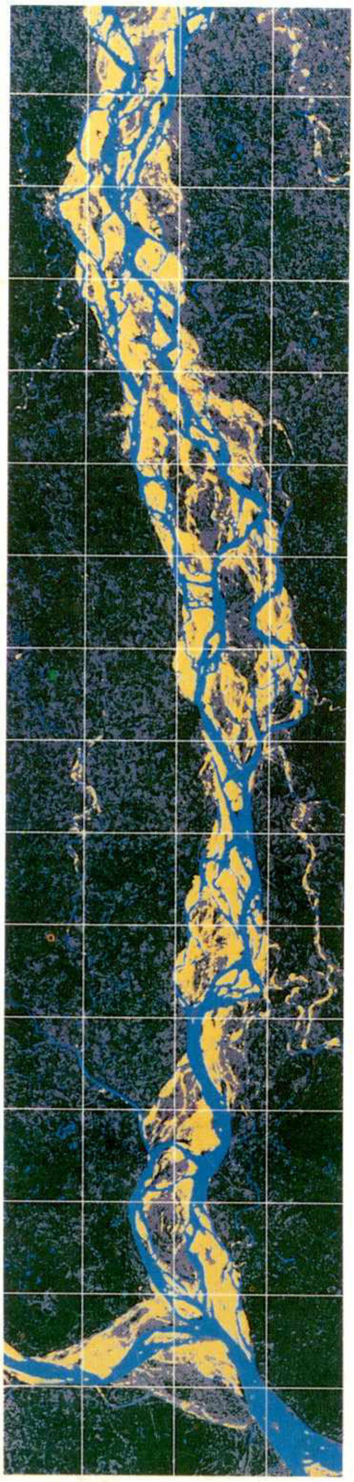
GOVERNMENT OF PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANIZATION

FEDERAL REPUBLIC OF GERMANY

KREDITANSTALT FÜR
WIEDERAUFBAU (KfW)

FRENCH REPUBLIC

CAISSE FRANCAISE DE
DEVELOPPEMENT (CFD)



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

TEST AND IMPLEMENTATION PHASE FAP 21

REPORT ON MONITORING AND ADAPTATION AT BAHADURABAD TEST SITE

ANNEXES

MARCH 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)

2

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

TEST AND IMPLEMENTATION PHASE FAP 21

REPORT ON MONITORING AND ADAPTATION AT BAHADURABAD TEST SITE

A-54

MDP-229

ANNEXES

MARCH 1999

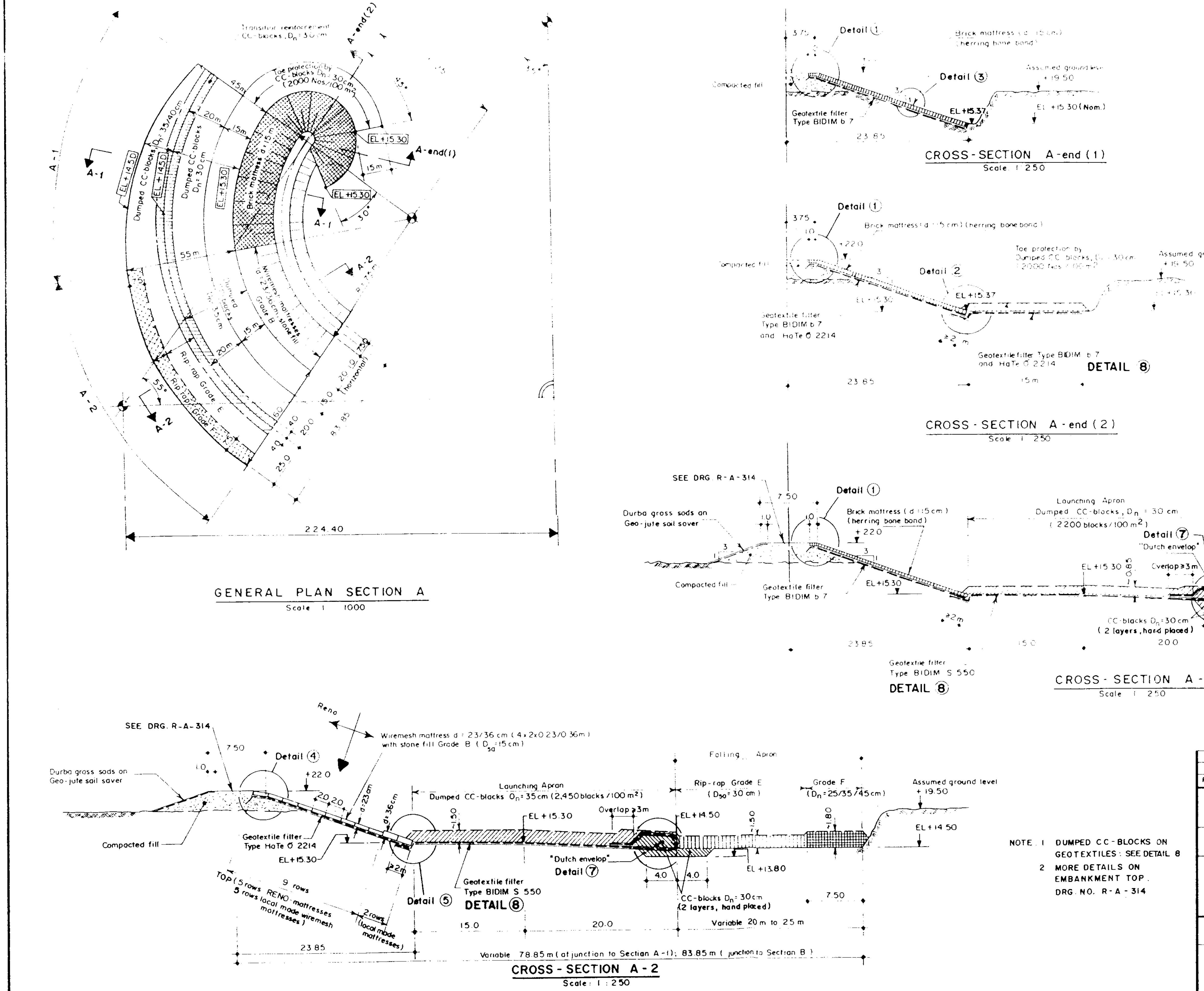
BANK PROTECTION AND RIVER TRAINING/AFPM PILOT PROJECT
FAP 21/22

REPORT ON MONITORING AND ADAPTATION AT BAHADURABAD TEST SITE

LIST OF ANNEXES

ANNEX A

As-Built Drawings



NOTES

1. Levels refer to +0.00m PWD
2. Measurements are shown in meter, unless shown otherwise
3. Dredging, excavation, filling and compaction to comply with Specifications, Sections 800 and 900
4. Geotextile filter materials as per Specifications, Sections 200 and 1000
5. Revetment materials as per Specifications, Sections 200 and 1000
6. Falling apron materials as per Specifications, Sections 200 and 1000
7. Reference Drawings
   - R-A-302 Detailed Layout of Test Structures
   - R-A-304 Geotextile Filter Materials General Arrangement
   - R-A-30? Typical Revetment Detail
   - R-A-3?4 Rip-rap Gradations

Scale 1 : 250 (0, 5, 10, 20 m)

Scale 1 : 1000 (0, 25, 50, 100 m)

NOTE
1. DUMPED CC-BLOCKS ON GEOTEXTILES: SEE DETAIL 8
2. MORE DETAILS ON EMBANKMENT TOP. DRG. NO. R-A-314

REV	DATE	NAME	DESCRIPTION	APPROVED
1	22.4.97	Anowar	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

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

TEST SITE II - BAHADURABAD

TEST STRUCTURE A
GENERAL PLAN AND CROSS-SECTIONS

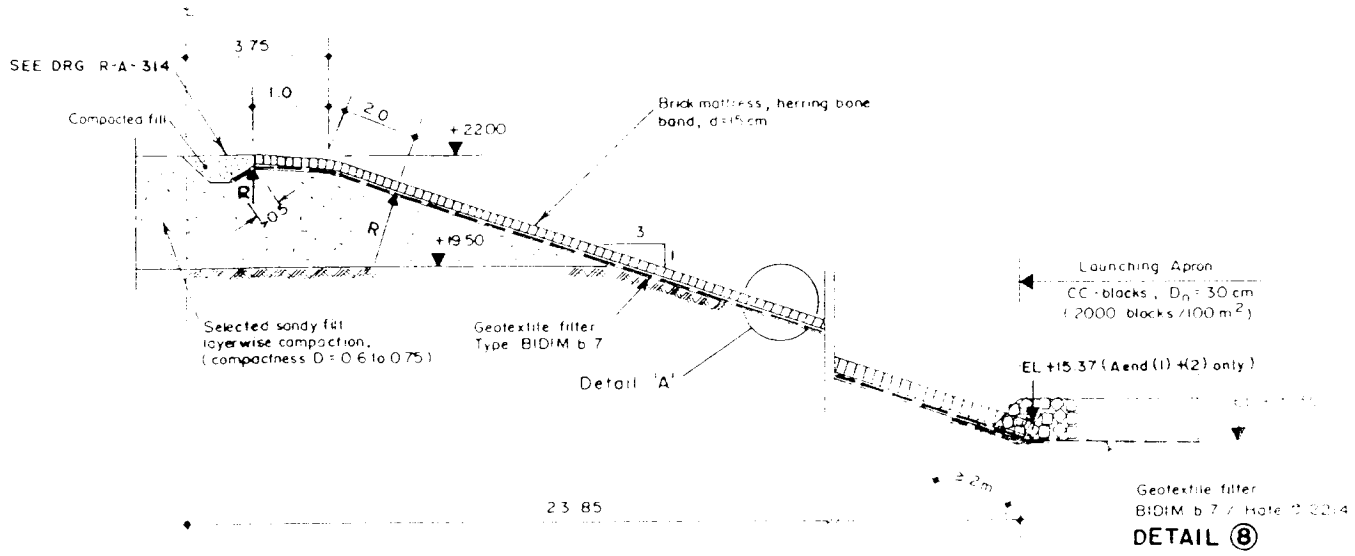
	NAME	DATE
DRAWN	ANOWAR	16-10-96
CHECKED		24-10-96
APPROVED		

SCALE: 1:1000 , 1:250

DRAWING NO. R-A-305

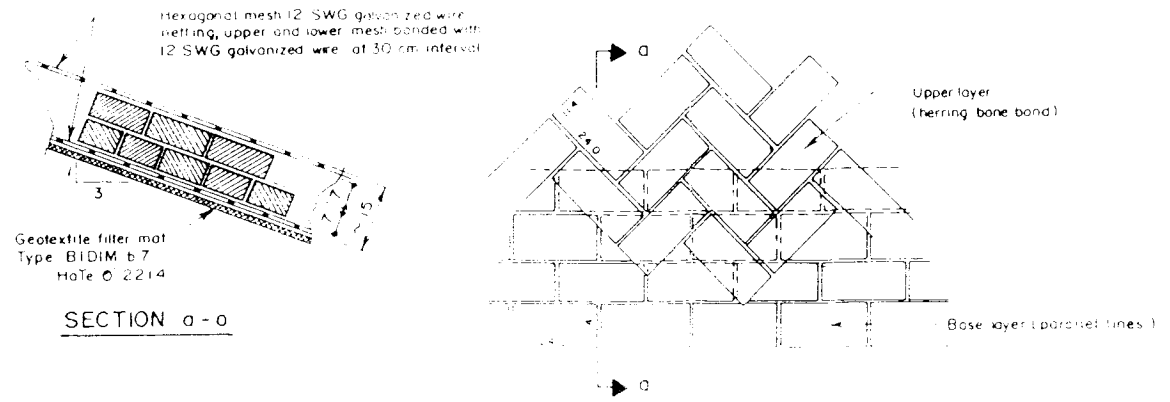
REVISION 1

DRAWING PHOTOREDUCED BY 50%

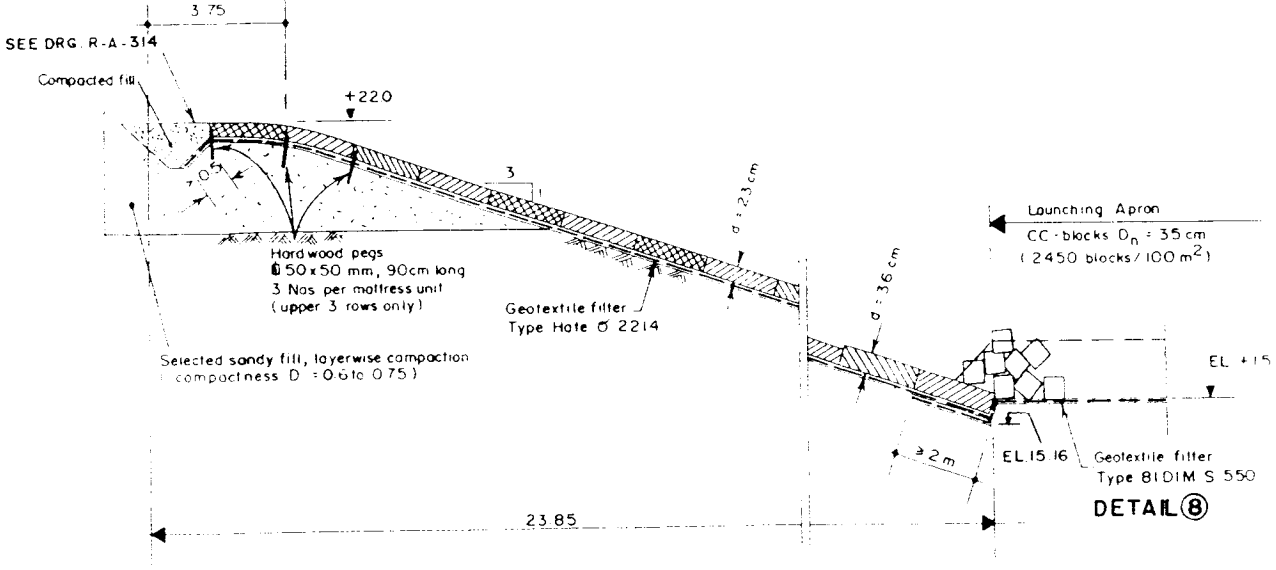


DETAIL ①
Scale 1 : 100

DETAIL ②
Scale 1 : 100

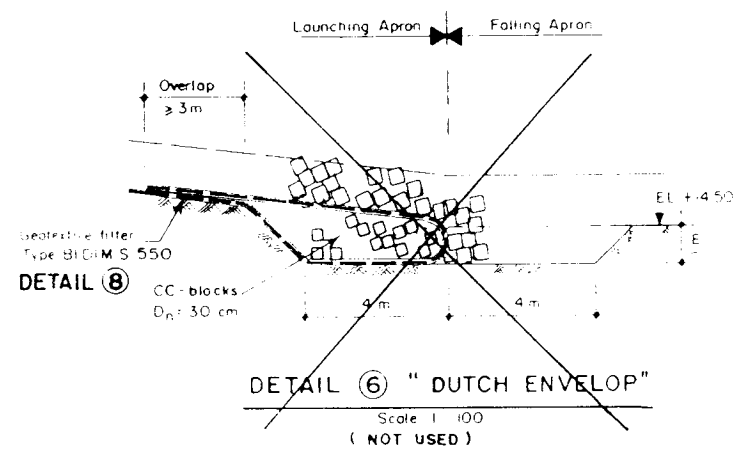


DETAIL ③ BRICK MATTRESS, d = 15 cm (measurements in cm)

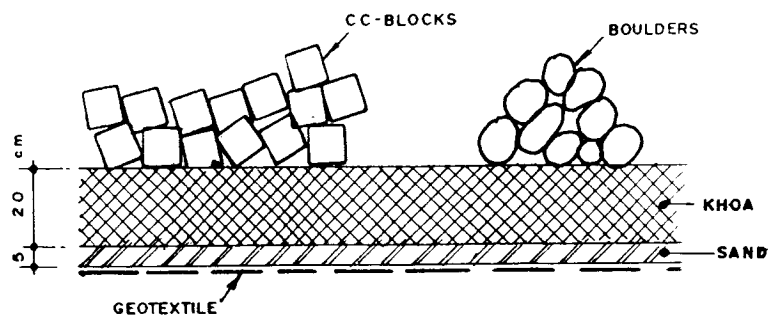


DETAIL ④
Scale 1 : 100

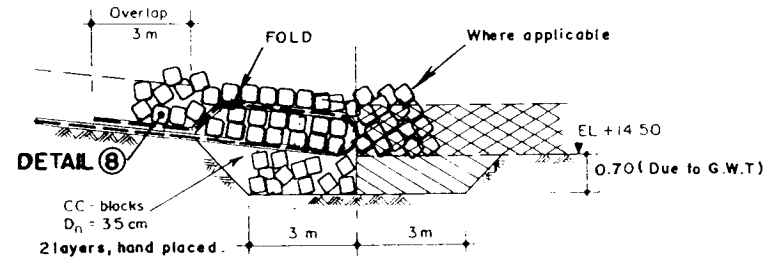
DETAIL ⑤
Scale 1 : 100



DETAIL ⑥ " DUTCH ENVELOP"
Scale 1 : 100
(NOT USED)



DETAIL ⑧ PROTECTION LAYER
NOT TO SCALE



DETAIL ⑦ "DUTCH ENVELOPE (Alternative)"
Scale. 1 : 100

ENVELOPE . 2 LAYERS PLACED INSIDE } A-1, B
1 LAYER PLACED ON TOP } 80%, A-2
VICE VERSA : A-2 (20 %)

NOTES

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4. Geotextile filter materials as per Specifications Sections 200 and 1000.
5. Revetment materials as per Specifications, Sections 200 and 1000
6. Falling apron materials as per Specifications, Sections 200 and 1000.
7. Reference Drawings
   - R-A-302 Detailed Layout of Test Structures
   - R-A-304 Geotextile Filter Materials, General Arrangement
   - R-A-305 Test Structure A, General Plan and Cross Sections

2.5 0 5.0 10.0 m
Scale 1 : 100

REV	DATE	NAME	DESCRIPTION	APPROVED
1	23.4.97	Anowar	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

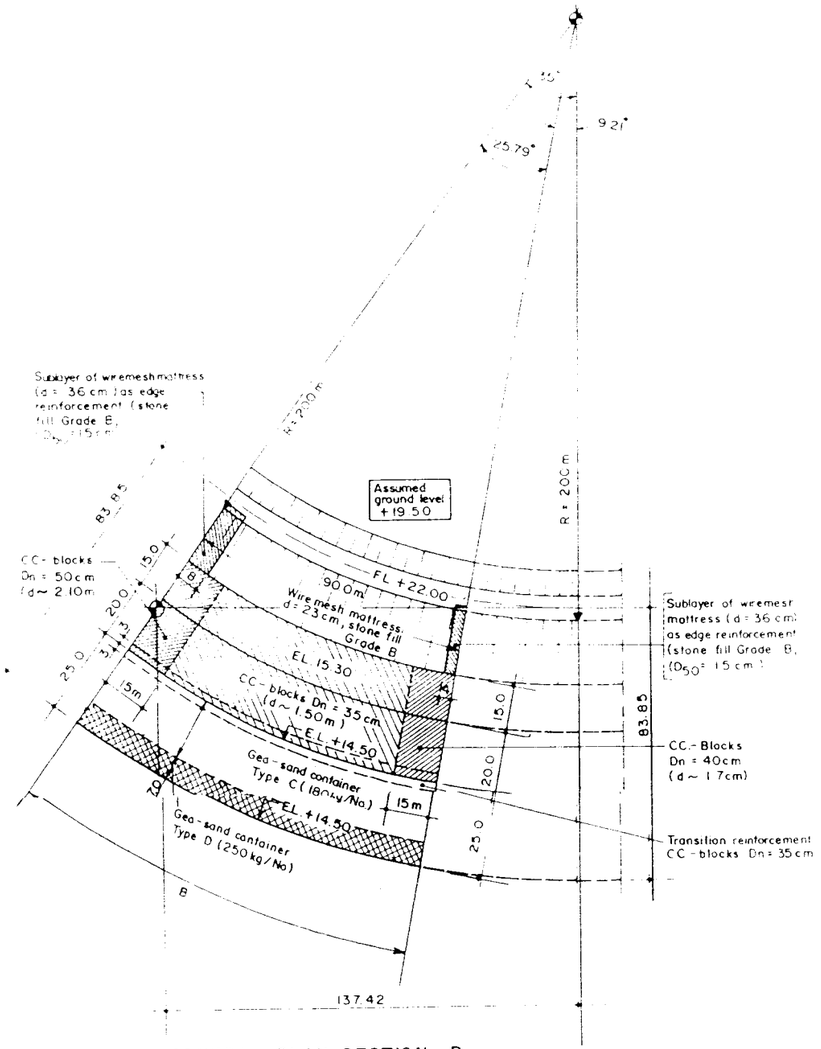
JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE
CONSULTING CONSORTIUM FAP 21/22
RHEIN-RUHR ING.-GES MBH, DORTMUND/GERMANY
COMPAGNIE NATIONALE DU RHONE, LYON/FRANCE
PROF.DR. LACKNER & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS
In association with:
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD (BETS)
DESH UPODESH LIMITED (DUL)

TEST SITE II - BAHADURABAD

TYPICAL REVETMENT DETAILS
NO. ① TO NO. ⑧

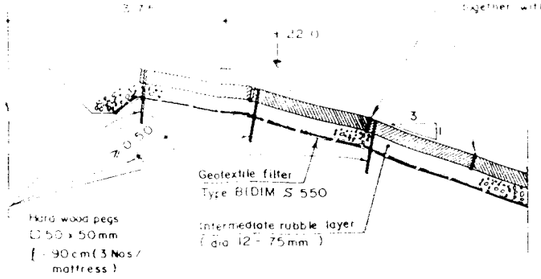
	NAME	DATE	SCALE:
DRAWN	ANOWAR	23-10-96	1 : 100
CHECKED		24-10-96	DRAWING NO. R-A-306 / REVISION 1
APPROVED			

DRAWING PHOTOREDUCED BY 50%



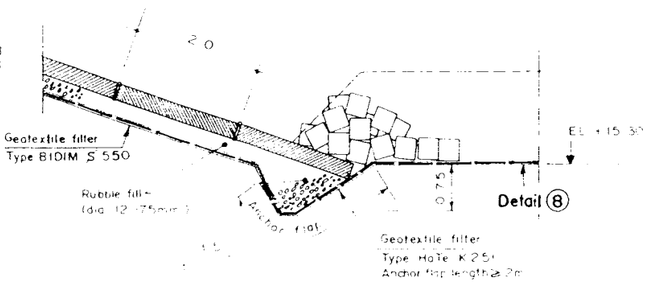
GENERAL PLAN SECTION - B

Scale 1 : 1000



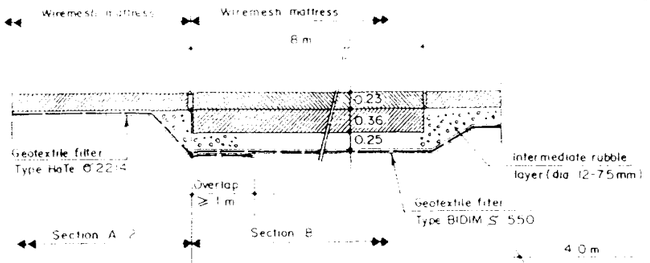
DETAIL A

Scale 1 : 50



DETAIL B

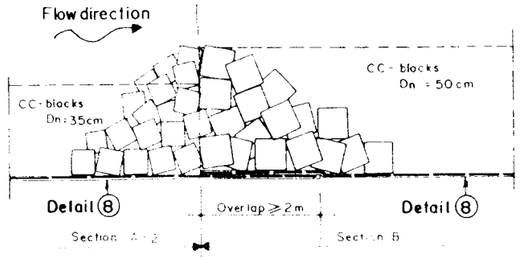
Scale 1 : 50



UPSTREAM TRAINSITION DETAIL

(above berm slope)

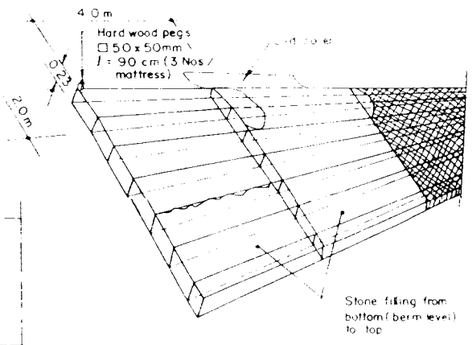
Scale 1 : 50



UPSTREAM TRANSITION DETAIL

(at/below berm level)

Scale 1 : 50

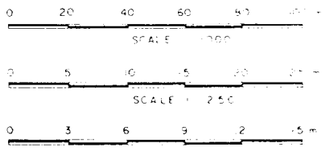


SCHEMATIC SYSTEM OF WIRE MESH - MATTRESSES

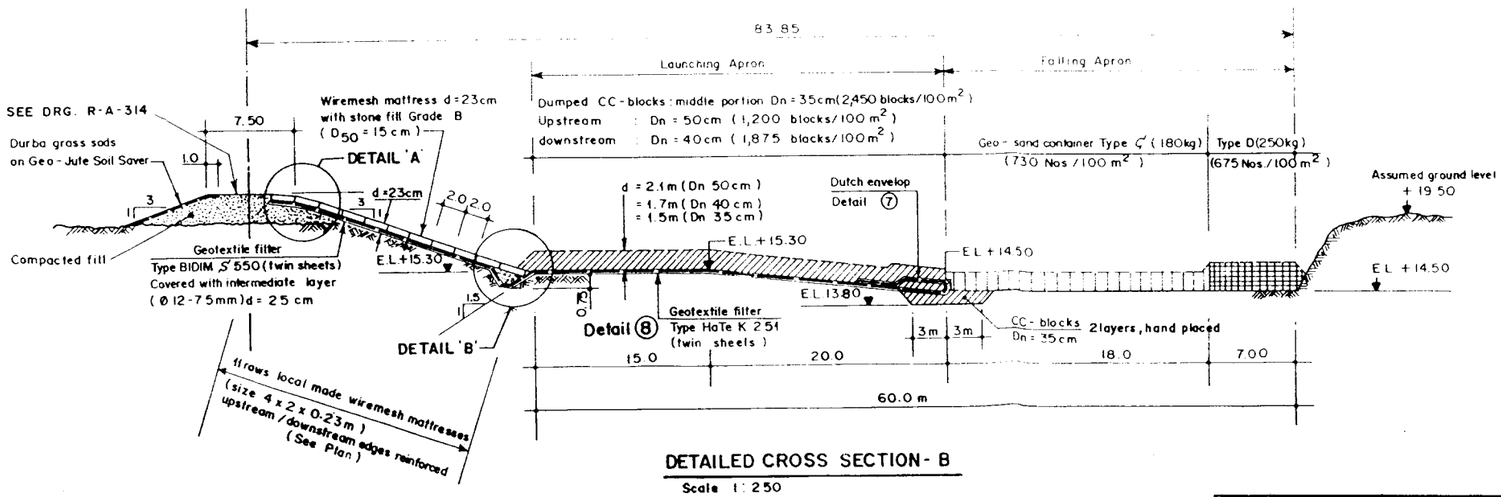
(Not to Scale)

NOTES

1. Levels refer to + 0.00 m PWD
2. Measurements are shown in meter, unless shown otherwise
3. Dredging, excavation, filling and compaction to comply with Specification, Sections 800 and 900
4. Geotextile filter materials as per Specifications, Sections 200 and 1000
5. Revetment materials as per Specifications, Sections 200 and 1000
6. Falling apron materials as per Specification, Sections 200 and 1000
7. Reference Drawings
   - R - A - 302 Detailed Layout of Test Structures
   - R - A - 304 Geotextile Filter Materials
   - R - A - 306 Typical Revetment Detail (1) to (7)
   - R - G - 014 Rip - Rap Gradations



i.e. Top of embankment shown DRG. R-A-314



DETAILED CROSS SECTION - B

Scale 1 : 250

DRAWING PHOTOREDUCED BY 50%

REV	DATE	NAME	DESCRIPTION	APPROVED
1	26.4.97	Anowar	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

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. LACOSTE & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD., DHAKA/BANGLADESH
HALCROW INTERNATIONAL LIMITED, U.K.

