these activities is to get more information on erosion and sedimentation in the channel in front of the structure, in the area of the falling aprons and on the functioning of the falling/launching

aprons. However, due to the morphological development these measurements had to be stopped by end of October. Results are given as cross-sections in Annex I.

(2) Topographic Measurements

During the period under review the following works were performed:

12/10	char downstream from the test structure in front of Belgacha
13/10	bankline from Section H to 2.5 km downstream from Ghutail Bazar
14/10	char in front of the Ghat
15/10	bankline from 4 km upstream from the Ghat to Section C
04/11	bankline from Belgacha to 2.5 km downstream from Ghutail char in front of Ghutail
19-20/11	cross-sections at Ghutail
21-26/11	set out of third test structure at Ghutail
27/11	bankline at Ghutail
12/12	set out of third test structure at Ghutail
13-20/12	levelling for third test structure at Ghutail

(3) Measurement of Flow Velocity and Direction

Float track measurements were continued as well as measurements with the Valeport currentmeter. Results of flow measurements are presented in the monthly reports on monitoring and in Annex G.

(4) Observations

The last peak water level of the year was recorded on October 26 at 17.83 m+PWD followed by a continuous fall of the water level till end of December when 14.03 m+PWD were measured.

Till end of October small erosion was observed in front of the test structure, however, about 100 m away from the falling apron. In the following months a strip of land gradually surfaced due to the continuously falling water level and the local population started immediately to cultivate the new land. The flow velocity along the new bankline was about 0.3 to 0.4 m/s.

Small erosion continued in October upstream from the structure at Harindhara, whereas the scour hole in front of the railway Ghat started to silt up. In November/December the morphological changes declined more and more. The differential map of December (see Appendix H-4) shows only deposition and minor erosion of less than 2 m in the area from north of Harindhara to downstream from Ghutail.

2.4 TEST SITE III

2.4.1 Introduction

During the monsoon season 1997 and the following dry season severe erosion occurred further downstream from the Revetment Test Structure at Bahadurabad. Following the demand of the local population for suitable protection of their land and homesteads, WARPO requested the donors KfW and AFD during their review mission in July 1998 to agree to the implementation of a third test site at Ghutail, about 4 km downstream from the Revetment Test Structure. Since the test structures at Kamarjani and Bahadurabad had been implemented within the available budget and taking into account a cost estimate for their monitoring and maintenance until the completion of the Project by the end of December 1999, remaining funds of about DM 8.4 million were estimated. Taking further into account the intention to utilise the contract amount up to 100 %, it was agreed between the donors, WARPO and BWDB in July 1998 to implement a third FAP 21 test site at Ghutail.

Immediately after the decision had been taken in favour of a third test site, the Consultant started necessary investigations and surveys and arrived finally at the conviction that any test structure at any suitable test site on the Jamuna could not be completed before the monsoon season 1999. It was therefore suggested in letter No. CC/F21-22/WARPO-KfW/L/98-332 of November 01, 1998 to start the actual construction of the third test structure after the monsoon season 1999 only.

In December 1998 a technical and financial proposal for the implementation of a third test structure along with a proposal for necessary modification of consulting services was submitted by the Consultant because the existing Contract was scheduled up to the end of 1999 only. The client and the donors approved the extension of the Contract up to end of 2000, but asked for some modifications of the financial proposal taking into account also the discussions and findings of the donors' review mission of March 1999. A revised proposal was submitted in May 1999, which was finally approved by the donors and the client as well.

2.4.2 Selection of Test Site

Within the feasible reach of the test sites of Kamarjani and Bahadurabad, six locations had been investigated and assessed with regard to their suitability for a third test structure. Basis of the analysis of the pre-selected sites were the site selection criteria already defined in the Final Planning Study Report FAP 21. Finally, Ghutail and the consolidation of the Revetment Test Structure at Test Site II were assessed to be most suitable for the implementation of a third test structure. Details of the assessment were presented in a revision of the "Proposal for Modification of Consulting Services for Test Site III" in May 1999.

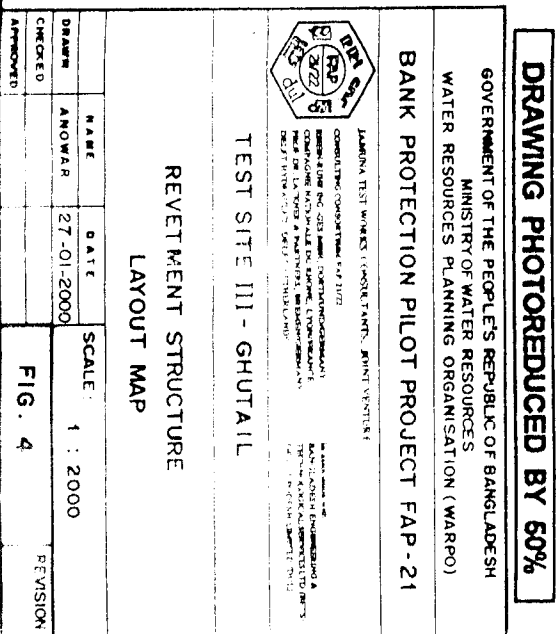
Since small erosion in front of Ghutail continued more or less throughout the year, it was decided to build the third test structure in this area. The final location of the structure has been determined mid November 1999 taking into account the something-to-defend criterion, the prevailing situation on site after the monsoon season 1999, in particular the actual bankline, and budget constraints as well. The final general layout of the structure is shown in Fig. 4.

2.4.3 The Structure

Based on the local situation and the investigations/observations since July 1998, when the general decision was taken to implement a third test site, it was decided to build another Revetment Test Structure taking into account the experience of Bahadurabad Test Site. A preliminary design was submitted with the "Proposal for Modification of Consulting Services for Test Site III in May 1999, which had to be adapted to the actual situation on site at mid November of this year.

The revetment will consist of an embankment and 2 different sections of launching/falling aprons. The crest of the embankment is at 21.50 m+PWD and the launching/falling aprons will be built in the dry at +15.0 m+PWD, i.e. above Standard Low Water Level, which is at about +12.85 m+PWD. The total length of the aprons is 30 m in Section A and 27 m in Section B. They are designed to cope with scouring up to about -5 m+PWD. The 16 m long launching aprons will be constructed of articulated RENO-mattresses with rubble-fill placed on geotextile filter. For the falling apron cc-blocks will be used, the size of which is 40 and 45 cm in Section A and 35 and 40 cm in Section B. The water side slope of the embankment is protected by brick mattressing on geotextile filter. For further details see the detailed layout and cross-sections in Annex M.

To be completed by BWD8 in future years if the need arises due to ongoing upstream erosion



2.4.4 Execution of Works

The Contract with the Subcontractor for the execution of construction works was signed on June 23, 1999. The same day an order was placed for the supply of boulders. The Subcontractor started the site installation at Ghutail in July and the production of cc-blocks for the falling aprons on September 01.

The land acquisition procedure began in April 1999 and a first assessment followed in November after the final location of the structure and its dimensions were determined.

The major equipment for earth works arrived at site mid of November, but the actual construction works (earth works) could only be started on December 18, 1999 because of temporary problems with the local population in connection with compensation for crops and shifting of houses.

2.5 **REPORTING**

2.5.1 Introduction

In accordance with the Terms of Reference and the Consulting Agreement the Consultant has critically to assess the results of the test programme at the end of the Project and present a

Final Technical, Financial and Economical Project Evaluation Report

together with

Guidelines and Manuals for Planning, Design and Implementation of River Training and Bank Protection Works.

The latter are to be prepared on the basis of all available know-how and experience gained during the Project and should be applicable to more or less standard solutions for rivers in Bangladesh, in particular the Brahmaputra/Jamuna River.

On the occasion of the donors' review mission in July 1998 the Consultant presented in a work shop on July 20, 1998 his concept for the above mentioned reports. Tables of Content were elaborated and discussed with the donors and engineers of BWDB and WARPO. Finally, a time schedule was agreed upon in the workshop for the presentation of the guidelines and manuals. Since however, the project period was extended until end of 2000 due to the implementation of third test site, the schedule for elaborating the guidelines and manuals needed to be modified. After a discussion of all parties concerned during the donors' review mission of March 1999, the programme of July 1998 was reviewed and the following updated programme was jointly agreed upon:

Date	Task	Action
December 1998	Determination of participants and composition of BWDB/WARPO working group; Definition of general concept and degree of Detailing	Finalized
December 1998	Determination of Table of Contents	Approved

December 1999	Submission and presentation of draft Guidelines and Manuals	Consultant
May 2000	Submission of consolidated comments and suggestions of modification to draft Guidelines and Manual	BWDB / WARPO
October 2000	Inclusion of additional experiences from the monsoon 2000 season, if any	Consultant
December 2000	Submission of Final Document	Consultant

2.5.2 Status of Works

(a) Final Project Evaluation Report

All information, experience and data gathered at the test sites with the different systems during the construction and monitoring period respectively have to be analysed in order to define the most suitable solutions for bank protection structures in Bangladesh with regard to their design, construction materials and construction methods. Hence, the results of and the experience with the test structures will be compiled for each of the structures in reports on

- design;
- procurement and construction;
- monitoring, and
- evaluation of hydraulic loads and river response

together with a report on the morphological behaviour of the river in the test site areas and relevant investigations respectively.

These reports will be presented as annexes to the technical part of the evaluation report. The latter will contain summaries of the annexes in a form as condensed as possible together with the conclusions and lessons learned.

This concept holds also for the other part of the final report viz. the financial and economical evaluation. The following annexes are under preparation and their status at the end of the period under report was as follows:

Annex 1	Morphological Investigations	95%
Annex 2	Socio-economic Investigations	-
Annex 3	Ecological Assessment	50%
Annex 4	The Groyne Test Structure Design Report	90%
Annex 5	The Groyne Test Structure Procurement and Construction Report	20%
Annex 6	The Groyne Test Structure Monitoring Report	30%
Annex 7	The Groyne Test Structure Evaluation of Hydraulic Loads and River Response	60%
Annex 8	The Revetment Test Structure Design Report	60%
Annex 9	The Revetment Test Structure Procurement and Construction Report	-

Annex 10	The Revetment Test Structure Monitoring Report	30%
Annex 11	The Revetment Test Structure Evaluation of Hydraulic Loads and River Response	80%
Annex 12	Financial and Economic Evaluation	-

The status of relevant chapters of the main report correspond more or less to the above given figures.

(b) Guidelines and Manuals

The main topics of the Guidelines are **Planning, Design and Implementation** of river training and bank protection works. The structure of the documents has been discussed in the workshop in July 1998 and takes into account the existing guidelines and manuals of BWDB. In the course of preparation slight modifications of the Tables of Content were required, but the focal points of the documents are still:

- identification of priority protection sites;
- preparatory investigations and studies;
- general planning requirements;
- design principles for the individual bank protection and river training works;
- construction (materials, methods, equipment and implementation), and
- monitoring and maintenance.

At the end of 1999 the first draft of the Guidelines was complete by about 95%. Only 2 chapters out of 22 were incomplete:

- Chapter 11 Design Principles for Groynes, and
- Chapter 20 Construction Equipment.

The preparation of the Design Manual was not yet started.

3 RIVER TRAINING (AFPM) COMPONENT (FAP 22)

3.1 PRELIMINARY REMARK

After the activities under FAP 22 had been suspended in 1995, the Consultant was requested by WARPO on March 06, 1996 to take up recurrent measure activities. Therefore, the project works were resumed at the beginning of April 1996 and concentrated mainly on the completion of the desk study and a report on the activities in 1995/96 which was submitted on September 05, 1996 along with a proposal and work plan for the project continuation for the implementation of recurrent measures during the lean season 1996/97. The work plan covered the selection of suitable test sites as well as the design, implementation and testing of appropriate recurrent measures as Low Water Bandals, Improved Bandals and Sills.

Immediately after the positive comments of KfW on the Consultants programme of investigations in 1996/97 were received in September 1996, a suitable test site had been selected in the outflanking Katlamari channel just upstream from Fulchari where a combination of two measures viz. a 210 m long bandal structure and an earth dam about 600 m downstream from the bandals was built. Design and construction works started in the last quarter of 1996 and were completed mid March 1997. These measures were tested by the Jamuna river and monitored by the Consultants during the monsoon season 1997. It was intended to supplement/modify the test structures based on the experience of the first test season and to continue the investigations during the monsoon season 1998. A technical and financial proposal for further investigations was submitted to the client and the

donors in the last quarter of 1997, but at the end of the flood season 1997 it emerged that the overall morphological development in the test site area and the Fulchari channel did not allow the continuation of the tests at Katlamari Test Site. Therefore, at the beginning of January 1998 a new test site was selected for testing of recurrent measures during the monsoon season 1998 which is located about 5 km east of the Groyne Test Structure of FAP 21 at Kamarjani.

Table 2.2-1 and Table 2.2-3 are showing the Work Plan as per proposal of August 1996 and December 1997 respectively whereas Table 2.2-5 the Staffing Schedule for the study period 1996 till 1998 including that one of the modified proposal of December 1997. Table 2.2-2 and 2.2-4 are showing the actual activities up to the end of 1997 and 1998 respectively and Table 2.2-6 and 2.2-7 the actual input of the expatriate and the local professional staff fielded up to end of December 1999.

3.2 TEST SITE I AT KATLAMARI

3.2.1 The Test Structures

Two different structures were built at Katlamari:

- (a) improved bandals with a total length of 210 m and consisting of 4 main components at the off-take of the Katlamari channel with the aim to deflect the flow and to encourage siltation behind the structure;
- (b) an earth dam 600 meters downstream from the bandal structure with the aim to close the Katlamari channel at the beginning of the flood season.

The idea behind these measures was to deflect the flow into the Fulchari channel, to decrease the size of the Katlamari channel and thus concentrate more flow in the Fulchari channel, to deepen the latter and to improve the ferry operations to Fulchari Ghat. In parallel it was expected that the size of the Katlamari channel would decrease, that bank erosion would diminish and agrable land could be won.

Both the structures were designed to support the effectiveness of each other and thus to increase their overall efficiency.

3.2.2 Monitoring of the Test Structures

After the Fulchari channel started to move westwards and finally washed away Section E of the bandal structure, it was decided to abandon this test site. In January/February 1998 dismantling of the remaining sections of the structure except Section A was started and the dismantled material of the bandal structure was transported to the new test site at Kundarapara and partly used for the construction of low water bandals. After the monsoon season also Section A was given up.

Hence, no monitoring activities are to be reported from the period under review.

3.3 TEST SITE II AT KUNDARAPARA

3.3.1 The Test Structures

In order to reduce the severe erosion in the outer bend of the Kamarjani channel between Syedpur and Balashi Ghat it was planned to promote the development of the Kundarapara cut-off channel. The following recurrent measures were planned to be constructed and investigated:

٢٢

(a) Low Water Bandals

Low water bamboo bandals were installed in February / March 1998 at the entrance of the Kamarjani bypass channel in order to increase the inflow into the Kundarapara channel and at the same time to reduce the inflow into the Kamarjani bypass channel. The bandals were removed end of March 1998 when the water level started to rise.

(b) Improved Bandals with adjustable Screens

After permanent problems with the local population, it was decided on March 10, 1998 to stop the construction of the improved bandals when it became obvious that they could not be completed in time before the flood season 1998

(c) Floating Screens

In the course of positioning and anchoring of the elements, local people sabotaged the activities so that the Consultant had no choice but to stop the investigations with floating screens for the flood season 1998.

3.3.2 Monitoring of the Test Structures

During the period under report bathymetric surveys and flow measurements were continued in the Kundarapara channel the results of which are presented in Annex B and C (FAP 21, Test Site I). However, testing of the floating elements remained suspended.

3.4 REPORTING

Valuable results of the tests with recurrent measures gained at Katlamari and Kundarapara Test Sites will be included in the Guidelines for river training and bank protection works, which are under preparation (Section 2.5).

Table 1.1-1

BANK PROTECTION TEST STRUCTURES - FAP 21

EXPATRIATE PROFESSIONAL STAFF

Activities during the period of 10/99 to 12/99

VERSION : 14.01.00

Sl. No.	Function	Person	Code	Company	Period		Remarks
					From	To	
1.1	Project Director	Dr. D. Neuhaus / Dr. H. Kramer	DN / HK	RRI	01/10	31/12	Part time in Europe
1.2	Home Office Support						
1.3.1	Project Manager	C. Netzeband	CN	RRI	01/10	31/12	
1.4	Chief Hydraulic Design Engineer	Dr. H. Kramer	HK	L&P	01/10	20/10	
2.1.1	Hydraulic Design Engineer	M. Schwarz	MS	L&P	03/11 11/11	17/12 26/11	
2.2	Structural Engineer	-	-	-	-	-	
2.3	Mechanical Engineer	-	-	-	-	-	
2.4	Procurement Expert	-	-	-	-	-	
2.5.1	Subsoil Expert	H. Wessling	HW	L&P	-	-	
3.1.	Chief Supervising Engineer	-	-	-	-	-	
3.2.1	Supervising Engineer	K. Oberhagemann	KO	RRI	26/11 31/12	22/12 31/12	
3.4.1	Surveyor	J. Heise	JH	RRI	-	-	
3.5.1	Administrator	B. Thomas	BT	CNR	-	-	
3.6.1	Monitoring Expert	T. Döschner	TD	RRI	03/11	29/11	
4.1.1	Morphologist	Dr. E. Mosselman	EM	DELFT	01/10	31/12	Part time in Europe
4.2.1	Modelling Expert	M. v. d. Wal	MvdW	DELFT	01/10	10/10	Part time in Europe
					01/10	30/11	
		D. Carrion	DC	CNR	-	-	
		E. Divet	ED	CNR	-	-	
		C. Bertrand	CB	CNR	-	-	
		--	-	-	-	-	
		--	-	-	-	-	
4.3.1	Environmental Expert						
4.5.1	Economist						
4.6.1	Unallocated						

Table 1.1-2

BANK PROTECTION TEST STRUCTURES - FAP 21
LOCAL PROFESSIONAL STAFF
Activities during the period of 10/99 to 12/99

VERSION : 14.01.00

Sl. No.	Function	Person	Code	Company	Period		Remarks
					From	To	
1.2	Home Office Support	NN	SM	BETS	01/10	31/12	
1.3.2	Deputy Project Manager	S. M. Mansur					
2.1.2	Hydraulic Design Engineer 2	A. Q. Mohammed Ali	MA	BETS	-	-	
2.3.2	Mechanical Engineer 2	Masih-ur-Rahman	MR	DUL	-	-	
2.4.2	Procurement Expert 2	Masih-ur-Rahman	MR	DUL	-	-	
2.5.2	Subsoil Expert 2	-	-	-	-	-	
3.2.2	Supervising Engineer 2	Fazlur Rahman / Sk. Golam Kader	FR	BETS	-	-	
3.3	Quantity Surveyor	Faizur Rahman Khan	SGK	BETS	01/10	31/12	
3.4.2	Surveyor 2	-	FRK	DUL	-	-	
3.6.2/3/4	Monitoring Expert 2	A.B.M. Anwar Haider	-	-	-	-	
	Jr. Monitoring Expert	Pankaj K. Maitra	AH	BETS	01/10	31/12	
	Monitoring Data Processor	Yasmin Khayer	PKM	BETS	01/10	31/12	Part time
			YK	FL	01/10	31/12	
4.1.2	Morphologist 2	M. H. Sarker	MHS	FL	-	-	
4.2.2	Modelling Expert 2	Monjur Kader	MoK	BETS	-	-	
4.3.2	Environmental Expert 2	Dr. A.K.M. Nazrul Islam	NI	BETS	01/10	31/12	Part time
4.4	Socio-Economist	Tauhidun Nabi	TN	BETS	01/10	31/12	
4.5.2	Economist 2	NN	-	-	-	-	
4.6.2	Unallocated 2		-	-	-	-	

Table 1.1-3

BANK PROTECTION TEST STRUCTURES - FAP 21
LOCAL SUPPORT STAFF
Activities during the period of 10/99 to 12/99

VERSION : 14.01.00

Sl. No.	Function	Person	Company	Period		Remarks
				From	To	
1	Bilingual Secretary	Sk. Zakirul Islam	BETS	01/10	31/12	
2	Receptionist	Md. Razaul Karim	BETS	01/10	31/12	
3	Operator / Data Input	Md. Khorshed Alam	BETS	01/10	31/12	
4	Senior Draftsman	Anowarul Alam	BETS	01/10	31/12	
5	Draftsman	Md. Fazle Hossain Bhuiyan	BETS	01/10	31/12	
6	Photocopy Operator	Md. Q M Hussain (Babu)	BETS	01/10	31/12	
7	Accountant	A.B.M Bazlur Rashid	BETS	01/10	31/12	
8	Asstt. Acct. Purchase	Md. Shafiuddin	BETS	01/10	31/12	
9	Messenger	Md. Aziz	BETS	01/10	31/12	
10	Peon	Md. Habibur Rahman Hawladar	BETS	01/10	31/12	
11	Guards (8 hours shift)	Md. Farid Sikder /	BETS	01/10	31/12	
		Md. Moqbul Hossain /	BETS	01/10	31/12	
		Md. Shakawat Hossain	BETS	01/10	31/12	
12-19	Drivers	Eight Drivers	L&S	01/10	31/12	