TEST SITE II - BAHADURABAD

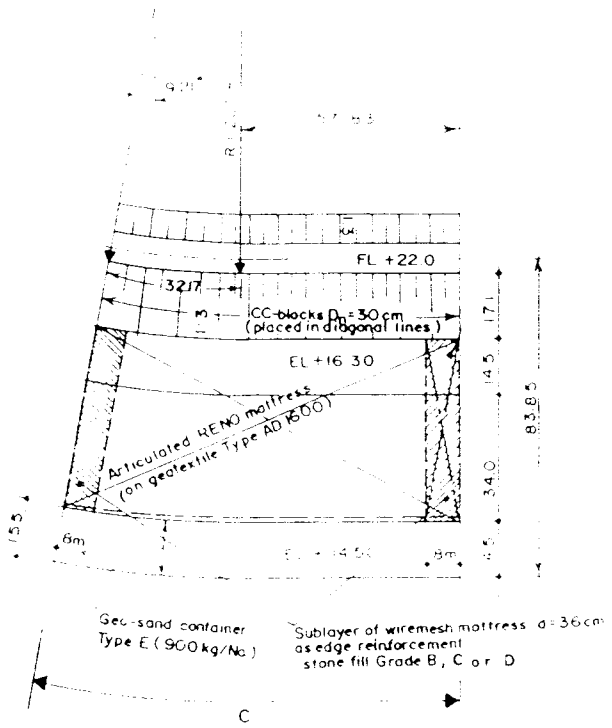
TEST STRUCTURE - B
GENERAL PLAN
CROSS - SECTION, DETAILS

	NAME	DATE
DRAWN	F. HOSSAIN	16 - 10 - 96
CHECKED		19 - 10 - 96
APPROVED		

SCALE. 1:1000, 1:250 1:150

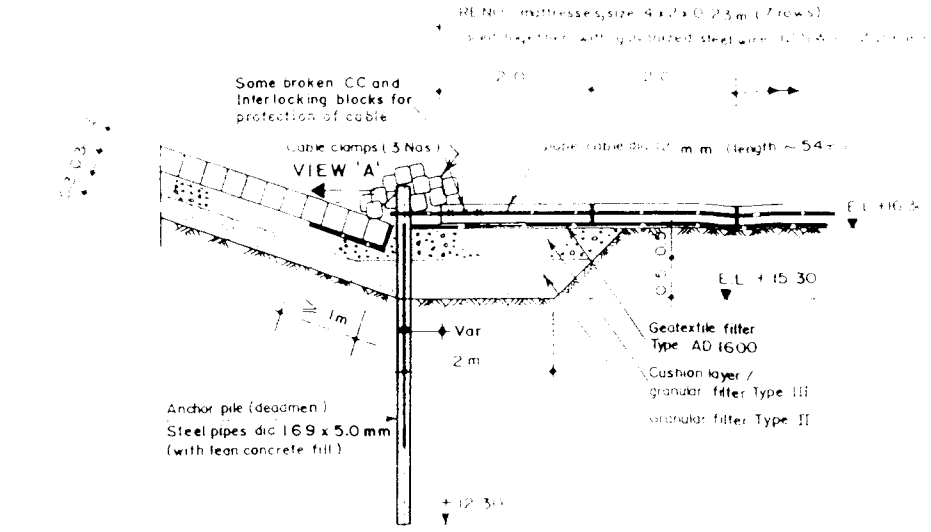
DRAWING NO. R-A-307

REVISION 1



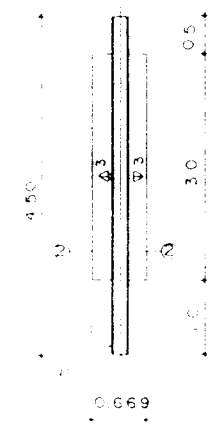
GENERAL PLAN SECTION-C

Scale 1 : 1000



DETAIL - A

Scale 1 : 50

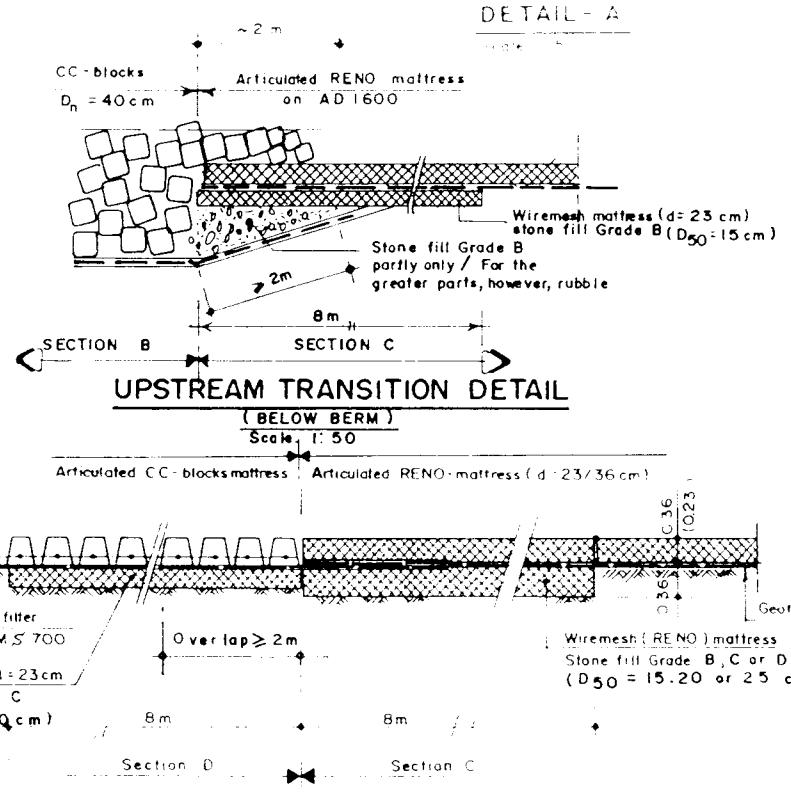


ANCHOR PILE

(Front view)

Scale 1 : 50

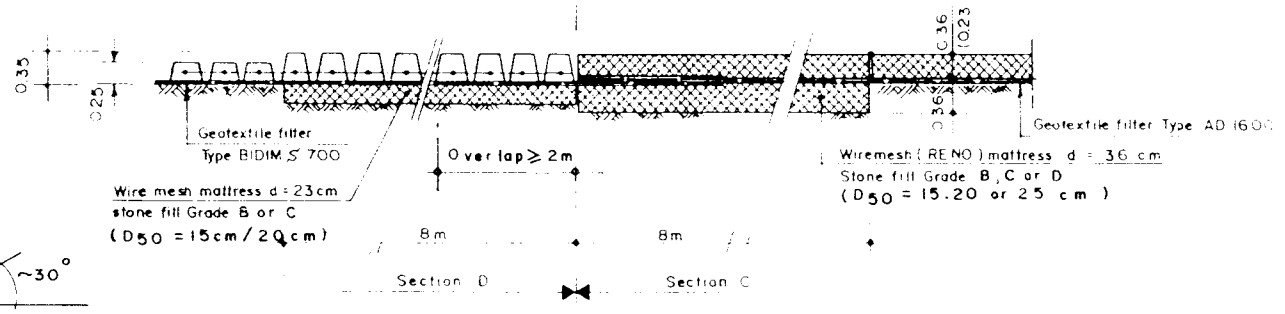
Steel Schedule - Anchor Pile					
Item	No.	Size m m	Weight kg/No.	Weight kg
1	24	Ø169 x 5.0 x 4500	91.0	2184
2	48	250 x 6 x 3000	35.3	1694
Total Weight Section C				3878



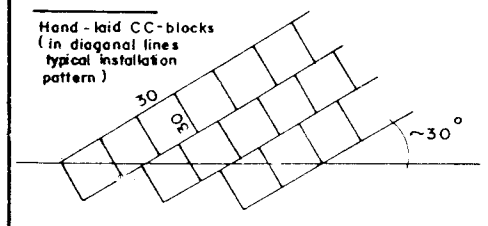
UPSTREAM TRANSITION DETAIL

(BELOW BERM)

Scale 1 : 50

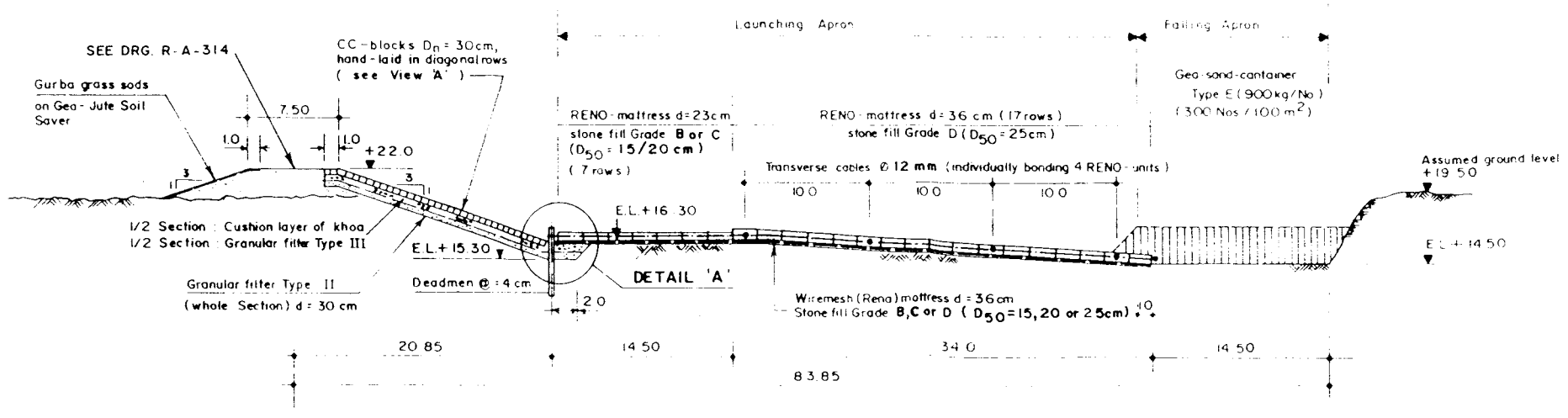


VIEW 'A'



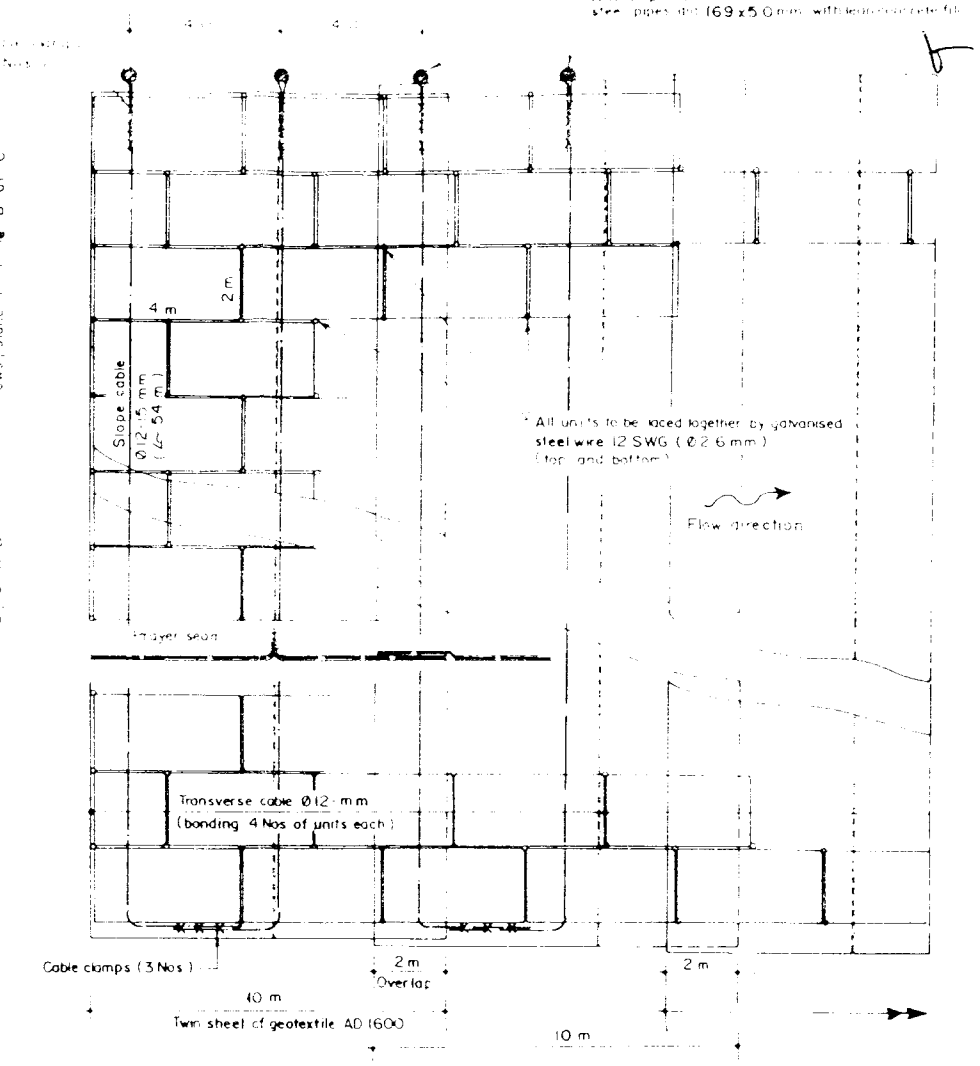
TRANSITION DETAIL (BELOW BERM) SECTION C / D

SCALE 1 : 50



DETAILED CROSS-SECTION C

Scale 1 : 250

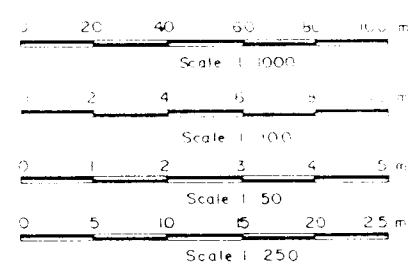


NOTES

1. Levels refer to ±0.00m PWD
2. Measurements are shown in meter unless shown other wise
3. F.L = Finished level, E.L = Excavation level
4. Dredging, excavation, filling and compaction to comply with Specification, Sections 800 and 900
5. Geotextile filter materials as per Specifications, Sections 200 and 1000
6. Revetment materials as per Specifications, Sections 200 and 1000
7. Falling apron materials as per Specifications, Sections 200 and 1000
8. Reference Drawings
   - R-A-302 Detailed Layout of Test Structures
   - R-A-304 Geotextile Filter Materials
   - R-G-014 Rip-rap Gradations

GENERAL PLAN OF ARTICULATED RENO-MATTRESS

Scale 1 : 100



REV	DATE	NAME	DESCRIPTION	APPROVED
3	26.4.97	Anowar	AS BUILT DRAWING	
2	30-01-97	F Hossain	Details corrected	
1	13-01-97	ANOWAR	Changes Articulated Reno-Mattress for Sec. C	

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

BANK PROTECTION PILOT PROJECT FAP-21

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. LACROIX & LATHEUS, BRUSSELS (BELGIUM)
DELFT HYDRAULICS, DELFT (NETHERLANDS)
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD. (BETS)
DESH UPODESH LIMITED (DUL)

TEST SITE II - BAHADURABAD

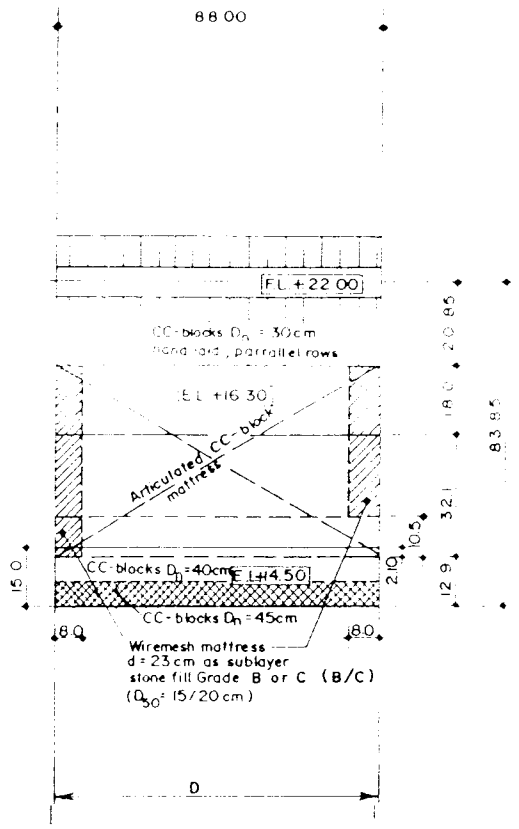
TEST STRUCTURE - C
GENERAL PLAN
CROSS - SECTION, DETAILS

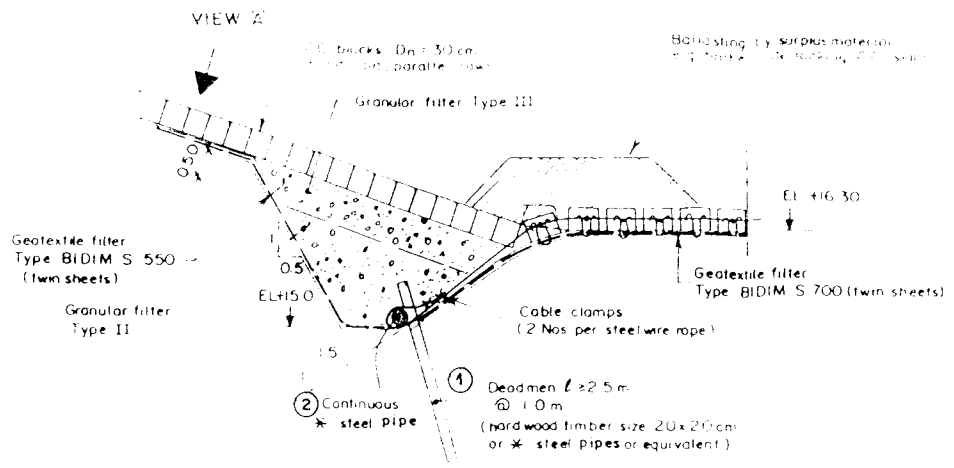
	NAME	DATE
DRAWN	F HOSSAIN	17 - 10 - 96
CHECKED		22 - 10 - 96
APPROVED		

SCALE 1 : 1000, 1 : 100
1 : 50

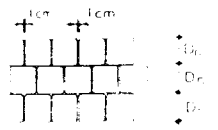
DRAWING NO. R-A-308 | REVISION 3

DRAWING PHOTOREDUCED BY 50%

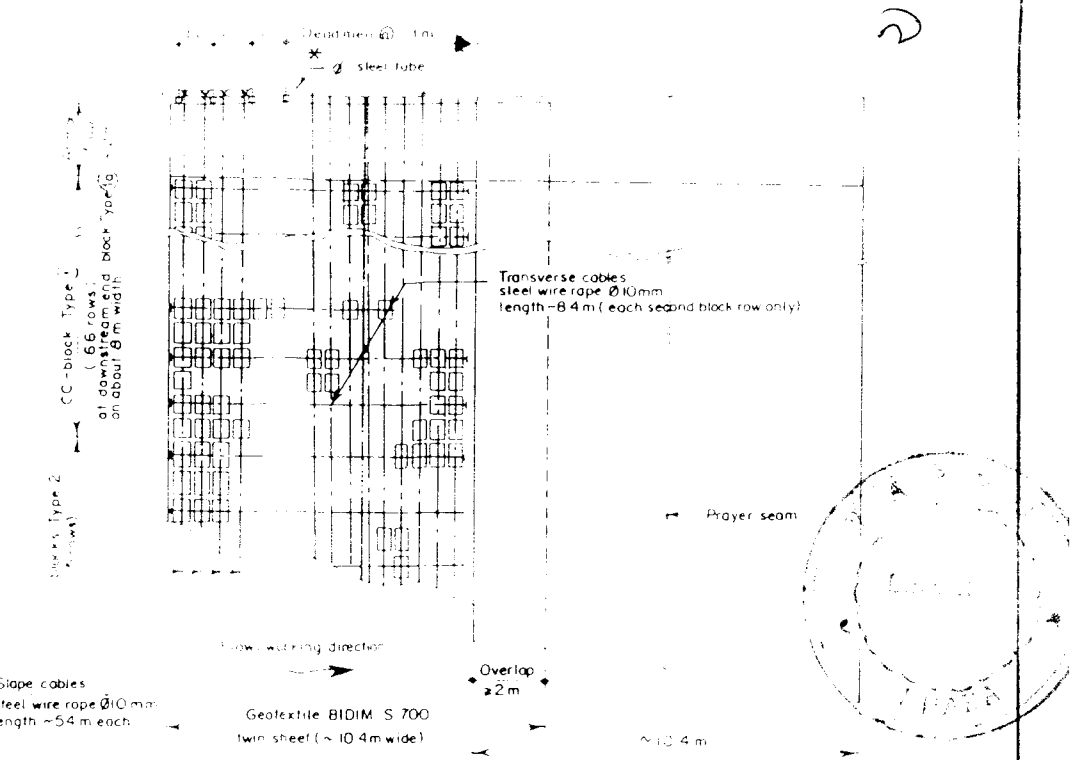




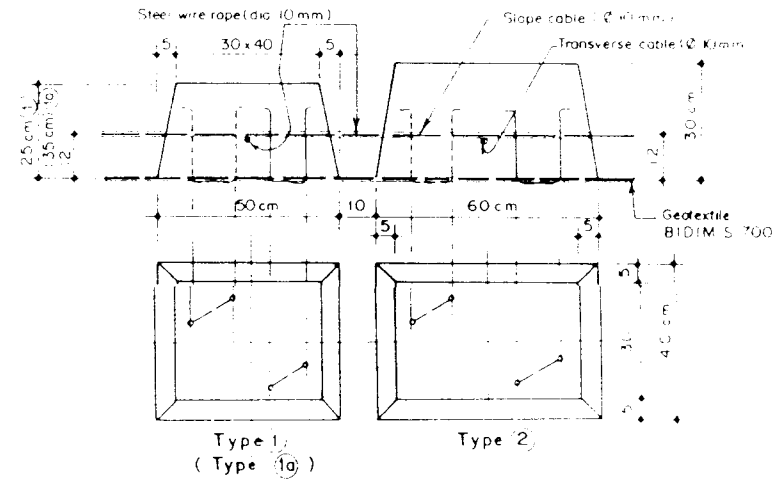
DETAIL 'A'
Scale : 1 50



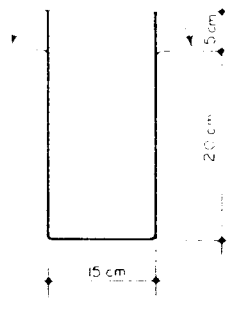
VIEW 'A'
CC-BLOCKS, D_n = 30 cm
Hand Laid in Parallel Rows
Typical Installation Pattern



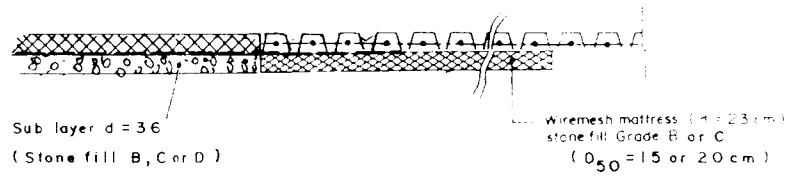
GENERAL PLAN OF ARTICULATED BLOCK MATTRESS
Scale : 1 100



CC-BLOCK DIMENSIONS FOR THE ARTICULATED MATTRESS (Cast in-situ) (Measurements in centimeters)
Scale 1 10



STEEL WIRE NEEDLE Ø 4 mm (8 SWG)
Scale 1 5 (galvanized)
(Punch needles through geotextile
shape end hooks only thereafter)

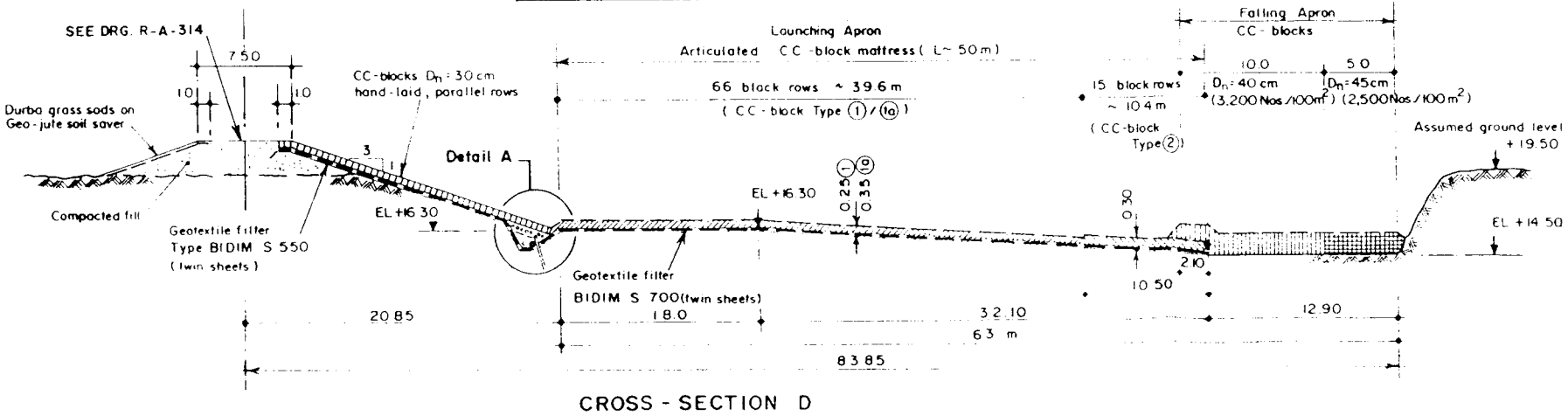


UPSTREAM TRANSITION DETAIL
(below berm)
Scale 1 50

GENERAL PLAN SECTION D
Scale 1 1000

STEEL SCHEDULE ANCHORING					
ITEM	QTY	UNIT	SIZE (mm)	WEIGHT/UNIT (kg)	WEIGHT (kg)
①	89	Nos	Ø169x5.0x2500	50.6	4,500
②	88	ml	Ø169x5.0	20.2	1,780
Total weight section D					6,280

Concrete quality for cast in-situ blocks of mattress: Concrete Class B 25 Cement content ≥ 350 kg/m³ concrete W/C ratio 0.6 Coarse aggregates size 0-20mm (crushed aggregates)	✱ STEEL PIPE 169 x 5 mm (To be Grout / Concrete filled after installation)



CROSS - SECTION D
Scale 1 250

NOTES
1 Levels refer to ±0.00 PWD
2 Measurements are shown in meter unless shown otherwise
3 F L = Finished Level
E L = Excavation Level
4 Reference Drawings :
R-A-302 Detailed Layout of Test Structures
R-A-304 Geotextile Filter Materials General Arrangement
R-G-014 Rip-rap Gradations

0 25 50 100 m
SCALE. 1: 1000
0 50 100 150 200 250 m
SCALE. 1: 250
0 2.5 5 10 m
SCALE. 1: 100
0 1.0 2.5 5.0 m
SCALE. 1: 50
0 0.25 0.5 1.0 m
SCALE. 1: 10
0 0.1 0.2 0.3 0.4 0.5m
SCALE. 1: 5

DRAWING PHOTOREDUCED BY 50%

REV.	DATE	NAME	DESCRIPTION	APPROVED
3	26.4.97	Anowar	AS BUILT DRAWING	
2	30.01.97	F Hossain	Details corrected	
1	14.01.97	ANOWAR	Change Articulated Block Mattress in Sec. D	

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

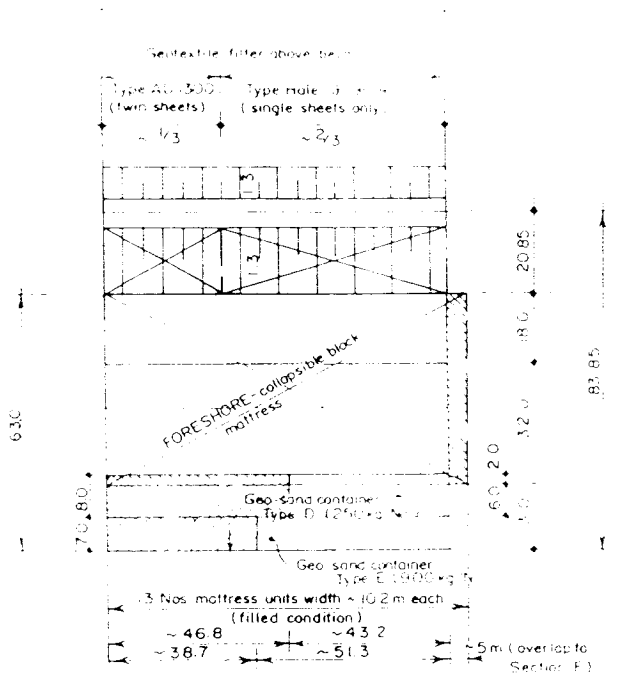
BANK PROTECTION PILOT PROJECT FAP-21

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. LACHER & PARTNERS, BREMEN/FRG
DELFT HYDRAULICS, DELFT/NETHERLANDS
in association with
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD (BETS)
DESH UPODESH LIMITED (DUL)

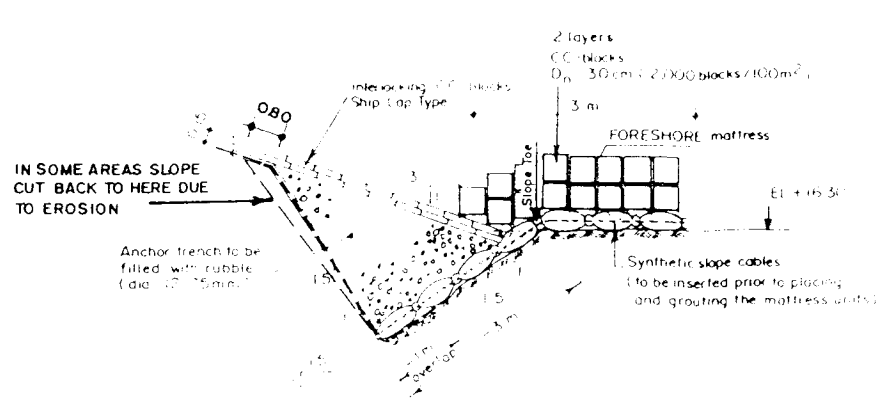
TEST SITE II - BAHADURABAD

TEST STRUCTURE D
GENERAL PLAN
CROSS-SECTION, DETAILS

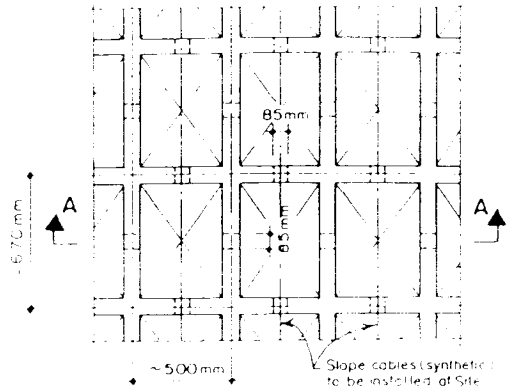
	NAME	DATE	SCALE : 1:1000, 1:250, 1:100, 1:50, 1:10, 1:5
DRAWN	ANOWAR	17-10-96	
CHECKED		20-10-96	DRAWING NO. R-A-309
APPROVED			REVISION 3



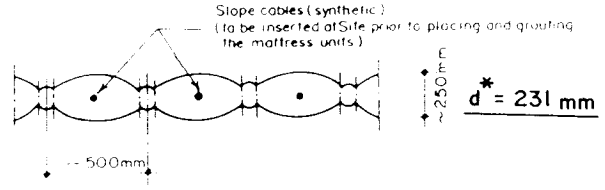
GENERAL PLAN SECTION E
Scale 1 : 1000



DETAIL A
Scale 1 : 50

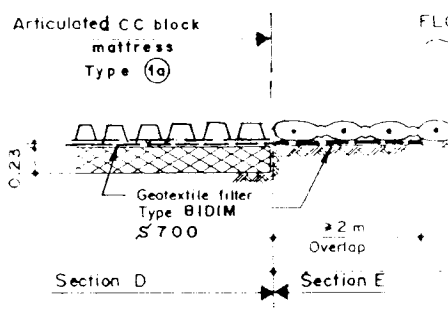


PARTIAL PLAN OF MATTRESS
Scale 1 : 20

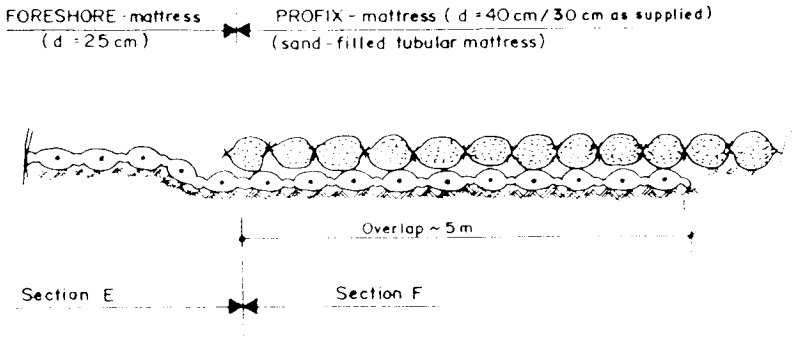


SECTION A - A
Scale 1 : 20

FORESHORE - Collapsible Block Mattress
(with cement mortar grouting)

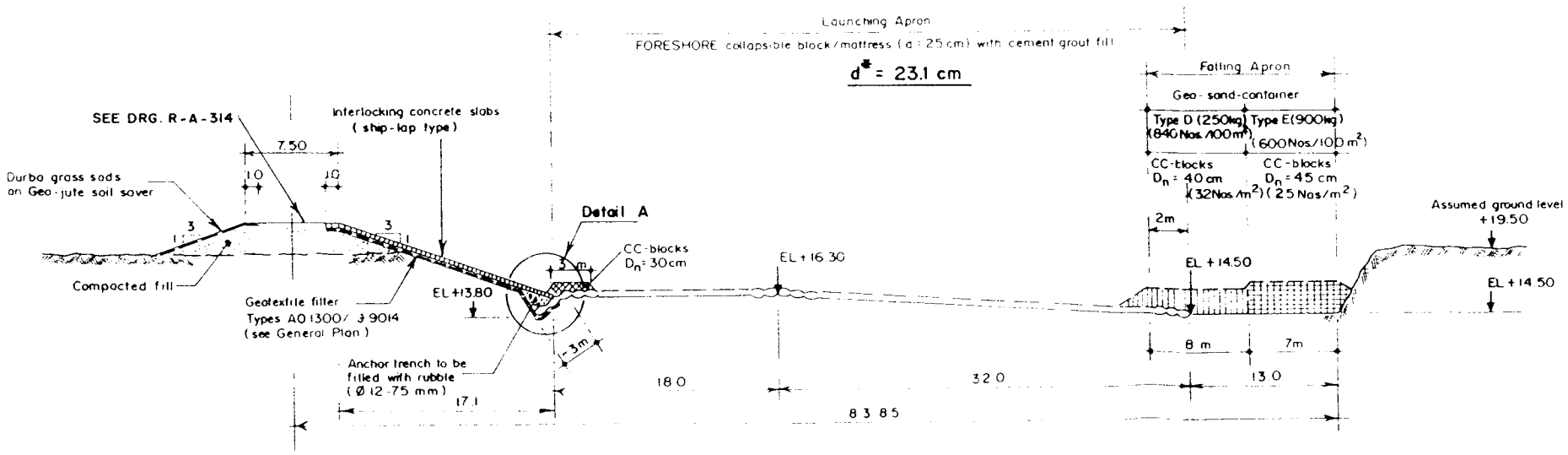


UPSTREAM TRANSITION DETAIL / MATTRESS OVERLAPS
Scale 1 : 50



DOWNSTREAM TRANSITION DETAIL
Scale 1 : 50

NOTE :
* collapsible block mattress "as built" d = 231 mm (average) in stead of d = 250 mm.