BANK PROTECTION TEST STRUCTURES FAP 21

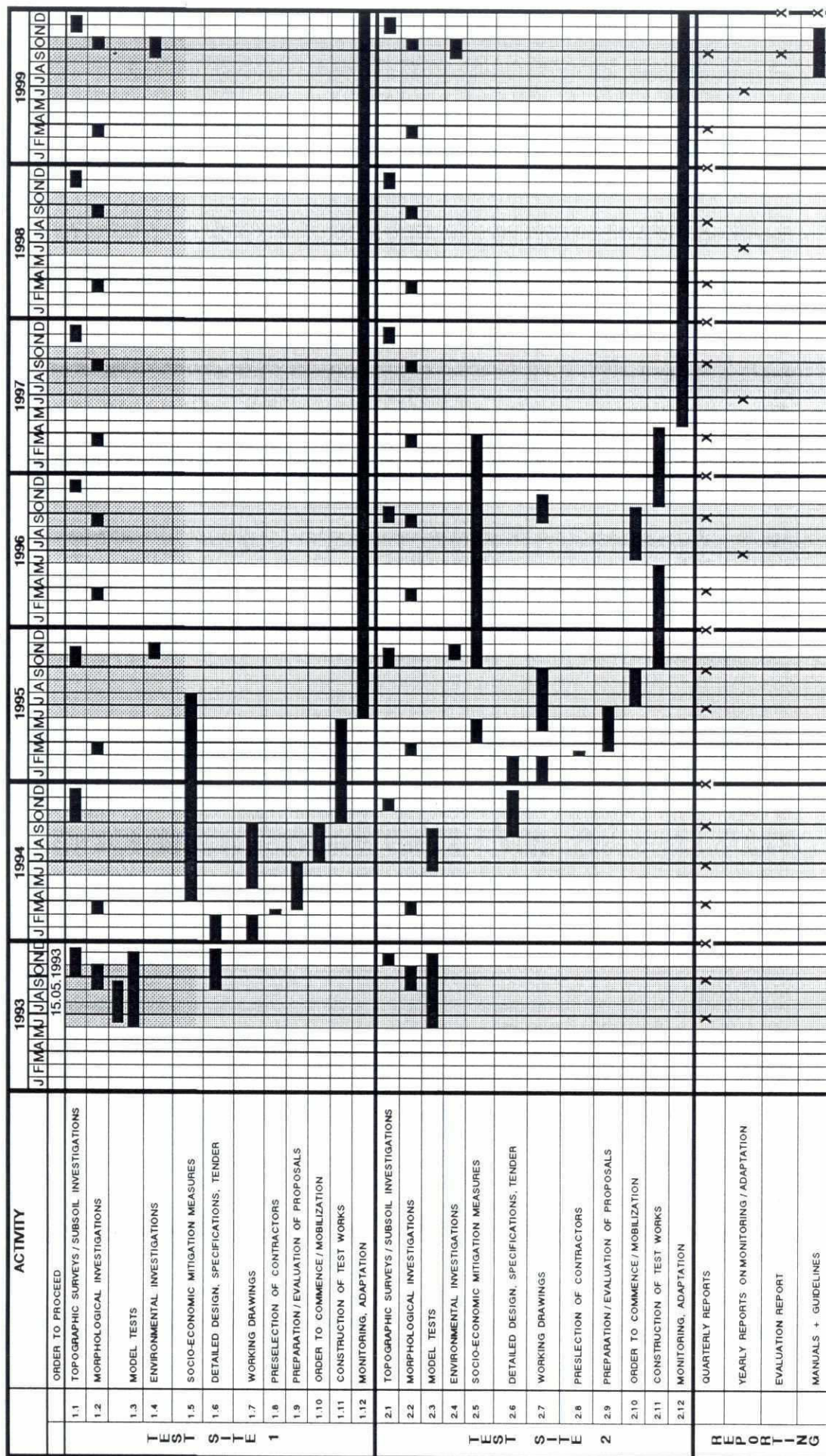
AS PER LETTER TO PROCEED OF MAY 1993

TABLE 1.2-1.2

BANK PROTECTION TEST STRUCTURES FAP 21

WORK PLAN

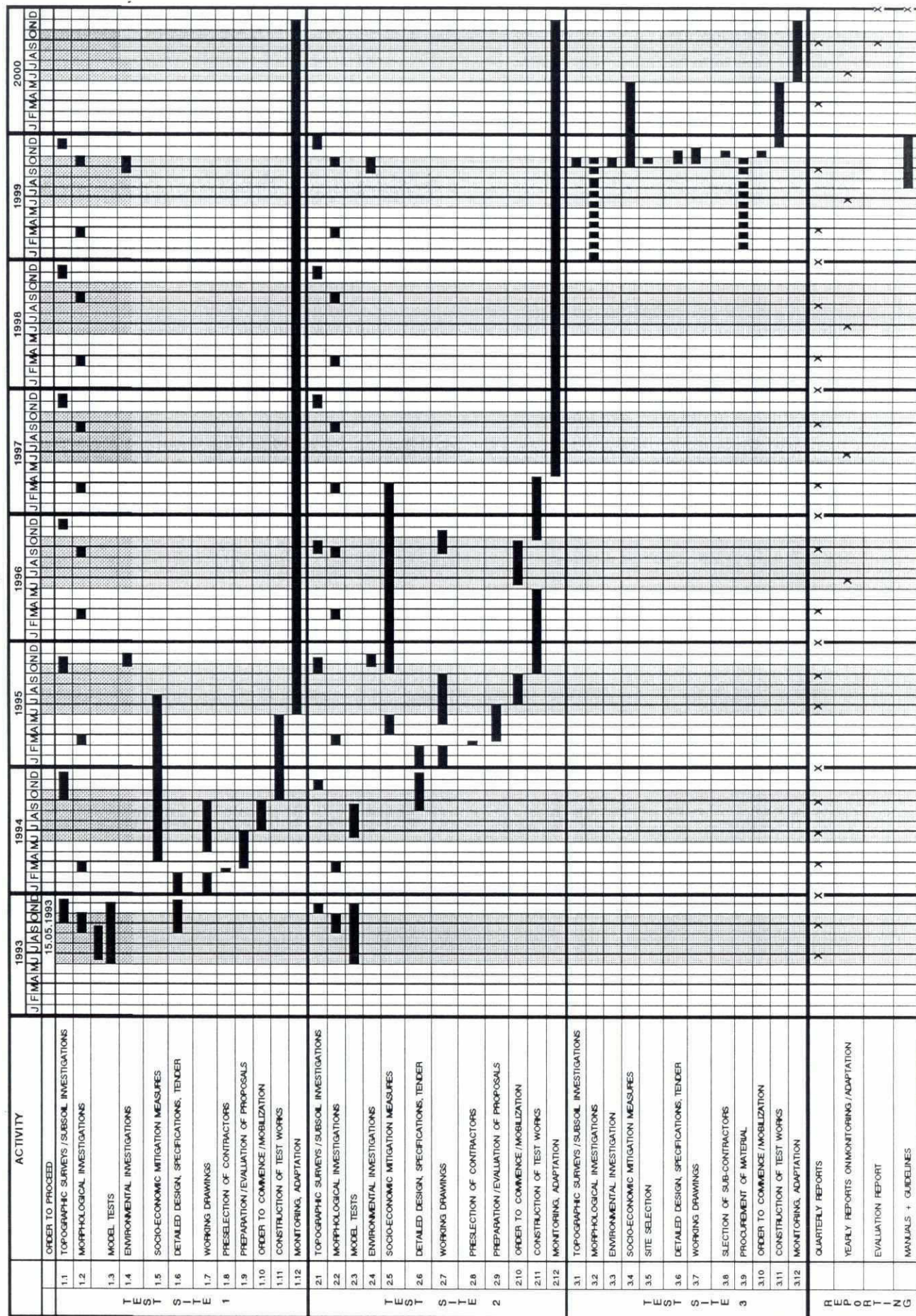
REVISION NO. 1 *)



*) AS PER PROPOSAL OF SEPTEMBER 1996

TABLE 1.2 - 1. 3

BANK PROTECTION TEST STRUCTURES FAP 21

WORK PLAN
REVISION NO. 2 *)

*) AS PER PROPOSAL OF MAY 1999

MONSOON

9

9

9

REVISION NO. 3 *)

STAFFING SCHEDULE - EXPATRIATE PROFESSIONAL STAFF; FIELDUP TO DECEMBER 31, 1999

MANUALS + GUIDELINES

OUTSIDE BANGLADESH

TABLE 2.1-1

STUDIES ON RECURRENT MEASURES - FAP 22
EXPATRIATE PROFESSIONAL STAFF
Activities during the period of 10/99 to 12/99

VERSION : 14.01.00

Sl. No.	Function	Person	Code	Company	Period		Remarks
					From	To	
1.1	Project Director	Dr. D. Neuhaus	DN	RRI	-	-	
1.2	Home Office Support	Dr. H. Kramer	HK		-	-	
1.3.1	Project Manager	C. Netzeband	CN	RRI	-	-	
1.4	Chief Hydraulic Design Engineer	Dr. H. Kramer	HK	L&P	-	-	
5.1.1	River Engineer	P. van Groen	PvG	DELFT	-	-	
5.2	Hydraulic Design Engineer	M. Schwarz	MS	L&P	-	-	
5.3.1	Surveyor	-	-	-	-	-	
5.4.1	Morphologist	Dr. E. Mosselman	EM	DELFT	-	-	
5.5	System Analyst	R. H. Buijsrogge	RHB	DELFT	-	-	
5.6	Programmer	M. Witteveen	MW	DELFT	-	-	
5.6.A	Programmer / Modeller	J. I. Crebas	JIC	DELFT	-	-	
5.7	GIS Specialist	G.K.F.M.Hesselmann	GMH	DELFT	-	-	
5.8.1	Supervising Engineer	K. Oberhagemann	KO	RRI	01/10	08/10	
5.9.1	Monitoring Expert	T. Döscher	TD	L&P	-	-	
5.10	Economist	-	-	-	-	-	

26

TABLE 2.1-2

STUDIES ON RECURRENT MEASURES - FAP 22
LOCAL PROFESSIONAL STAFF

Activities during the period of 10/99 to 12/99

VERSION : 14.01.00 *

Sl. No.	Function	Person	Code	Company	Period		Remarks
					From	To	
1.2	Home Office Support	NN	-	-	-	-	
1.3.2	Deputy Project Manager	S. M. Mansur	SM	BETS	-	-	
5.1.2	River Engineer 2	S. R. Khan	SRK	BETS	-	-	
5.3.2	Surveyor 2	--	-	-	-	-	
5.4.2	Morphologist 2	Salahuddin Khan	SK	BETS	-	-	
5.8.2	Supervising Engineer 2	F. R. Khan	FRK	DUL	-	-	
5.9.2/3/4	Monitoring Expert 2	A.B.M. Anwar Haider	AH	BETS	-	-	
	Jr. Monitoring Expert	Pankaj K. Maitra	PKM	BETS	-	-	
	Monitoring Data Processor	Yasmin Khayer	YK	FL	-	-	
5.10.2	Economist 2	--	-	-	-	-	

TABLE 2.2 - 1

STUDIES ON RECURRENT MEASURES - FAP 22
WORK PLAN AS PER PROPOSAL OF AUGUST 1996

SL. NO.	ACTIVITY	1996				1997											
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	PRE-SELECTION	■	■														
2	VERIFICATION SURVEY	■															
3	FIELD CHECKS		■	■	■	■											
4	FIELD SELECTION		■	■	*	*											
5	DETAILED SURVEY			■	■												
6	FINAL DESIGN		■	■	■	■											
7	TENDERING			■	■												
8	CONSTRUCTION				■	■	■	■									
9	OPERATION AND MAINTENANCE							■	■	■	■	■	■	■	■	■	■
10	MONITORING AND EVALUATION							■	■	■	■	■	■	■	■	■	■

NOTE: * DENOTES REVIEW OF FINAL SELECTION

TABLE 2.2 - 2

STUDIES ON RECURRENT MEASURES - FAP 22
WORK PLAN AS PER PROPOSAL OF AUGUST 1996
ACTIVITIES FIELDIED UP TO DECEMBER 31, 1997

SL. NO.	ACTIVITY	1997											
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	PRE-SELECTION												
2	VERIFICATION SURVEY												
3	FIELD CHECKS												
4	FIELD SELECTION												
5	DETAILED SURVEY												
6	FINAL DESIGN												
7	TENDERING												
8	CONSTRUCTION												
9	OPERATION AND MAINTENANCE												
10	MONITORING AND EVALUATION												

NOTE: * DENOTES REVIEW OF FINAL SELECTION

TABLE 2.2 - 3

STUDIES ON RECURRENT MEASURES - FAP 22
WORK PLAN AS PER PROPOSAL OF DECEMBER 1997

SL. NO.	ACTIVITY	1997				1998											
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	PRE-SELECTION OF SITE																
2	VERIFICATION SURVEY / FIELD CHECK																
3	MAINTENANCE/ADAPTATION OF EXISTING BANDALS																
4	ELONGATION OF IMPROVED BANDALS																
5	DESIGN OF FLOATING SCREEN ELEMENTS																
6	CONSTRUCTION OF FLOATING SCREEN ELEMENTS																
7	FINAL SITE SELECTION																
8	DETAILED SURVEY																
9	POSITIONING AT TEST SITE																
10	OPERATION AND MAINTENANCE																
11	MONITORING																
12	EVALUATION																

89

TABLE 2.2 - 4

STUDIES ON RECURRENT MEASURES - FAP 22
WORK PLAN AS PER PROPOSAL OF DECEMBER 1997
FILED UP TO DECEMBER 31, 1998

SL. NO.	ACTIVITY	1997				1998											
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	PRE-SELECTION OF SITE																
2	VERIFICATION SURVEY / FIELD CHECK																
3	MAINTENANCE/ADAPTATION OF EXISTING BANDALS																
4	ELONGATION OF IMPROVED BANDALS																
5	DESIGN OF FLOATING SCREEN ELEMENTS																
6	CONSTRUCTION OF FLOATING SCREEN ELEMENTS																
7	FINAL SITE SELECTION																
8	DETAILED SURVEY																
9	POSITIONING AT TEST SITE																
10	OPERATION AND MAINTENANCE																
11	MONITORING																
12	EVALUATION																

TABLE 2. 2 - 6

STUDIES ON RECURRENT MEASURES - FAP 22

STAFFING SCHEDULE *)

EXPATRIATE PROFESSIONAL STAFF - FIELDIED UP TO DECEMBER 31, 1999

	FUNCTION	NAME	1996												1997												1998												1999																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
1.1	PROJECT DIRECTOR	Dr. D. Neuhaus / Dr. H. Kramer																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

NOTE: * Some of the working time of the Professionals will be charged to FAP 21 project

*) AS PER PROPOSAL OF AUGUST 1996 AND DECEMBER 1997



92

ANNEX A

FAP 21 / Test Site I

- Water Level

BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT KAMARJANI TEST SITE
MONTH : OCTOBER 1999

DAYS	T I M E			REMARKS
	8.00	13.00	17.00	
1	19.300	19.280	19.260	
2	19.210	19.210	19.210	
3	19.150	19.130	19.120	
4	19.090	19.060	19.040	
5	18.960	18.950	18.930	
6	18.920	18.910	18.900	
7	18.850	18.840	18.840	
8	18.810	18.800	18.790	
9	18.820	18.840	18.850	
10	18.940	18.960	18.970	
11	18.990	19.000	19.010	
12	19.080	19.100	19.130	
13	19.210	19.220	19.230	
14	19.290	19.300	19.310	
15	19.320	19.310	19.310	
16	19.250	19.220	19.190	
17	19.040	18.980	18.940	
18	18.860	18.870	18.870	
19	18.840	18.850	18.890	
20	18.990	19.060	19.170	
21	19.580	19.630	19.660	
22	19.590	19.560	19.530	
23	19.500	19.510	19.520	
24	19.620	19.640	19.660	
25	19.750	19.770	19.780	
26	19.780	19.770	19.750	
27	19.630	19.590	19.550	
28	19.360	19.310	19.270	
29	19.090	19.040	19.000	
30	18.840	18.800	18.760	
31	18.620	18.590	18.560	

CE

BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT KAMARJANI TEST SITE
MONTH : NOVEMBER 1999

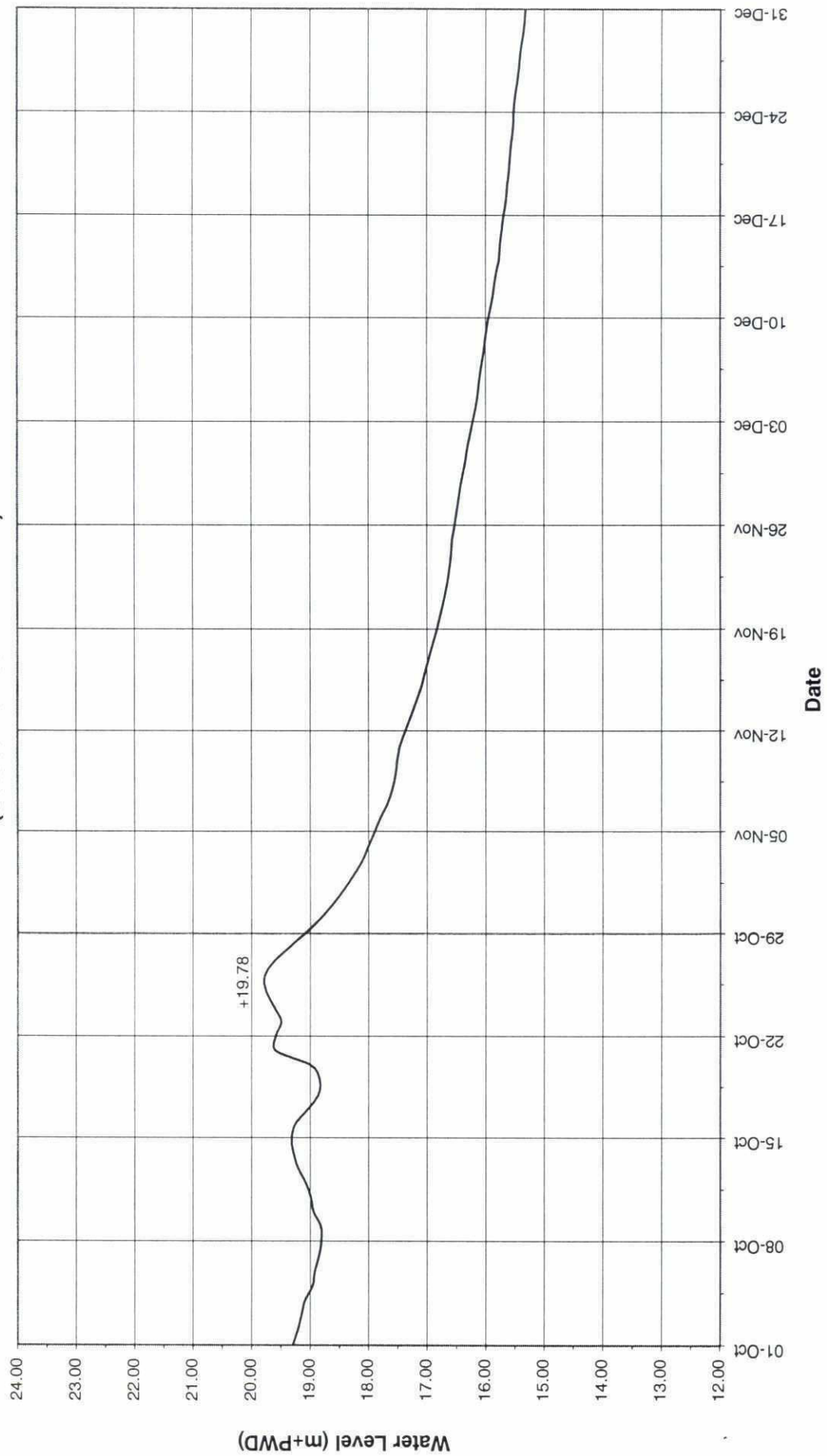
DAYS	T I M E			REMARKS
	8.00	13.00	17.00	
1	18.430	18.390	18.360	
2	18.260	18.220	18.180	
3	18.110	18.070	18.040	
4	18.000	17.970	17.940	
5	17.890	17.860	17.850	
6	17.790	17.770	17.760	
7	17.670	17.650	17.640	
8	17.590	17.580	17.570	
9	17.540	17.530	17.520	
10	17.510	17.510	17.500	
11	17.460	17.440	17.430	
12	17.370	17.350	17.340	
13	17.280	17.260	17.250	
14	17.190	17.170	17.150	
15	17.100	17.090	17.080	
16	17.040	17.020	17.010	
17	16.970	16.950	16.930	
18	16.900	16.890	16.880	
19	16.830	16.820	16.810	
20	16.770	16.750	16.740	
21	16.710	16.700	16.690	
22	16.660	16.650	16.650	
23	16.620	16.610	16.610	
24	16.590	16.590	16.580	
25	16.570	16.560	16.550	
26	16.530	16.520	16.520	
27	16.490	16.490	16.480	
28	16.450	16.440	16.440	
29	16.410	16.400	16.390	
30	16.360	16.350	16.350	

BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT KAMARJANI TEST SITE
MONTH : DECEMBER 1999

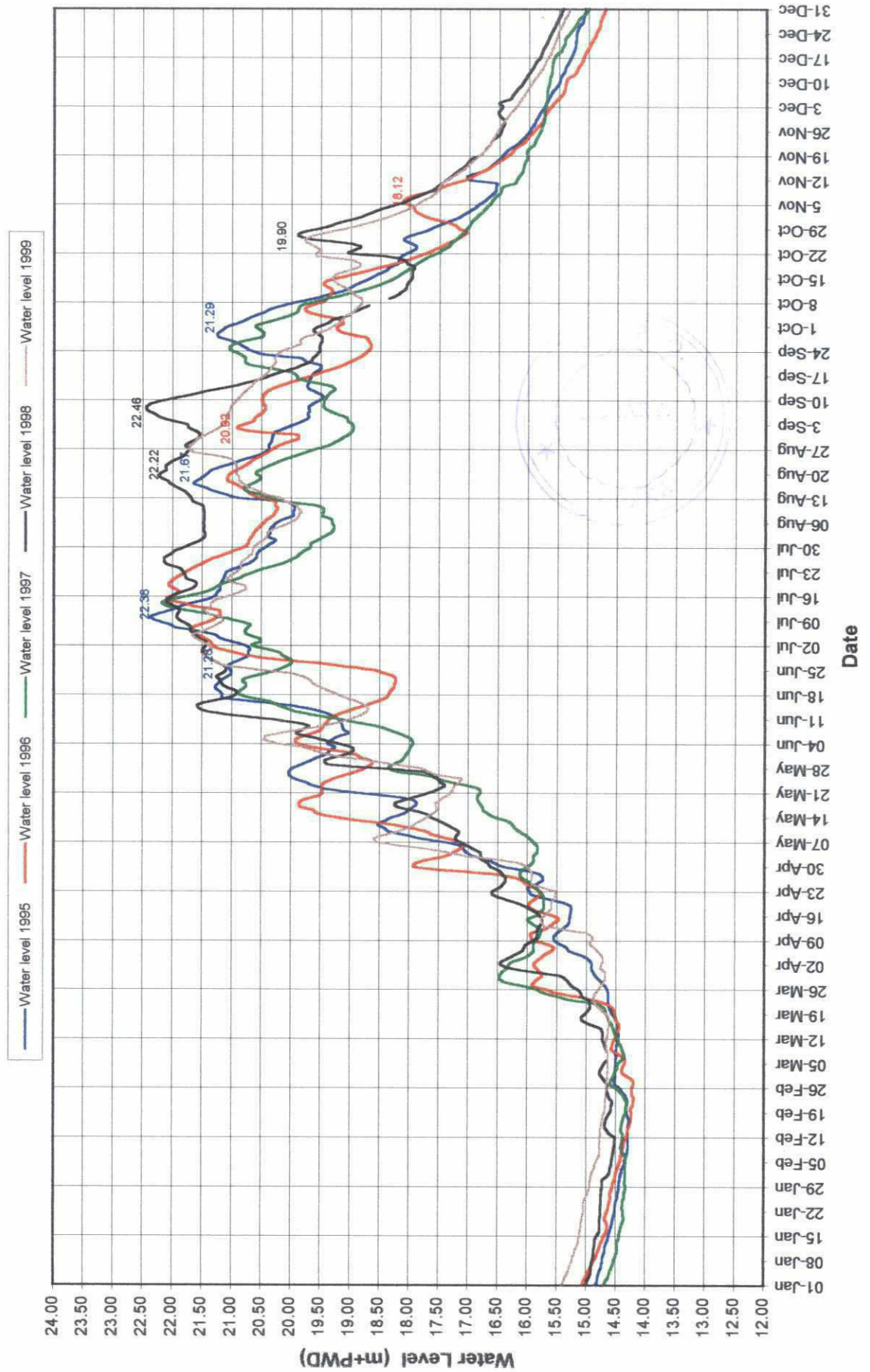
DAYS	T I M E			REMARKS
	8.00	13.00	17.00	
1	16.320	16.310	16.300	
2	16.270	16.260	16.260	
3	16.220	16.210	16.200	
4	16.170	16.170	16.160	
5	16.130	16.120	16.120	
6	16.100	16.090	16.090	
7	16.060	16.050	16.050	
8	16.020	16.010	16.010	
9	15.990	15.980	15.980	
10	15.950	15.940	15.930	
11	15.900	15.890	15.890	
12	15.860	15.850	15.850	
13	15.820	15.810	15.810	
14	15.770	15.760	15.760	
15	15.750	15.740	15.740	
16	15.720	15.710	15.710	
17	15.690	15.680	15.670	
18	15.650	15.640	15.640	
19	15.630	15.620	15.620	
20	15.600	15.600	15.600	
21	15.580	15.580	15.570	
22	15.560	15.560	15.560	
23	15.530	15.530	15.530	
24	15.520	15.510	15.510	
25	15.500	15.490	15.490	
26	15.460	15.450	15.450	
27	15.430	15.430	15.420	
28	15.410	15.410	15.400	
29	15.370	15.370	15.360	
30	15.340	15.340	15.340	
31	15.320	15.320	15.310	

82

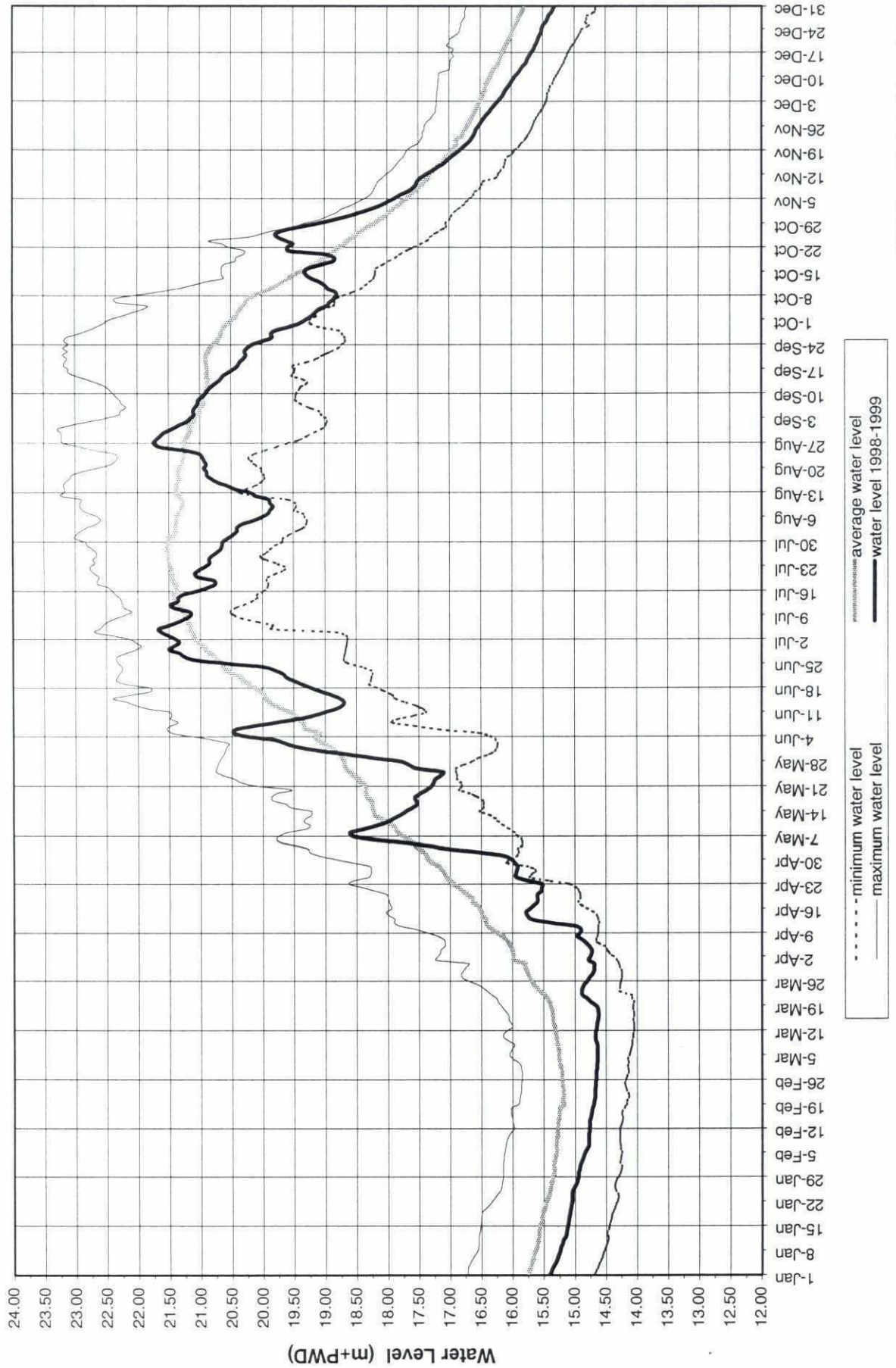
BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT KAMARJANI TEST SITE
(October to December 1999)



BANK PROTECTION TEST STRUCTURES - FAP 21 **WATER LEVEL AT KAMARJANI TEST SITE** **(January to December)**



BANK PROTECTION TEST STRUCTURES - FAP 21 **BWDB WATER LEVEL FREQUENCY CURVES VERSUS ACTUAL FAP 21 WATER LEVEL** **AT KAMARJANI TEST SITE UP TO DECEMBER '99**