DETAILED CROSS - SECTION E
Scale 1 : 250

NOTES

1. Levels refer to ± 0.00 m PWD
2. Measurements are shown in meter, unless shown otherwise
3. F.L. = Finished level
   E.L. = Excavation level
4. The textile mattress type FORESHORE will be supplied by the Employer. The dimensions shown on this drawing are indicative only. The actual material supply may differ slightly for block size, mattress width and length.
5. Reference Drawings :
   R - A - 302 Detailed Layout of Test Structures
   R - A - 304 Geotextile Filter Materials General Arrangement

0 25 50 100 m
SCALE 1 : 1000

0 5 10 15 20 25 m
SCALE 1 : 250

0 1 2 3 4 5m
SCALE 1 : 50

0.0 0.5 1.0 2.0 m
SCALE 1 : 20

REV.	DATE	NAME	DESCRIPTION	APPROVED
3	24.5.97	Anowar	AS BUILT DRAWING	
2	30.1.97	F Hossain	Detail corrected	
1	14-01-97	ANOWAR	Change of Falling Apron	

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
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BANK PROTECTION PILOT PROJECT FAP-21

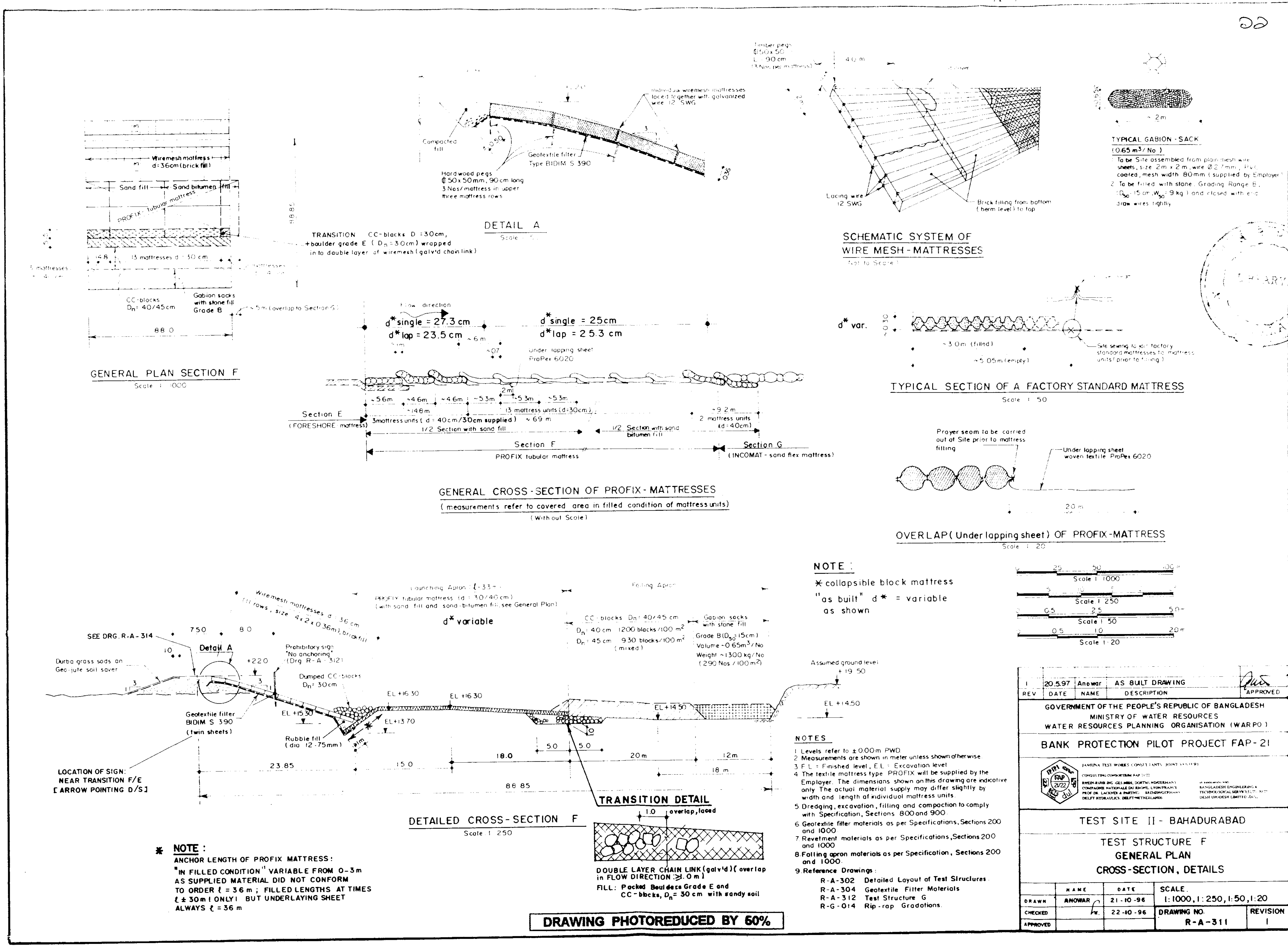
JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE
CONSULTING CONSORTIUM FAP 21/22
RHEIN-RUHR ING.-GES. mbH, DORTMUND/GERMANY
COMPAGNIE - ATIONALE DU RHONE, LYON/FRANCE
PROF. DR. LACKNER & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS

TEST SITE II - BAHADURABAD

TEST STRUCTURE E
GENERAL PLAN
CROSS-SECTION, DETAILS

	NAME	DATE	SCALE
DRAWN	ANOWAR	20-10-96	1:1000, 1:250, 1:50, 1:20
CHECKED		21-10-96	DRAWING NO. R-A-310
APPROVED			REVISION 3

DRAWING PHOTOREDUCED BY 50%


GENERAL PLAN SECTION F
Scale 1:1000
Wiremesh mattress d=36cm (brick fill)
Sand fill
Sand bitumen
fill
PROFIX tubular mattress
13 mattresses d=30cm
CC-blocks Dn: 40/45cm
Gabion sacks with stone fill Grade B
~5m (overlap to Section G)
88.0
TRANSITION CC-blocks D=30cm, +boulder grade E (Dn=30cm) wrapped in to double layer of wiremesh (galv'd chain link)
DETAIL A
Compacted fill
Hardwood pegs Ø50x50mm, 90cm long 3 Nos/mattress in upper three mattress rows
Geotextile filter Type BIDIM S 390
Individual wiremesh mattresses laced together with galvanized wire 12 SWG
SCHEMATIC SYSTEM OF WIRE MESH-MATTRESSES
Not to Scale
Timber pegs Ø50x50 L=90cm
4.0m
Lacing wire 12 SWG
Brick filling from bottom (berm level) to top
TYPICAL GABION-SACK
(0.65 m³/No)
1 To be Site assembled from plain mesh wire sheets, size 2m x 2m, wire Ø2.7mm, PVC coated, mesh width 80mm (supplied by Employer)
2 To be filled with stone. Grading Range B, (D50 15cm, W50 9kg) and closed with end draw wires tightly
~2m
Flow direction
d* single = 27.3 cm
d* lap = 23.5 cm
d* single = 25cm
d* lap = 25.3 cm
Under lapping sheet ProPex 6020
~5.6m ~4.6m ~4.6m ~5.3m ~5.3m ~5.3m
2m
~14.8m
13 mattress units (d=30cm)
~9.2m
2 mattress units (d=40cm)
Section E (FORESHORE mattress)
3 mattress units (d=40cm/30cm supplied) ~69m
1/2 Section with sand fill
1/2 Section with sand bitumen fill
Section F
PROFIX tubular mattress
Section G
(INCOMAT - sand flex mattress)
GENERAL CROSS-SECTION OF PROFIX-MATTRESSES
(measurements refer to covered area in filled condition of mattress units)
(Without Scale)
d* var.
~0.30
~3.0m (filled)
~5.05m (empty)
Site sewing to join factory standard mattresses to mattress units (prior to filling)
TYPICAL SECTION OF A FACTORY STANDARD MATTRESS
Scale 1:50
Proper seam to be carried out at Site prior to mattress filling
Under lapping sheet woven textile ProPex 6020
20m
OVERLAP (Under lapping sheet) OF PROFIX-MATTRESS
Scale 1:20
NOTE:
* collapsible block mattress
"as built" d* = variable as shown
Scale 1:1000
Scale 1:250
Scale 1:50
Scale 1:20
Launching Apron (~33m)
PROFIX tubular mattress (d=30/40cm) (with sand fill and sand-bitumen fill, see General Plan)
Falling Apron
d* variable
Wiremesh mattresses d=36cm (11 rows, size 4x2x0.36m), brick fill
CC-blocks Dn: 40/45cm
Dn: 40cm 1200 blocks/100 m²
Dn: 45cm 930 blocks/100 m² (mixed)
Gabion sacks with stone fill Grade B(D50=15cm) Volume ~0.65m³/No Weight ~1300 kg/No (290 Nos/100 m²)
SEE DRG. R-A-314
Detail A
7.50
8.0
+22.0
Durba grass sods on Geo-jute soil saver
Prohibitory sign "No anchoring" (Drg R-A-312)
Dumped CC-blocks Dn: 30cm
EL +16.30
EL +16.30
EL +15.30
EL +13.70
Geotextile filter BIDIM S 390 (twin sheets)
Rubble fill (dia 12-75mm)
EL +14.50
Assumed ground level +19.50
EL +14.50
5.0
5.0
18.0
20m
12m
18m
23.85
15.0
86.85
LOCATION OF SIGN: NEAR TRANSITION F/E [ARROW POINTING D/S]
DETAILED CROSS-SECTION F
Scale 1:250
TRANSITION DETAIL
1.0
overlap, laced
DOUBLE LAYER CHAIN LINK (galv'd) (overlap in FLOW DIRECTION ≥1.0m)
FILL: Packed Boulders Grade E and CC-blocks, Dn = 30cm with sandy soil
* NOTE:
ANCHOR LENGTH OF PROFIX MATTRESS:
"IN FILLED CONDITION" VARIABLE FROM 0-3m AS SUPPLIED MATERIAL DID NOT CONFORM TO ORDER ℓ = 36m; FILLED LENGTHS AT TIMES ℓ ± 30m (ONLY) BUT UNDERLAYING SHEET ALWAYS ℓ = 36m
DRAWING PHOTOREDUCED BY 60%

NOTES

1. Levels refer to ±0.00m PWD
2. Measurements are shown in meter unless shown otherwise
3. F.L = Finished level, E.L = Excavation level
4. The textile mattress type PROFIX will be supplied by the Employer. The dimensions shown on this drawing are indicative only. The actual material supply may differ slightly by width and length of individual mattress units.
5. Dredging, excavation, filling and compaction to comply with Specification, Sections 800 and 900
6. Geotextile filter materials as per Specifications, Sections 200 and 1000
7. Revetment materials as per Specifications, Sections 200 and 1000
8. Falling apron materials as per Specification, Sections 200 and 1000.
9. Reference Drawings:
   - R-A-302 Detailed Layout of Test Structures
   - R-A-304 Geotextile Filter Materials
   - R-A-312 Test Structure G
   - R-G-014 Rip-rap Gradations

REV	DATE	NAME	DESCRIPTION	APPROVED
1	20.5.97	Anowar	AS BUILT DRAWING	

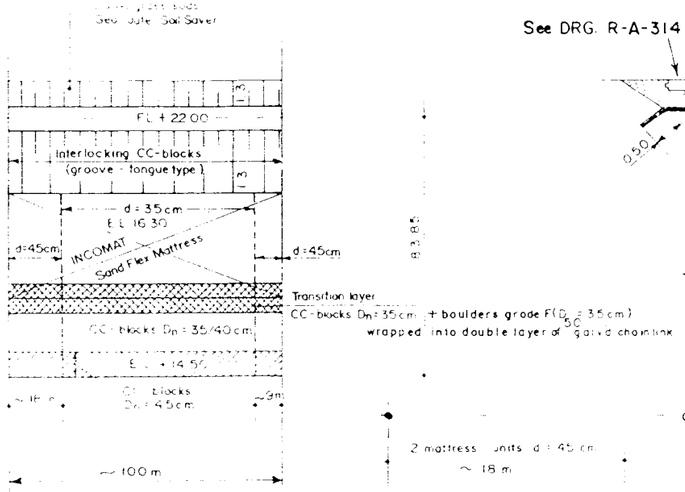
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANISATION (WARPO)

BANK PROTECTION PILOT PROJECT FAP-21

TEST SITE II - BAHADURABAD

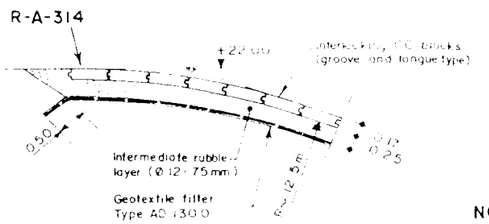
TEST STRUCTURE F
GENERAL PLAN
CROSS-SECTION, DETAILS

	NAME	DATE	SCALE. 1:1000, 1:250, 1:50, 1:20
DRAWN	ANOWAR	21-10-96	
CHECKED		22-10-96	DRAWING NO. R-A-311
APPROVED			REVISION 1



GENERAL PLAN SECTION-G

Scale 1:1000



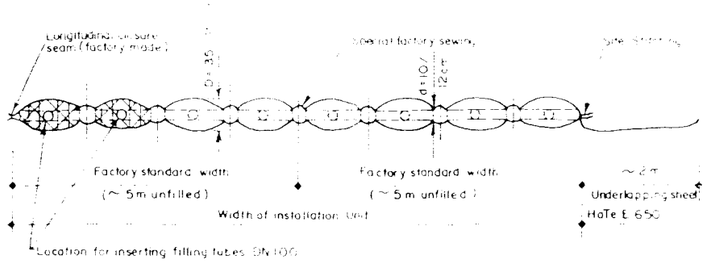
DETAIL 'A'

Scale 1:50

NOTE :

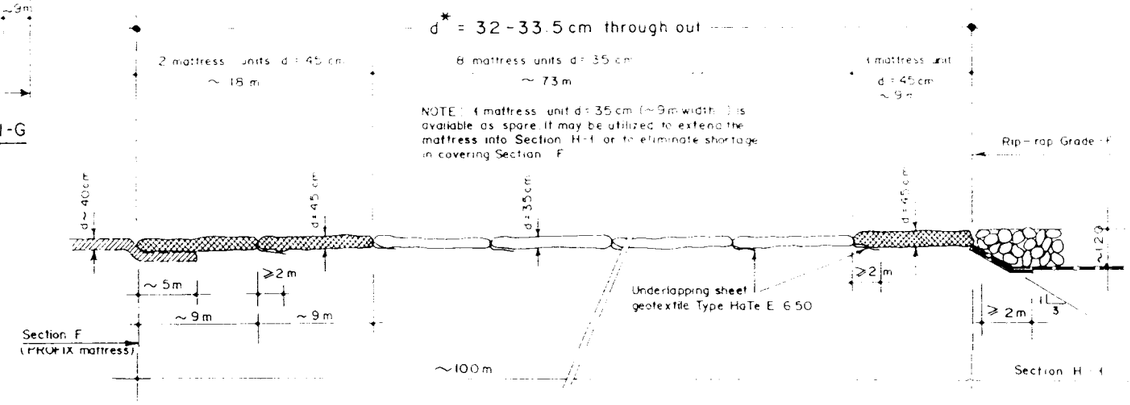
* collapsible block mattress

"as built" d * = variable as shown



GENERAL SECTION OF ONE MATTRESS UNIT

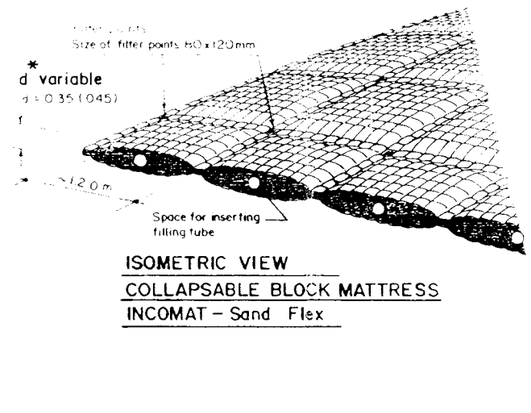
(Not to scale)



GENERAL CROSS-SECTION OF INCOMAT SAND FLEX MATTRESSES

(measurements refer to covered area in filled condition)

(without scale)



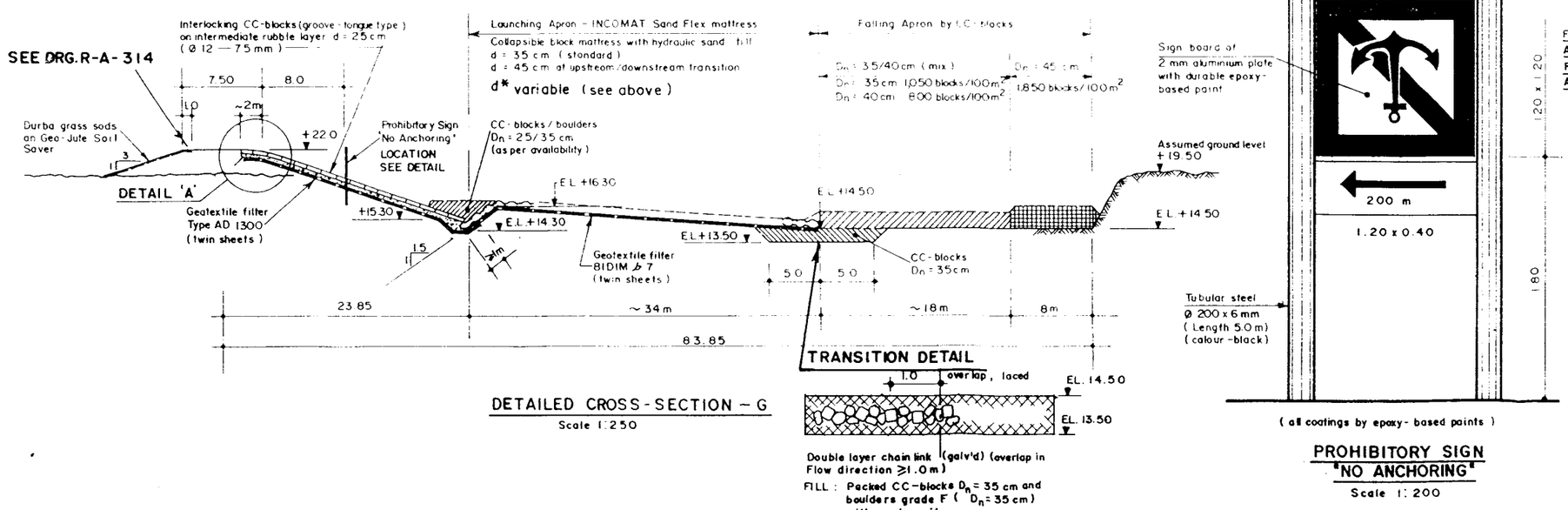
ISOMETRIC VIEW

COLLAPSABLE BLOCK MATTRESS

INCOMAT - Sand Flex

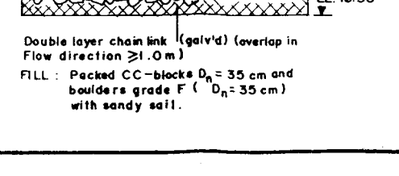
NOTES

1. Levels refer to +0.00 m PWD
2. Measurements are shown in meter, unless shown otherwise
3. F.L. = Finished level
   E.L. = Excavation level
4. The textile mattress type INCOMAT Sand Flex will be supplied by the Employer. The dimensions shown on this drawing are indicative only. The actual material supply may differ slightly for block size and mattress width
5. Dredging, excavation, filling and compaction to comply with Specifications, Sections 600 and 900
6. Geotextile filter materials as Specifications, Sections 200 and 1000
7. Revetment materials as per Specifications, Sections 200 and 1000
8. Falling apron materials as per Specifications, Sections 200 and 1000
9. Reference Drawings
   - R-A-302 Detailed Layout of Test Structure
   - R-A-304 Geotextile Filter Materials General Arrangement



DETAILED CROSS-SECTION - G

Scale 1:250



FILL : Packed CC-blocks D_n = 35 cm and boulders grade F (D_n = 35 cm) with sandy soil.

LOCATION: SIGN PLACED NEAR TRANSITION G/H - 1

ARROW POINTING U/S

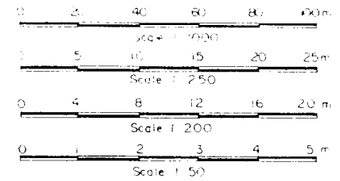
(all coatings by epoxy - based paints)

PROHIBITORY SIGN

"NO ANCHORING"

Scale 1:200

FIELD : WHITE
ANCHOR : BLACK
FRAME+BAR : RED
ARROW : RED ON WHITE



REV	DATE	NAME	DESCRIPTION	APPROVED
1	20.5.97	Anowar	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

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE
CONSULTING CONSORTIUM FAP 21/22
RHEIN-RUHR ING. GES. MBH, DORTMUND/GERMANY
COMPAGNIE NATIONALE DU RHONE, LYON/FRANCE
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DELFT HYDRAULICS, DELFT/NETHERLANDS
In association with:
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD. (BETS)
DESH UPODESH LIMITED (DUL)

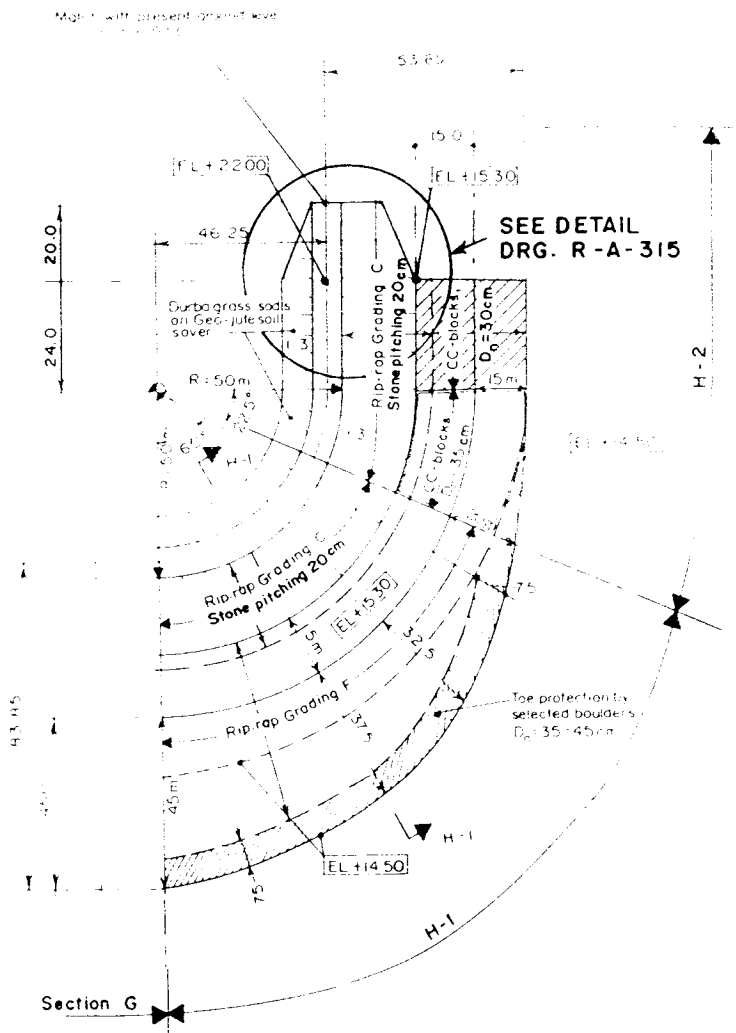
TEST SITE II - BAHADURABAD

TEST STRUCTURE - G
GENERAL PLAN
CROSS - SECTION, DETAILS

	NAME	DATE	SCALE 1:1000, 1:250 1:200,
DRAWN	F. HOSSAIN	21-10-96	
CHECKED		23-10-96	DRAWING NO. R-A-312
APPROVED			REVISION 1

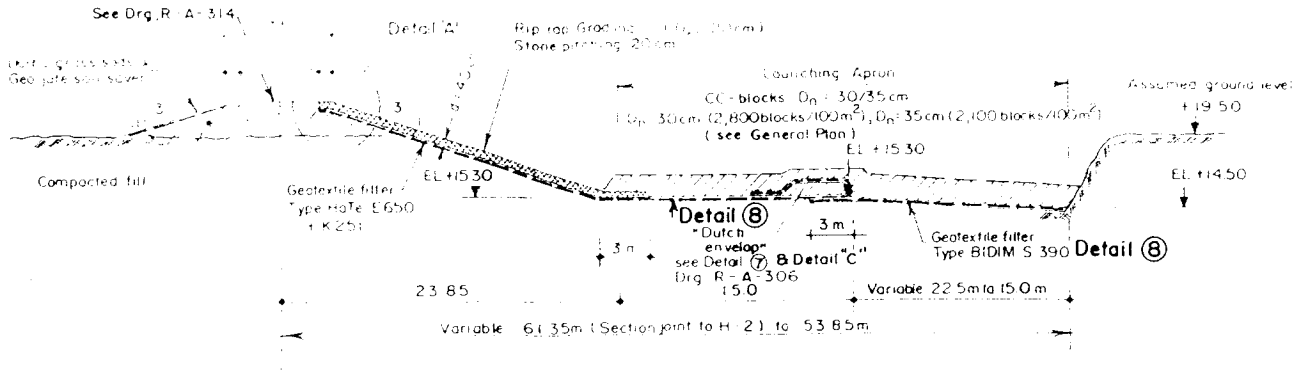
DRAWING PHOTOREDUCED BY 50%

26



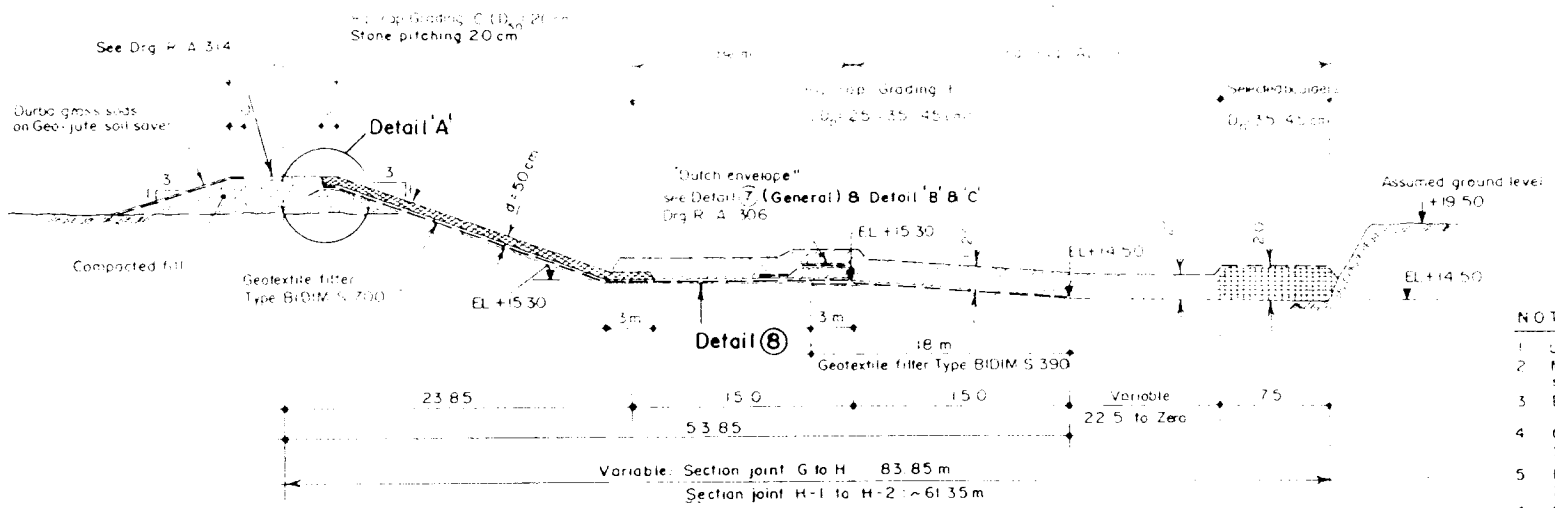
GENERAL PLAN SECTIONS H-1, H-2

Scale 1 : 1000



DETAILED CROSS-SECTION H-2

Scale 1 : 250



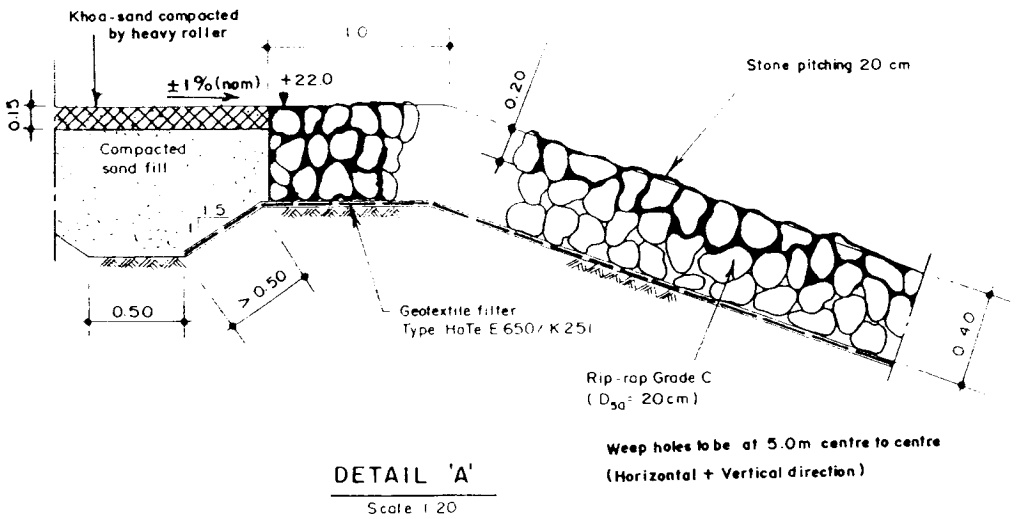
DETAILED CROSS - SECTION H - 1

Scale 1 : 250

NOTES

1. Level refer to ± 0.00m PWD
2. Measurements are shown in meter, unless shown otherwise
3. Dredging, excavation, filling and compaction to comply with Specifications Sections 800 and 900
4. Geotextile filter materials as per Specifications Sections 200 and 1000
5. Revetment materials as per Specifications, Sections 200 and 1000
6. Falling apron materials as per Specifications, Sections 200 and 1000
7. Reference Drawings

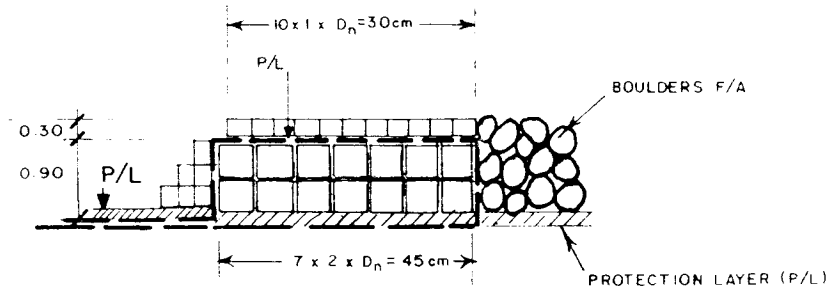
R-A-302 Detailed Layout of Test Structures
R-A-304 Geotextile Filter Materials General Arrangement
R-A-305 Typical Revetment Details No. (1) to No. (7)



DETAIL 'A'

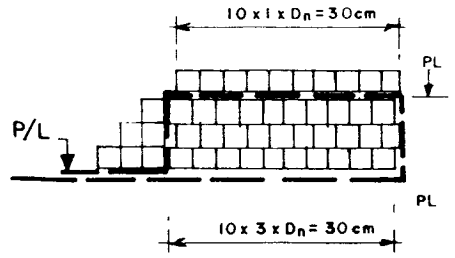
Scale 1 : 20

Weep holes to be at 5.0m centre to centre (Horizontal + Vertical direction)



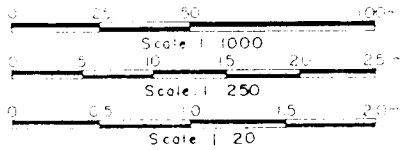
DETAIL 'B'

Scale. 1 : 100



DETAIL 'C'

Scale. 1 : 100



REV.	DATE	NAME	DESCRIPTION	APPROVED
1	20.5.97	Anowar	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

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

CONSULTING CONSORTIUM FAP 21/22

RHEIN-RUHR ING. GES. MBH, DORTMUND/GERMANY
SNC-LAVALIN INTERNATIONAL INC., MONTREAL/CANADA
SOCIETE NATIONALE DU RHONE, LYON/FRANCE
PROF. DR. LACKNER & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS

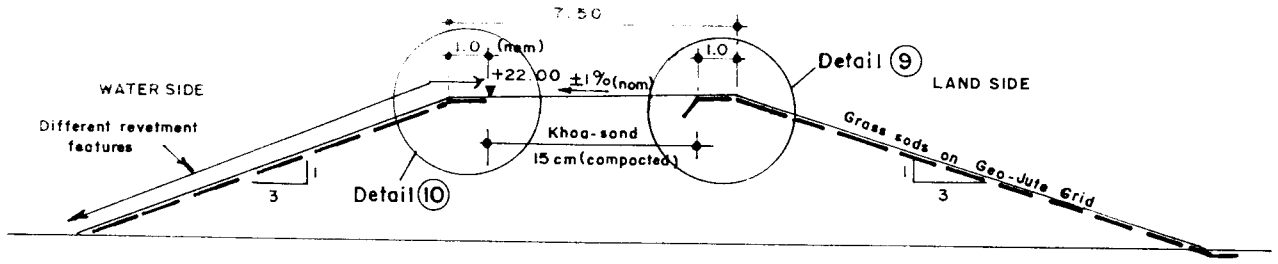
In association with:
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES (TA) (BETS)
DESH UPODESH LIMITED (DUL)

TEST SITE II - BAHADURABAD

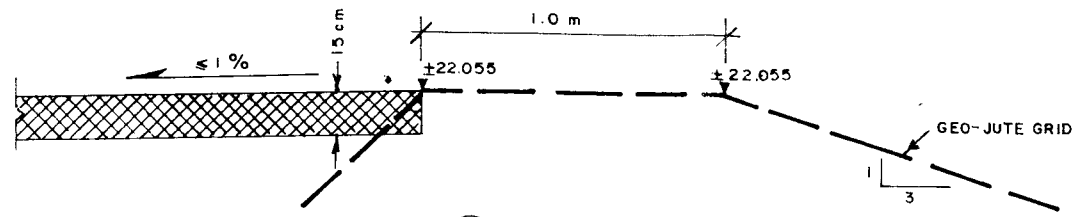
TEST STRUCTURE H
GENERAL PLAN SECTIONS H-1, H-2
CROSS-SECTIONS, DETAILS

	NAME	DATE	SCALE:
DRAWN	ANOWAR	22-10-96	1:1000, 1:250, 1:20
CHECKED		23-10-96	DRAWING NO. R-A-313
APPROVED			REVISION 1

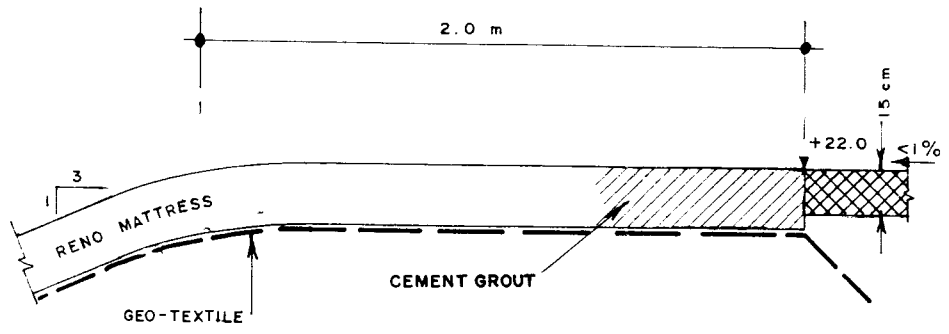
DRAWING PHOTOREDUCED BY 50%



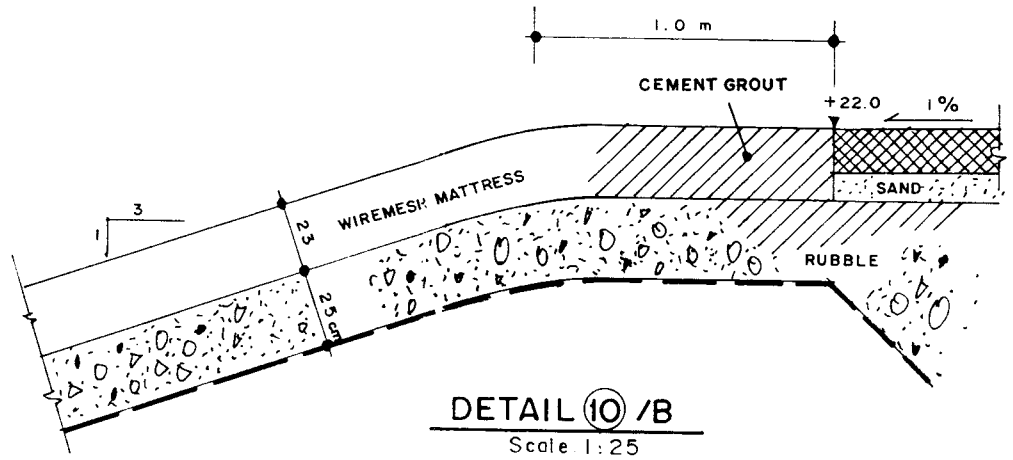
EMBANKMENT TOP
General Cross-Section
Scale. 1 : 200



DETAIL (9)
Scale. 1:25



DETAIL (10) /"A-2"
Scale. 1 : 25



DETAIL (10) /B
Scale. 1:25

LEGEND

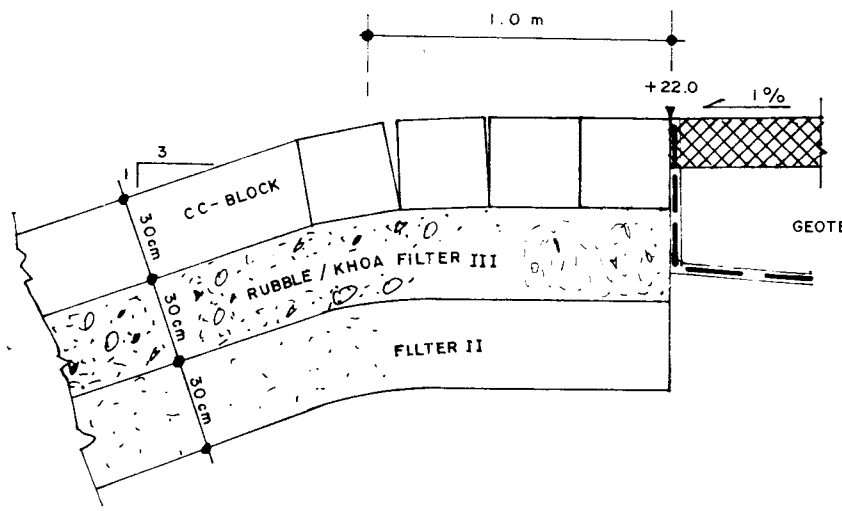
KHOA-SAND 15 cm (Compacted)

CEMENT GROUT

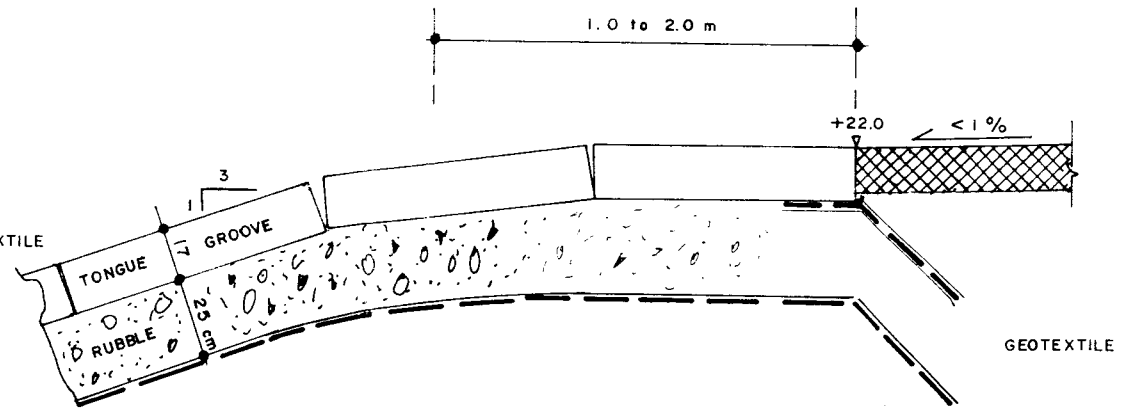
NOTE: AREAS OF CEMENT GROUTING SHOWN INDICATIVELY ONLY.

0 2.5 5.0 10.0 m
SCALE. 1 : 200

0 0.25 0.50 0.75 1.0 1.25 m
SCALE. 1:25



DETAIL (10) /"C"
Scale. 1 : 25



DETAIL (10) /"G"
Scale. 1 : 25

REV.	DATE	NAME	DESCRIPTION	APPROVED
1	1.6.97	Anowar	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

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. LACOSER & PARTNERS, BREMEN/GERMANY
DELFT HYDRAULICS, DELFT/NETHERLANDS
In association with:
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD. / BETS
DESH UNNAYAN LIMITED / DUL

TEST SITE II - BAHADURABAD

EMBANKMENT TOP
DETAILS

	NAME	DATE
DRAWN	ANOWAR	20.04.97
CHECKED		
APPROVED		6/10/97

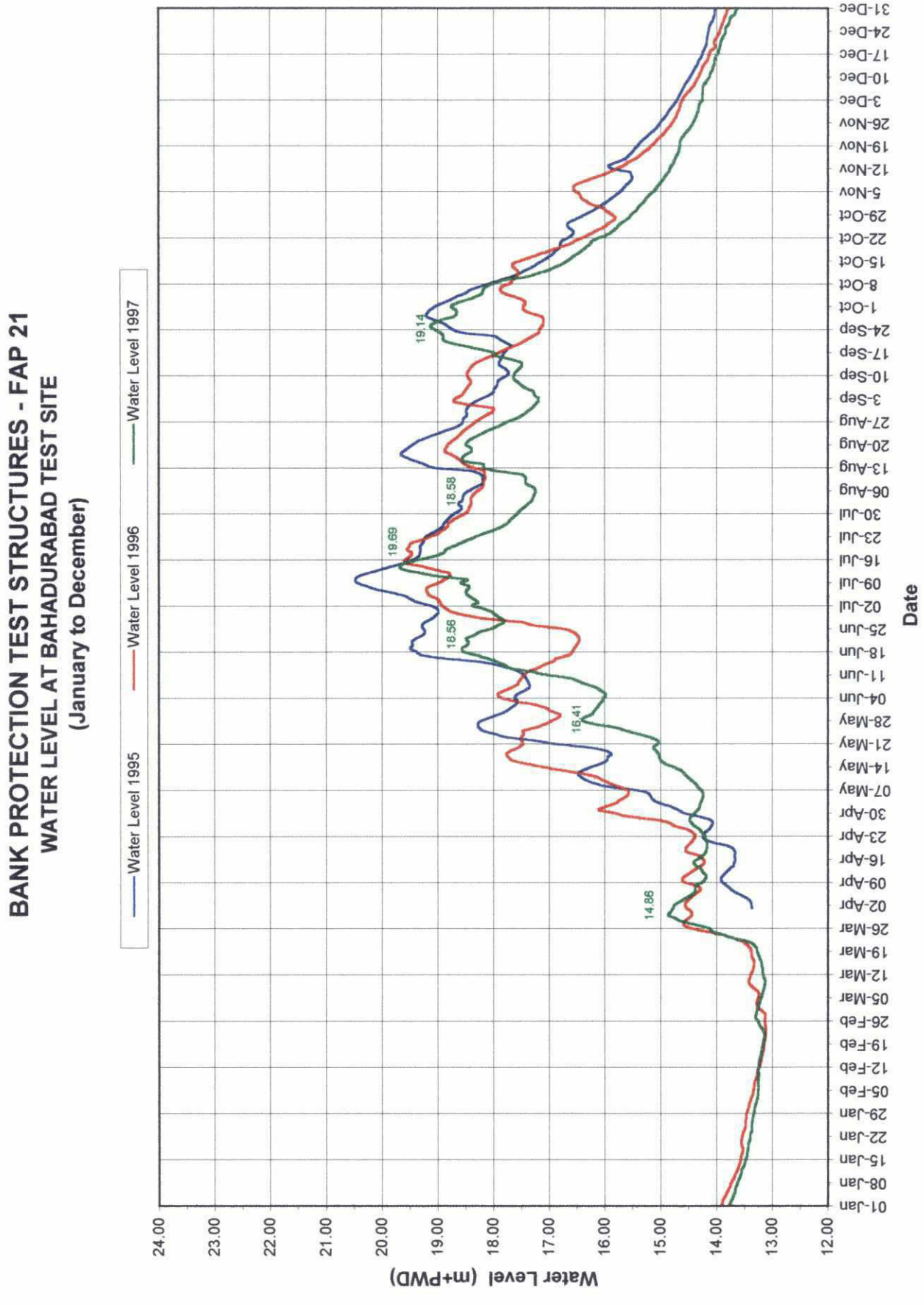
SCALE: 1:25, 1:200

DRAWING NO. R-A-314

REVISION 1

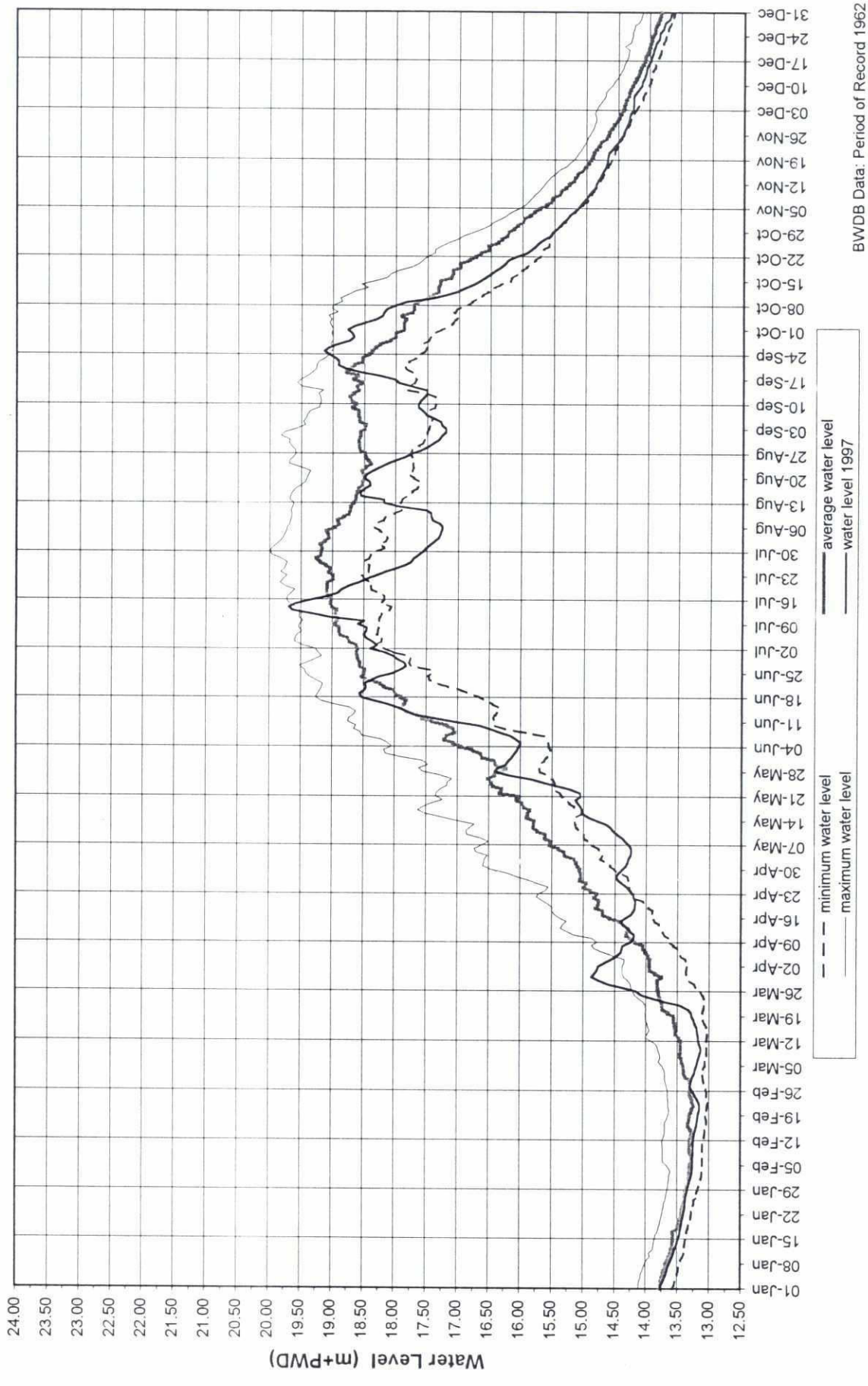
ANNEX B

Water Level


BANK PROTECTION TEST STRUCTURES - FAP 21
WATER LEVEL AT BAHADURABAD TEST SITE
(January to December)
Water Level 1995
Water Level 1996
Water Level 1997
Water Level (m+PWD)
Date
24.00
23.00
22.00
21.00
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
01-Jan
08-Jan
15-Jan
22-Jan
29-Jan
05-Feb
12-Feb
19-Feb
26-Feb
05-Mar
12-Mar
19-Mar
26-Mar
02-Apr
09-Apr
16-Apr
23-Apr
30-Apr
07-May
14-May
21-May
28-May
04-Jun
11-Jun
18-Jun
25-Jun
02-Jul
09-Jul
16-Jul
23-Jul
30-Jul
06-Aug
13-Aug
20-Aug
27-Aug
3-Sep
10-Sep
17-Sep
24-Sep
1-Oct
8-Oct
15-Oct
22-Oct
29-Oct
5-Nov
12-Nov
19-Nov
26-Nov
3-Dec
10-Dec
17-Dec
24-Dec
31-Dec
19.14
18.58
19.69
18.56
16.41
14.86

BANK PROTECTION TEST STRUCTURES - FAP 21

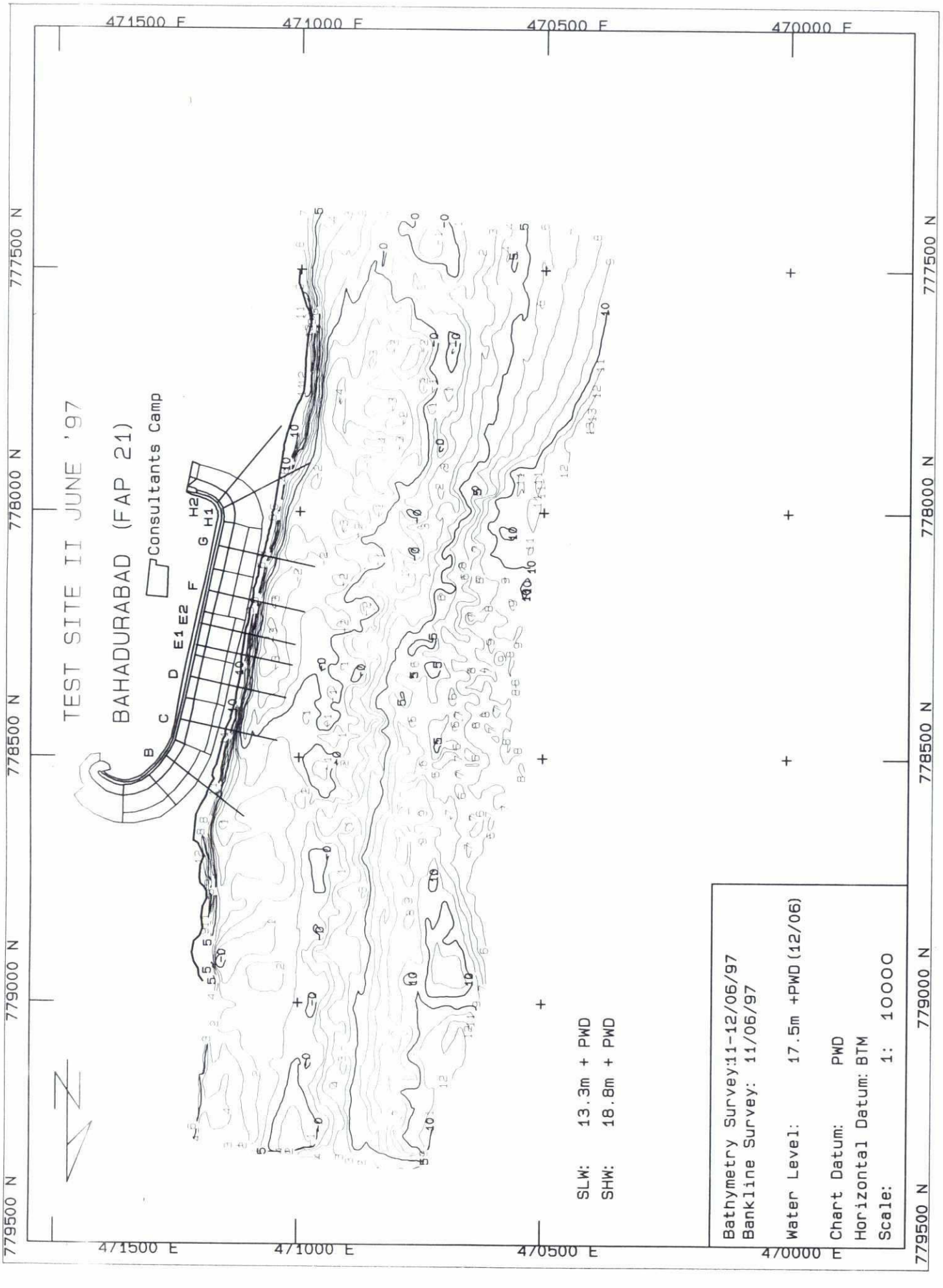
BWDB WATER LEVEL FREQUENCY CURVES VERSUS ACTUAL FAP 21 WATER LEVEL AT BAHADURABAD TEST SITE UP TO DECEMBER '97