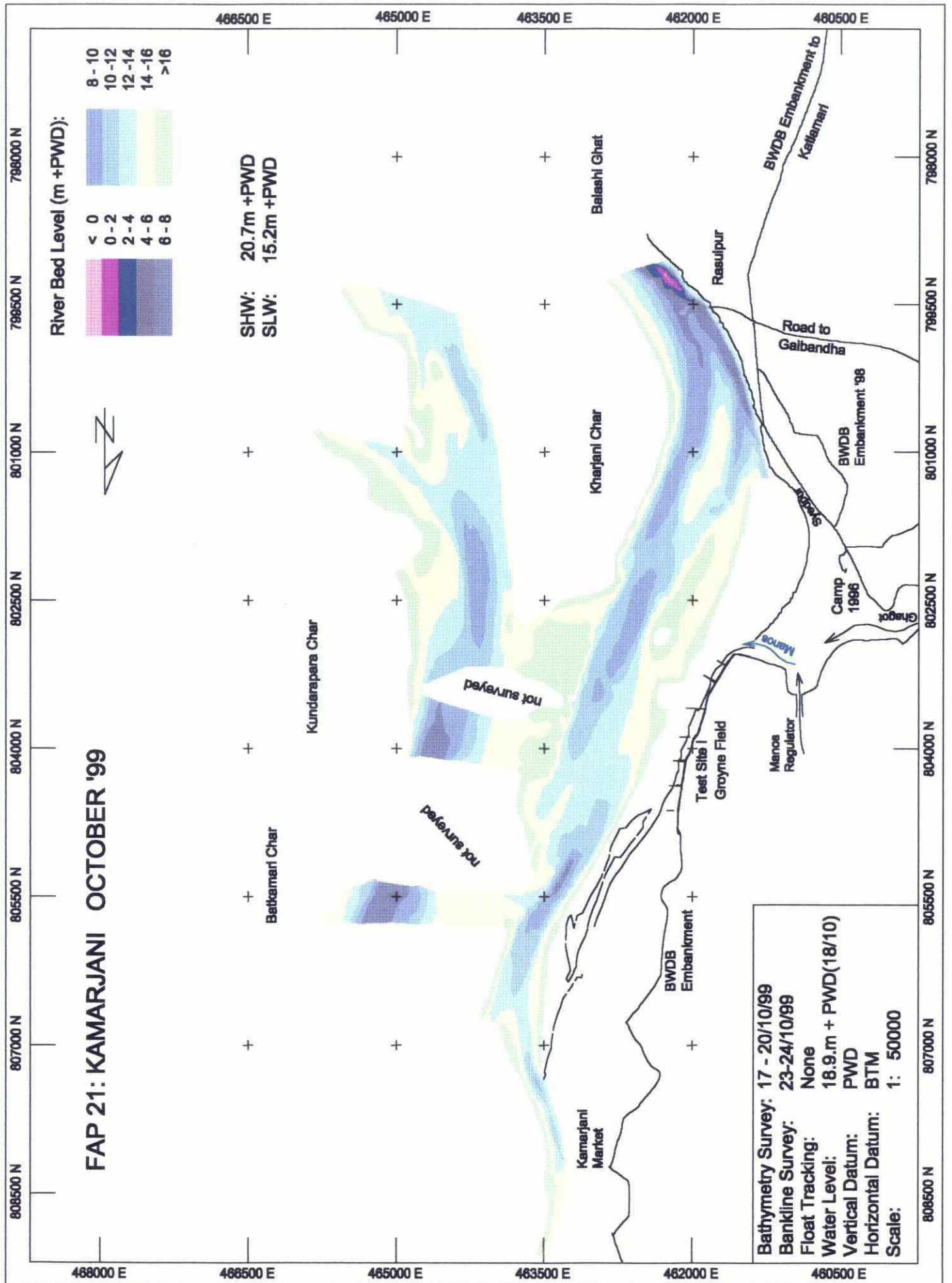
22

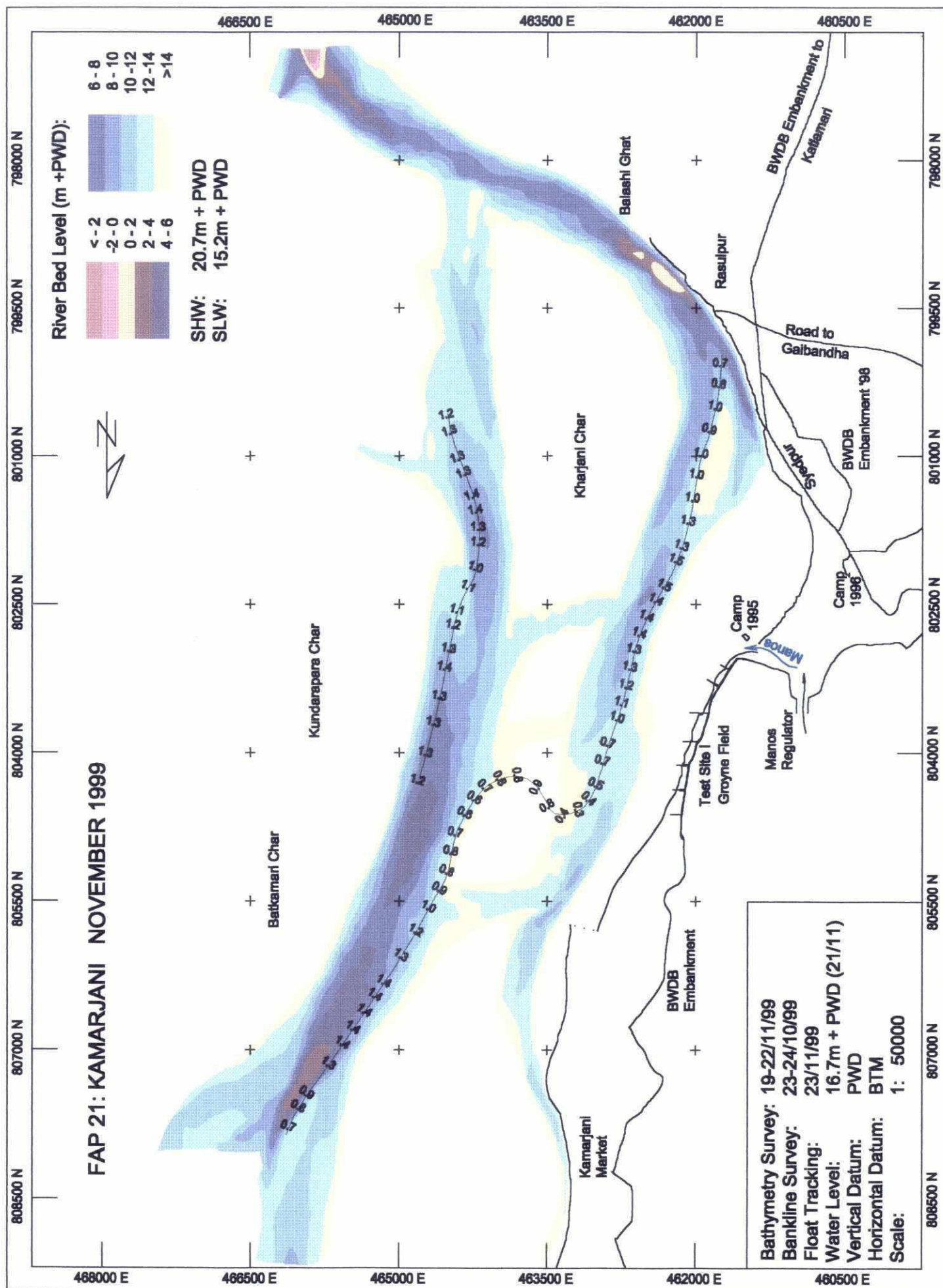
ANNEX B

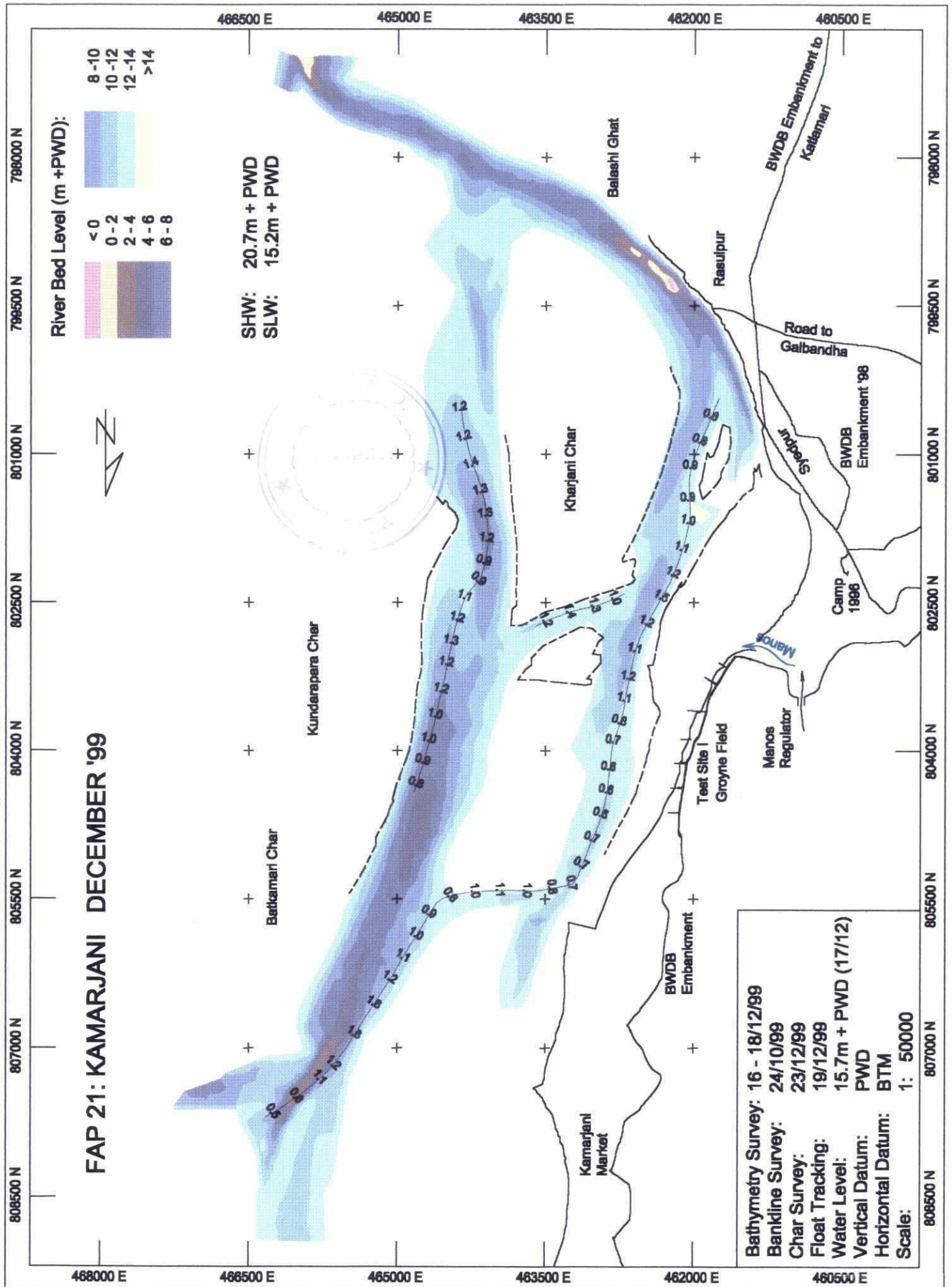
FAP 21 / Test Site I

- Bathymetric Survey and
Flow Velocities

130



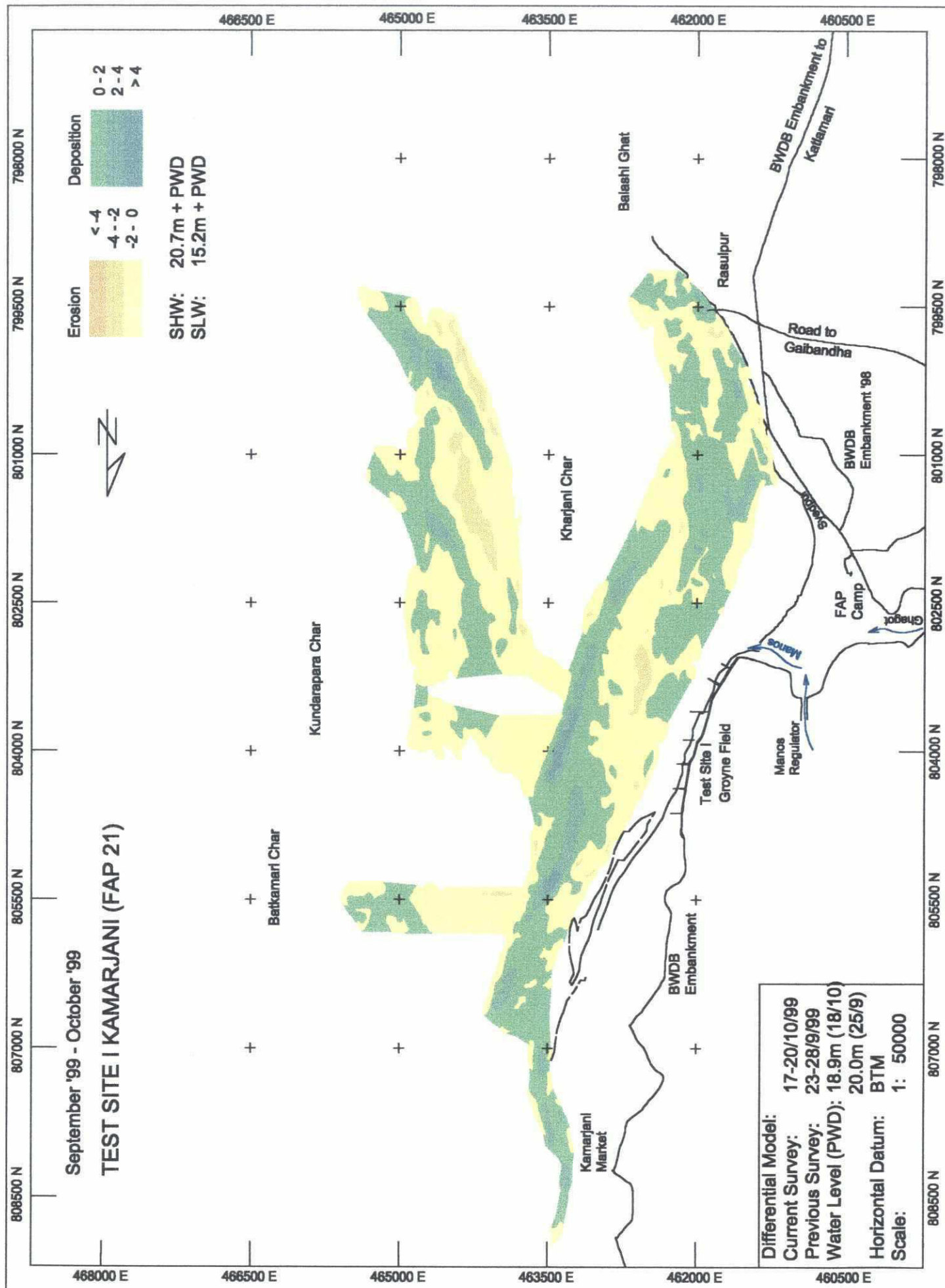


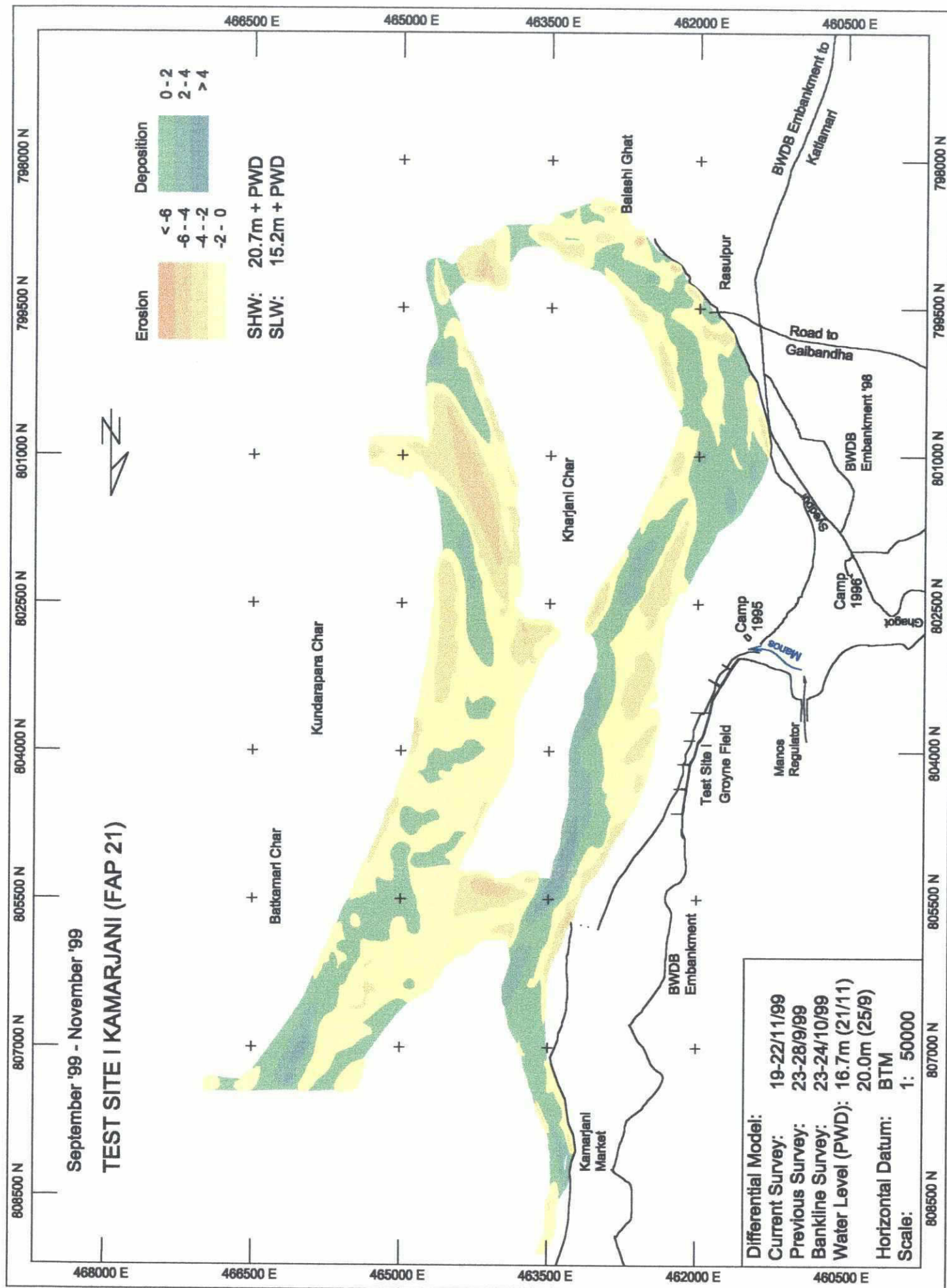


ANNEX C

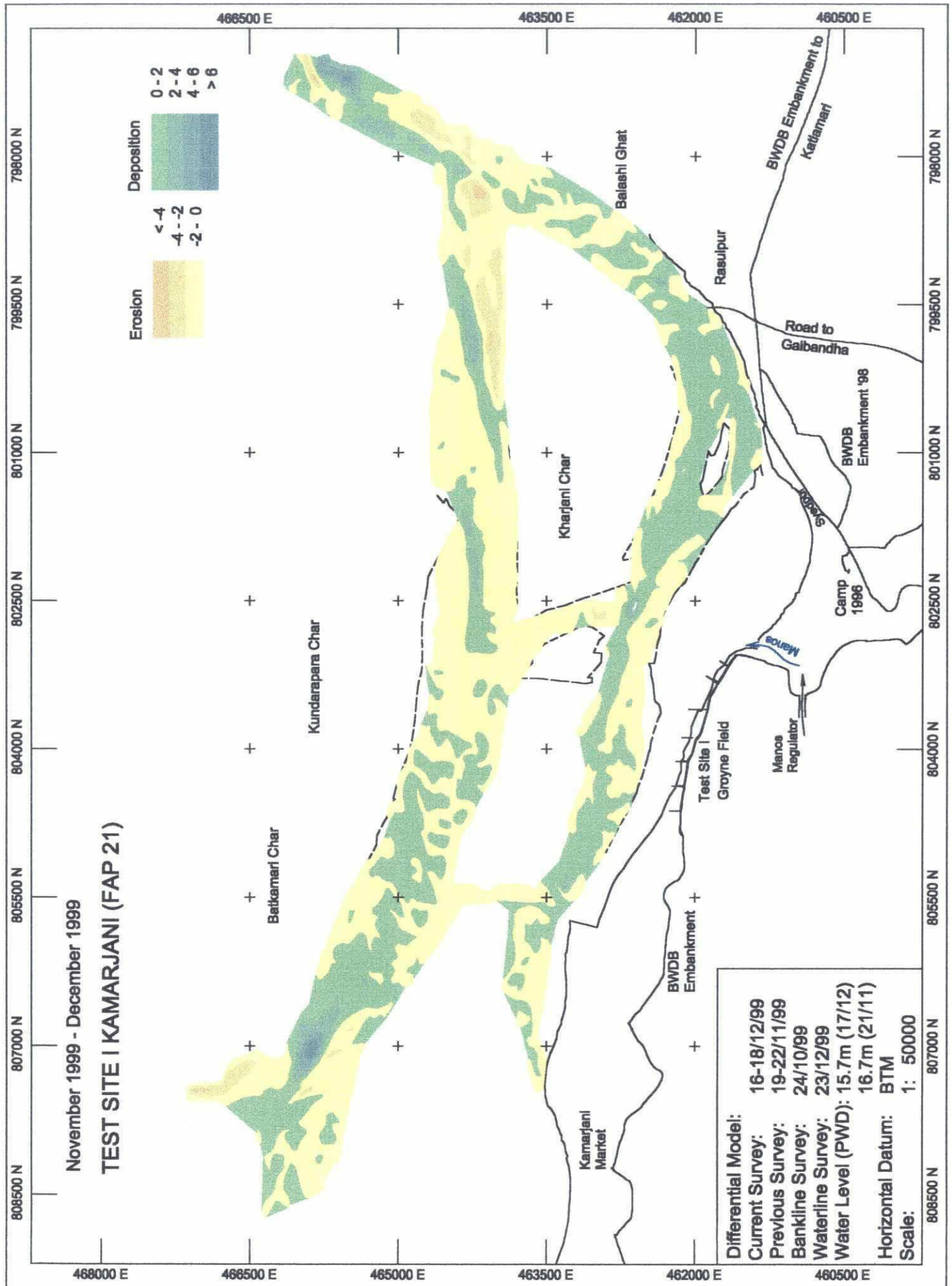
FAP 21 / Test Site I

- Differential Models





29

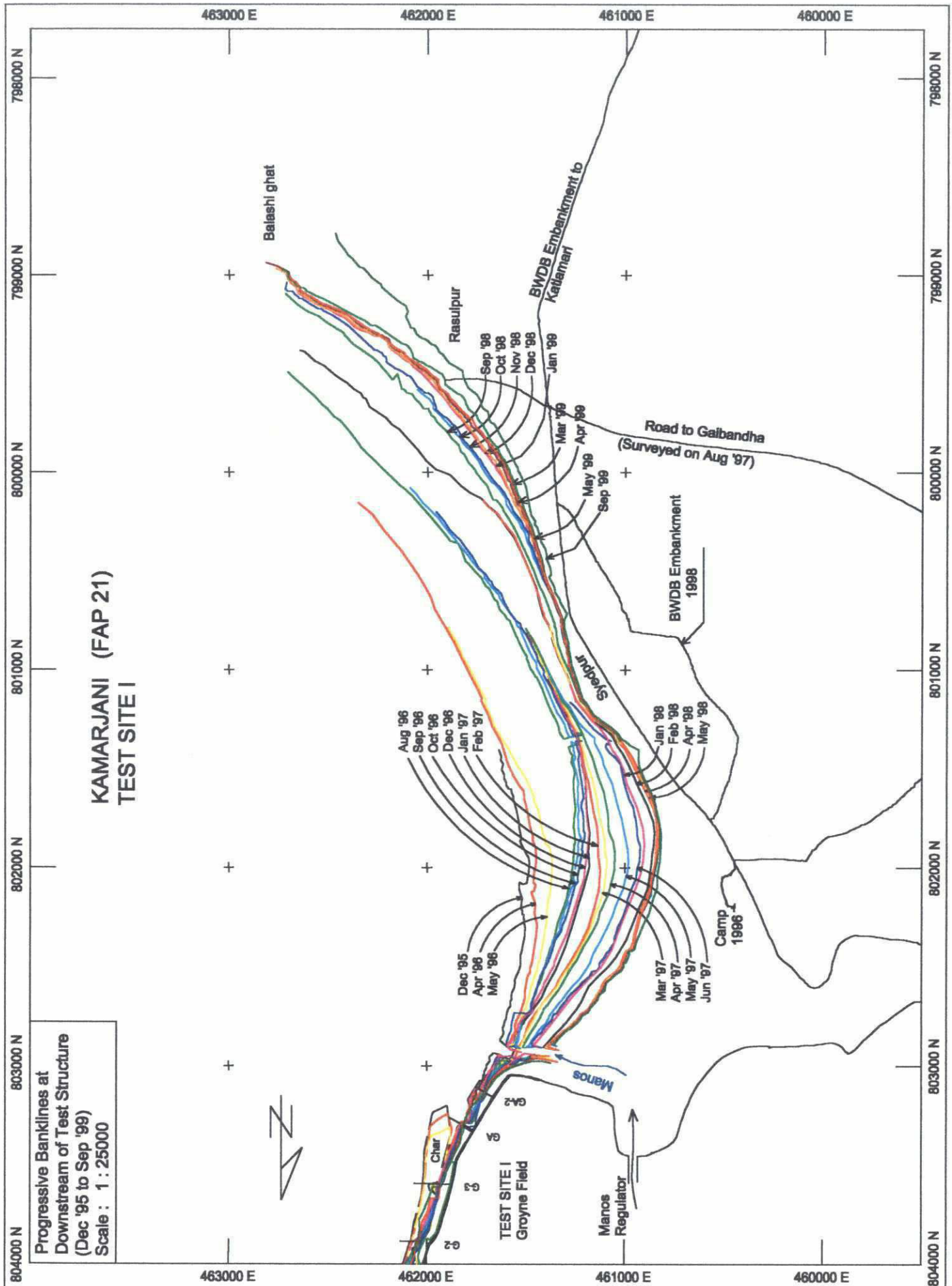


ANNEX D

FAP 21 / Test Site I

- Change of Bankline

36



ANNEX E

FAP 21 / Test Site I

- Photographs

There was no further development at the test site during the period under review.

Therefore, there are no photographs.



ANNEX F

FAP 21 / Test Site II

- Water Level

BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT BAHADURABAD TEST SITE
MONTH : OCTOBER 1999

DAYS	T I M E			REMARKS
	8.00	13.00	17.00	
1	17.500	17.490	17.480	
2	17.430	17.420	17.420	
3	17.390	17.380	17.360	
4	17.310	17.300	17.290	
5	17.210	17.200	17.190	
6	17.180	17.170	17.160	
7	17.140	17.130	17.120	
8	17.090	17.070	17.060	
9	17.060	17.070	17.080	
10	17.130	17.150	17.160	
11	17.170	17.180	17.190	
12	17.210	17.230	17.260	
13	17.310	17.330	17.340	
14	17.380	17.390	17.400	
15	17.410	17.410	17.410	
16	17.380	17.370	17.340	
17	17.210	17.180	17.160	
18	17.070	17.070	17.070	
19	17.000	16.990	16.970	
20	17.100	17.140	17.220	
21	17.540	17.600	17.650	
22	17.650	17.630	17.600	
23	17.560	17.570	17.570	
24	17.650	17.670	17.690	
25	17.770	17.790	17.800	
26	17.830	17.830	17.820	
27	17.730	17.680	17.640	
28	17.500	17.440	17.400	
29	17.250	17.210	17.180	
30	17.050	17.020	17.000	
31	16.870	16.850	16.810	

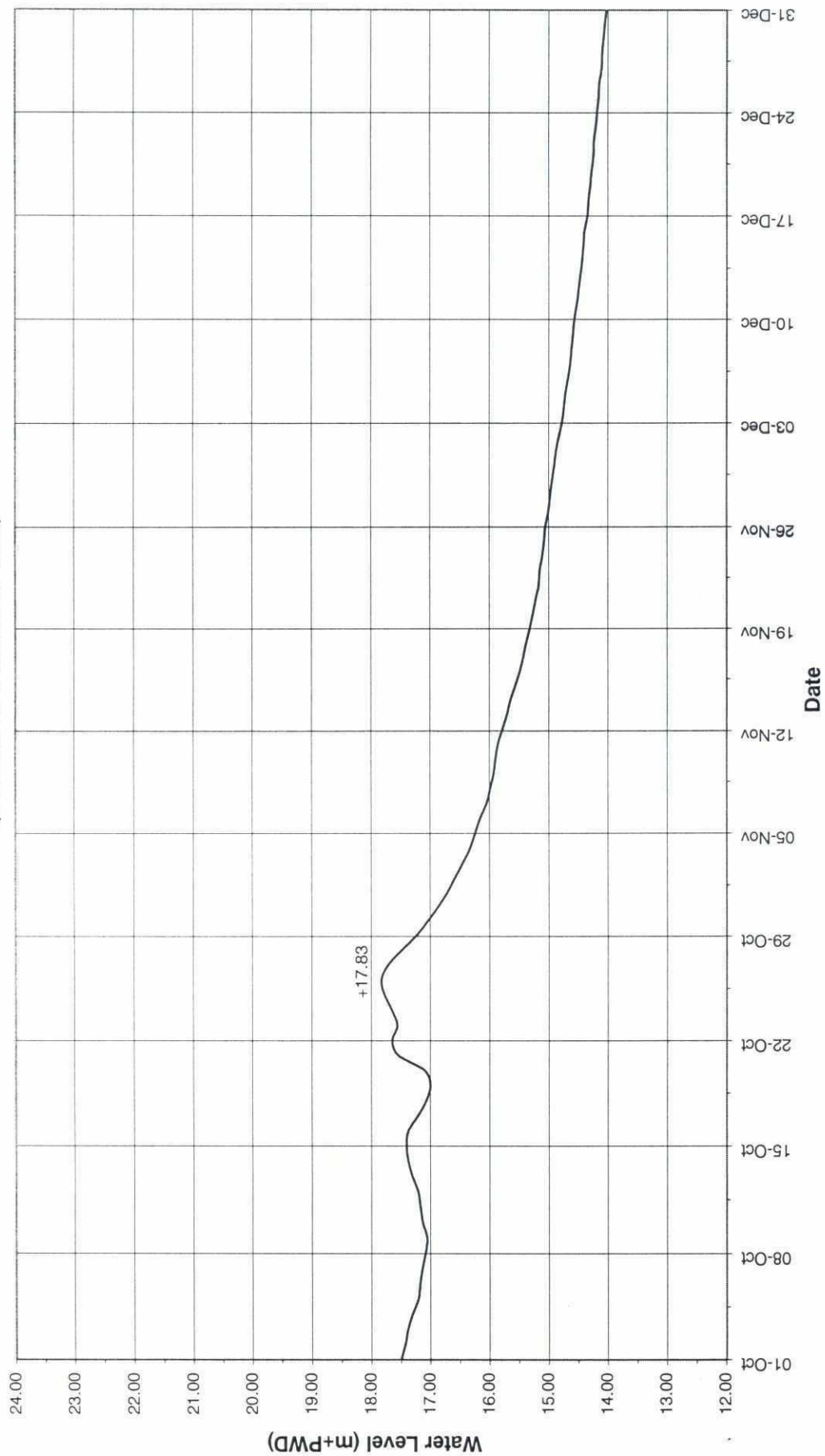
BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT BAHADURABAD TEST SITE
MONTH : NOVEMBER 1999

DAYS	T I M E			REMARKS
	8.00	13.00	17.00	
1	16.710	16.700	16.680	
2	16.580	16.550	16.530	
3	16.450	16.430	16.410	
4	16.330	16.310	16.300	
5	16.240	16.220	16.210	
6	16.160	16.140	16.090	
7	16.050	16.030	16.020	
8	15.990	15.980	15.970	
9	15.930	15.920	15.910	
10	15.900	15.900	15.890	
11	15.860	15.850	15.850	
12	15.790	15.780	15.770	
13	15.710	15.700	15.680	
14	15.650	15.640	15.630	
15	15.570	15.550	15.530	
16	15.490	15.480	15.470	
17	15.430	15.420	15.410	
18	15.380	15.370	15.360	
19	15.320	15.310	15.300	
20	15.270	15.260	15.250	
21	15.220	15.210	15.200	
22	15.170	15.160	15.160	
23	15.150	15.140	15.130	
24	15.110	15.100	15.090	
25	15.080	15.070	15.070	
26	15.060	15.060	15.050	
27	15.010	15.010	15.000	
28	14.980	14.980	14.980	
29	14.950	14.940	14.930	
30	14.910	14.960	14.900	

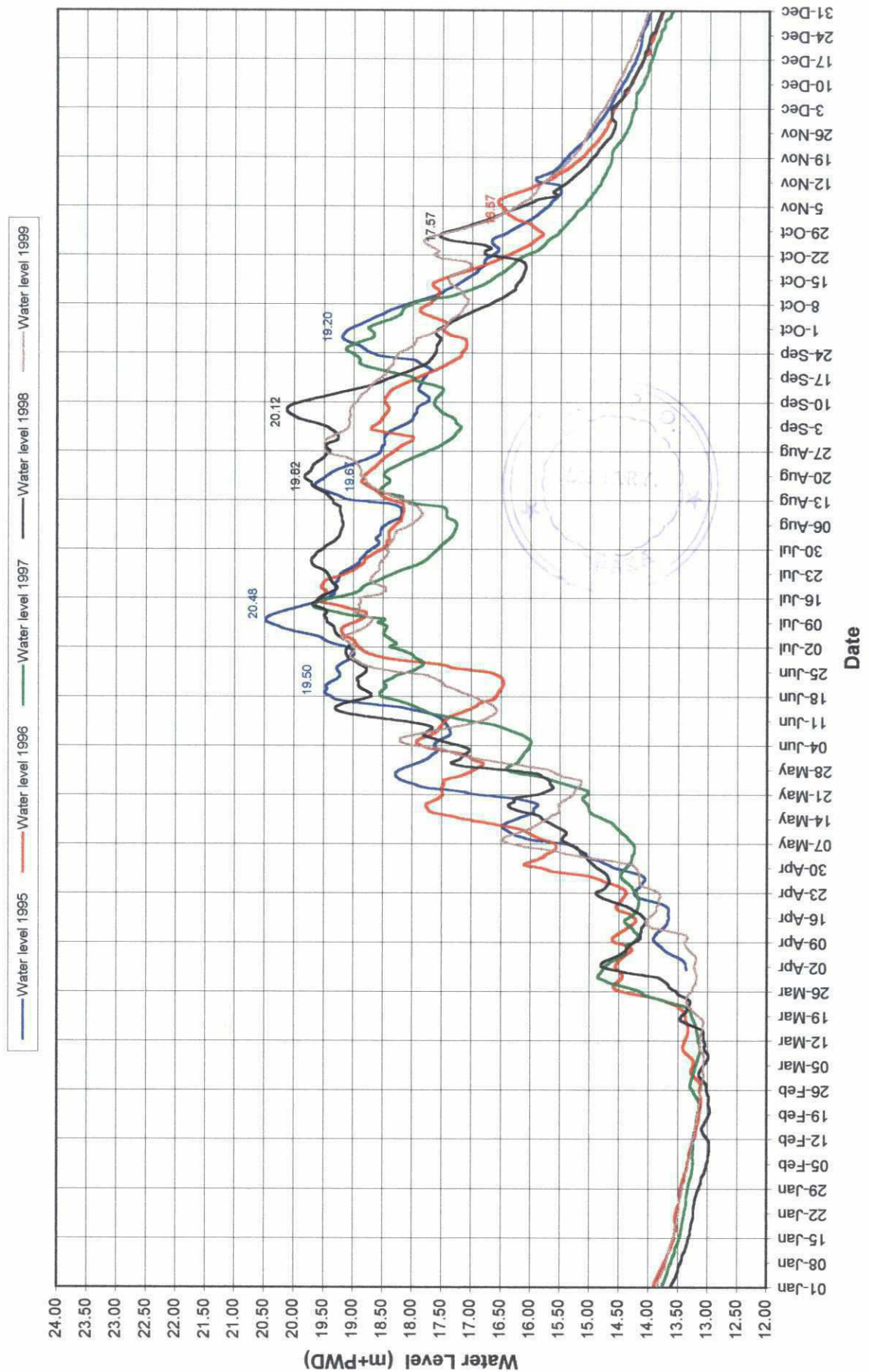
BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT BAHADURABAD TEST SITE
MONTH : DECEMBER 1999

DAYS	T I M E			REMARKS
	8.00	13.00	17.00	
1	14.880	14.860	14.860	
2	14.830	14.820	14.820	
3	14.780	14.780	14.780	
4	14.750	14.750	14.740	
5	14.720	14.710	14.700	
6	14.680	14.670	14.670	
7	14.640	14.640	14.640	
8	14.620	14.610	14.610	
9	14.590	14.590	14.580	
10	14.570	14.550	14.550	
11	14.530	14.520	14.520	
12	14.500	14.490	14.480	
13	14.470	14.460	14.460	
14	14.440	14.440	14.430	
15	14.420	14.410	14.410	
16	14.400	14.380	14.370	
17	14.350	14.350	14.350	
18	14.330	14.320	14.310	
19	14.300	14.290	14.280	
20	14.280	14.270	14.260	
21	14.250	14.250	14.250	
22	14.240	14.230	14.230	
23	14.210	14.210	14.200	
24	14.190	14.190	14.180	
25	14.160	14.160	14.160	
26	14.150	14.140	14.130	
27	14.110	14.110	14.100	
28	14.100	14.100	14.100	
29	14.080	14.070	14.070	
30	14.060	14.060	14.050	
31	14.030	14.030	14.030	

BANK PROTECTION TEST STRUCTURES - FAP 21 **WATER LEVEL AT BAHADURABAD TEST SITE** **(October to December 1999)**

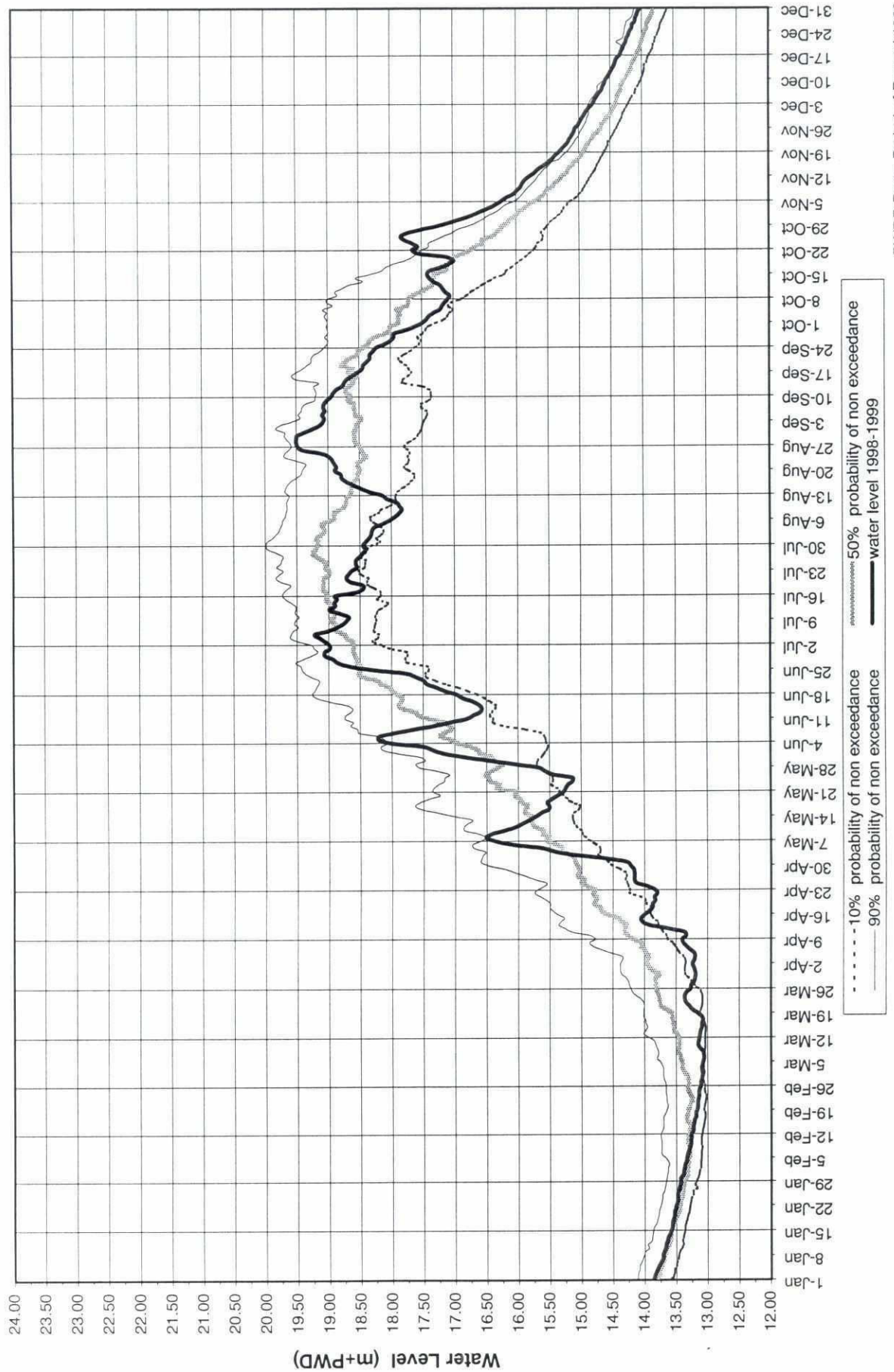


BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT BAHADURABAD TEST SITE
(January to December)