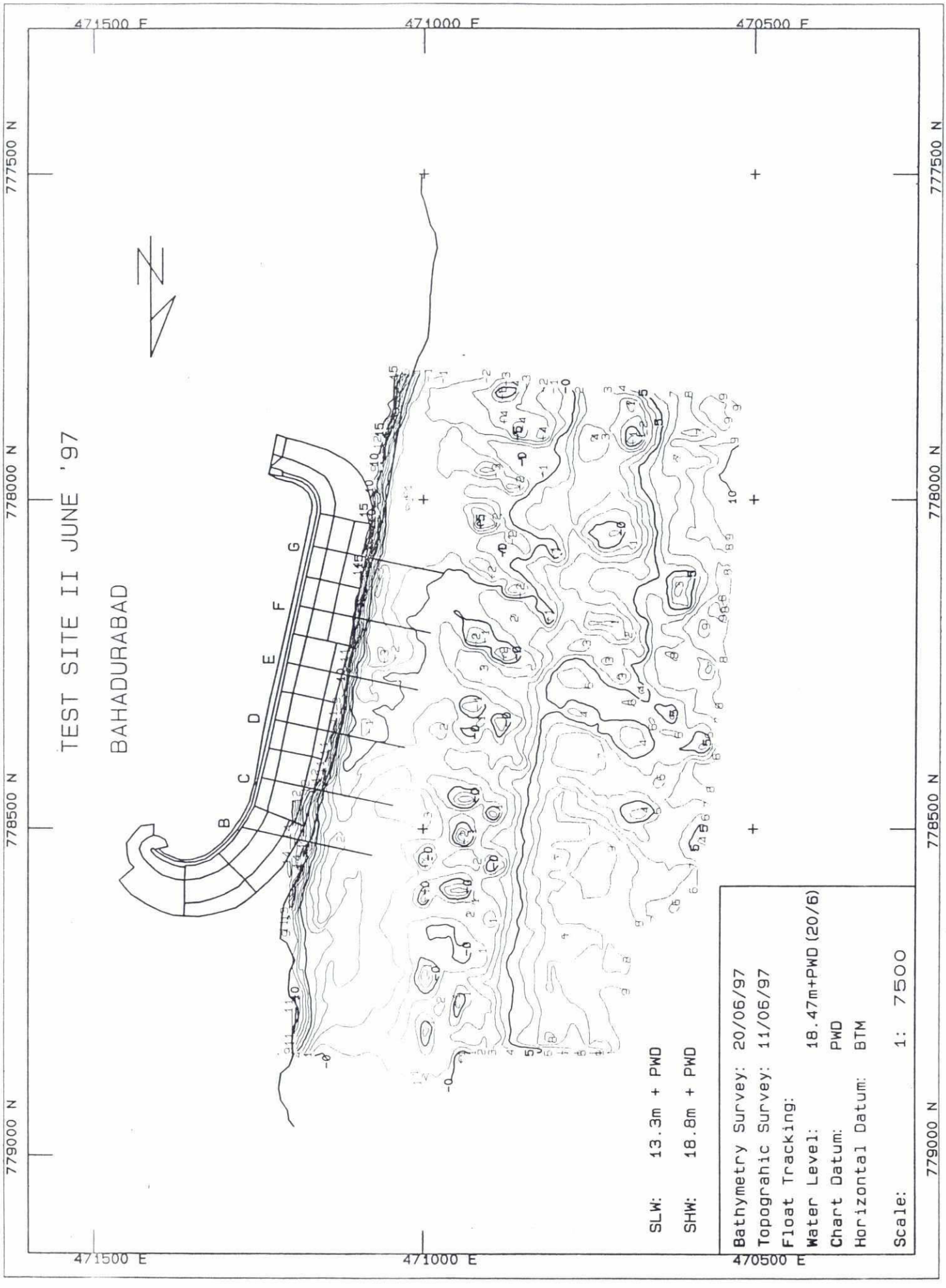


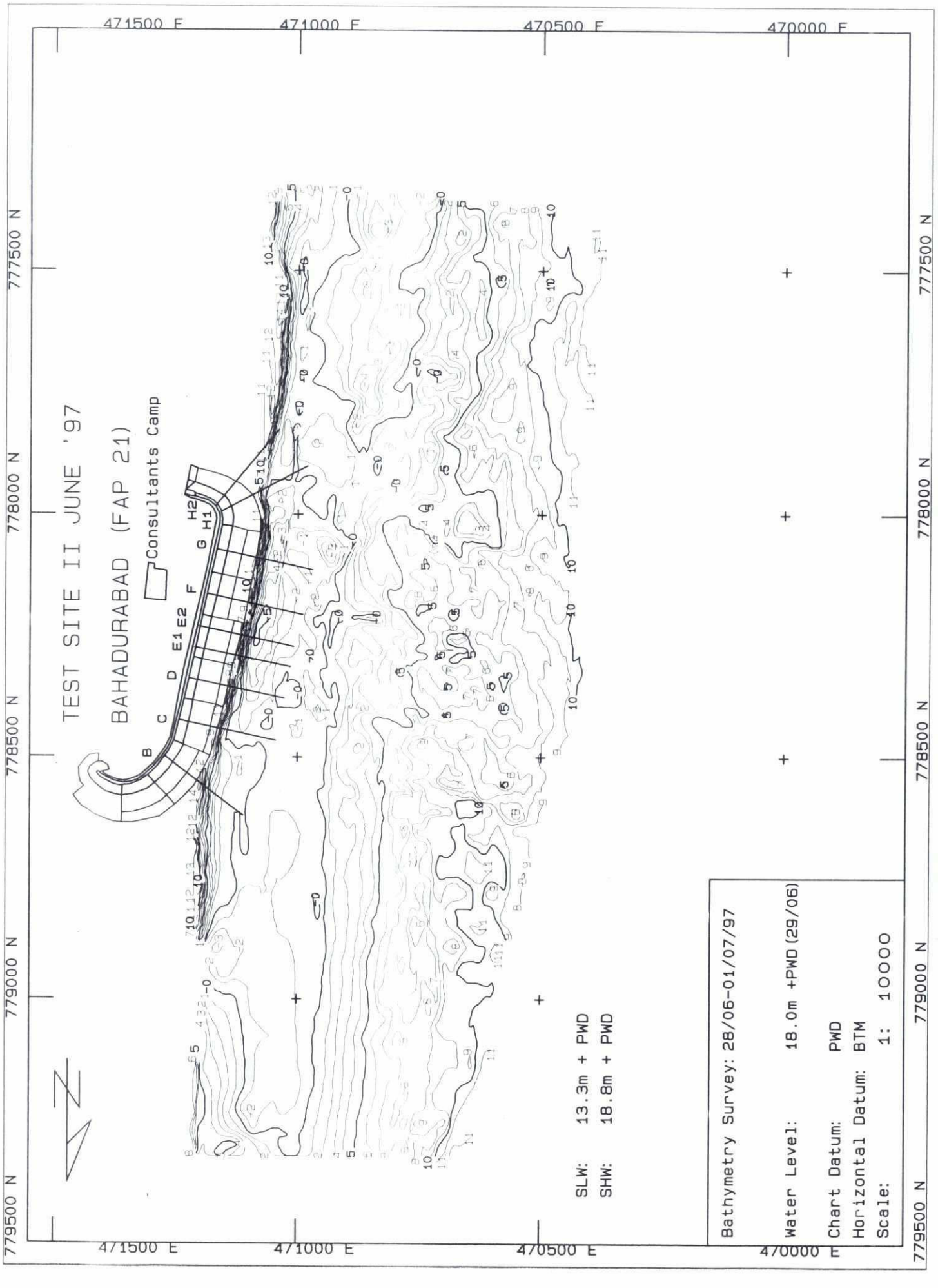
BWDB Data: Period of Record 1962 - 1994

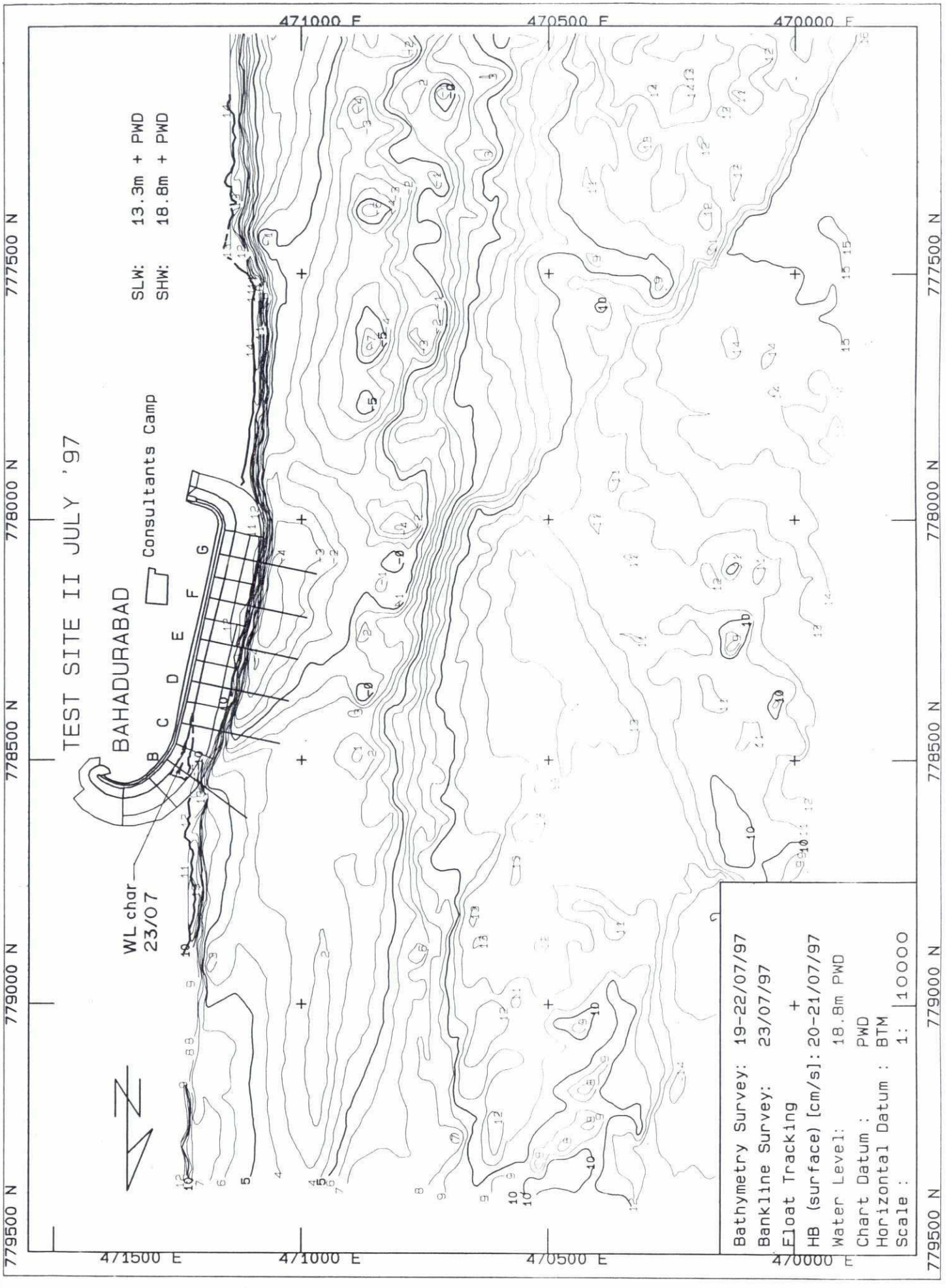
ANNEX C

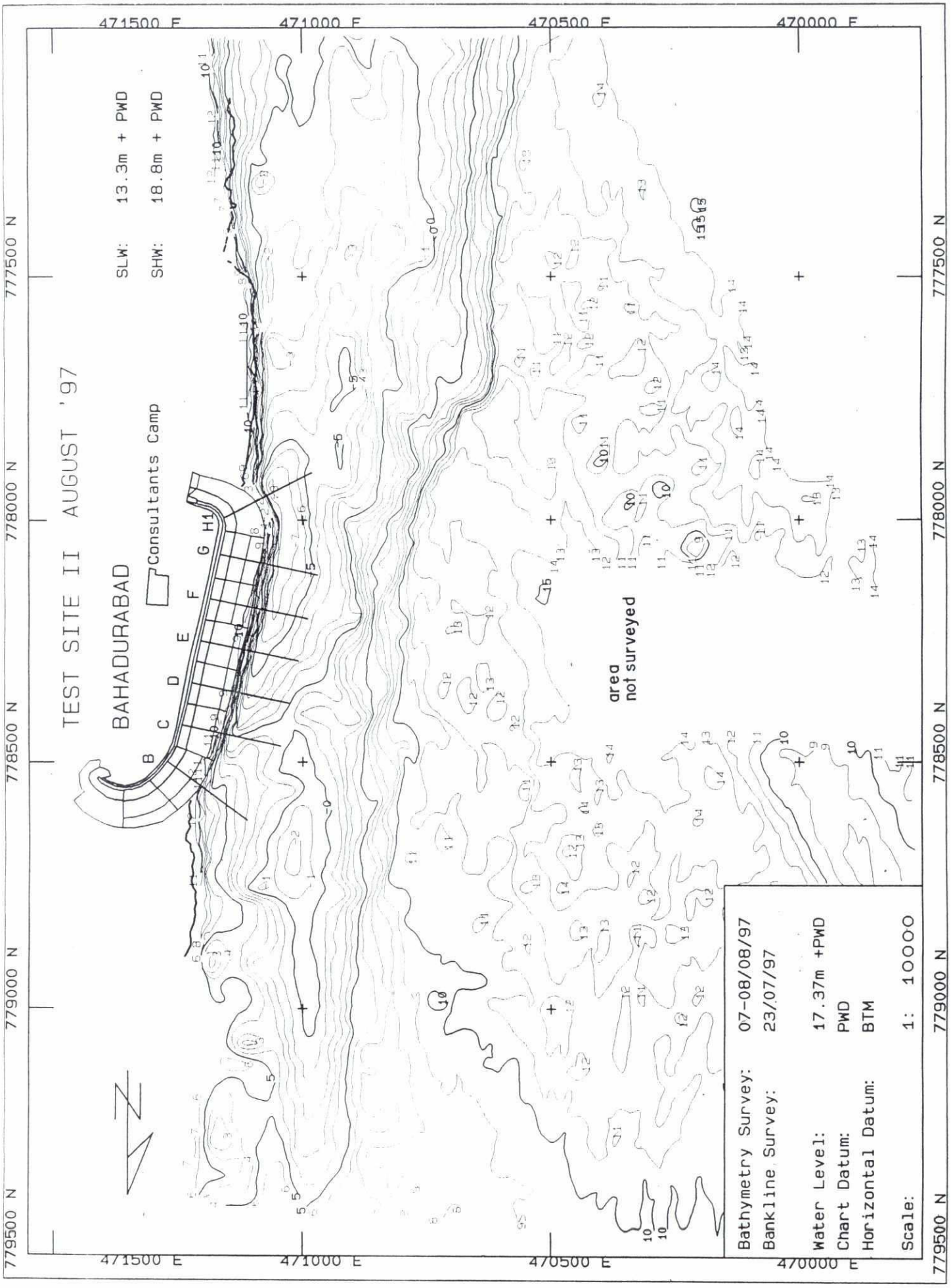
Bathymetric Survey

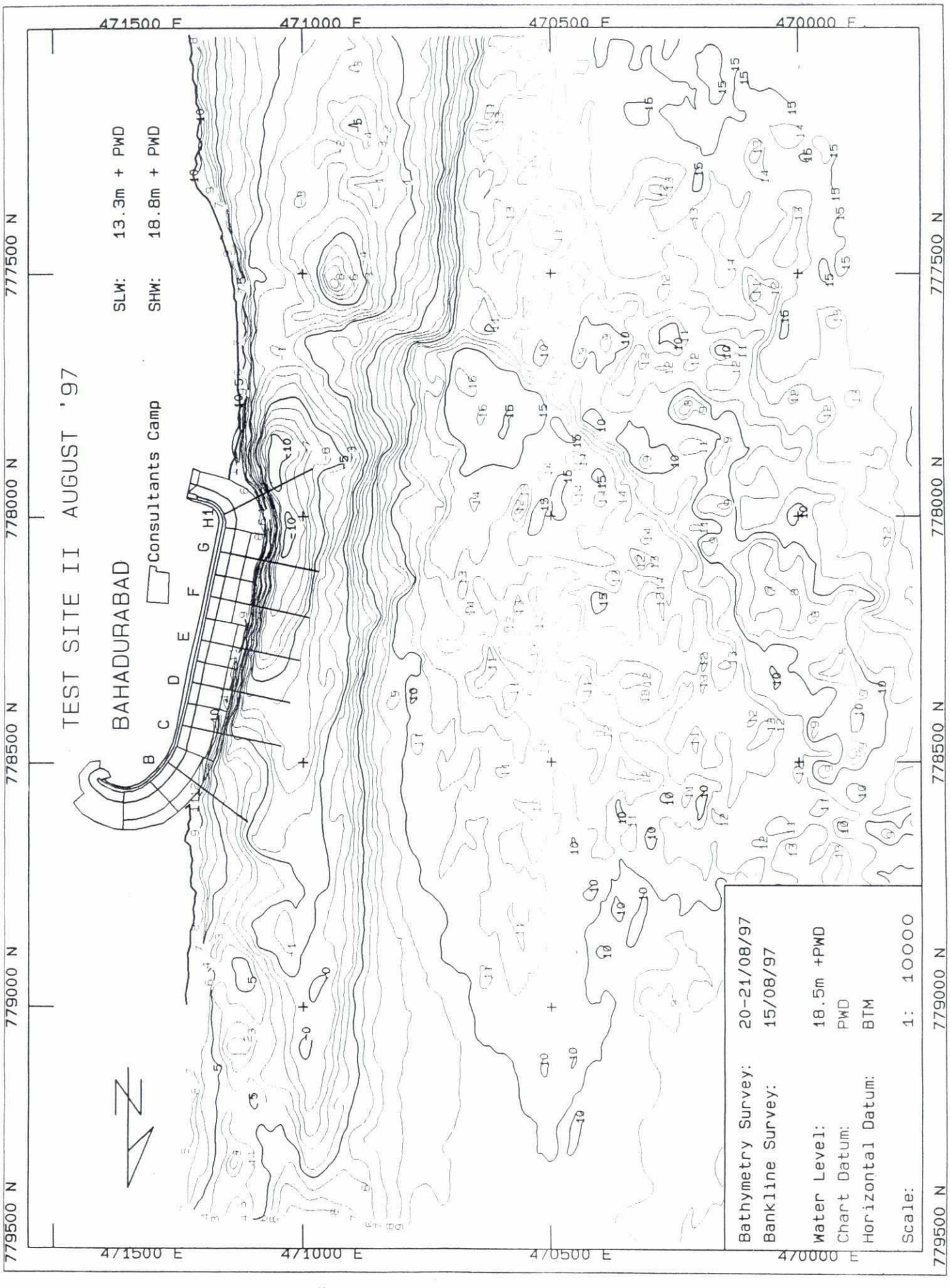

TEST SITE II JUNE '97
BAHADURABAD (FAP 21)
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
SLW: 13.3m + PWD
SHW: 18.8m + PWD
Bathymetry Survey:11-12/06/97
Bankline Survey: 11/06/97
Water Level: 17.5m +PWD (12/06)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

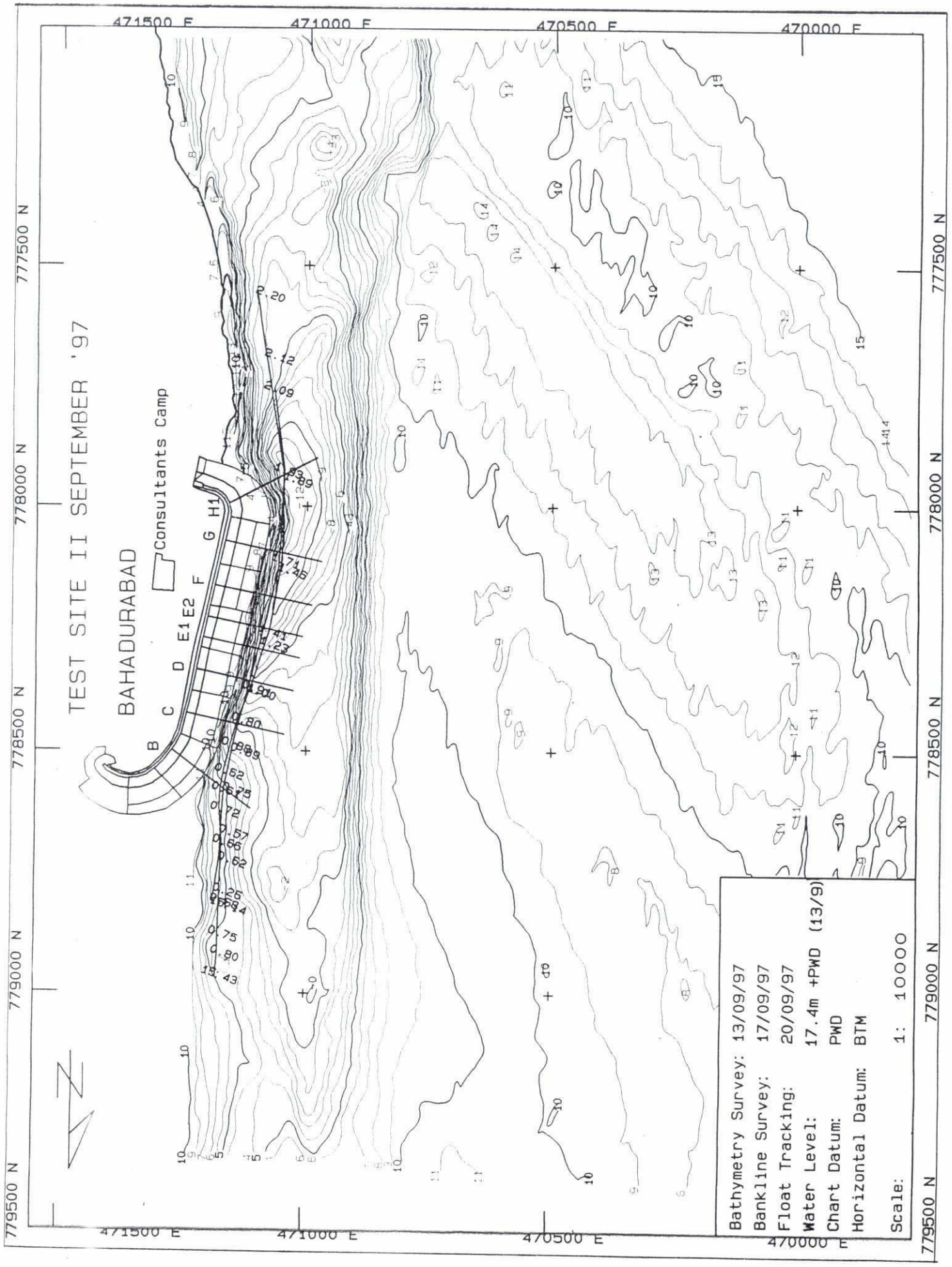

471500 E
471000 E
470500 E
777500 N
778000 N
778500 N
779000 N
TEST SITE II JUNE '97
BAHADURABAD
B
C
D
E
F
G
SLW: 13.3m + PWD
SHW: 18.8m + PWD
Bathymetry Survey: 20/06/97
Topograhic Survey: 11/06/97
Float Tracking:
Water Level: 18.47m+PWD (20/6)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 7500

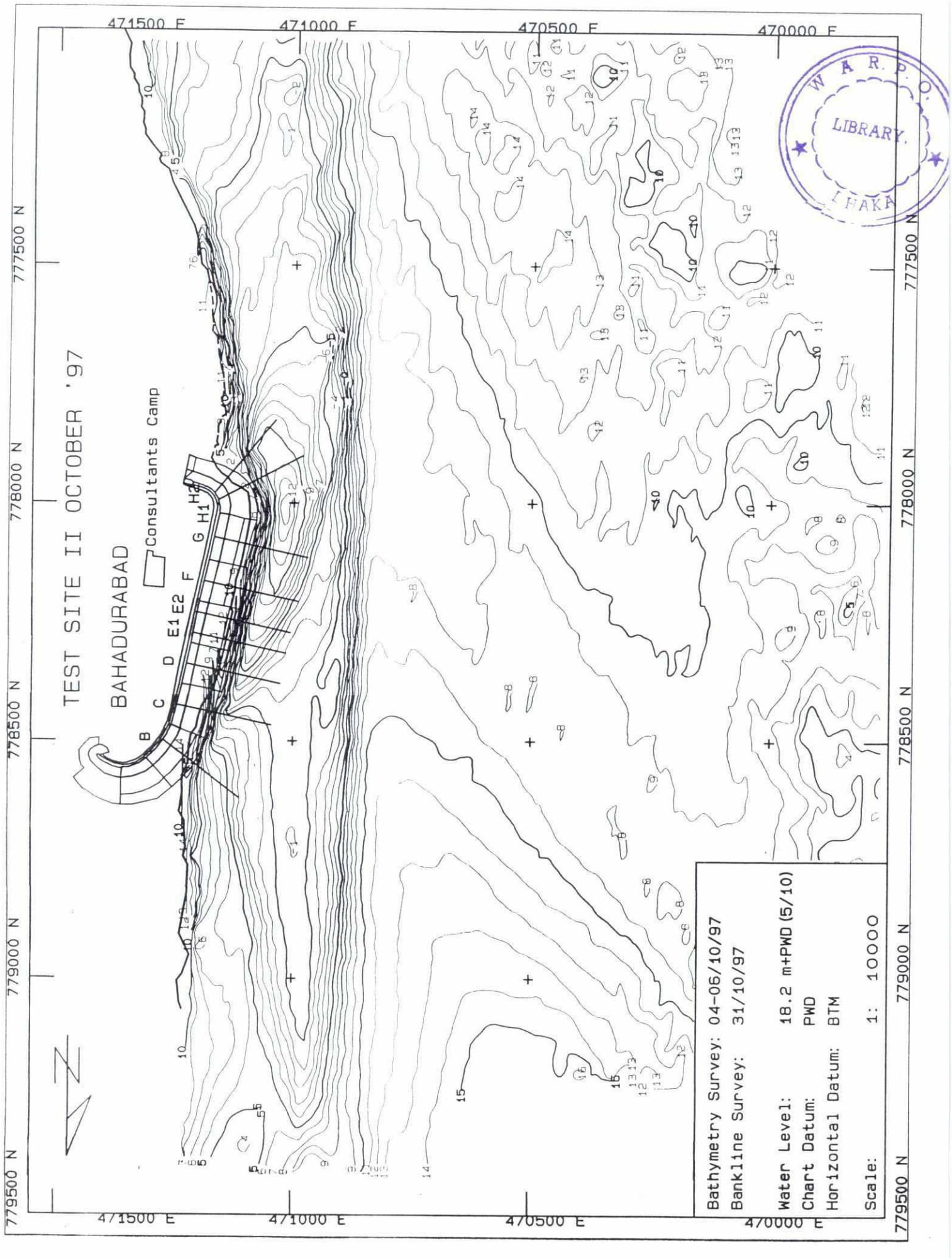

TEST SITE II JUNE '97
BAHADURABAD (FAP 21)
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
SLW: 13.3m + PWD
SHW: 18.8m + PWD
Bathymetry Survey: 28/06-01/07/97
Water Level: 18.0m +PWD (29/06)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

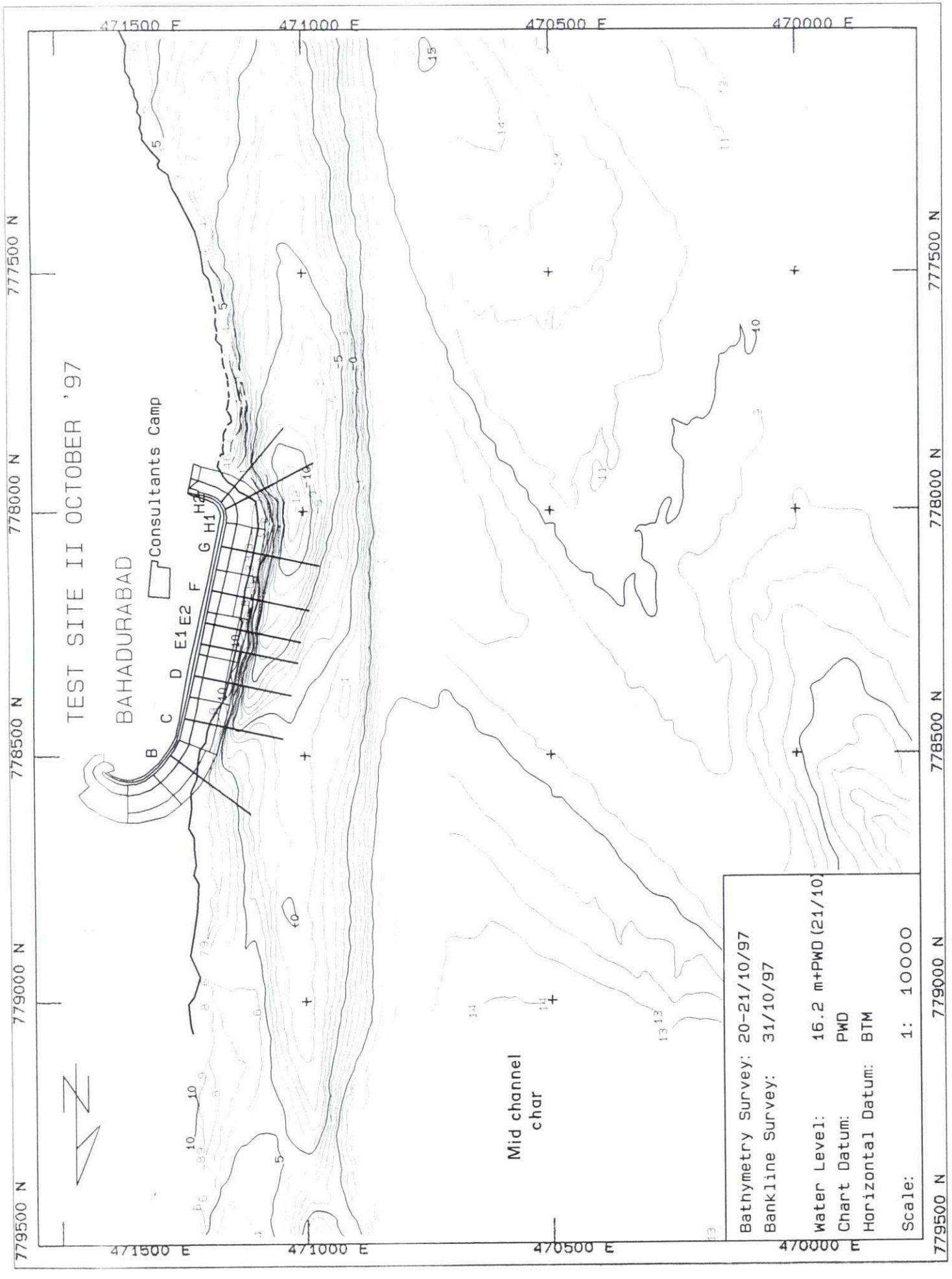

TEST SITE II JULY '97
BAHADURABAD
Consultants Camp
SLW: 13.3m + PWD
SHW: 18.8m + PWD
WL char
23/07
B C D E F G
471000 E
470500 E
470000 E
471500 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 19-22/07/97
Bankline Survey: 23/07/97
Float Tracking +
HB (surface) [cm/s]: 20-21/07/97
Water Level: 18.8m PWD
Chart Datum : PWD
Horizontal Datum : BTM
Scale : 1: 10000

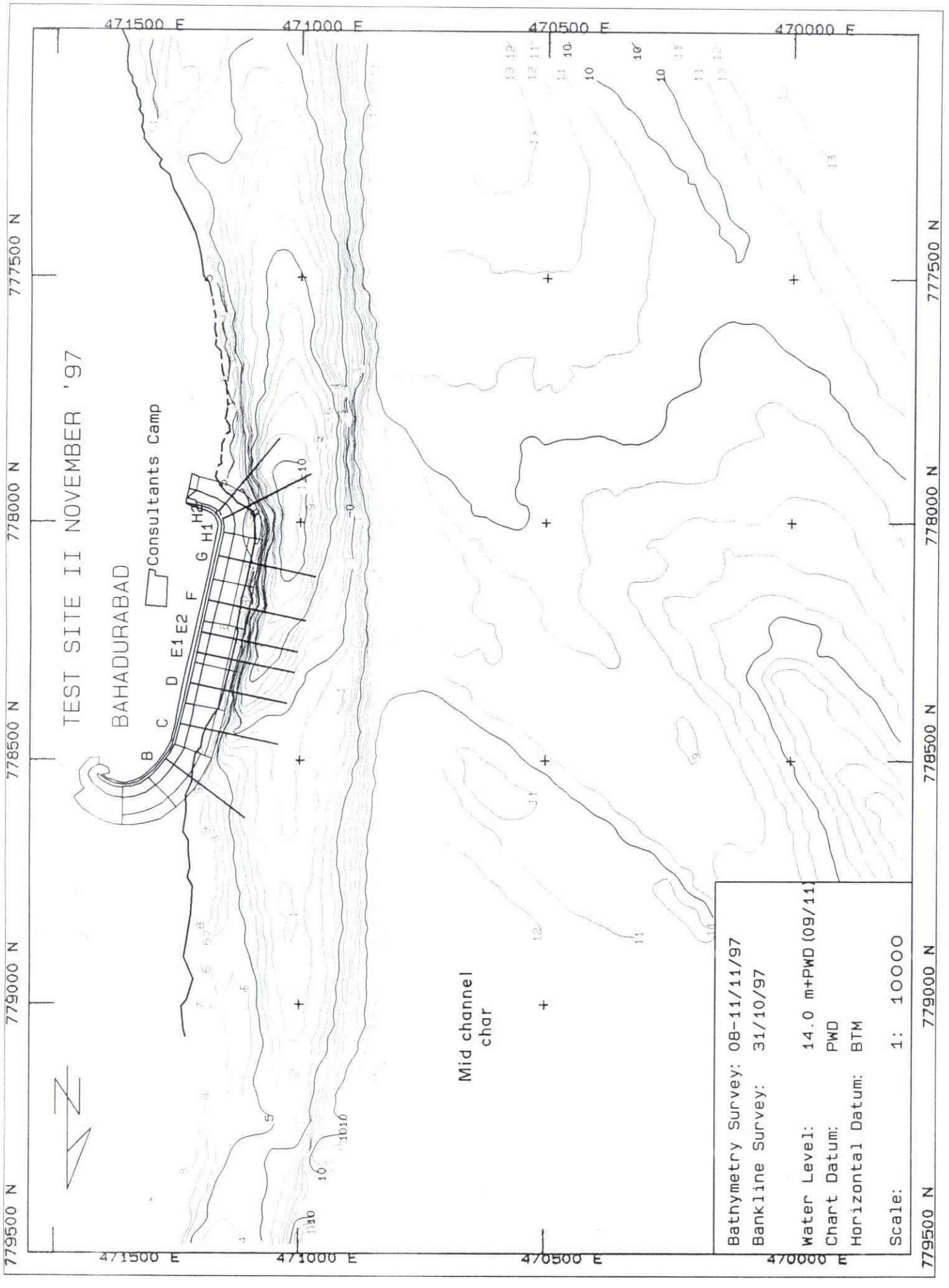

TEST SITE II AUGUST '97
BAHADURABAD
Consultants Camp
SLW: 13.3m + PWD
SHW: 18.8m + PWD
B C D E F G H1
area not surveyed
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 07-08/08/97
Bankline Survey: 23/07/97
Water Level: 17.37m +PWD
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

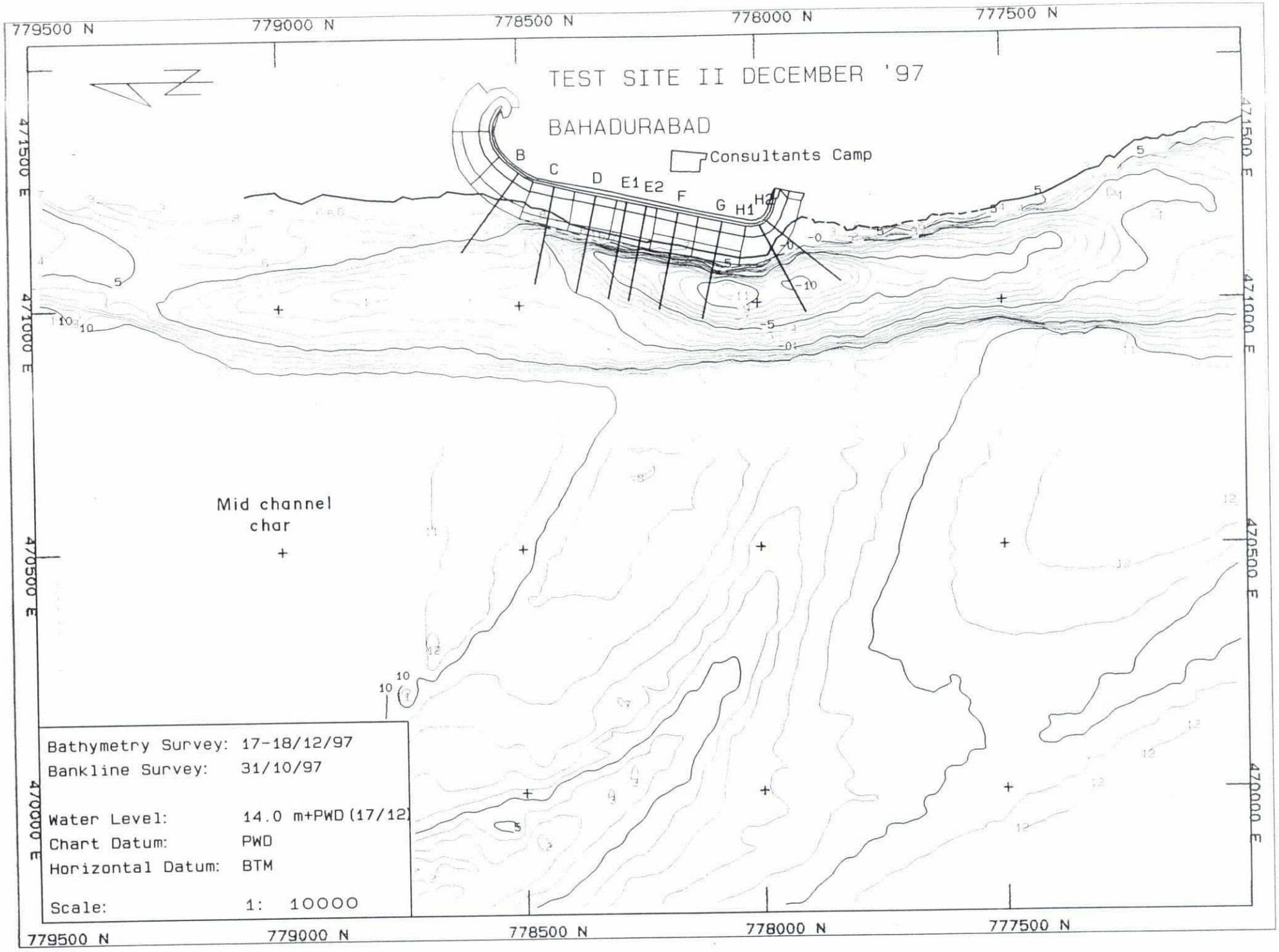

TEST SITE II AUGUST '97
BAHADURABAD
Consultants Camp
SLW: 13.3m + PWD
SHW: 18.8m + PWD
B
C
D
E
F
G
H1
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 20-21/08/97
Bankline Survey: 15/08/97
Water Level: 18.5m +PWD
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000


TEST SITE II SEPTEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 13/09/97
Bankline Survey: 17/09/97
Float Tracking: 20/09/97
Water Level: 17.4m +PWD (13/9)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000



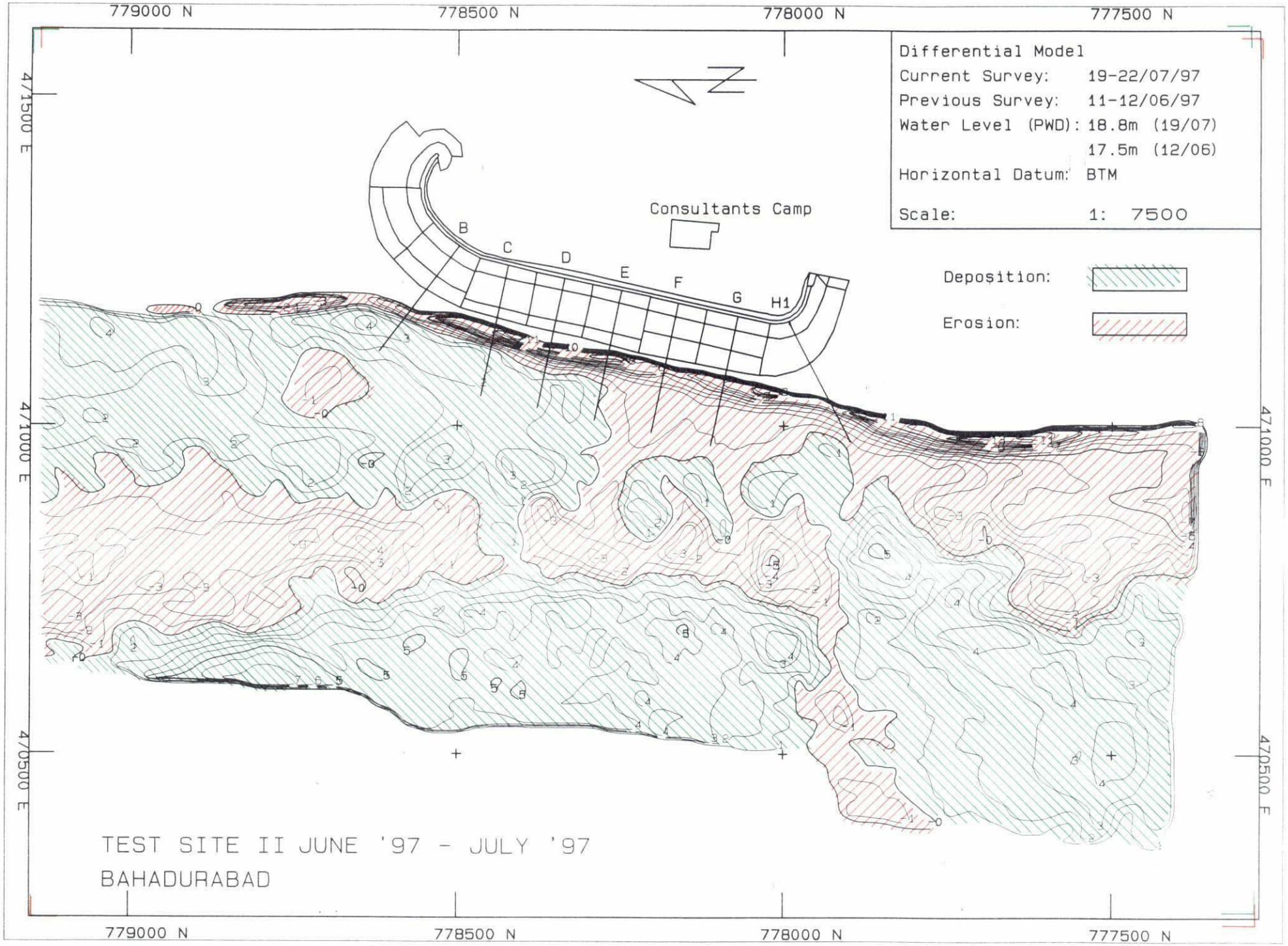

TEST SITE II OCTOBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
Mid channel
char
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 20-21/10/97
Bankline Survey: 31/10/97
Water Level: 16.2 m+PWD (21/10)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

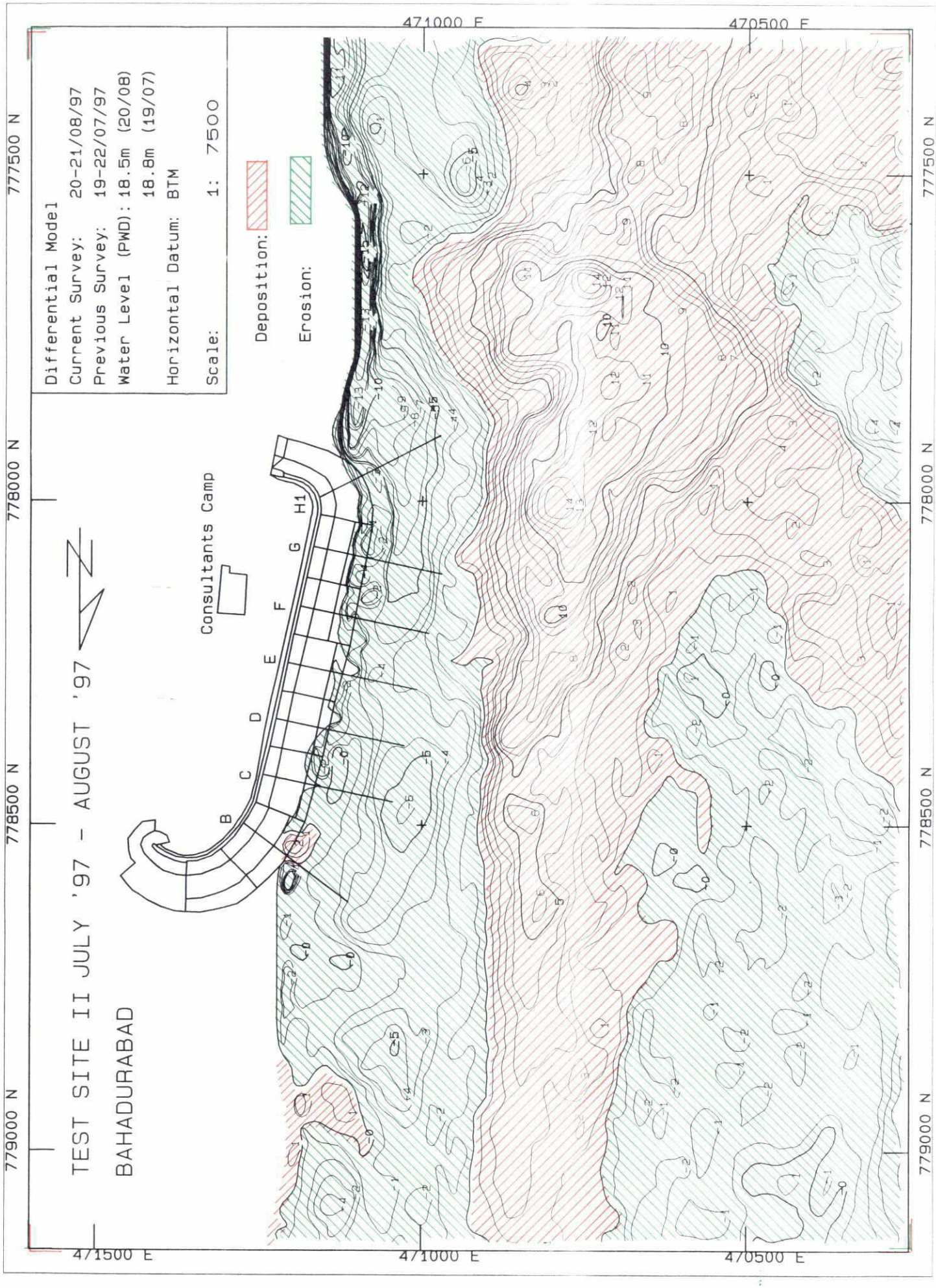

TEST SITE II NOVEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
Mid channel
char
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 08-11/11/97
Bankline Survey: 31/10/97
Water Level: 14.0 m+PWD (09/11)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

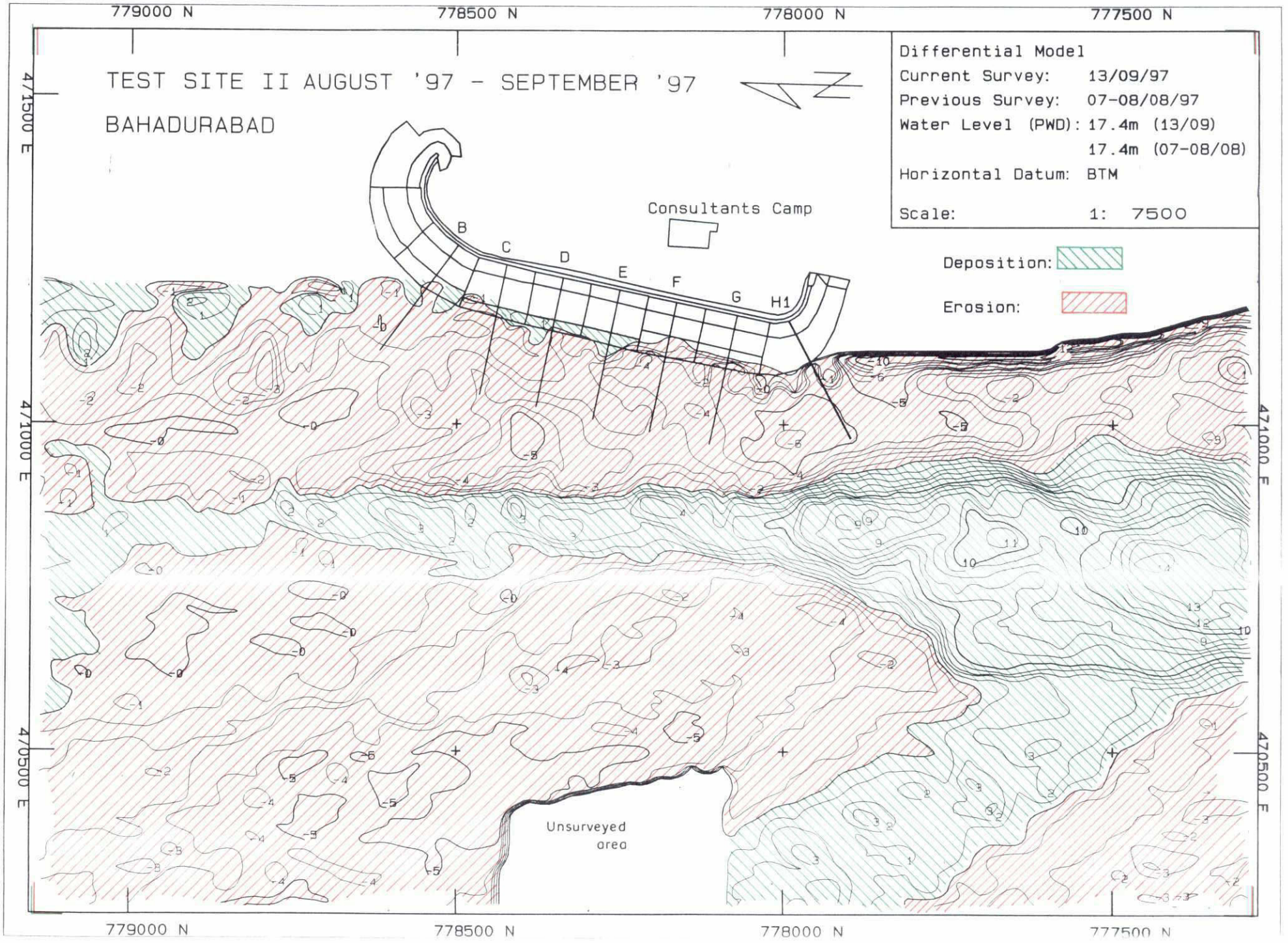

TEST SITE II DECEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
Mid channel
char
779500 N
779000 N
778500 N
778000 N
777500 N
471500 E
471000 E
470500 E
470000 E
Bathymetry Survey: 17-18/12/97
Bankline Survey: 31/10/97
Water Level: 14.0 m+PWD (17/12)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

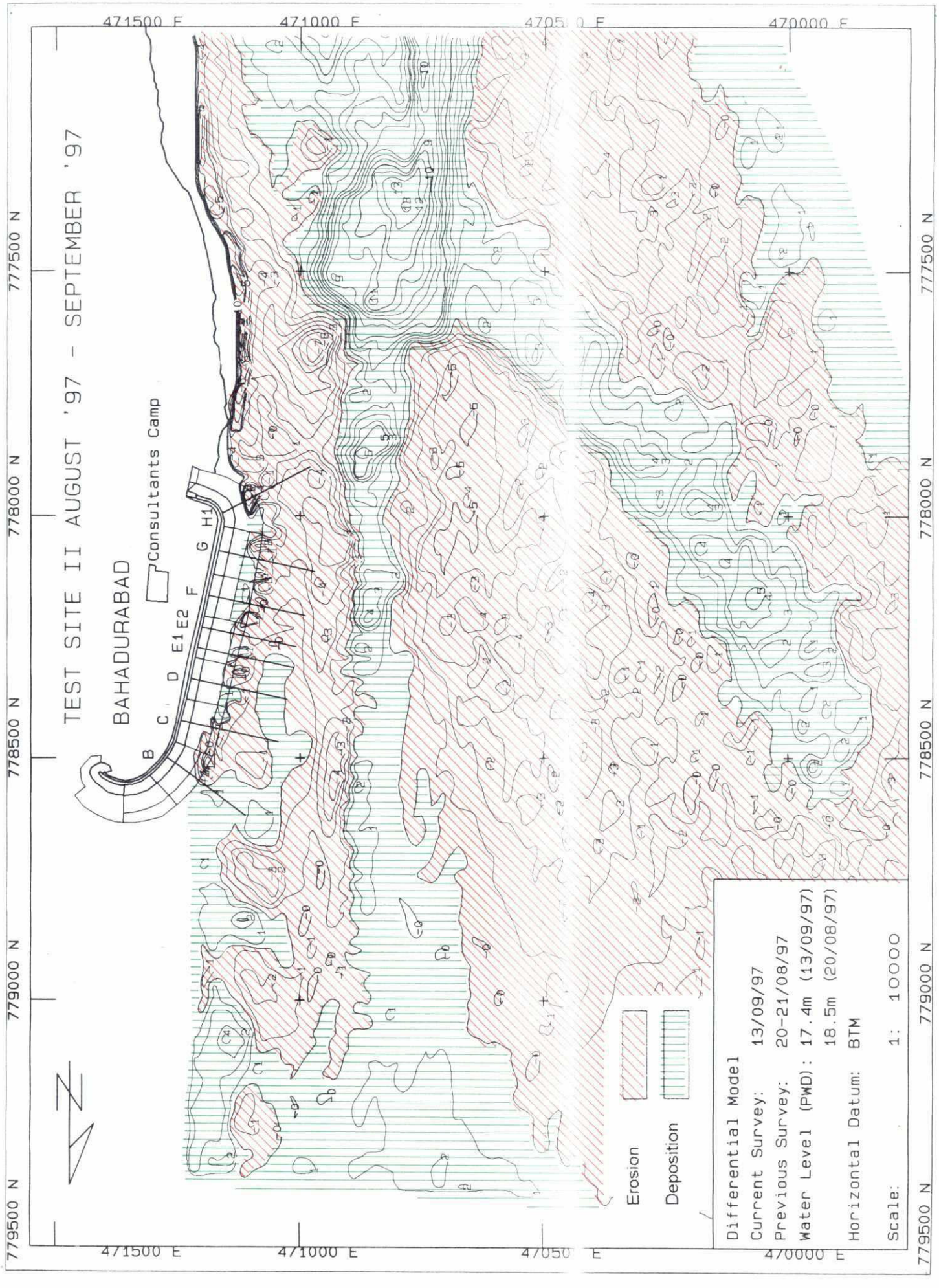
ANNEX D

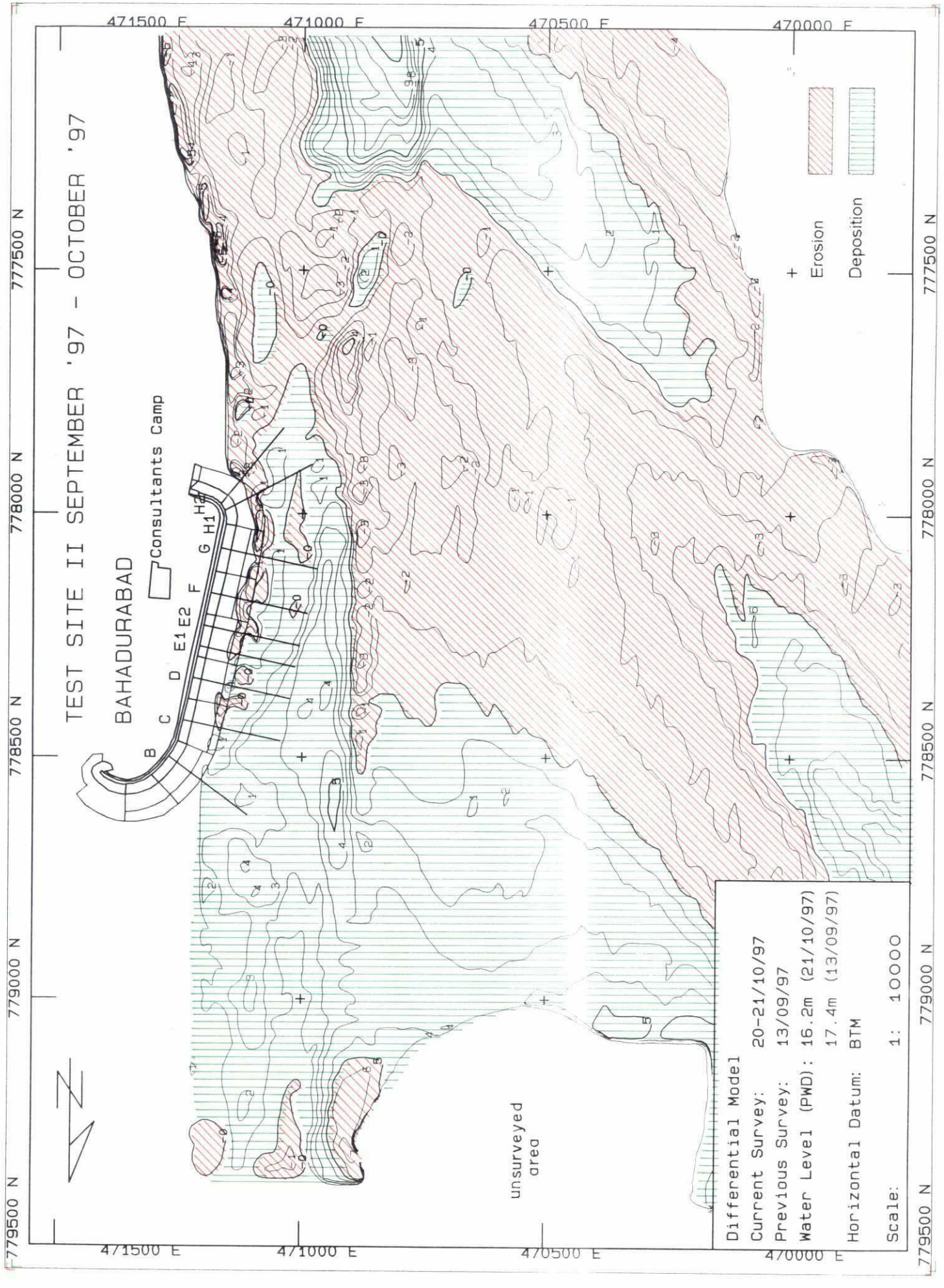
Differential Models

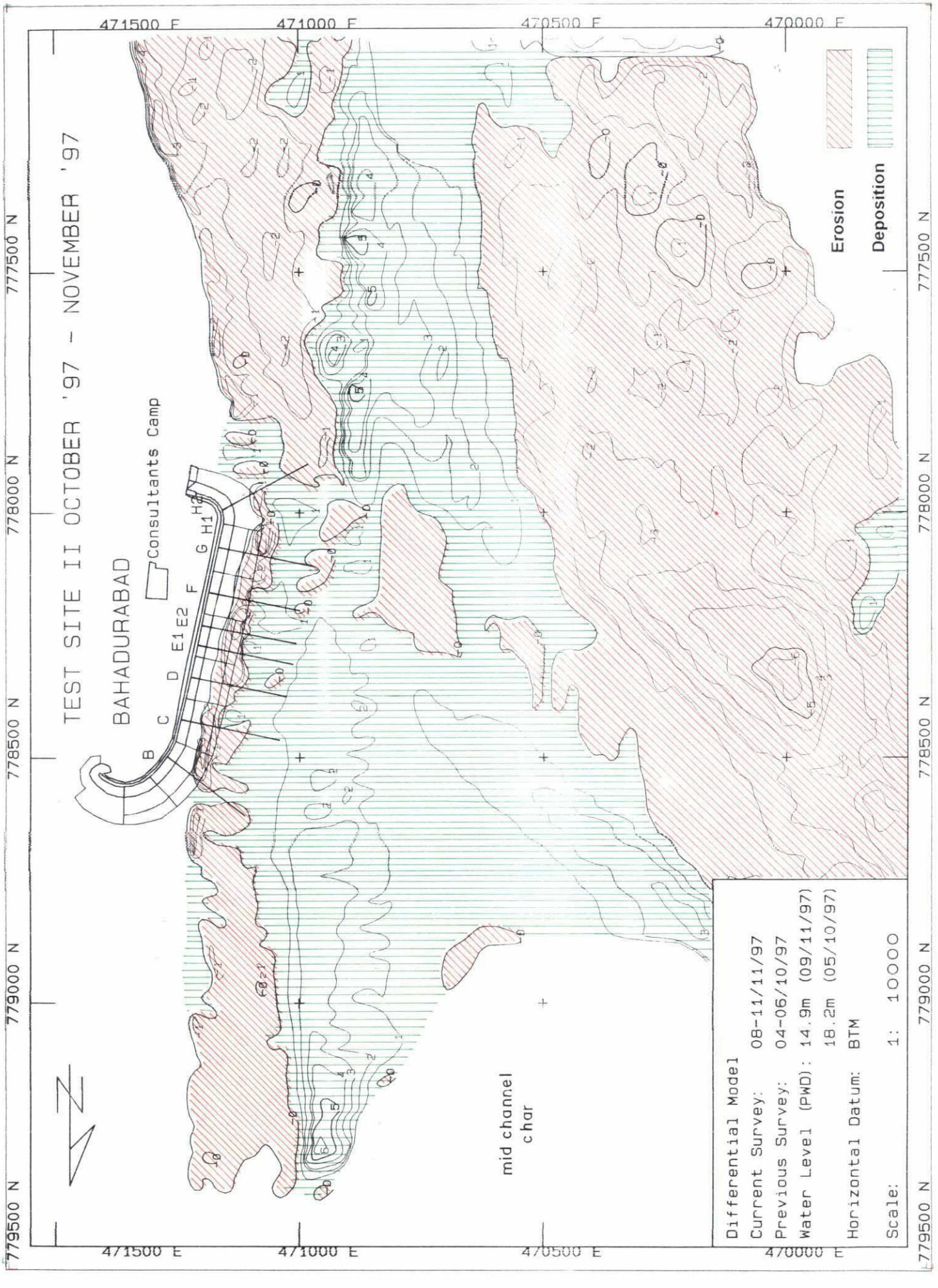

779000 N
778500 N
778000 N
777500 N
471500 E
471000 E
470500 E
Differential Model
Current Survey: 19-22/07/97
Previous Survey: 11-12/06/97
Water Level (PWD): 18.8m (19/07)
17.5m (12/06)
Horizontal Datum: BTM
Scale: 1: 7500
Consultants Camp
B
C
D
E
F
G
H1
Deposition:
Erosion:
TEST SITE II JUNE '97 - JULY '97
BAHADURABAD

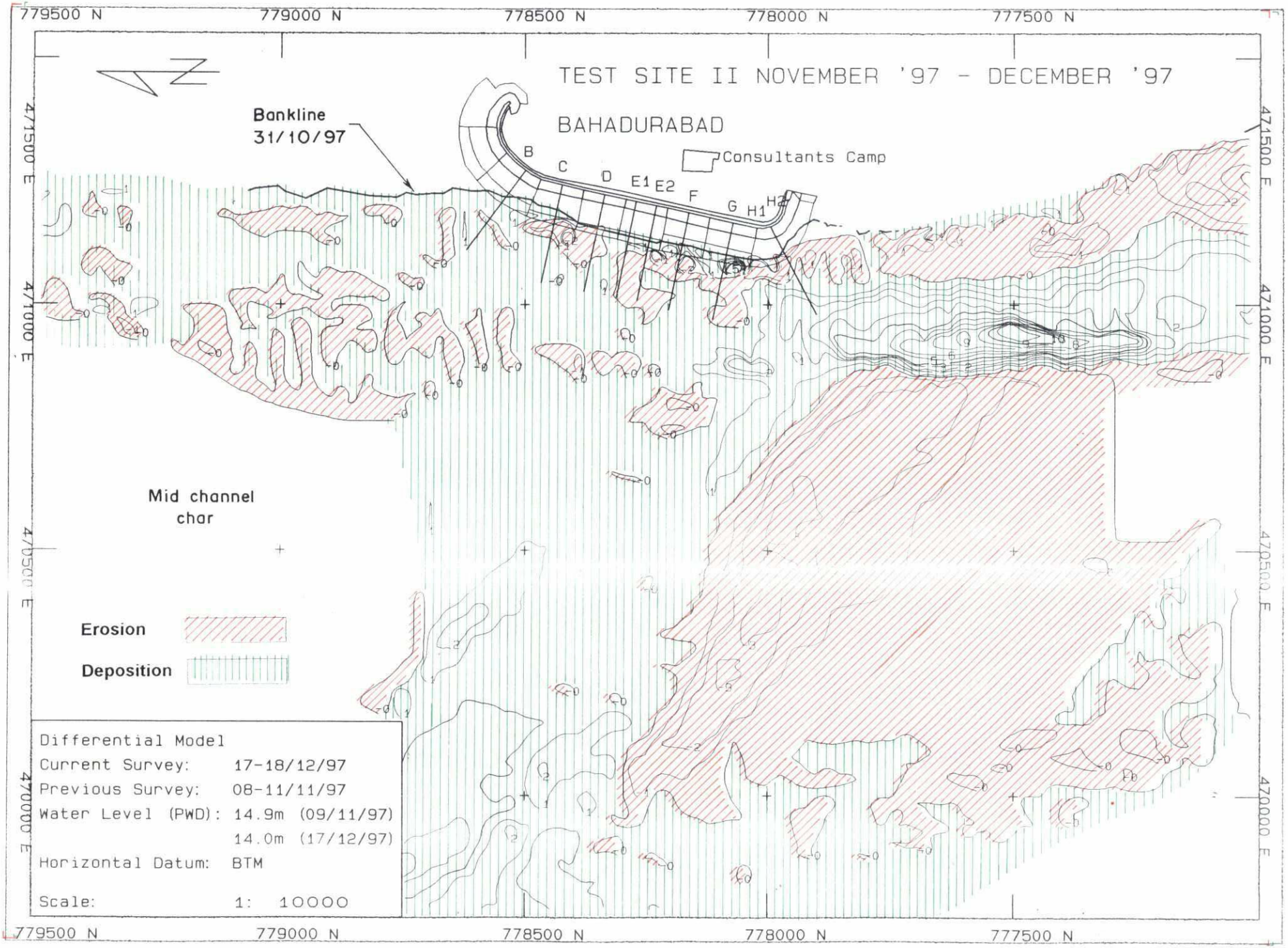

TEST SITE II JULY '97 - AUGUST '97
BAHADURABAD
Differential Model
Current Survey: 20-21/08/97
Previous Survey: 19-22/07/97
Water Level (PWD): 18.5m (20/08)
18.8m (19/07)
Horizontal Datum: BTM
Scale: 1: 7500
Deposition:
Erosion:
Consultants Camp
B
C
D
E
F
G
H1
471000 E
470500 E
777500 N
778000 N
778500 N
779000 N
471500 E
471000 E
470500 E


779000 N
778500 N
778000 N
777500 N
TEST SITE II AUGUST '97 - SEPTEMBER '97
BAHADURABAD
Differential Model
Current Survey: 13/09/97
Previous Survey: 07-08/08/97
Water Level (PWD): 17.4m (13/09)
17.4m (07-08/08)
Horizontal Datum: BTM
Scale: 1: 7500
Deposition:
Erosion:
Consultants Camp
B
C
D
E
F
G
H1
471500 E
471000 E
470500 E
Unsurveyed area


TEST SITE II AUGUST '97 - SEPTEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Erosion
Deposition
Differential Model
Current Survey: 13/09/97
Previous Survey: 20-21/08/97
Water Level (PWD): 17.4m (13/09/97)
18.5m (20/08/97)
Horizontal Datum: BTM
Scale: 1: 10000

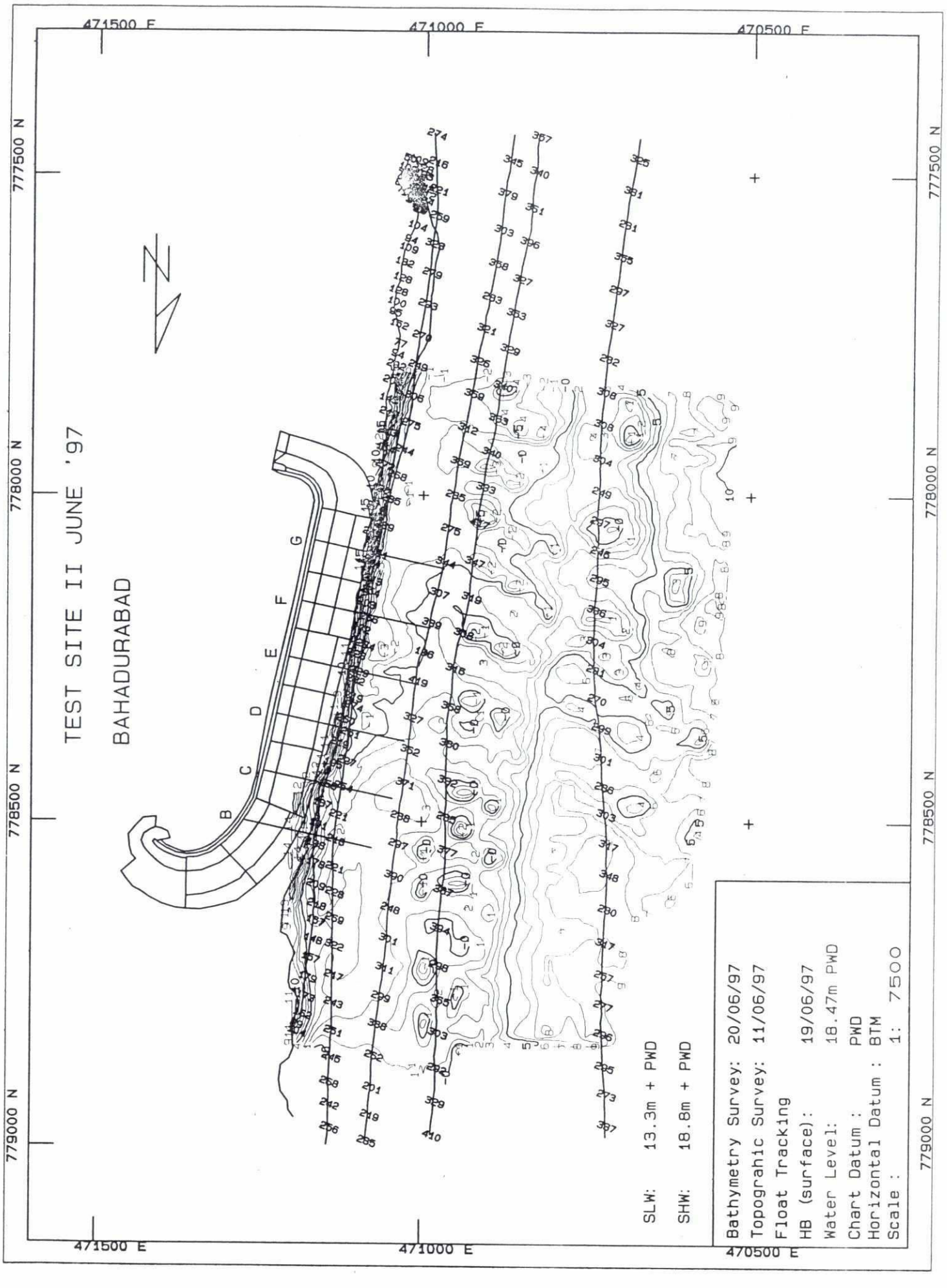

TEST SITE II SEPTEMBER '97 - OCTOBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Erosion
Deposition
unsurveyed area
Differential Model
Current Survey: 20-21/10/97
Previous Survey: 13/09/97
Water Level (PWD): 16.2m (21/10/97)
17.4m (13/09/97)
Horizontal Datum: BTM
Scale: 1: 10000

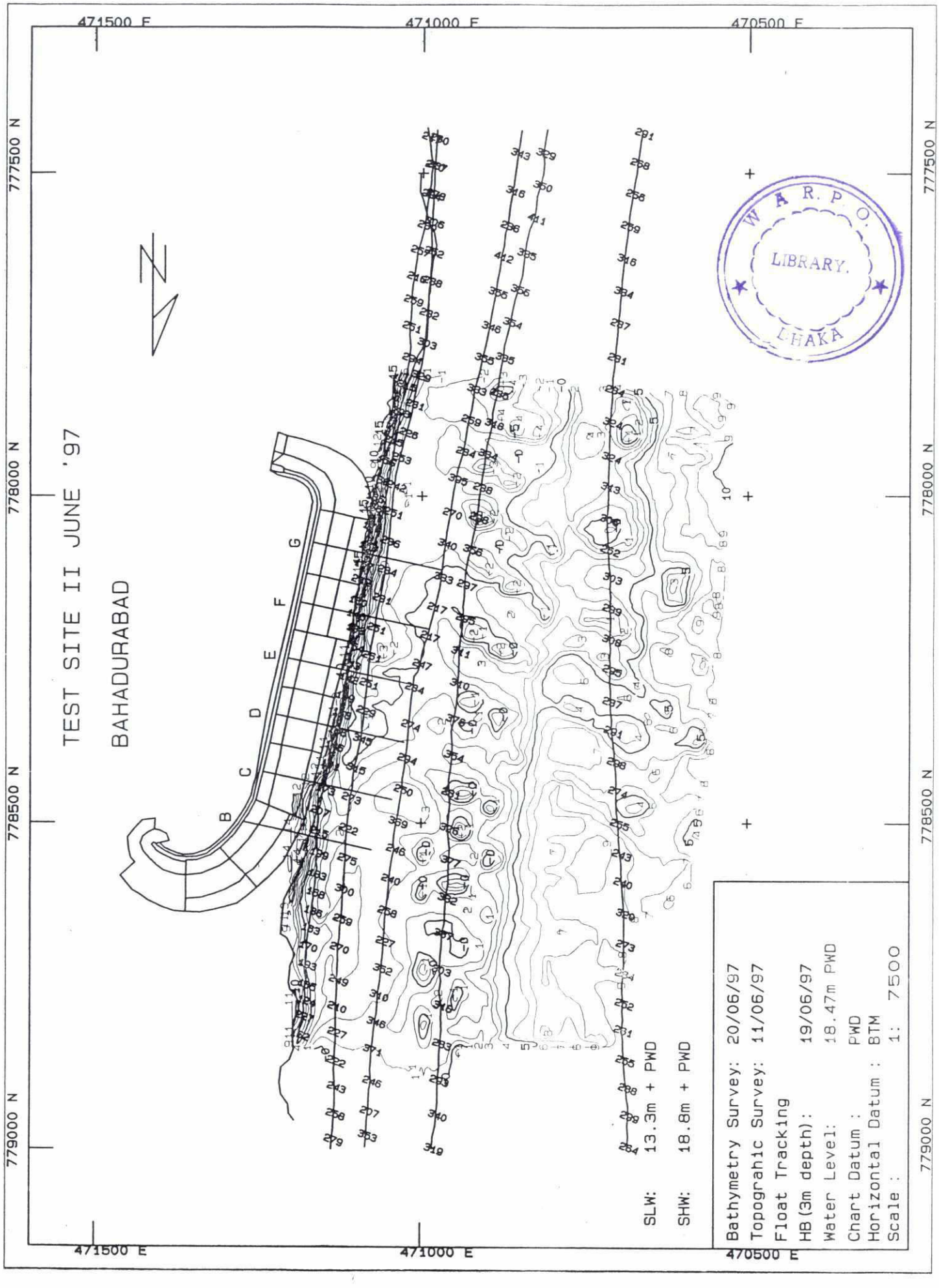

TEST SITE II OCTOBER '97 - NOVEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
mid channel
char
Erosion
Deposition
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Differential Model
Current Survey: 08-11/11/97
Previous Survey: 04-06/10/97
Water Level (PWD): 14.9m (09/11/97)
18.2m (05/10/97)
Horizontal Datum: BTM
Scale: 1: 10000