69

BANK PROTECTION TEST STRUCTURES - FAP 21
BWDB WATER LEVEL FREQUENCY CURVES VERSUS ACTUAL FAP 21 WATER LEVEL
AT BAHADURABAD TEST SITE UP TO DECEMBER '99



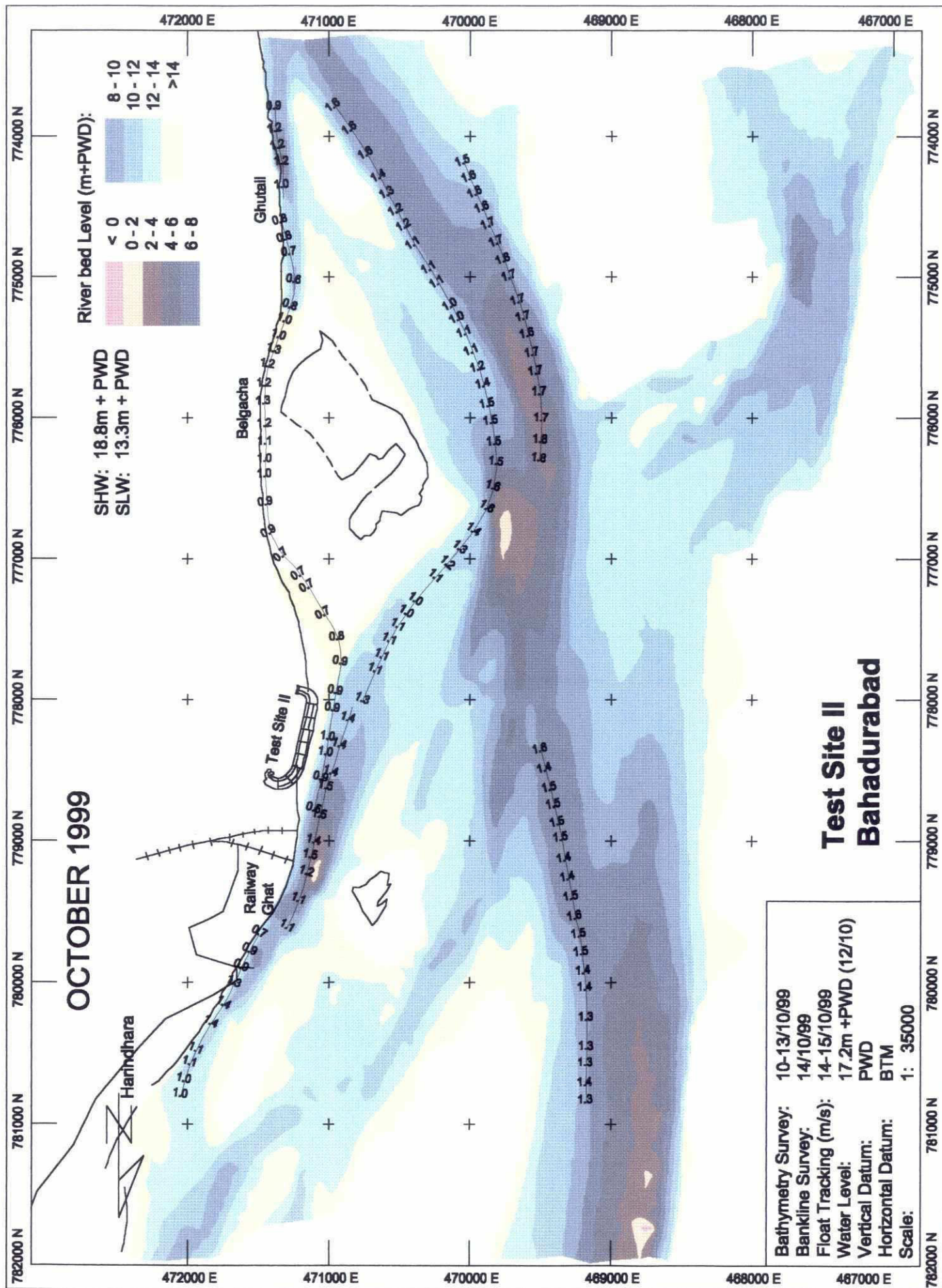
BWDB Data: Period of Record 1962 ~ 1994

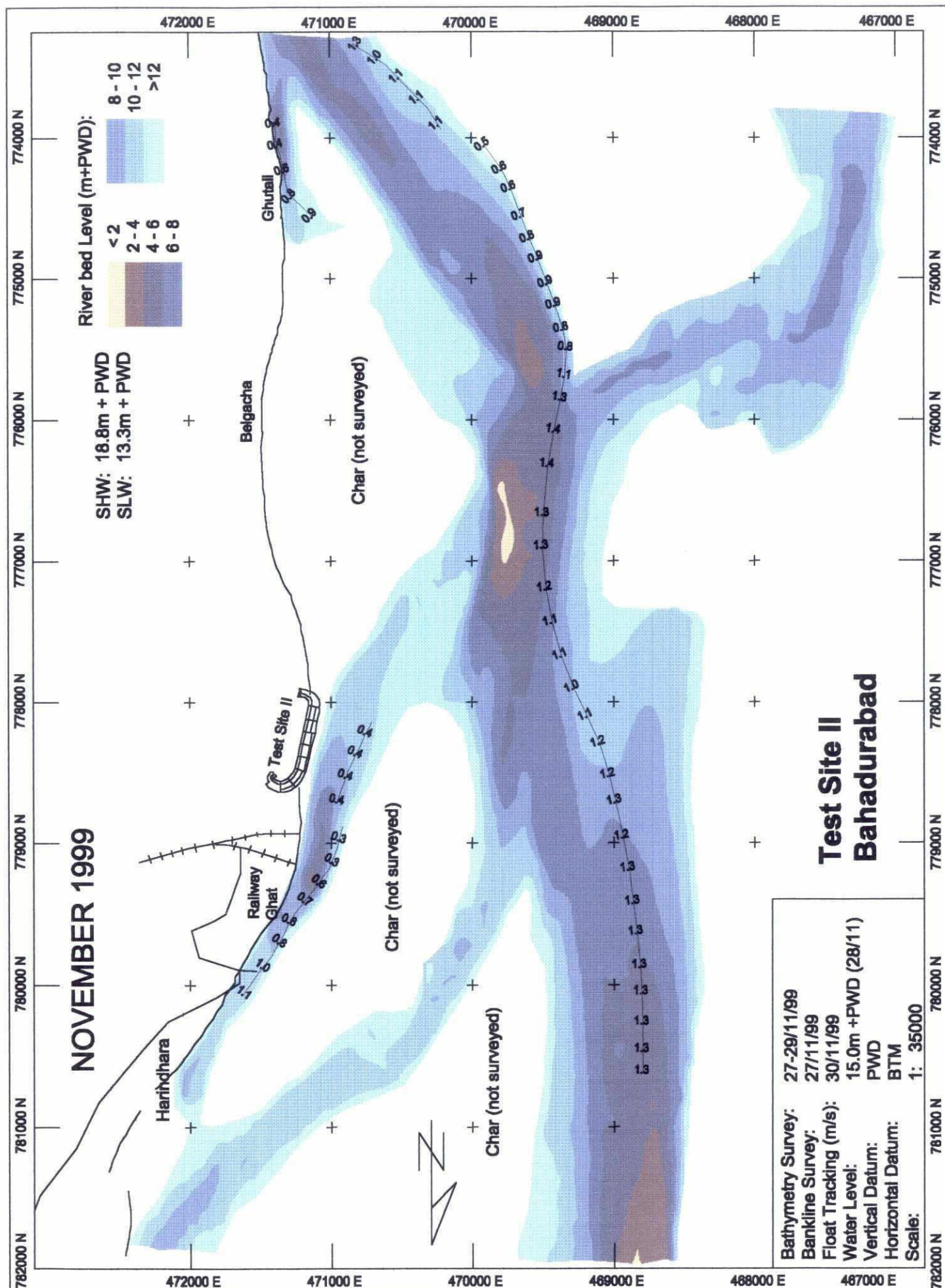
ANNEX G

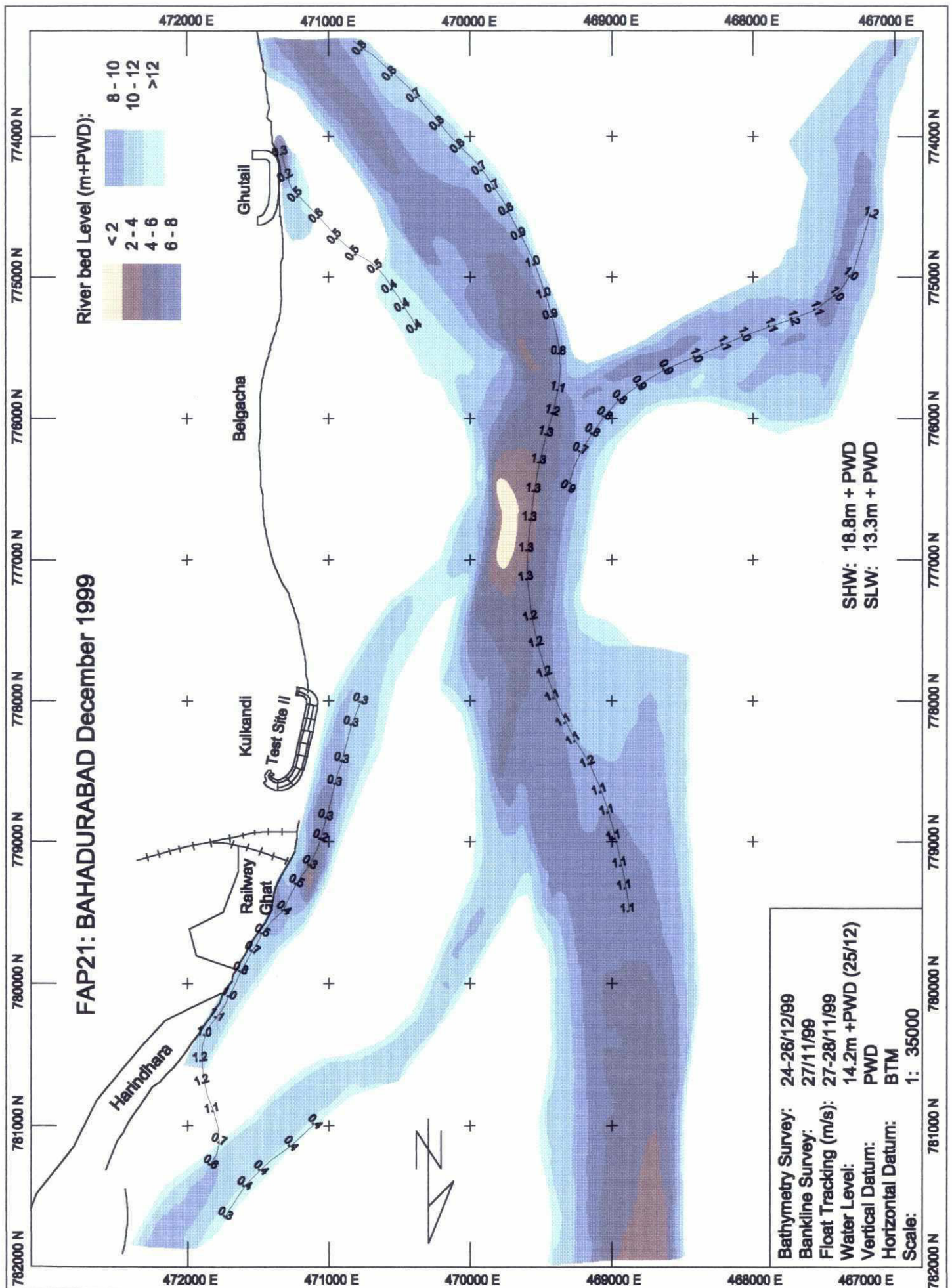
FAP 21 / Test Site II

- Bathymetric Survey and
Flow Velocities

92





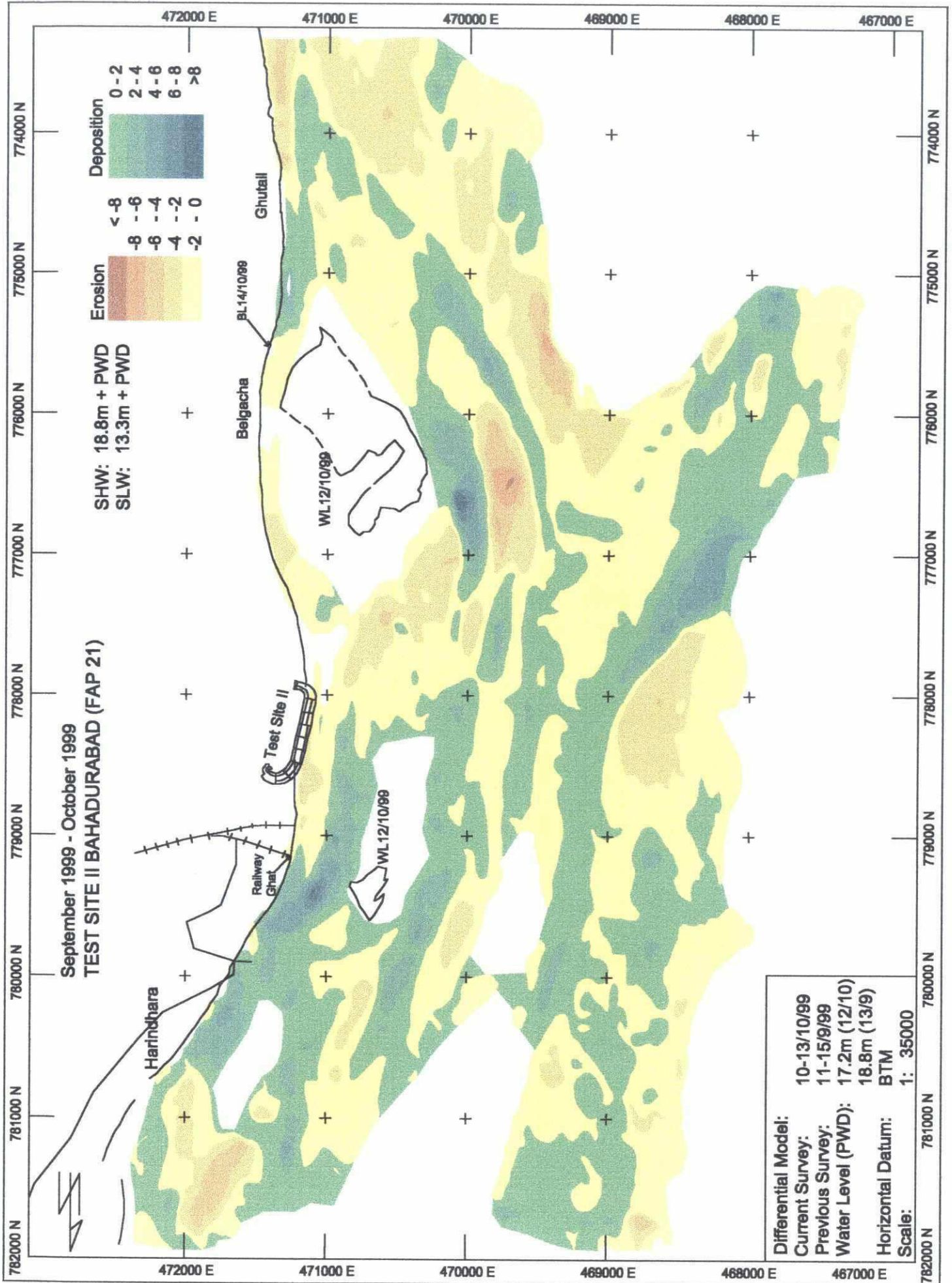


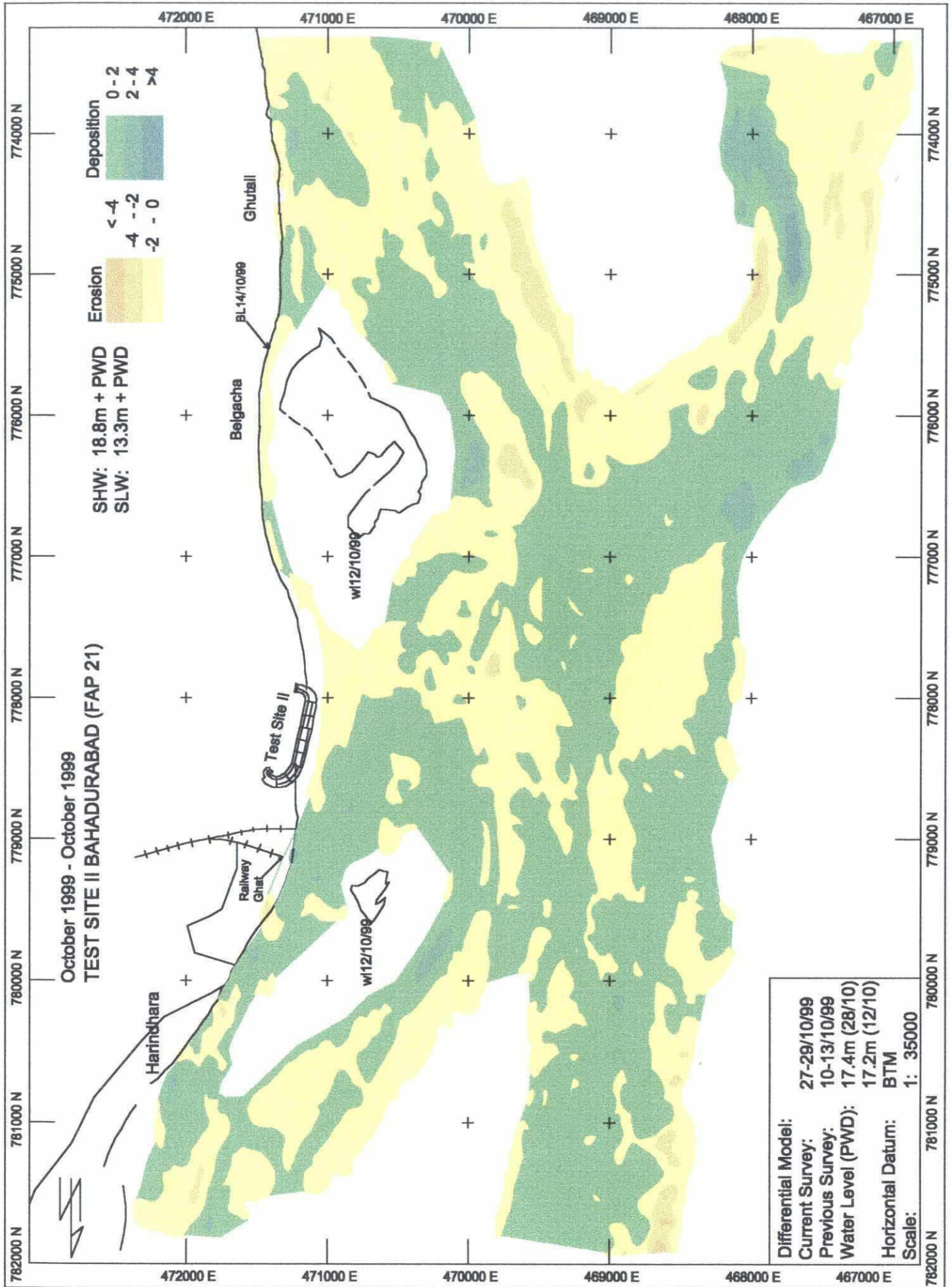


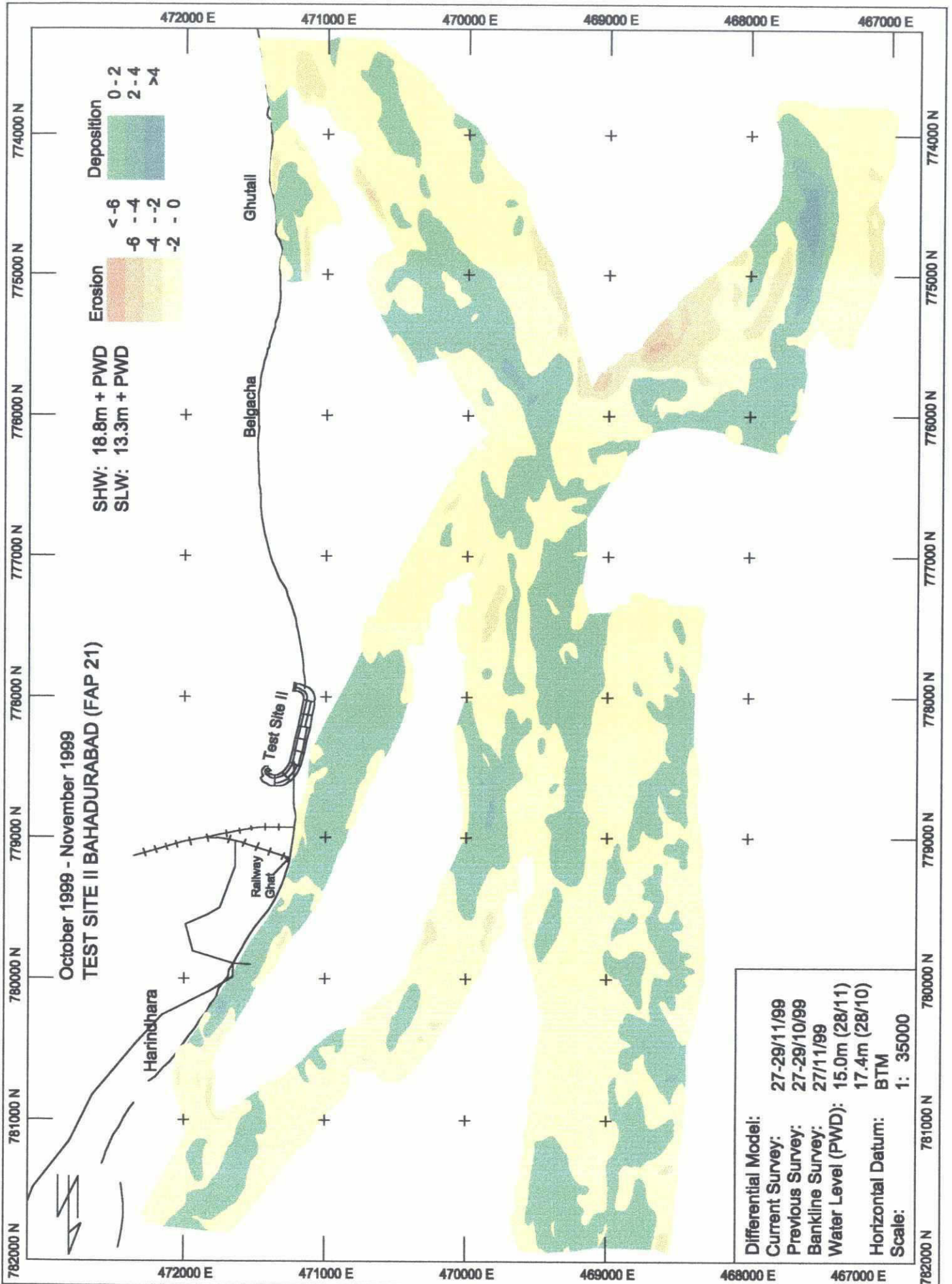
ANNEX H

FAP 21 / Test Site II

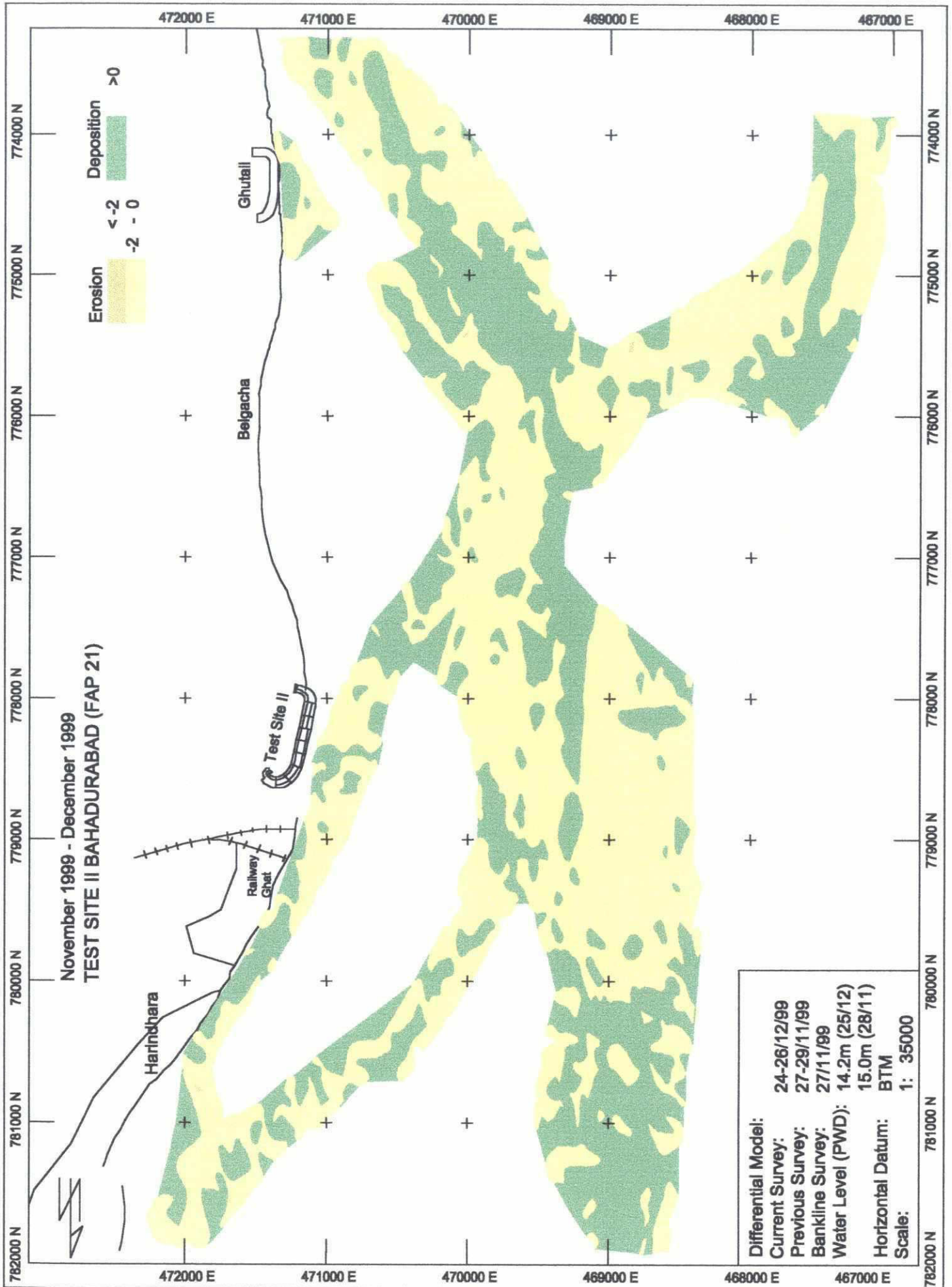
- Differential Models







69



28



ANNEX I

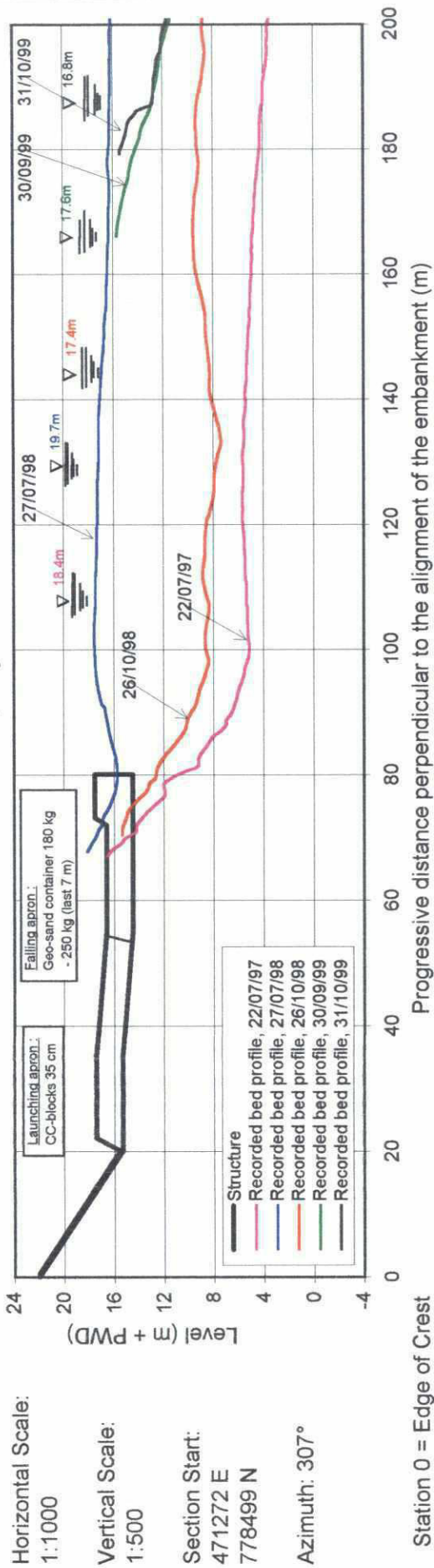
FAP 21 / Test Site II

- Cross-Sections end of October 1999

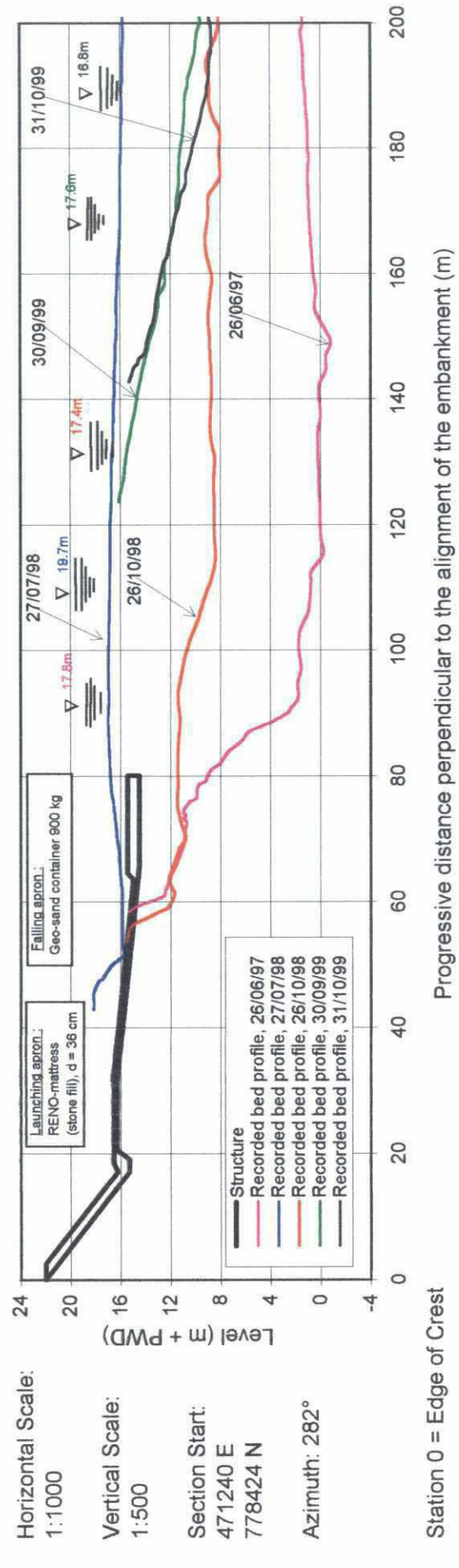
67

BAHADURABAD (FAP 21) - TEST SITE II

Cross-Section B, July '97 to October '99

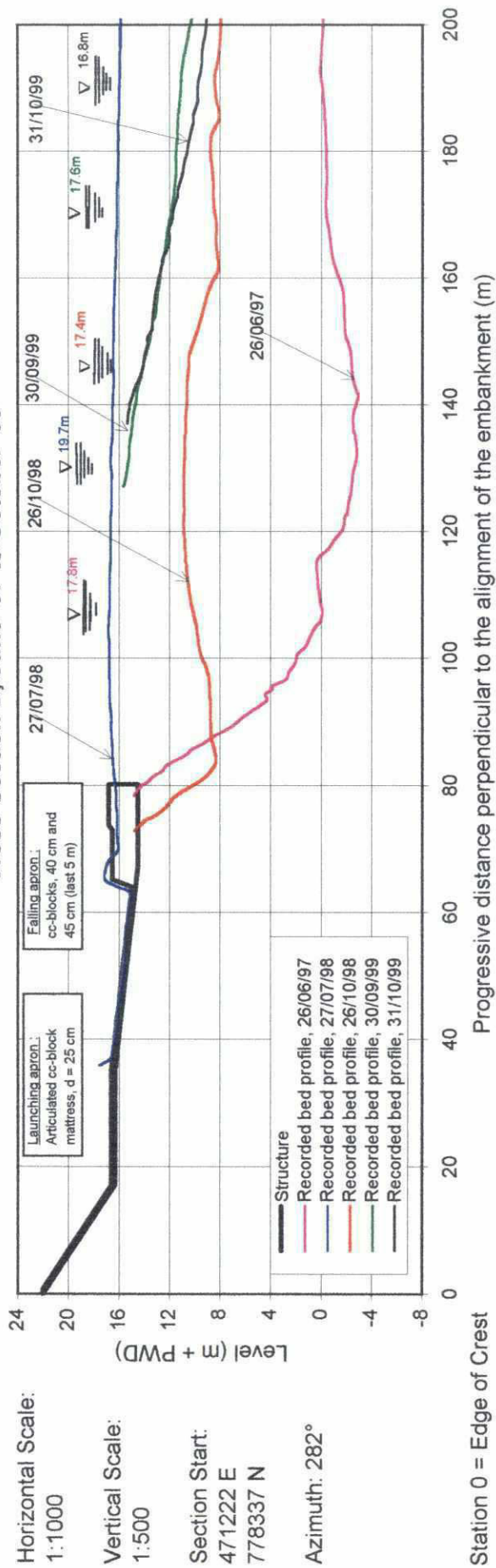


Cross-Section C, June '97 to October '99

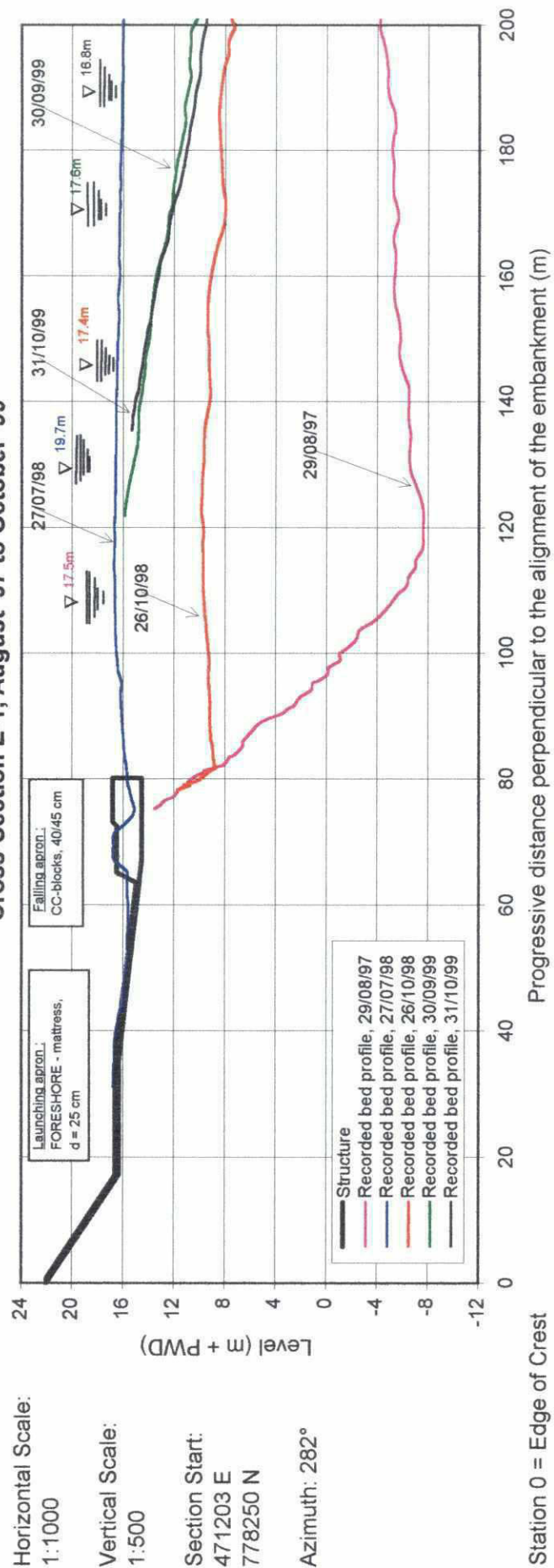


BAHADURABAD (FAP 21) - TEST SITE II

Cross-Section D, June '97 to October '99

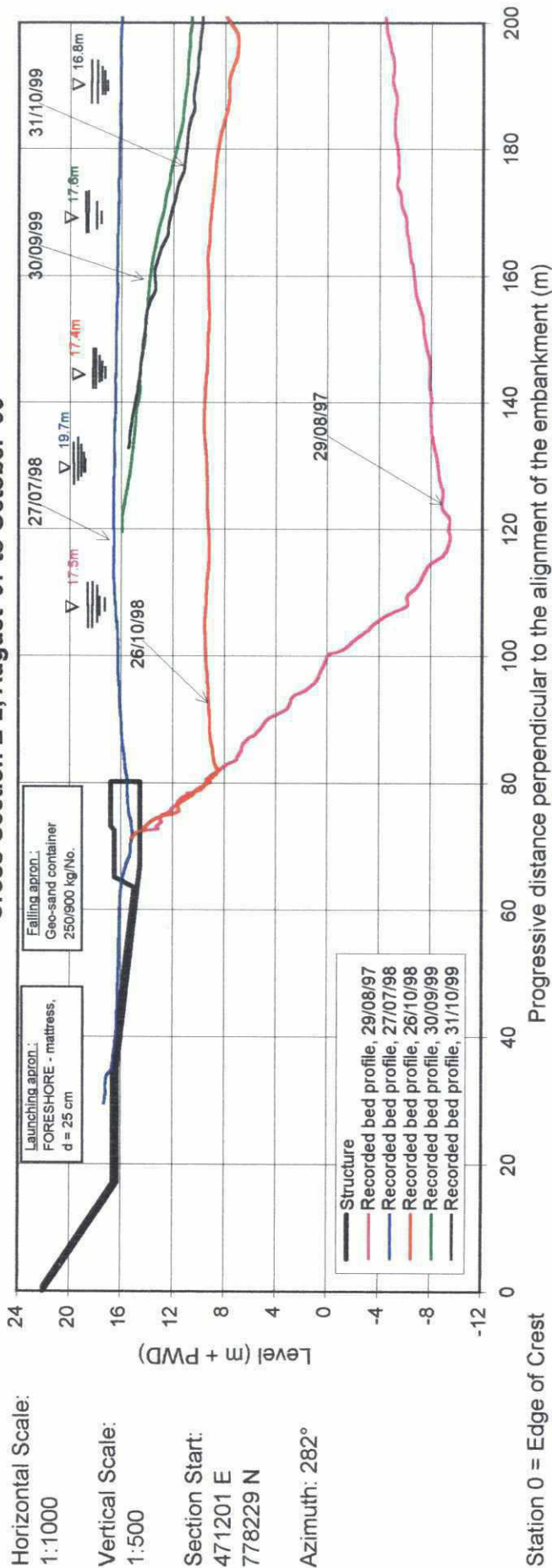


Cross-Section E-1, August '97 to October '99

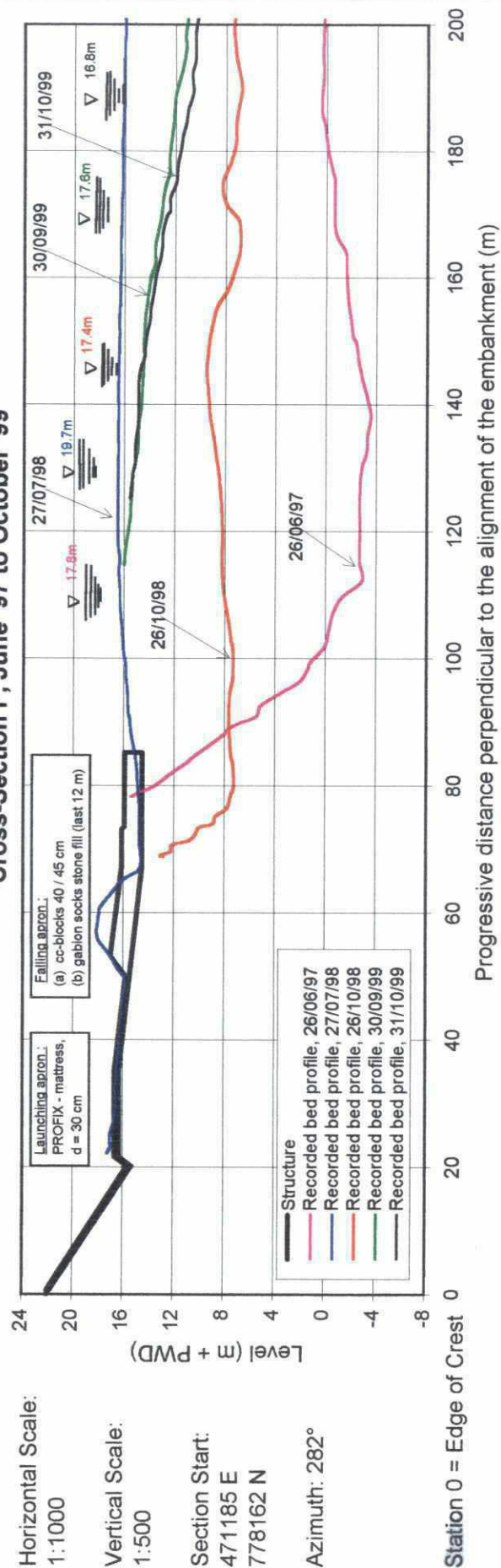


BAHADURABAD (FAP 21) - TEST SITE II

Cross-Section E-2, August '97 to October '99

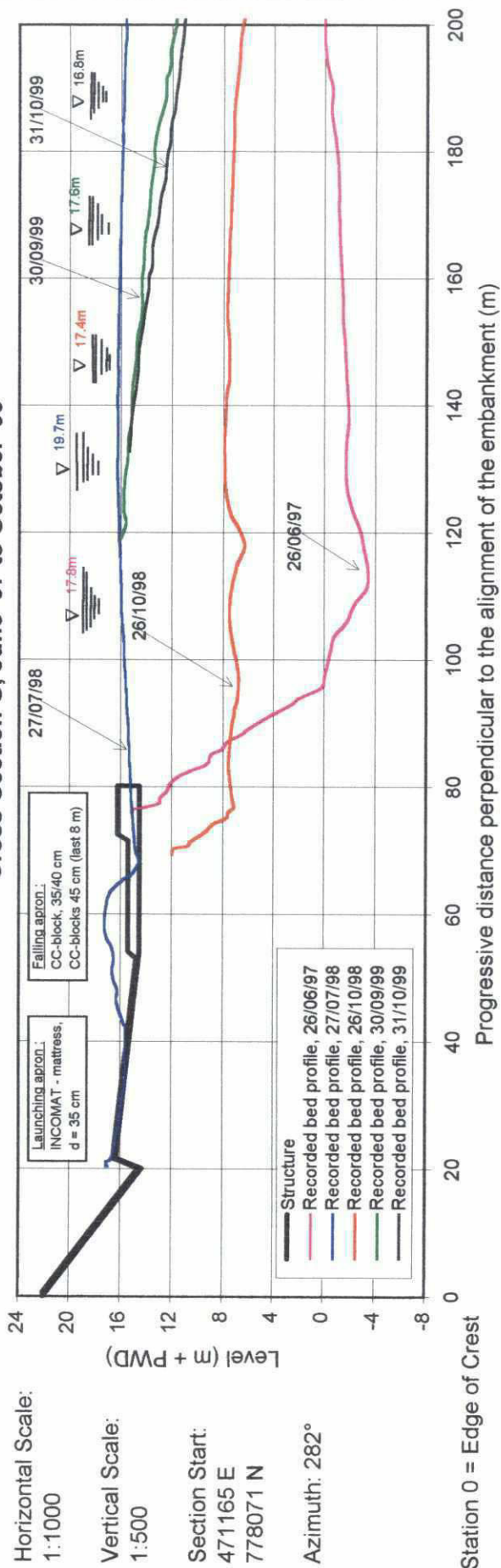


Cross-Section F, June '97 to October '99

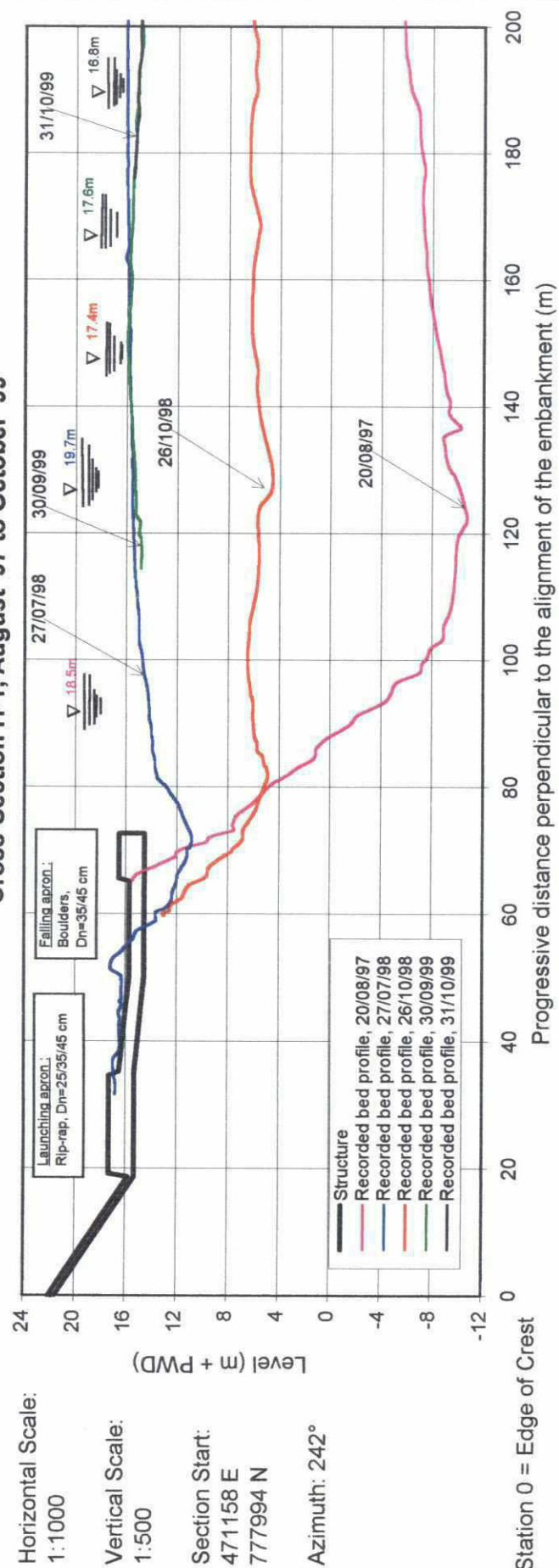


BAHADURABAD (FAP 21) - TEST SITE II

Cross-Section G, June '97 to October '99



Cross-Section H-1, August '97 to October '99

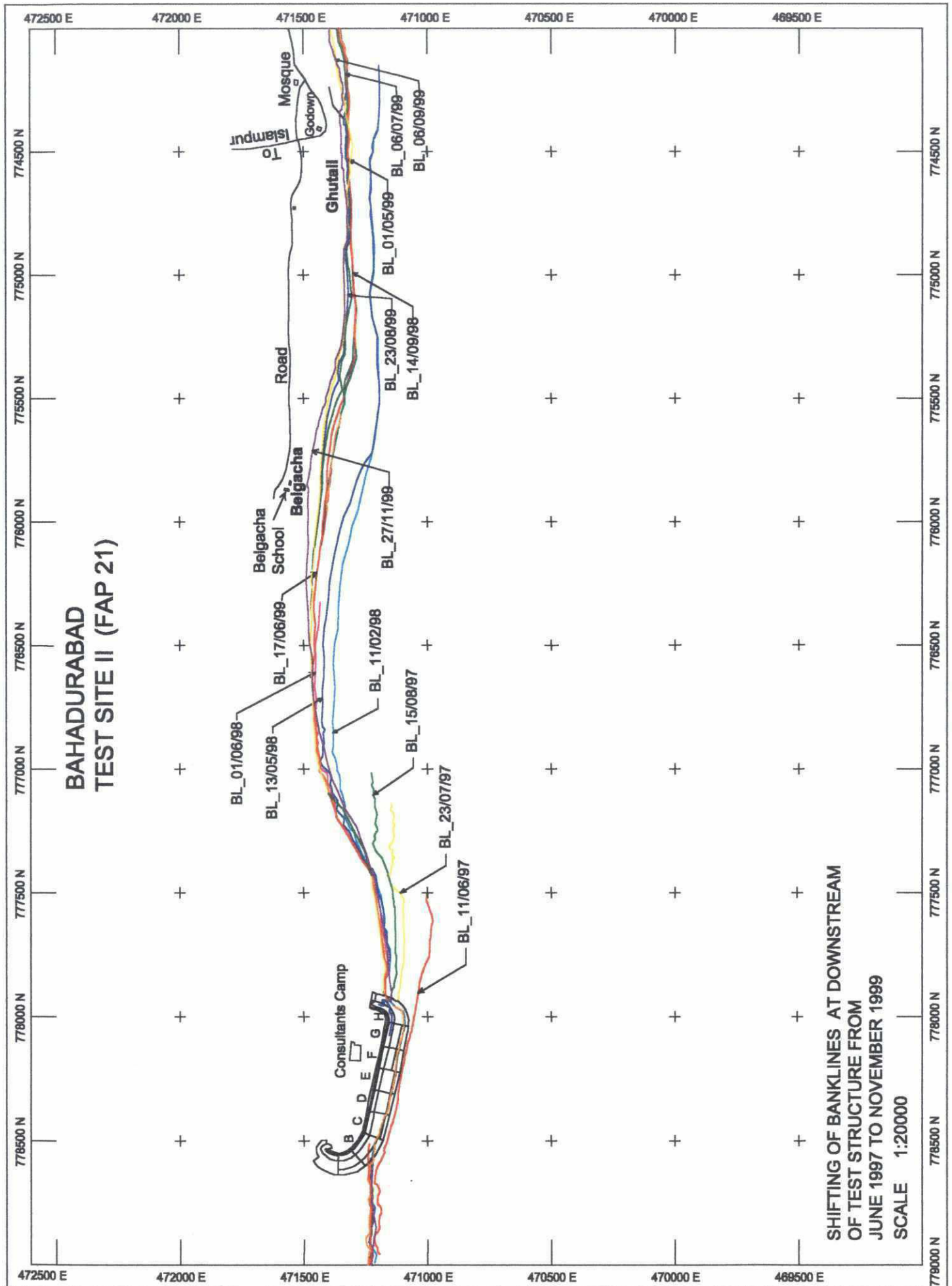




ANNEX K

FAP 21 / Test Site II

- Change of Bankline



28

ANNEX L

FAP 21 / Test Site II

- Photographs



Photo 1: Test Site II – Bahadurabad;
Cultivation after sedimentation in front of the test
structure end of 1999



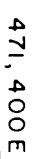
Photo 2: Test Site II – Bahadurabad;
Cultivation after sedimentation in front of the test
structure end of 1999



ANNEX M



FAP 21 / Test Site III

- Detailed Layout and Cross-Sections