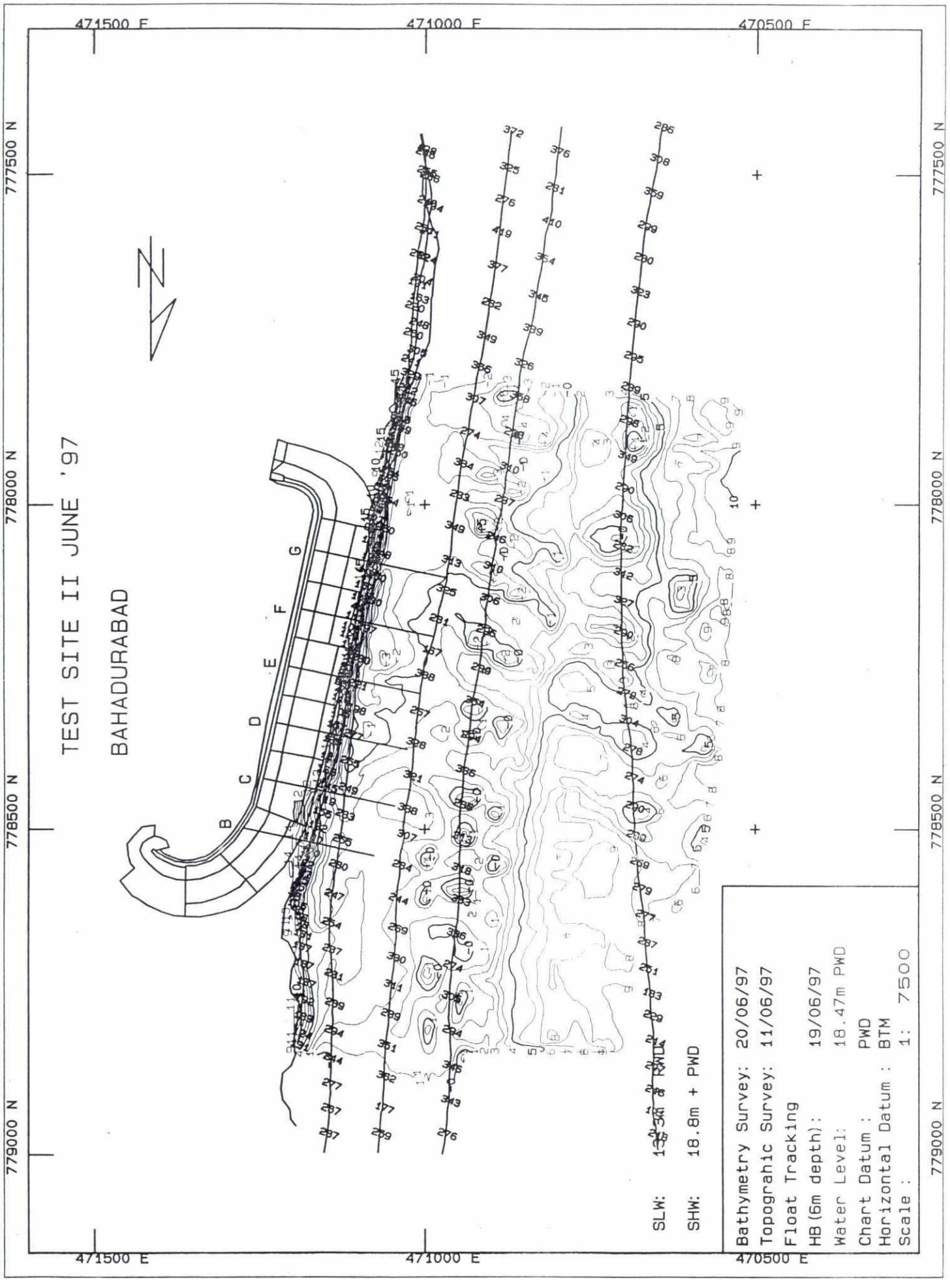

779500 N
779000 N
778500 N
778000 N
777500 N
TEST SITE II NOVEMBER '97 - DECEMBER '97
BAHADURABAD
Bankline
31/10/97
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
471500 E
471000 E
470500 E
470000 E
Mid channel
char
Erosion
Deposition
Differential Model
Current Survey: 17-18/12/97
Previous Survey: 08-11/11/97
Water Level (PWD): 14.9m (09/11/97)
14.0m (17/12/97)
Horizontal Datum: BTM
Scale: 1: 10000

ANNEX E

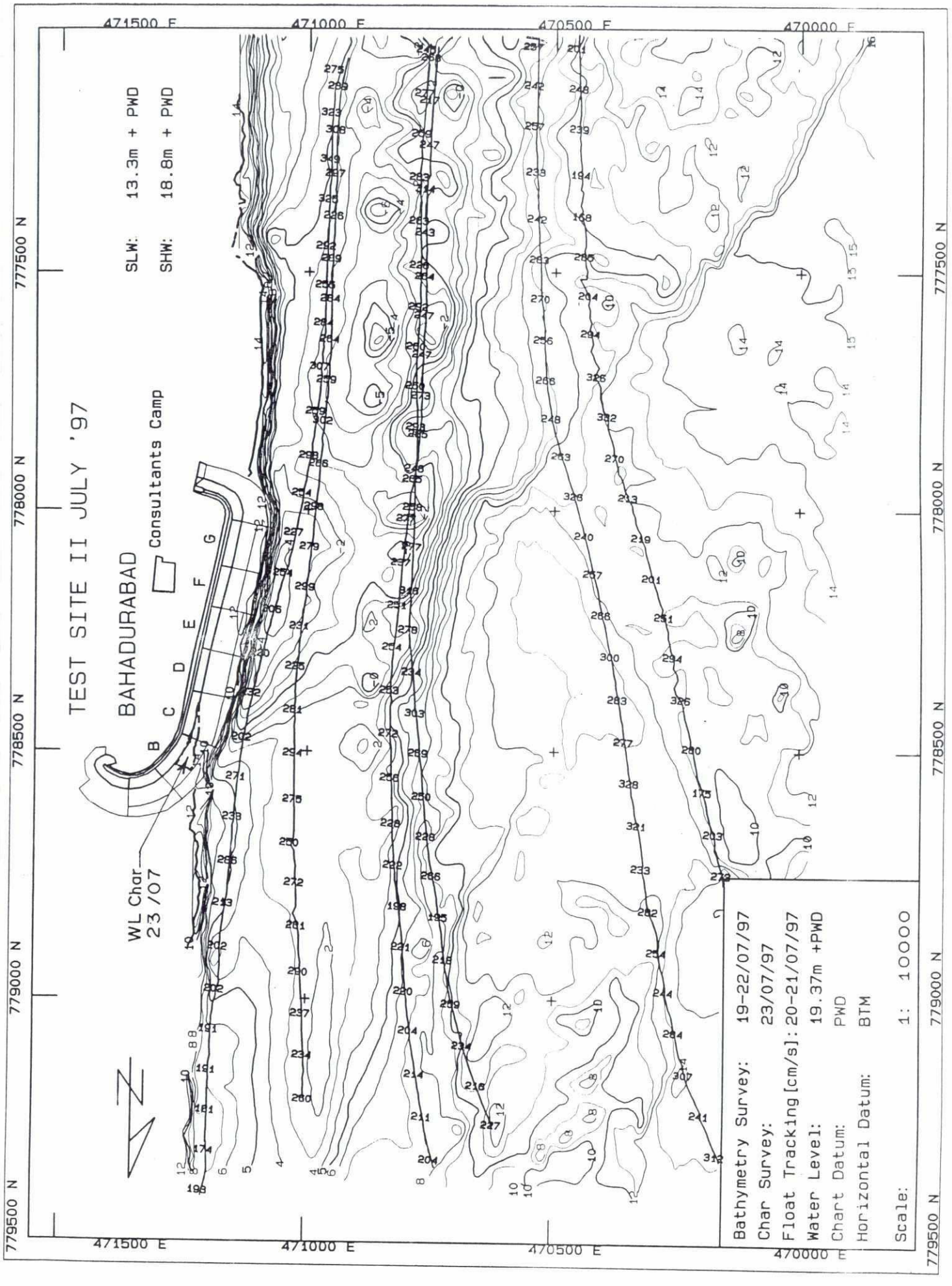
Flow Lines

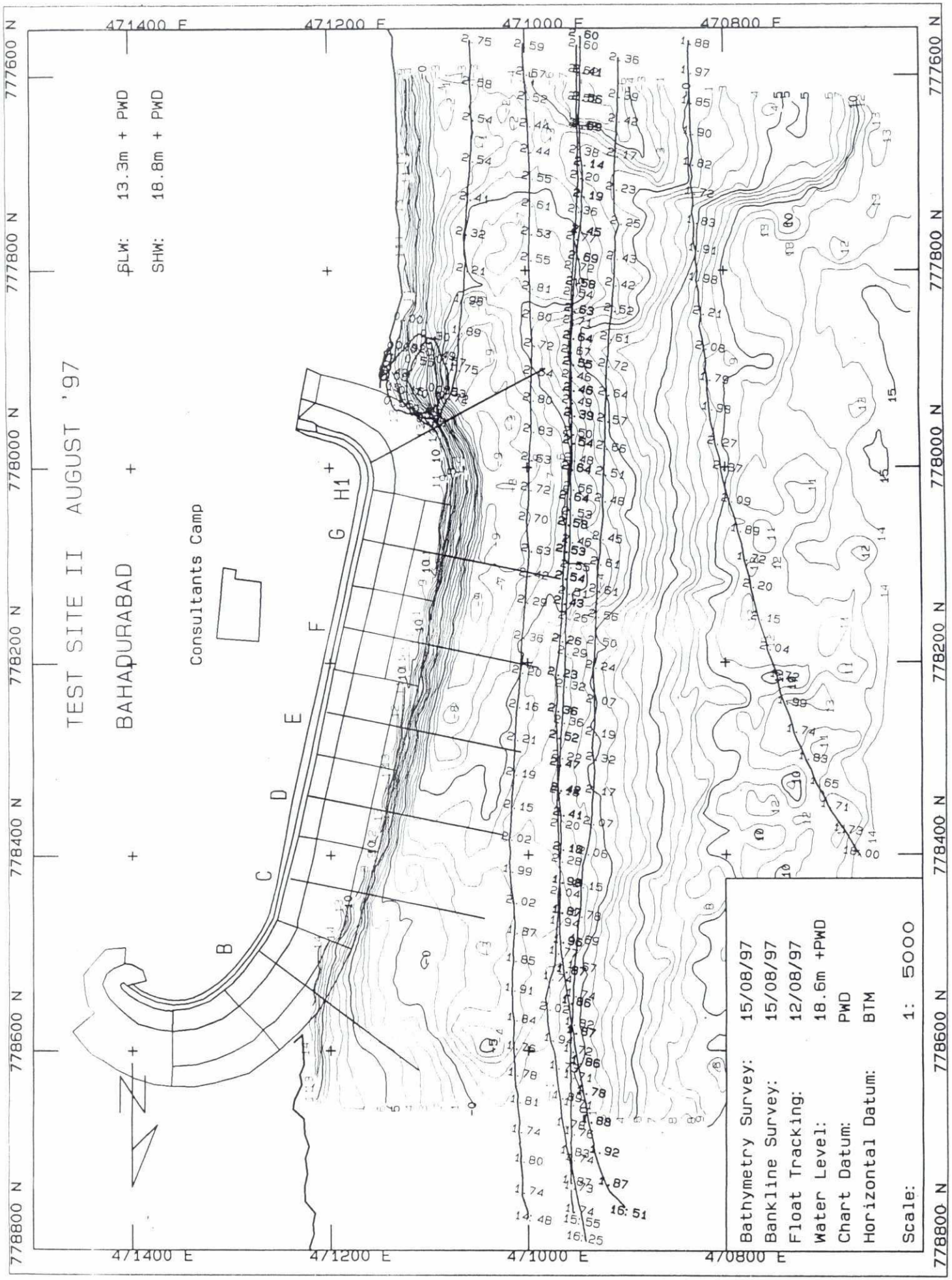

TEST SITE II JUNE '97
BAHADURABAD
B
C
D
E
F
G
471500 E
471000 E
470500 E
777500 N
778000 N
778500 N
779000 N
SLW: 13.3m + PWD
SHW: 18.8m + PWD
Bathymetry Survey: 20/06/97
Topograhic Survey: 11/06/97
Float Tracking
HB (surface): 19/06/97
Water Level: 18.47m PWD
Chart Datum : PWD
Horizontal Datum : BTM
Scale : 1: 7500

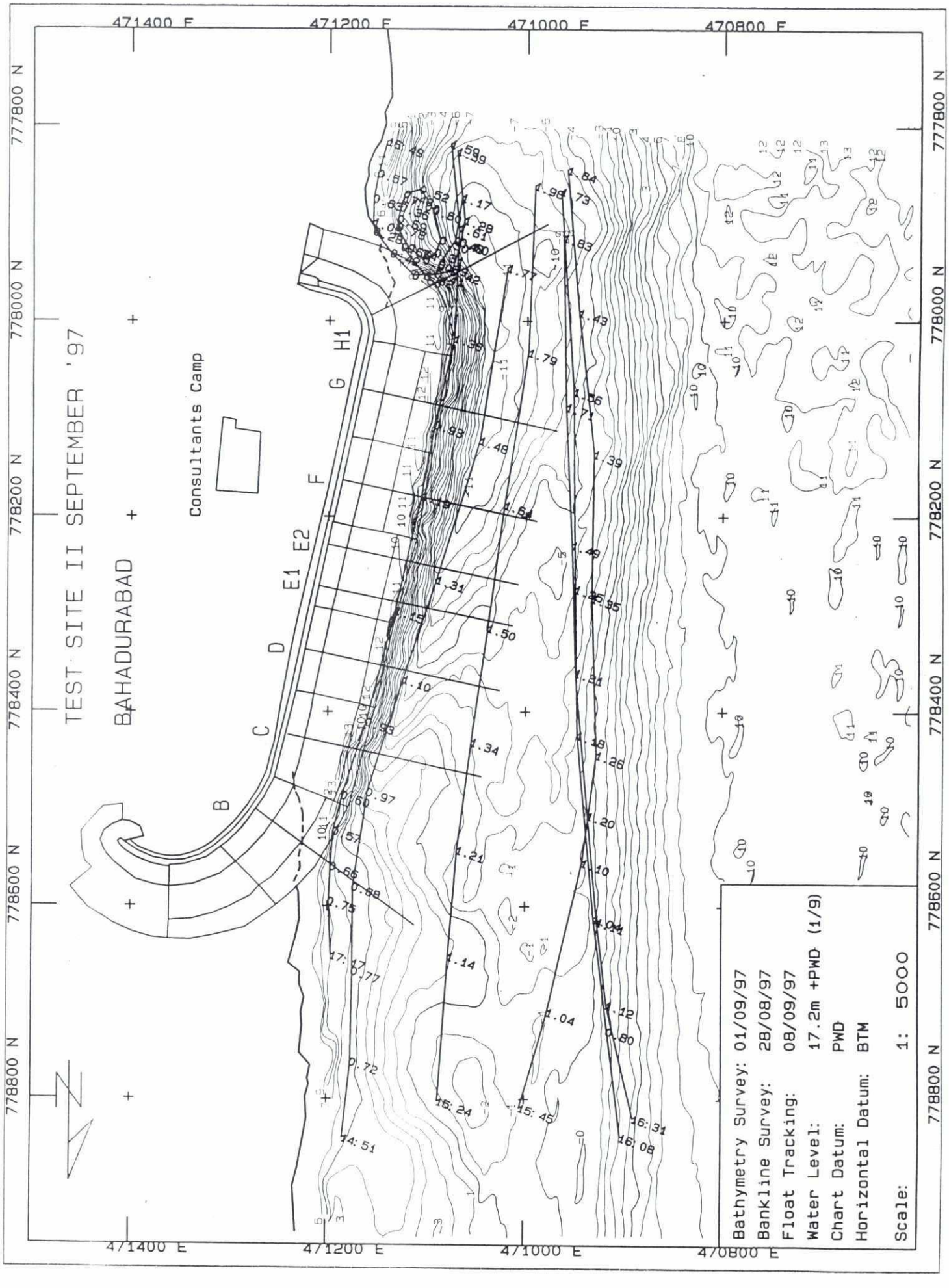


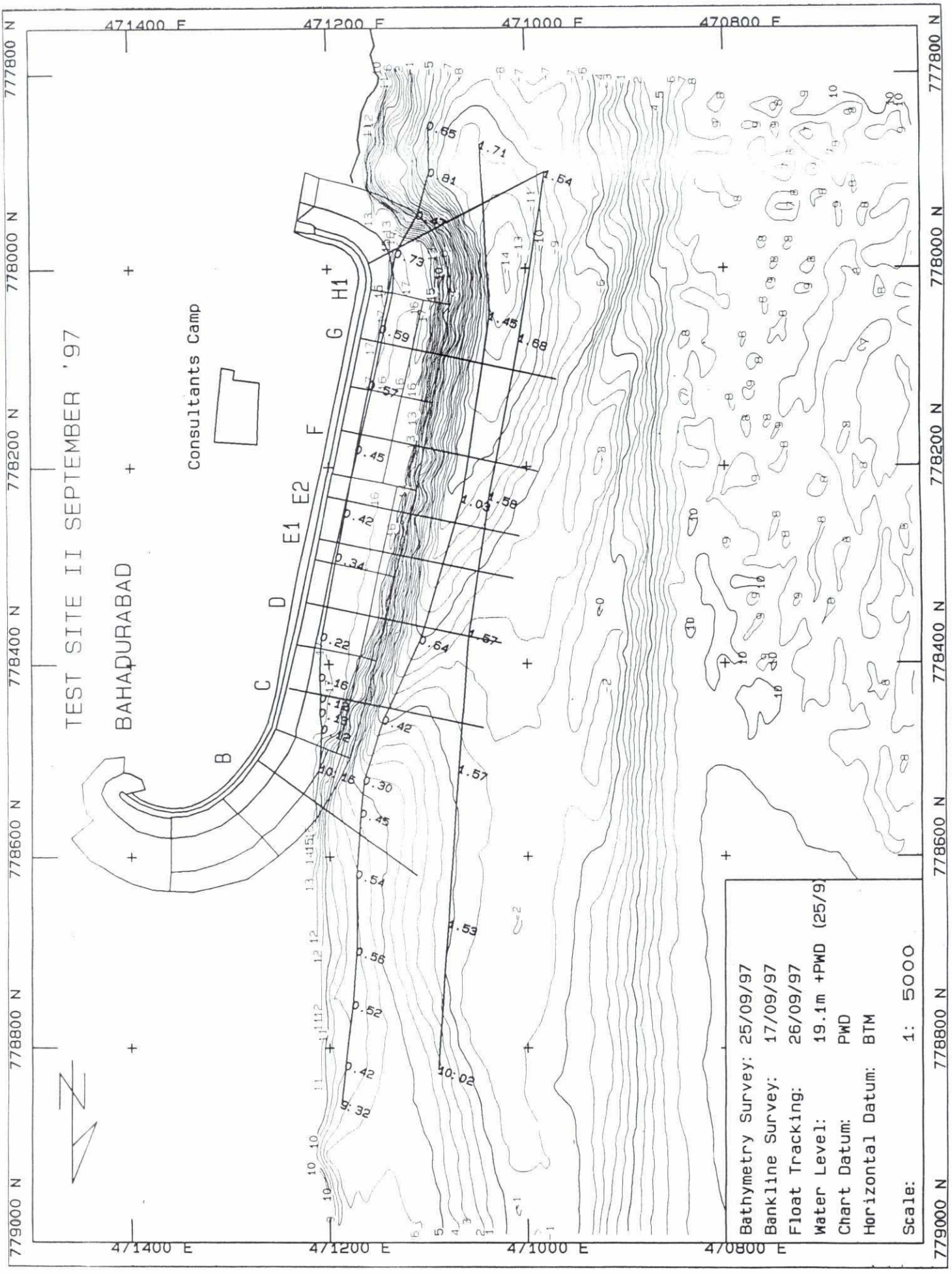

471500 E
471000 E
470500 E
777500 N
778000 N
778500 N
779000 N
TEST SITE II JUNE '97
BAHADURABAD
B
C
D
E
F
G
SLW: 13.3m + PWD
SHW: 18.8m + PWD
Bathymetry Survey: 20/06/97
Topographic Survey: 11/06/97
Float Tracking
HB (6m depth): 19/06/97
Water Level: 18.47m PWD
Chart Datum : PWD
Horizontal Datum : BTM
Scale : 1: 7500

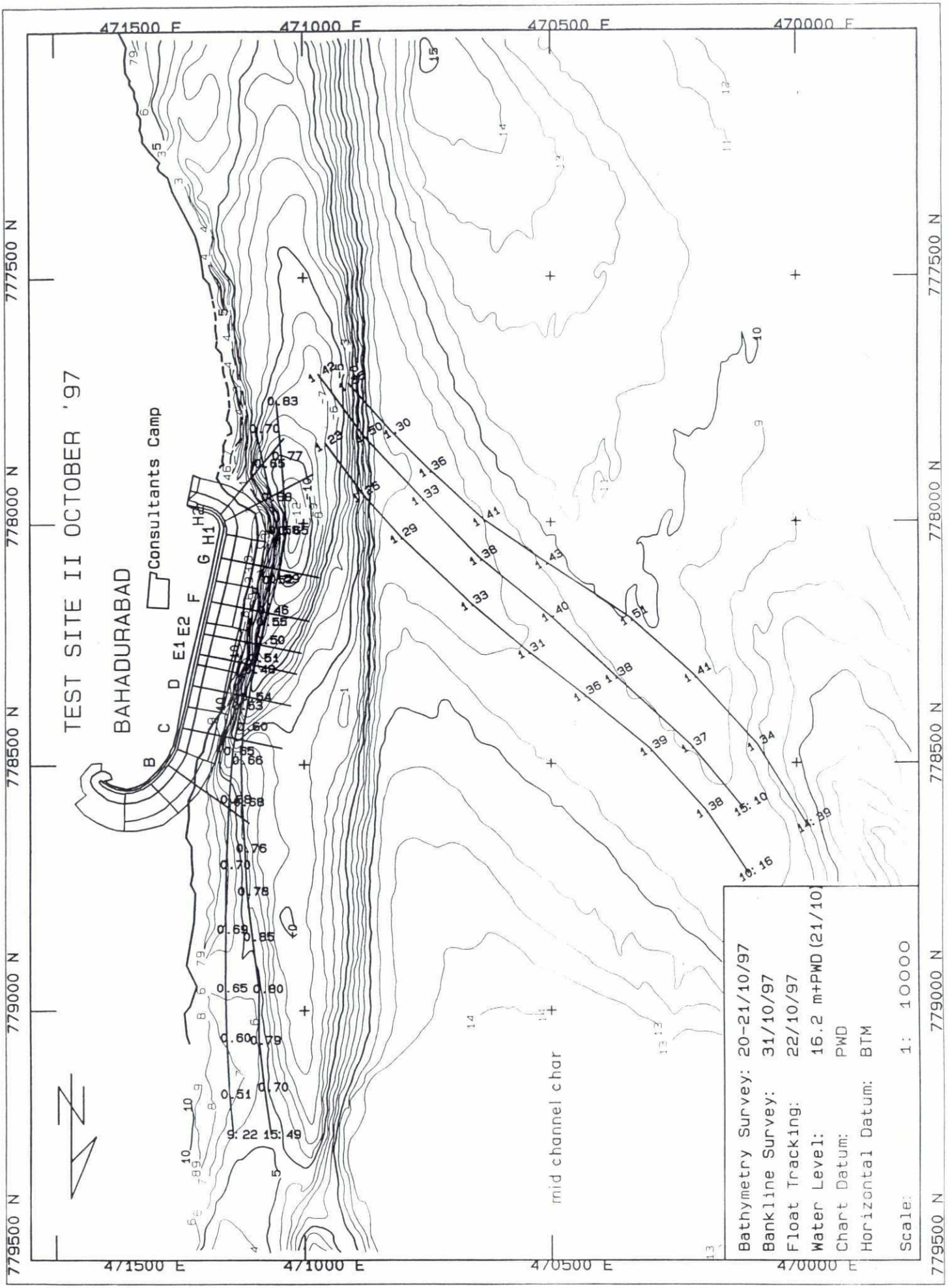
82

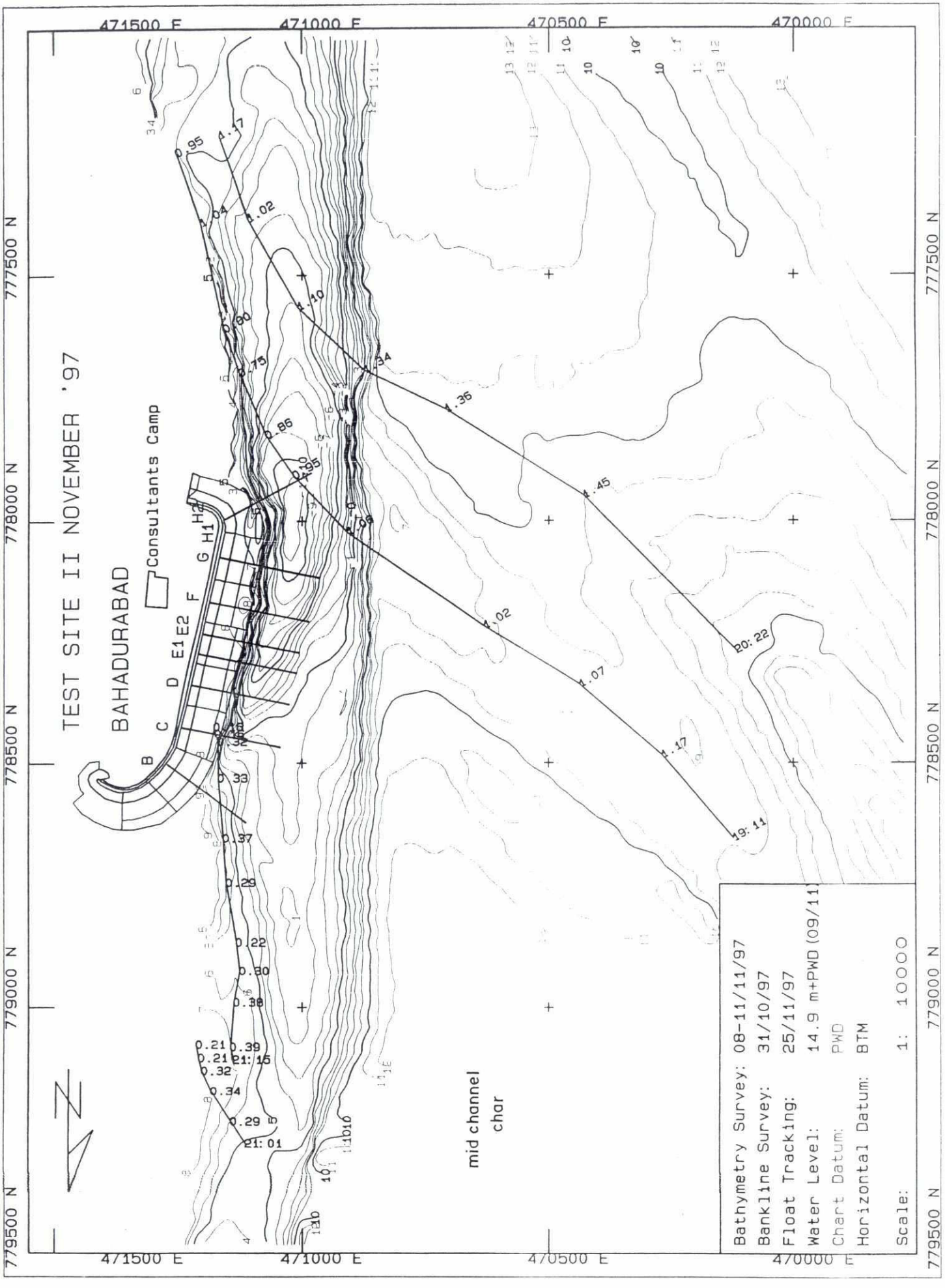

TEST SITE II JULY '97
BAHADURABAD
Consultants Camp
SLW: 13.3m + PWD
SHW: 18.8m + PWD
WL Char
23 /07
B
C
D
E
F
G
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 19-22/07/97
Char Survey: 23/07/97
Float Tracking[cm/s]: 20-21/07/97
Water Level: 19.37m +PWD
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

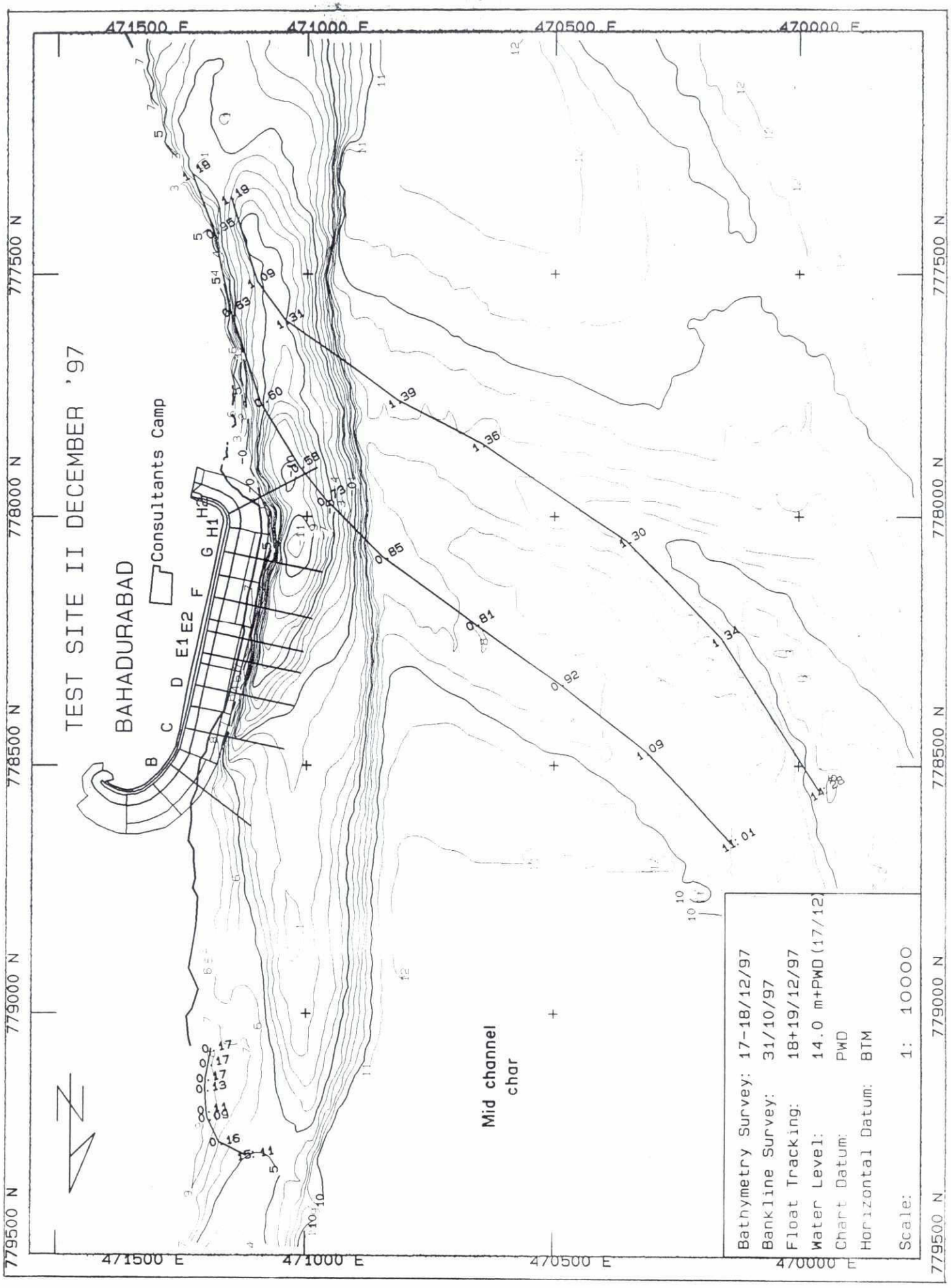

TEST SITE II AUGUST '97
BAHADURABAD
Consultants Camp
SLW: 13.3m + PWD
SHW: 18.8m + PWD
B
C
D
E
F
G
H1
471400 E
471200 E
471000 E
470800 E
777600 N
777800 N
778000 N
778200 N
778400 N
778600 N
778800 N
Bathymetry Survey: 15/08/97
Bankline Survey: 15/08/97
Float Tracking: 12/08/97
Water Level: 18.6m +PWD
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 5000