DETAILED LAYOUT

[illegible]

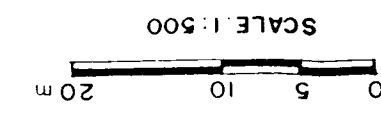
REV	NAME	DATE	DESCRIPTION	APPROVED
1	Answer	24-11-99	NOTATION C - E - H	
2	Answer	25-11-99	TRANSITION	

TEST SITE III - GHUTAIL

[illegible]

BANK PROTECTION PILOT PROJECT FAP-21

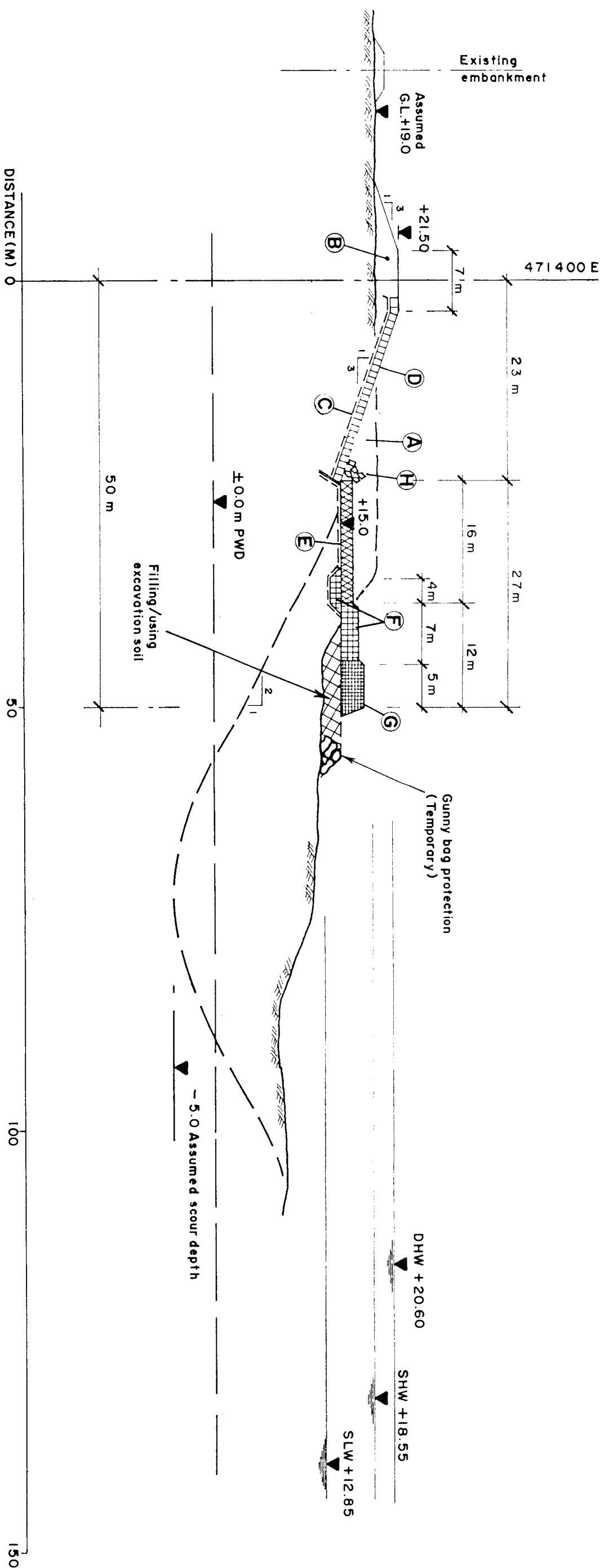
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
FLOOD PLAN CO-ORDINATION ORGANIZATION (FPCO)



1. All measurements in meters.
2. Levels refer to FLOM PWD.
3. SLW = Standard Low Water
SHW = Standard High Water
DHW = Design High Water

Notes

- | | (A) | (B) | (C) | (D) | (E) | |
|------------|-------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------------|--|
| Excavation | Fill, Compact + Profile | Geotextile filter POLYFELT TS-70 | Brick mattressing (d = 15cm) | Articulated RENO-mattresses | d = 30 cm, rubble - fill Grade B/C | (D ₅₀ = 15/20cm) |
| | | | | | | Geotextile filter BIDIM S-82 |
| | | | | | | CC - blocks 40" (32 Nos/m ²) |
| | | | | | | CC - blocks 45" (25 Nos/m ²) |
| | | | | | | CC - blocks 35" 40 Nos./m |



- (A) Excavation
- (B) Fill, Compact + Profile
- (C) Geotextile filter POLYFELT TS-70
- (D) Brick mattsing (d = 15cm)
- (E) Articulated RENO-mattsing
d = 30cm, rubble-fill Grade B/C
(D50 = 15/20cm)
- (F) Geotextile filter BIDIM S-82
- (G) CC-blocks 35^a cm (45 Nos/m²)
- (H) CC-blocks 40^a cm (32 Nos/m²)
- (H) CC-blocks 35^a, 40 Nos/m

Notes

1. All measurements in meters.
2. Levels refer to ±0.0m PWD.
3. S L W = Standard Low Water
S H W = Standard High Water
D H W = Design High Water

0 5 10 20 m
SCALE 1:500

2	Amor	25-11-99	TRANSITION	
1	Amor	21-11-99	NOTATION C-E-H	
REV	NAME	DATE	DESCRIPTION	APPROVED

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
FLOOD PLAN CO-ORDINATION ORGANIZATION (FPCO)

BANK PROTECTION PILOT PROJECT FAP-21

TEST SITE III - GHUTAIL

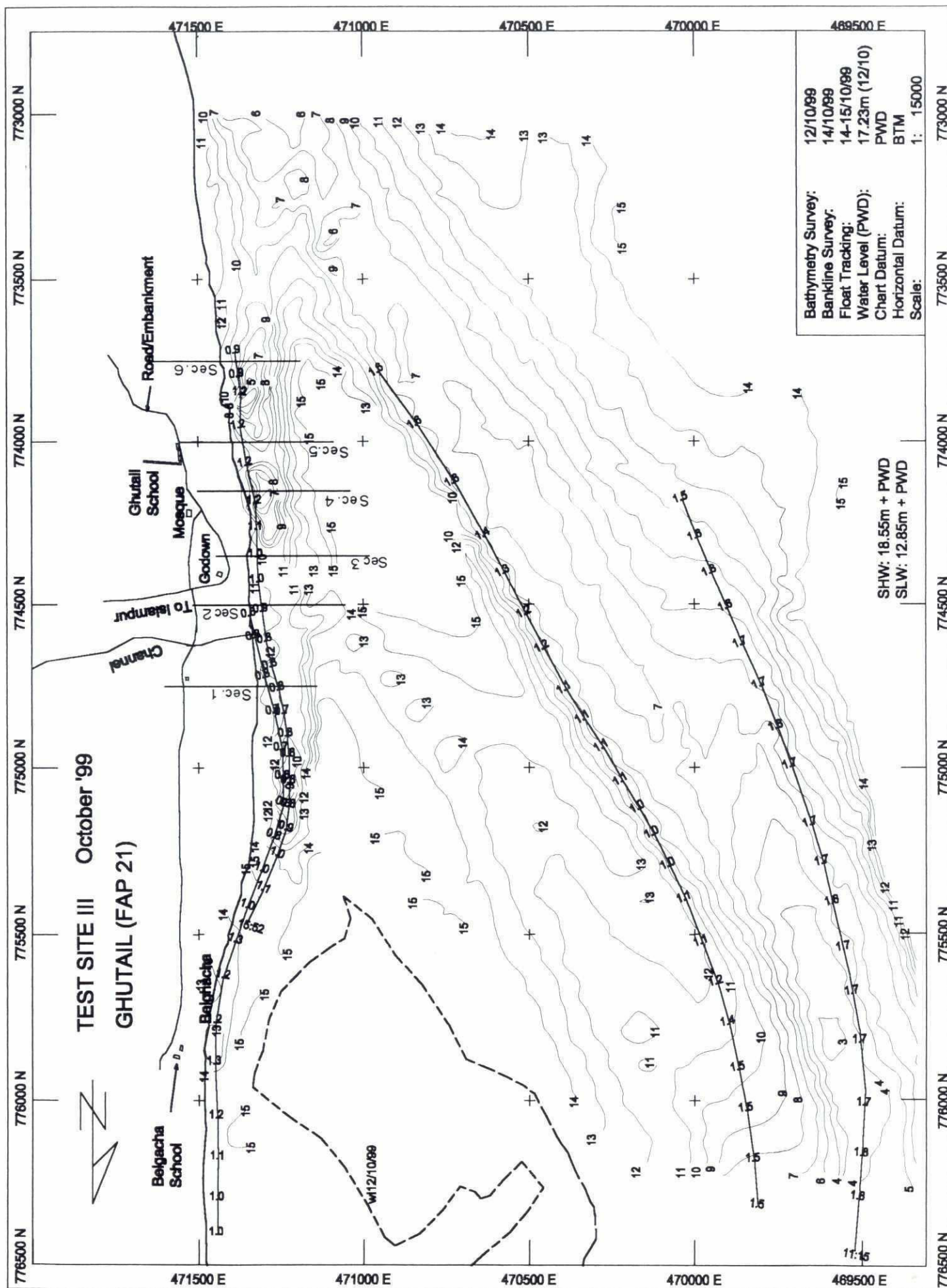
MODIFIED CROSS-SECTION B
(NOVEMBER, 1999)

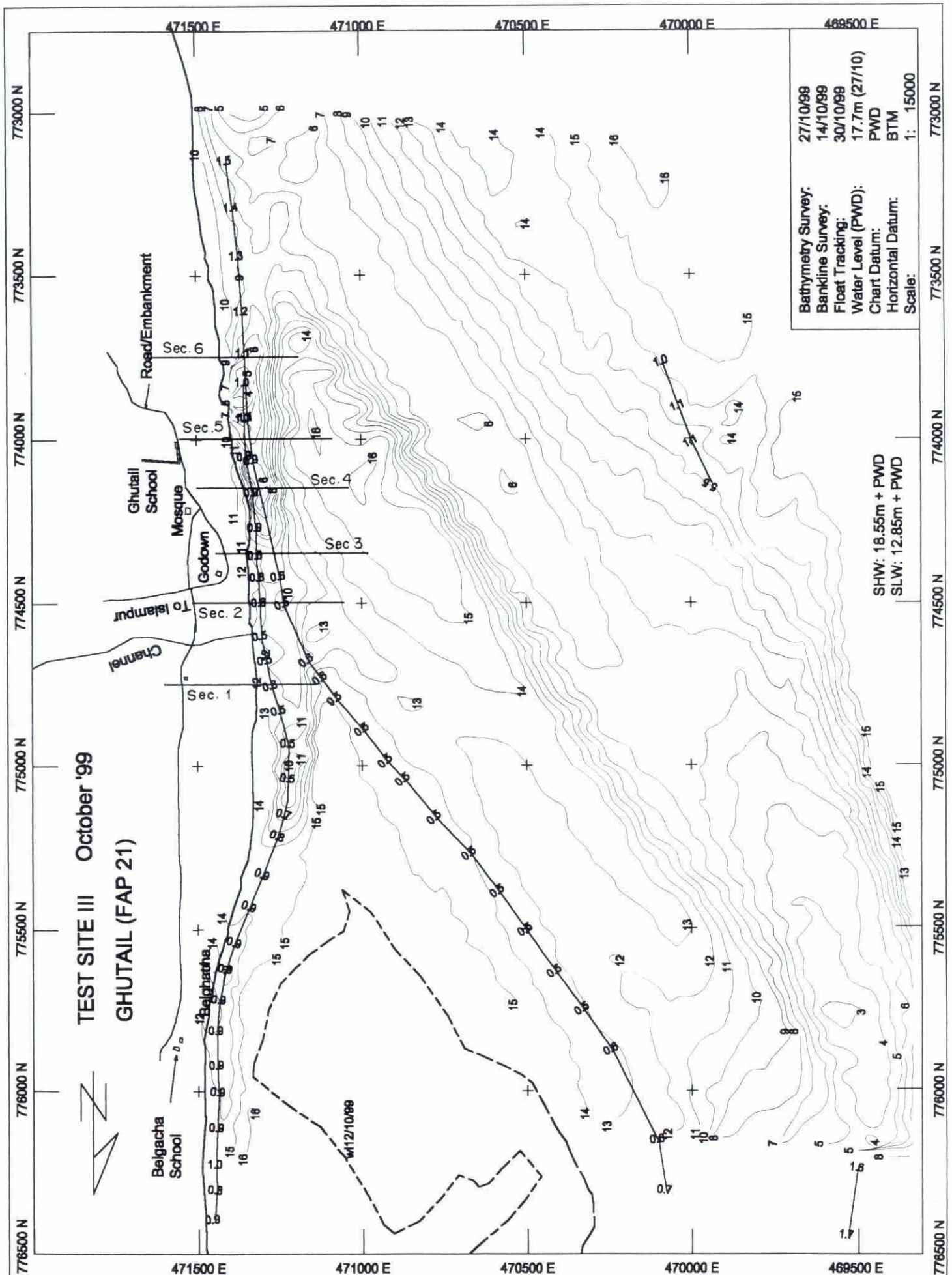
NAME	DATE	SCALE	1:500
DRAWN	AMOR	15-11-99	
CHECKED	21-11-99	DRAWING NO.	III-R-104
APPROVED		REVISION	2

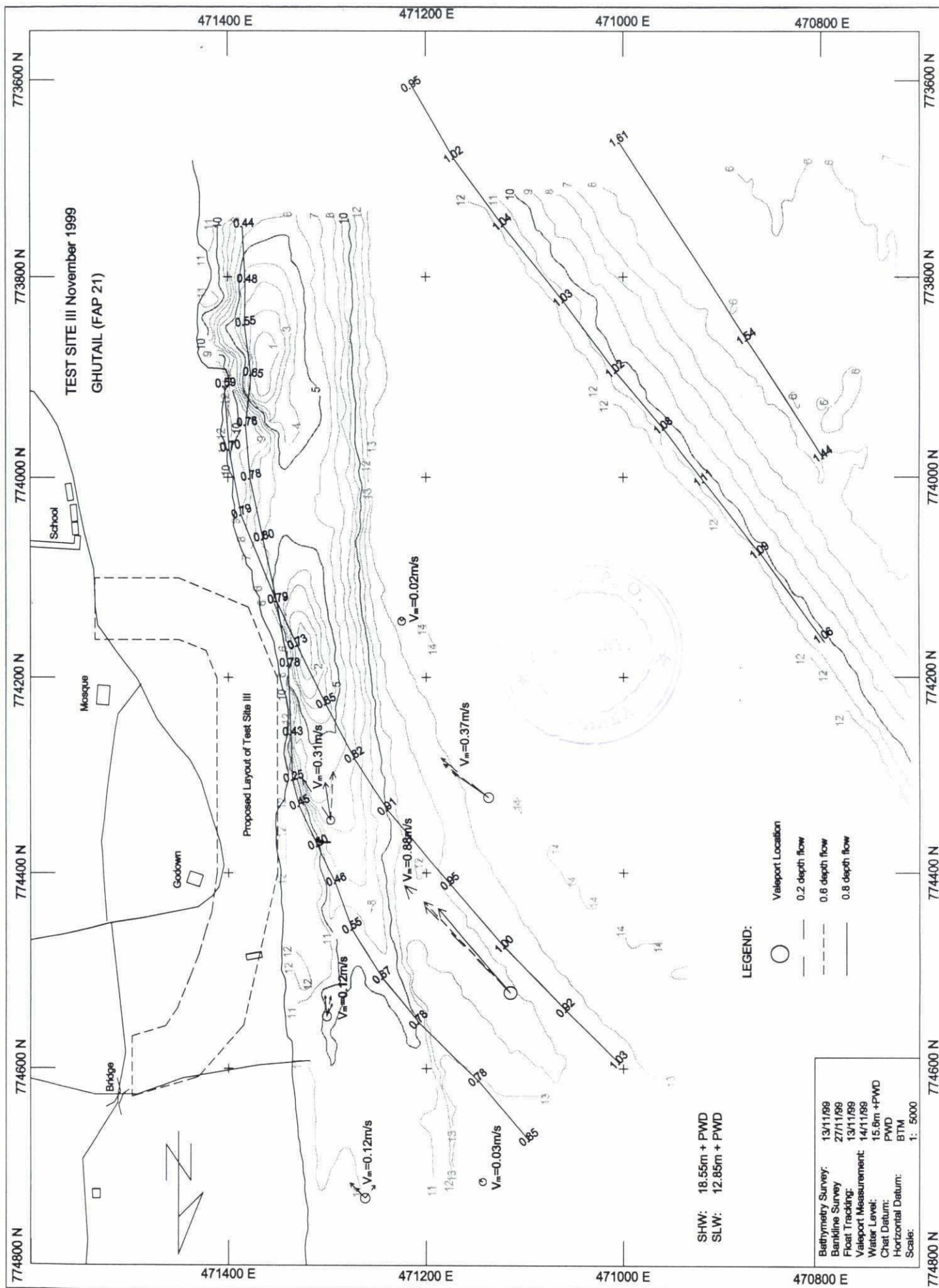
ANNEX N

FAP 21 / Test Site III

- Bathymetric Survey and Flow Velocities





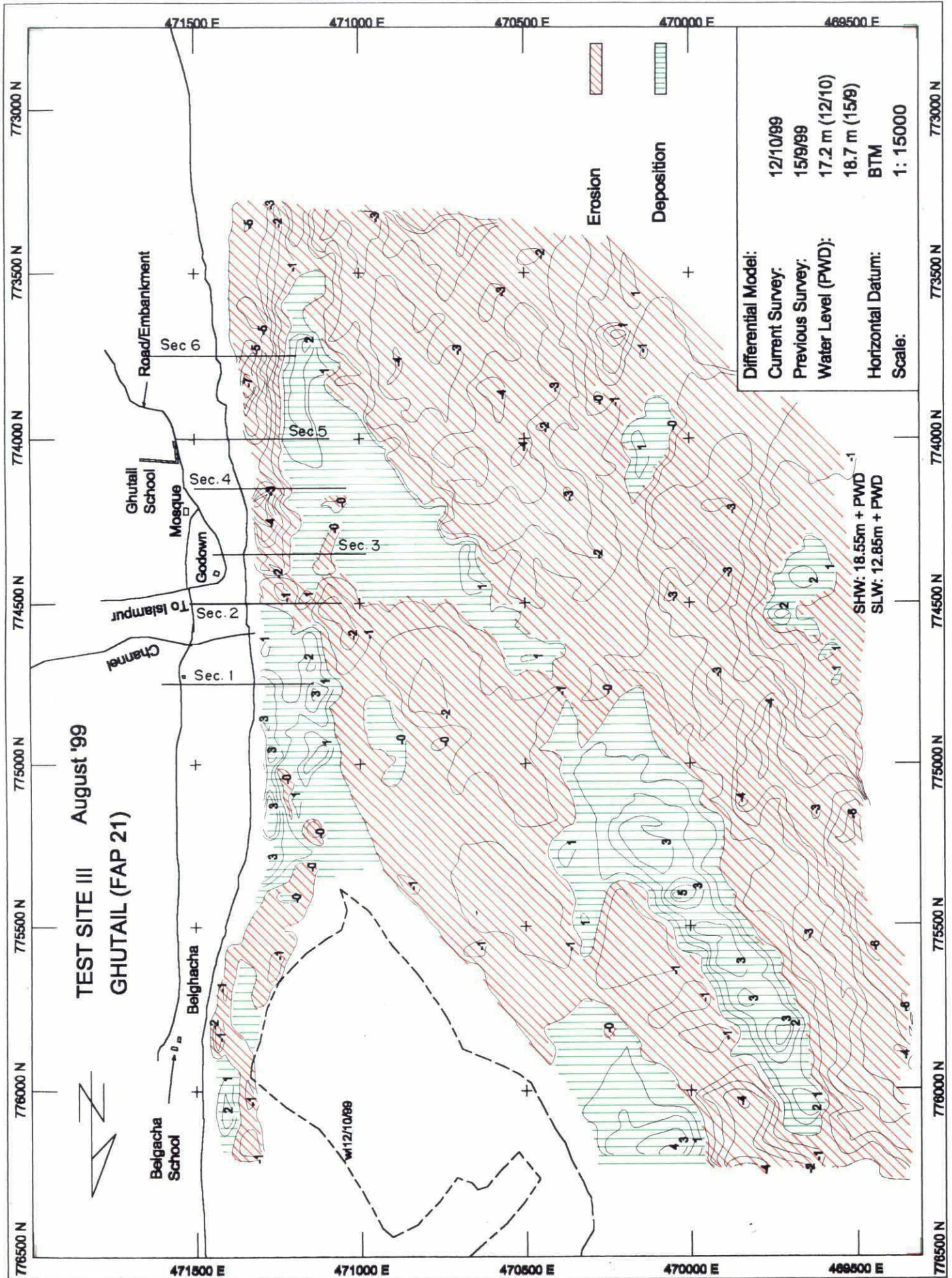


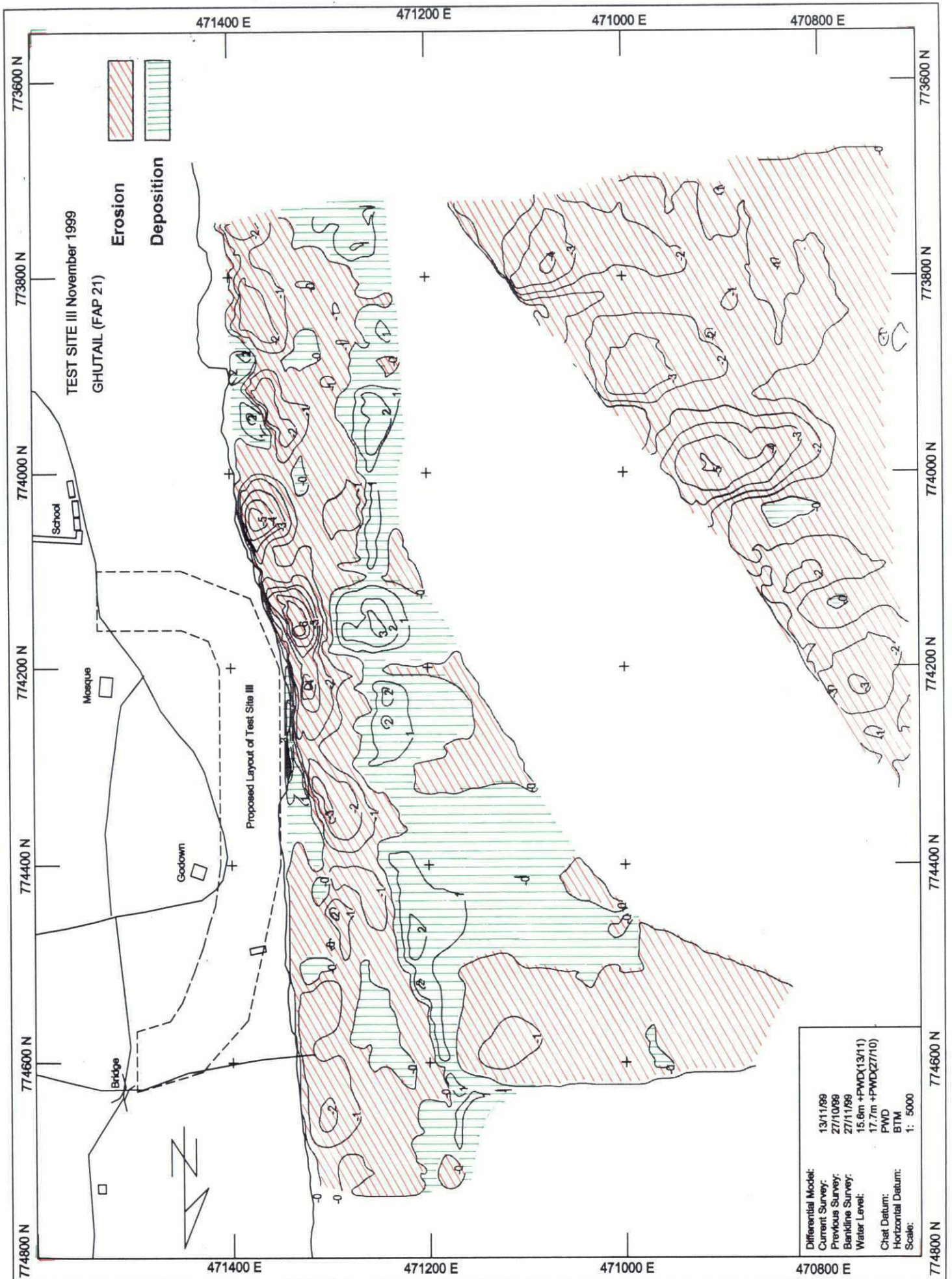


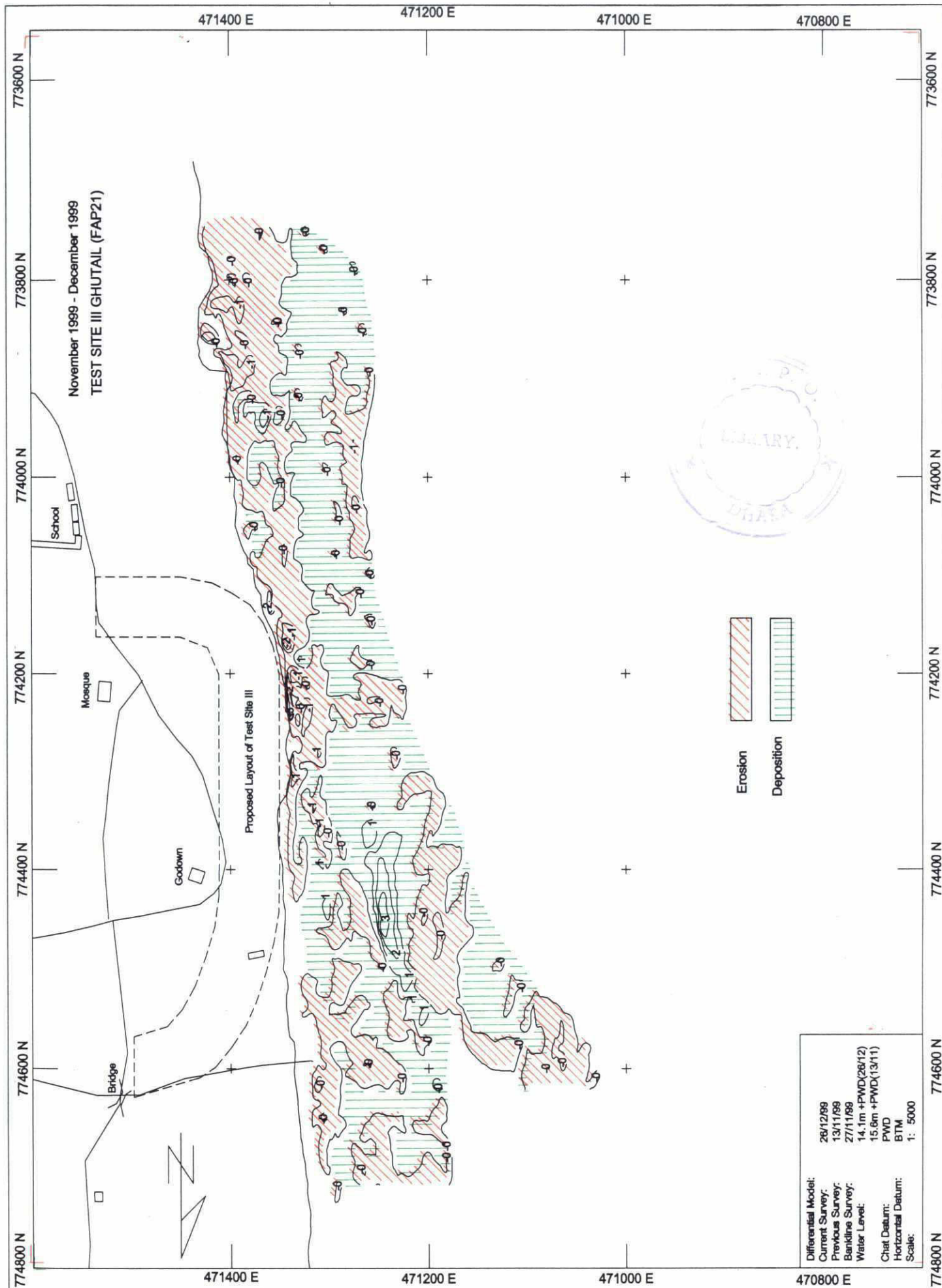
ANNEX O

FAP 21 / Test Site III

- Differential Models



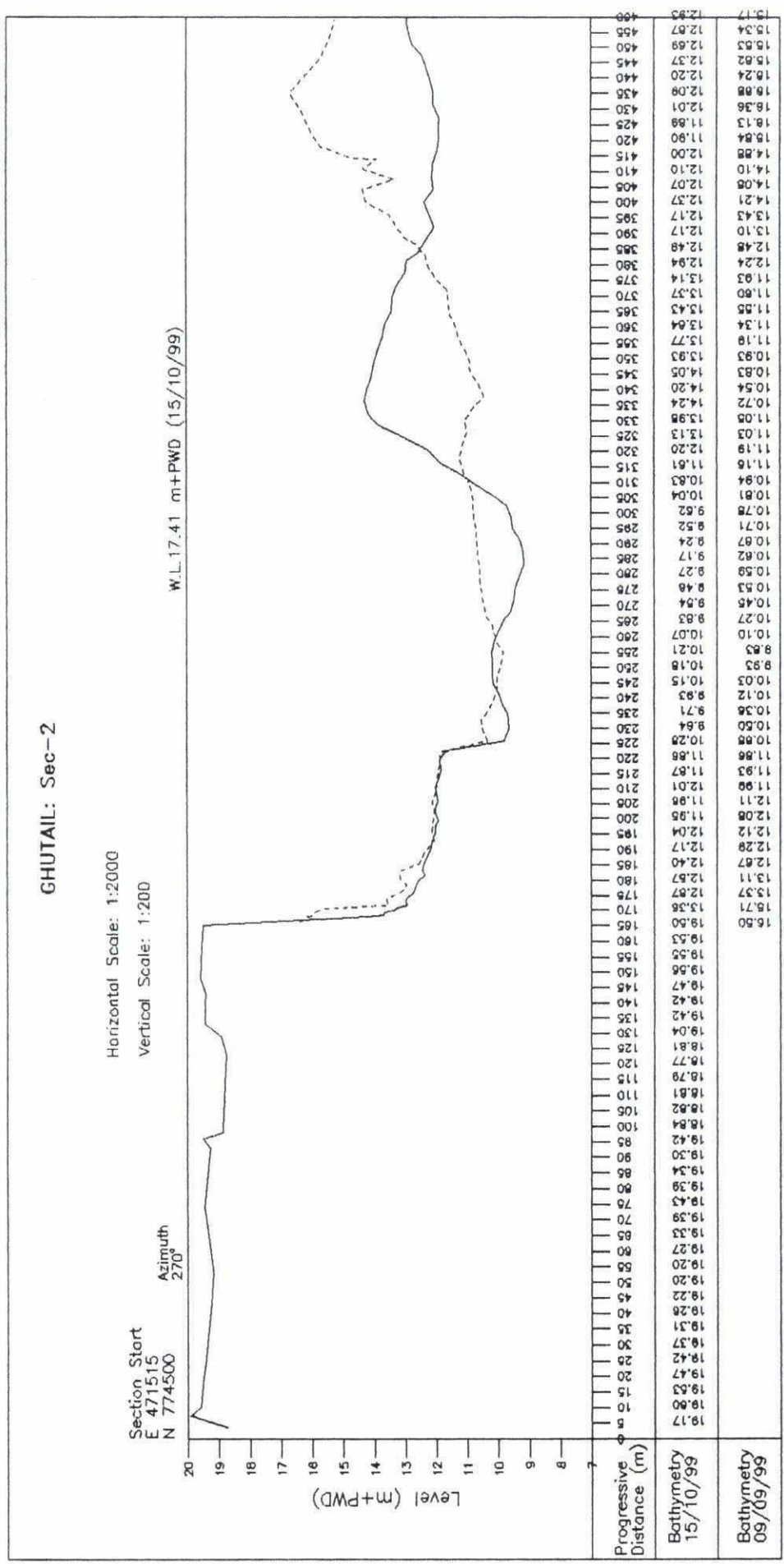




ANNEX P

FAP 21 / Test Site III

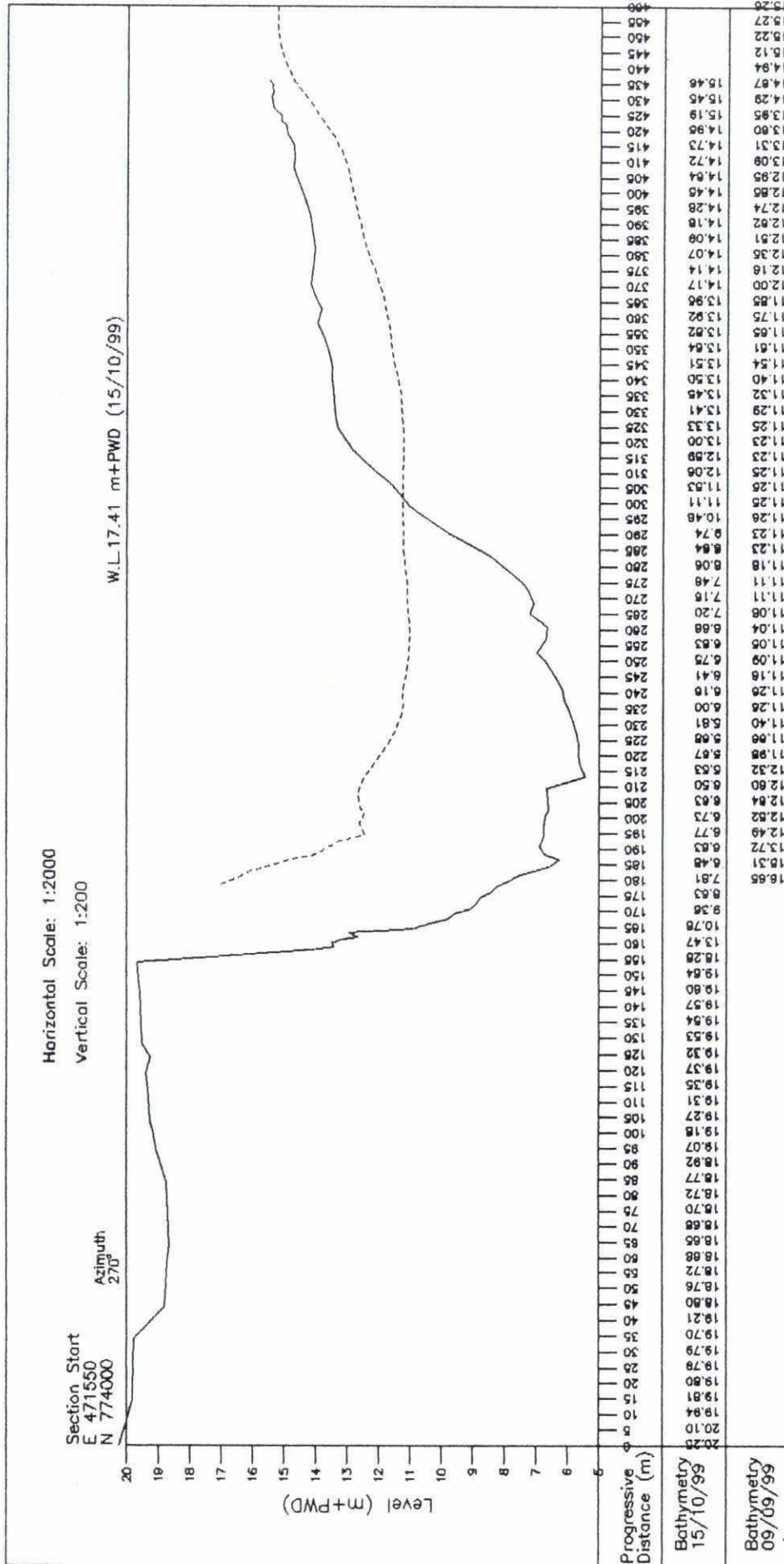
- Cross-Sections



LEGEND
15/10/99
09/09/99

Note: For location see Annex N

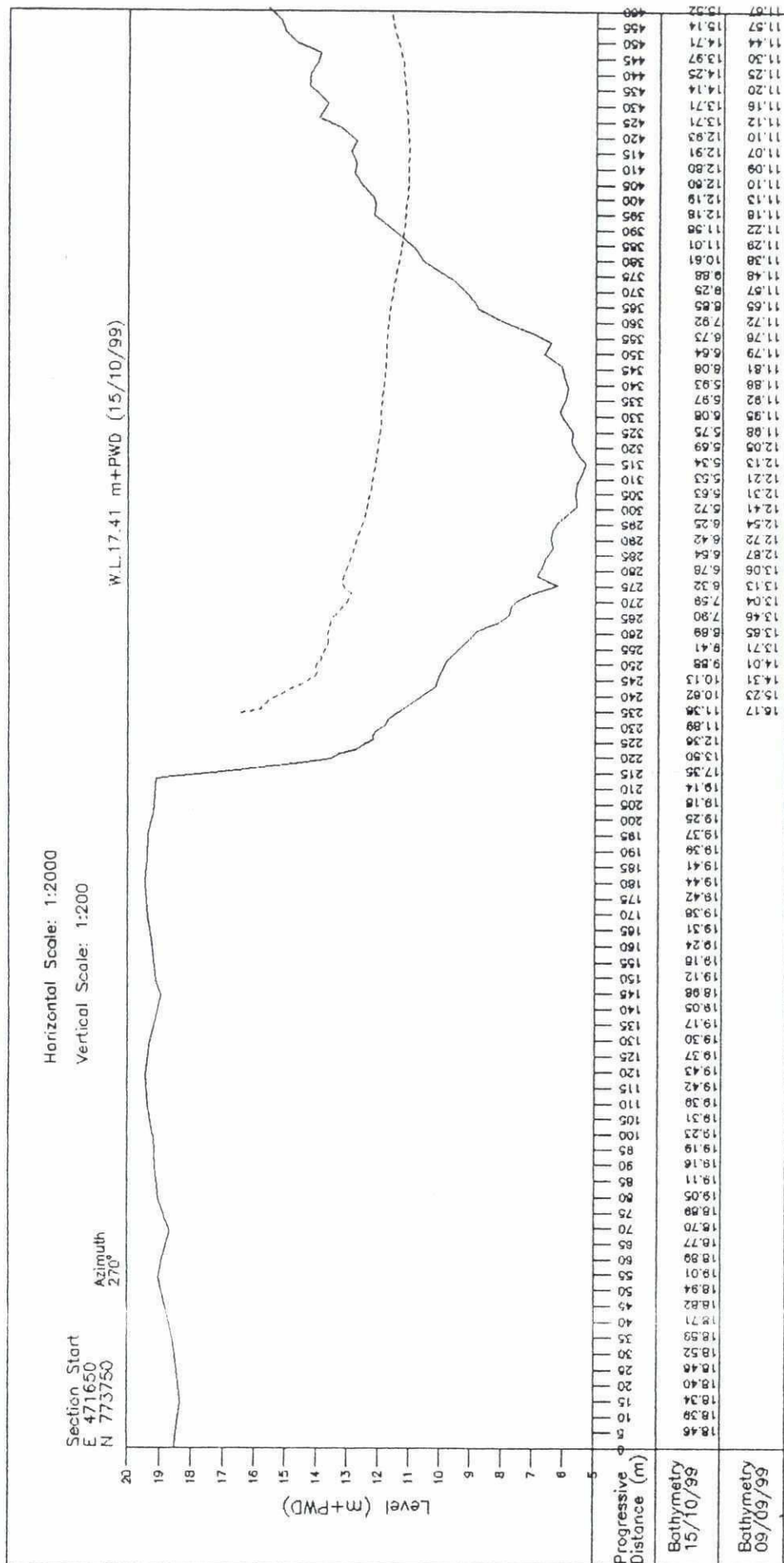
GHUTAIL: Sec-5



Note: For location see Annex N

LEGEND
15/10/99
09/09/99

CHUTAIL: Sec-6



Note: For location see Annex N

LEGEND
15/10/99
09/09/99

ANNEX Q

FAP 21 / Test Site III

- Photographs



Photo 1: Test Site III – Ghutail;
Earth works in progress



Photo 2: Test Site III – Ghutail;
Fabrication of cc-blocks