TEST SITE II SEPTEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
471400 E
471200 E
471000 E
470800 E
777800 N
778000 N
778200 N
778400 N
778600 N
778800 N
Bathymetry Survey: 01/09/97
Bankline Survey: 28/08/97
Float Tracking: 08/09/97
Water Level: 17.2m +PWD (1/9)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 5000


TEST SITE II SEPTEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
471400 E
471200 E
471000 E
470800 E
779000 N
778800 N
778600 N
778400 N
778200 N
778000 N
777800 N
Bathymetry Survey: 25/09/97
Bankline Survey: 17/09/97
Float Tracking: 26/09/97
Water Level: 19.1m +PWD (25/9)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 5000


TEST SITE II OCTOBER '97
BAHADURABAD
Consultants Camp
mid channel char
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 20-21/10/97
Bankline Survey: 31/10/97
Float Tracking: 22/10/97
Water Level: 16.2 m+PWD (21/10
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000


TEST SITE II NOVEMBER '97
BAHADURABAD
Consultants Camp
mid channel
char
Bathymetry Survey: 08-11/11/97
Bankline Survey: 31/10/97
Float Tracking: 25/11/97
Water Level: 14.9 m+PWD (09/11)
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N

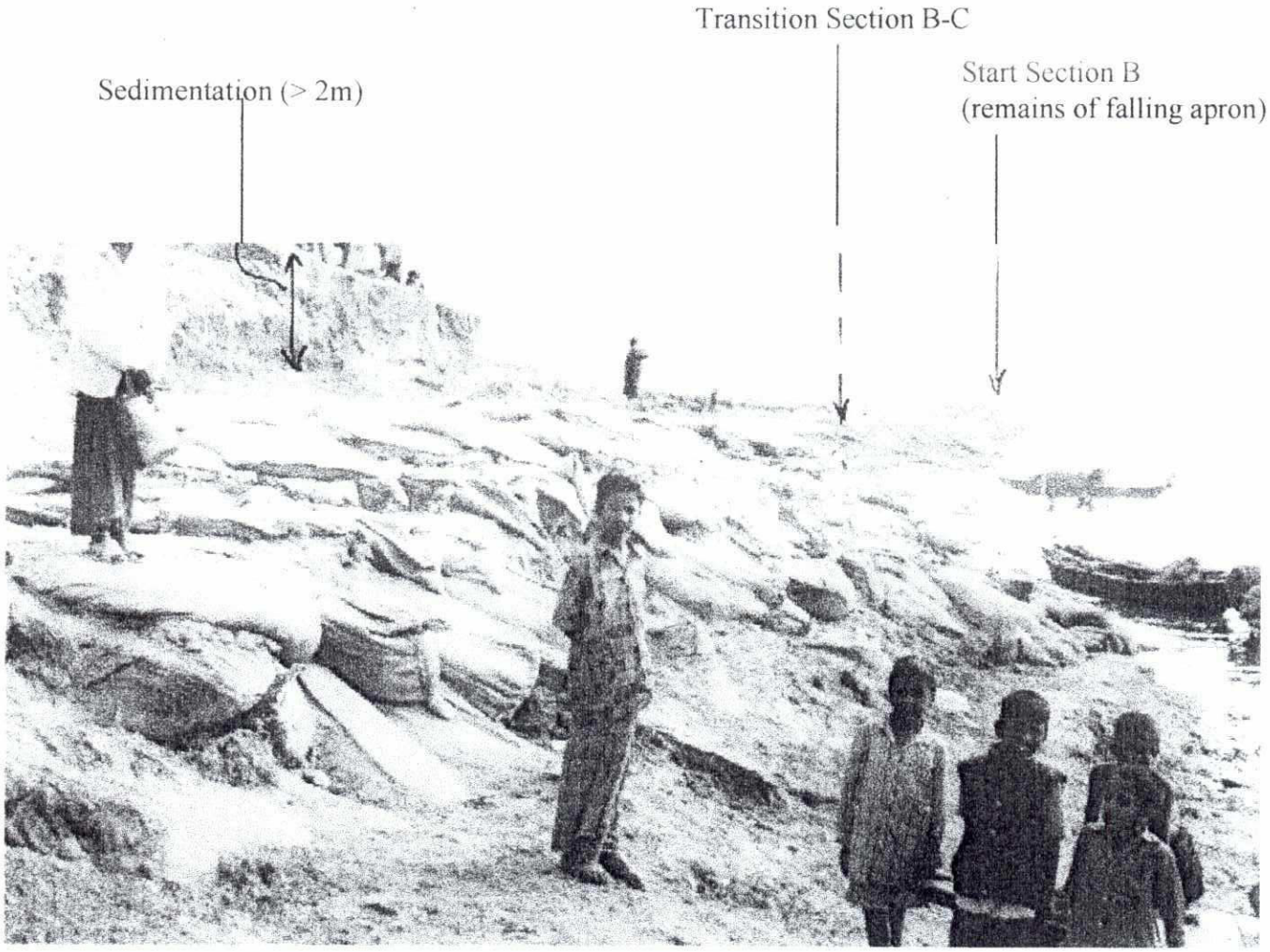

TEST SITE II DECEMBER '97
BAHADURABAD
Consultants Camp
B
C
D
E1
E2
F
G
H1
H2
Mid channel
char
471500 E
471000 E
470500 E
470000 E
779500 N
779000 N
778500 N
778000 N
777500 N
Bathymetry Survey: 17-18/12/97
Bankline Survey: 31/10/97
Float Tracking: 18+19/12/97
Water Level: 14.0 m+PWD (17/12
Chart Datum: PWD
Horizontal Datum: BTM
Scale: 1: 10000

ANNEX F

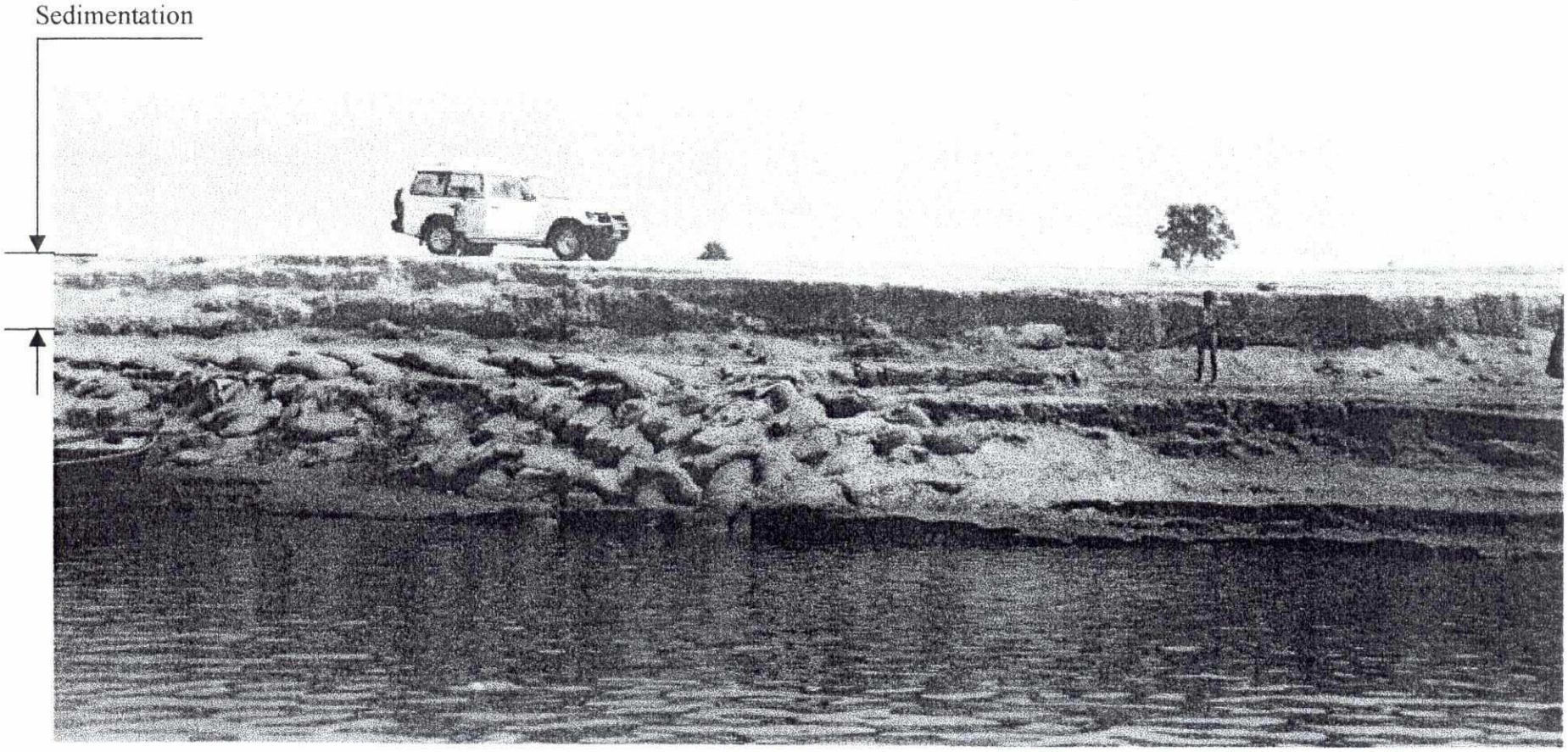
Conditions Survey Report

ANNEX F.1

Photo Documentary

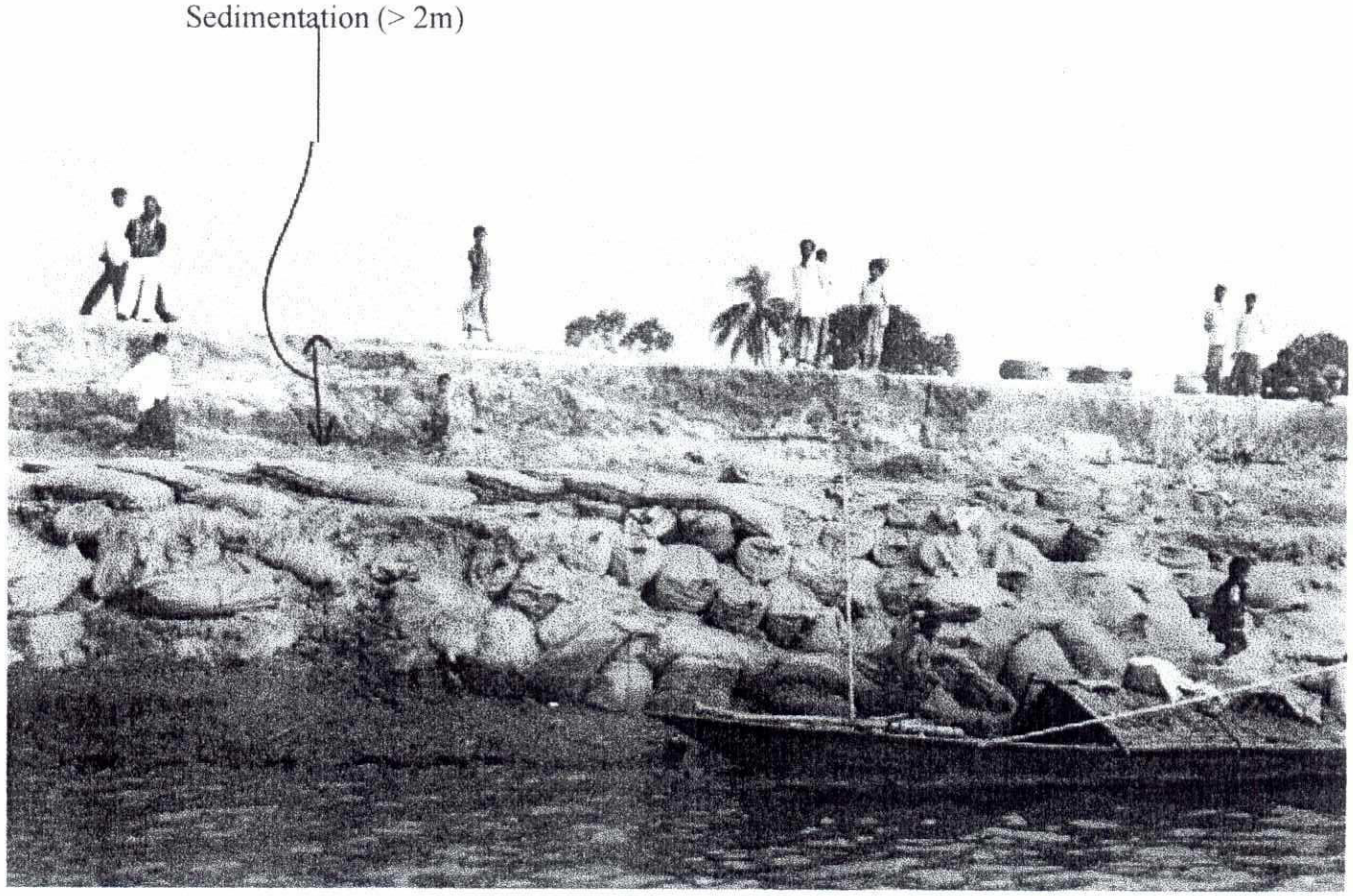


36 View from Section B towards South (downstream) (15.02.98; WL ~+13.0 m)
In front exposed falling apron of geo-sand containers (180/250 kg/

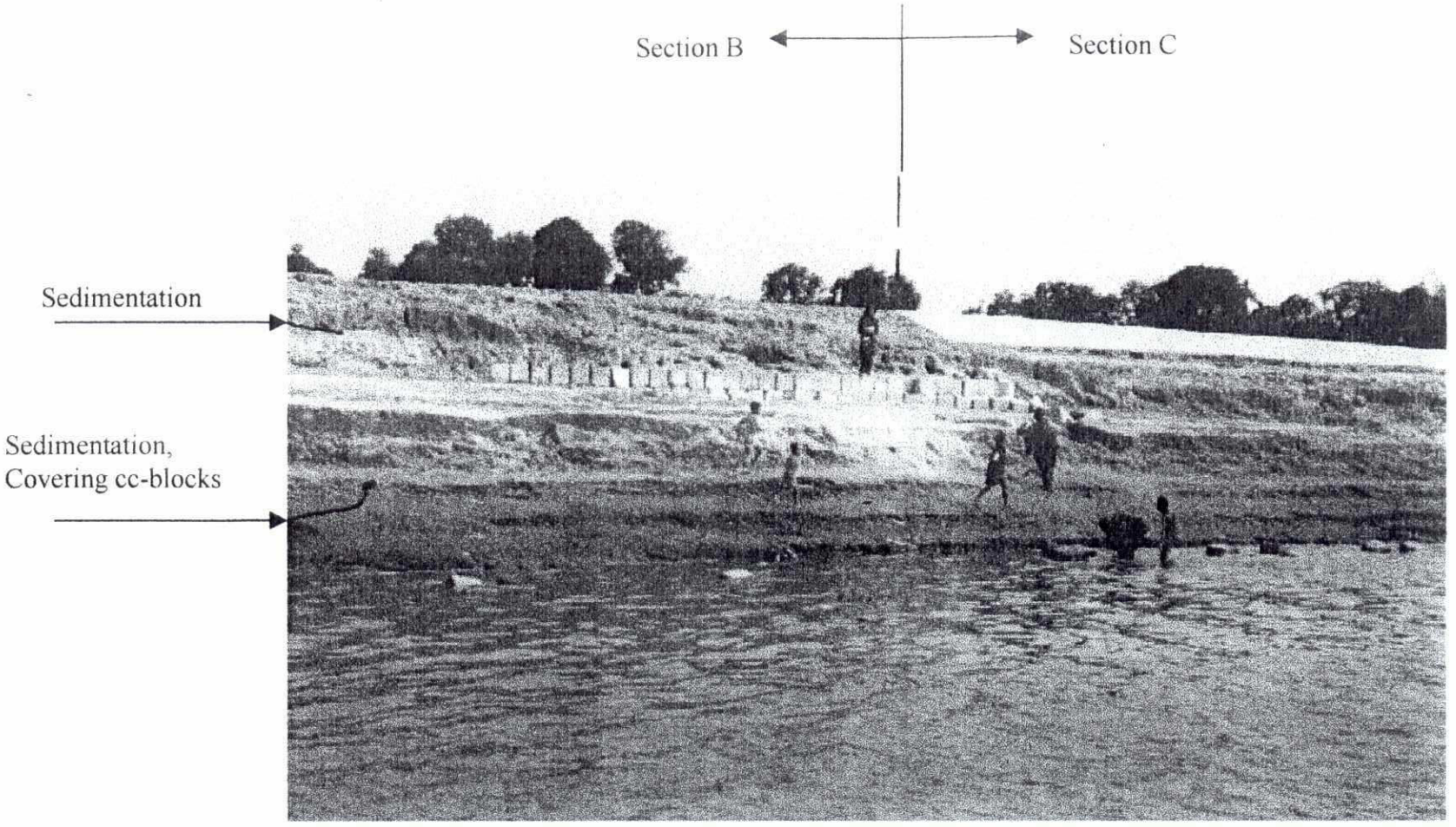


35 Section B:
Exposed falling apron of geo-sand containers (180/250 kg/No.)

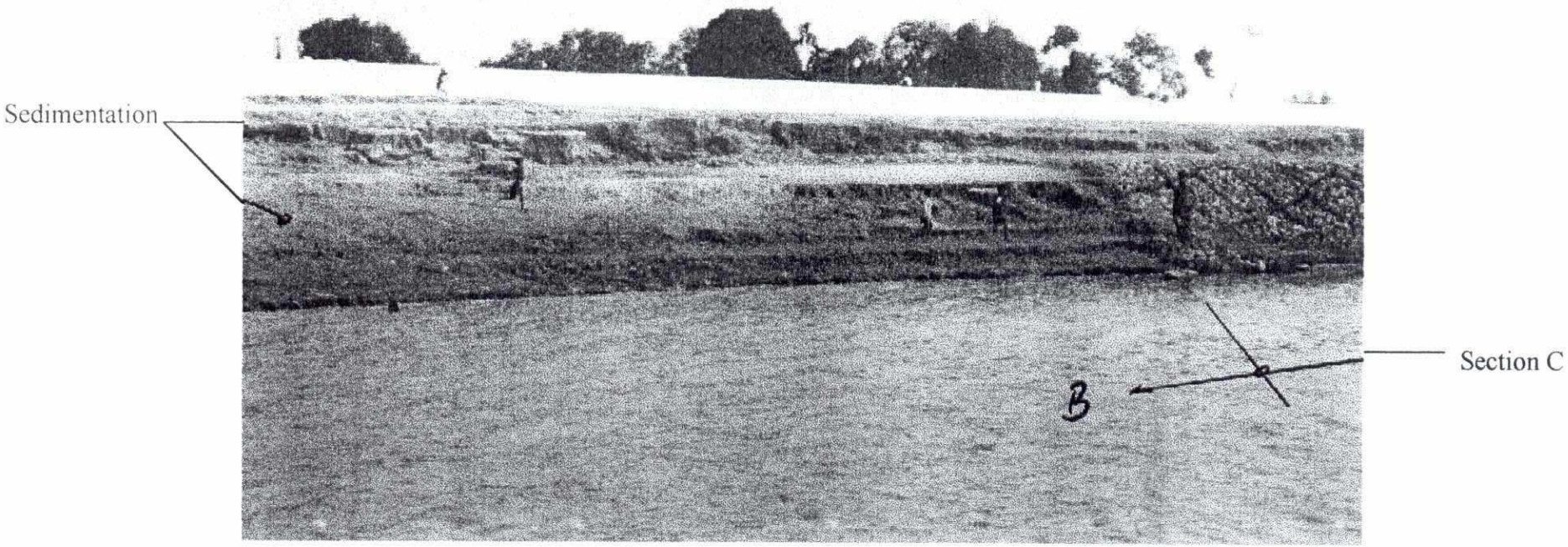
(15.02.98; WL~+13.0m)



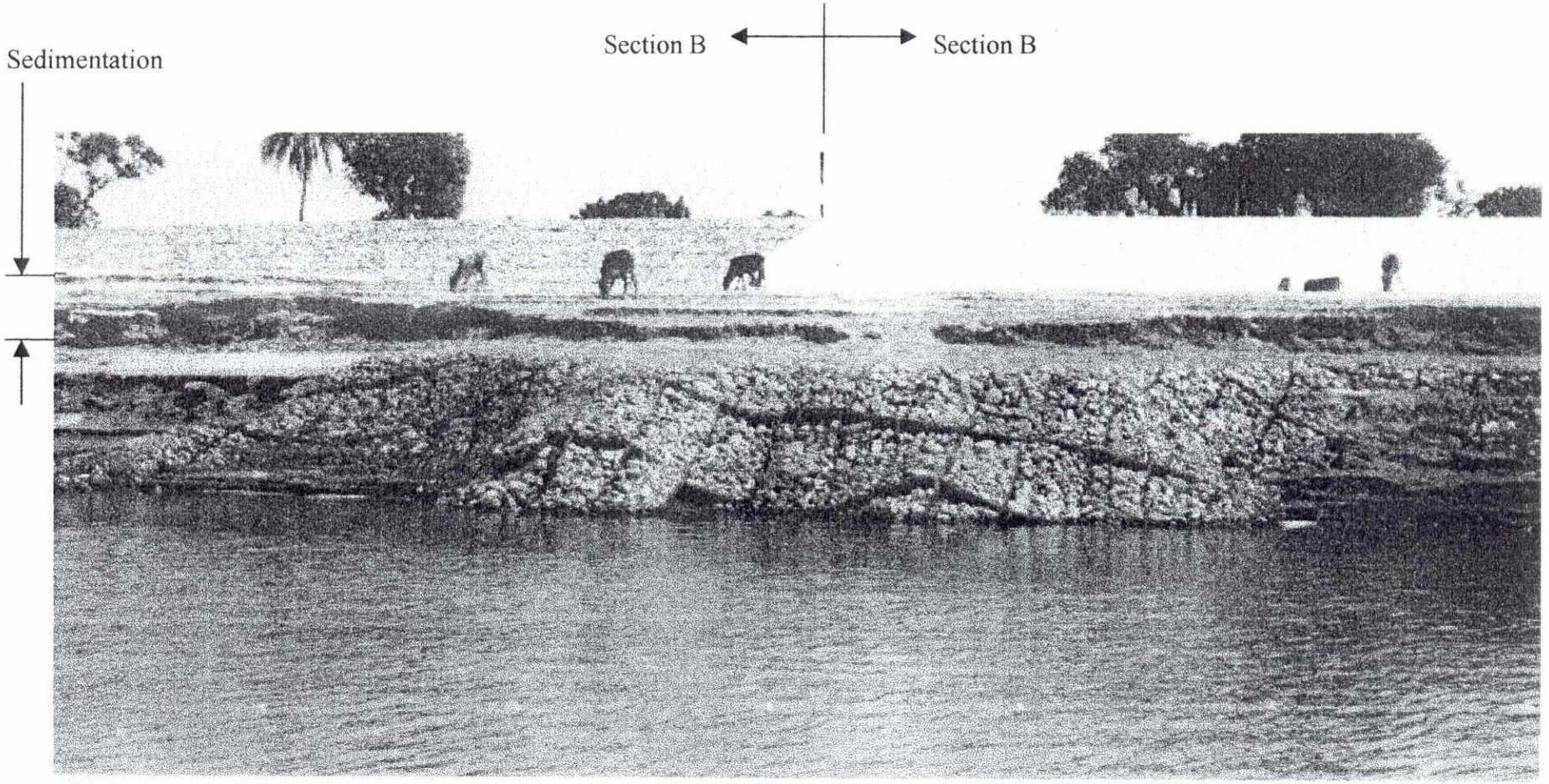
37 Section B: (15.02.98; WL~+13.0M)
Exposed falling apron of geo-sand containers (180/250 Kg/No.)



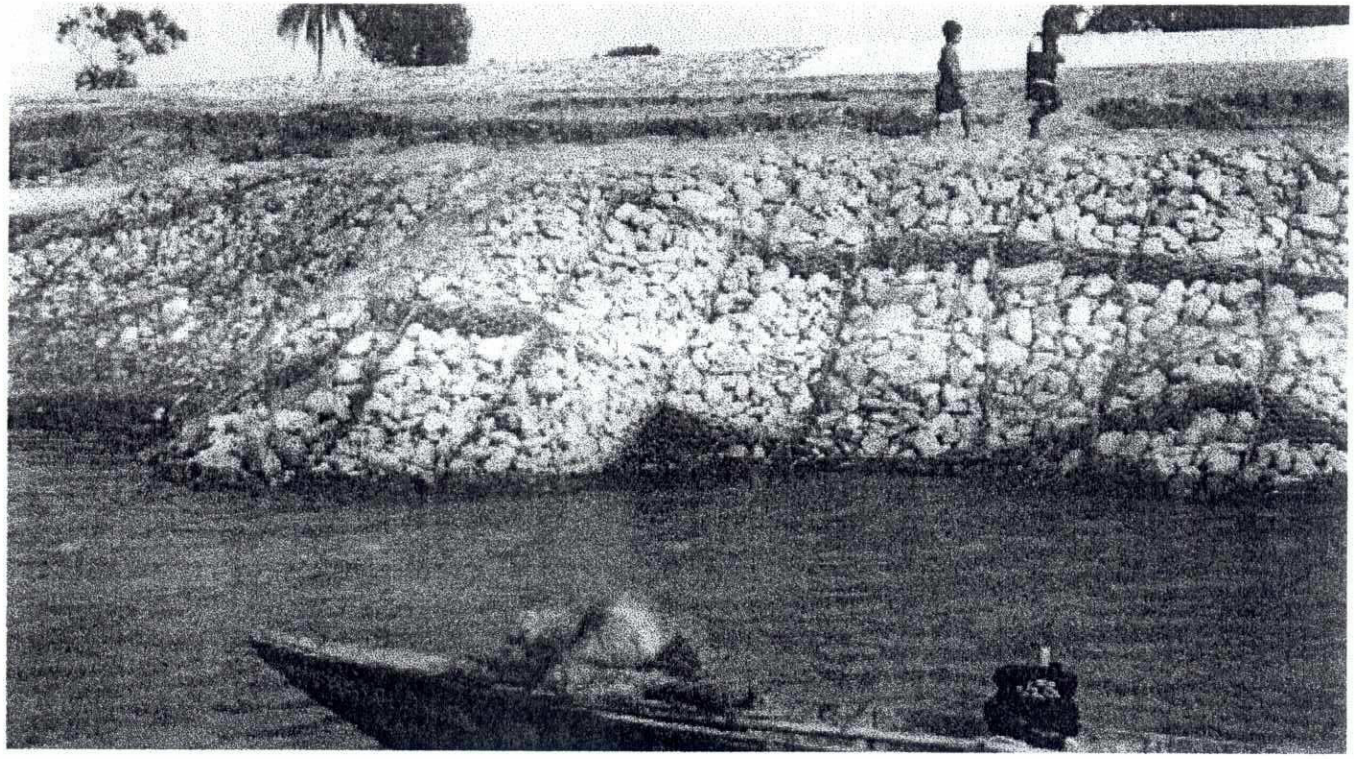
38 Section B: (15.02.98; WL~+13.0m)
Launching apron of cc-blocks exposed due to severe local erosion
(trial excavation proved existence of cc-blocks also between waterline
and visible blocks, well buried under sedimentation layers)



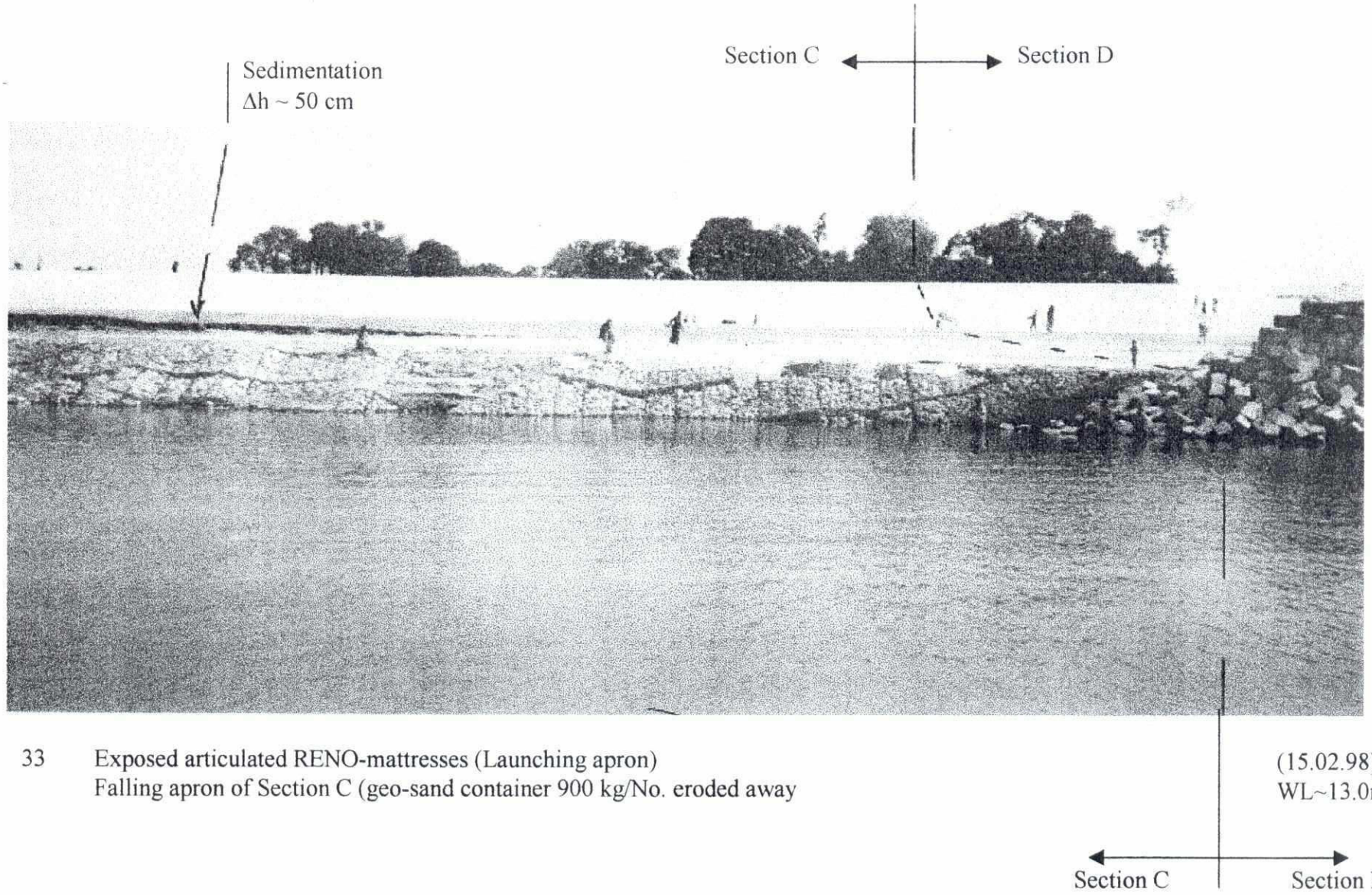
39 Exposed launching aprons in Sections B-C (15.02.98; WL~+13.0m)
In Section B heavily covered by sediments (trial pits produced evidence of cc-blocks)



34 Exposed launching apron in Section C: (15.02.98; WL~+13.0m)
(articulated RENO-mattresses have well adjusted to eroding bank; some RENO-boxes disintegrated (possibly due to inadequate closing of box cover). Falling apron of geo-sand containers (900 kg/No.) completely eroded away.

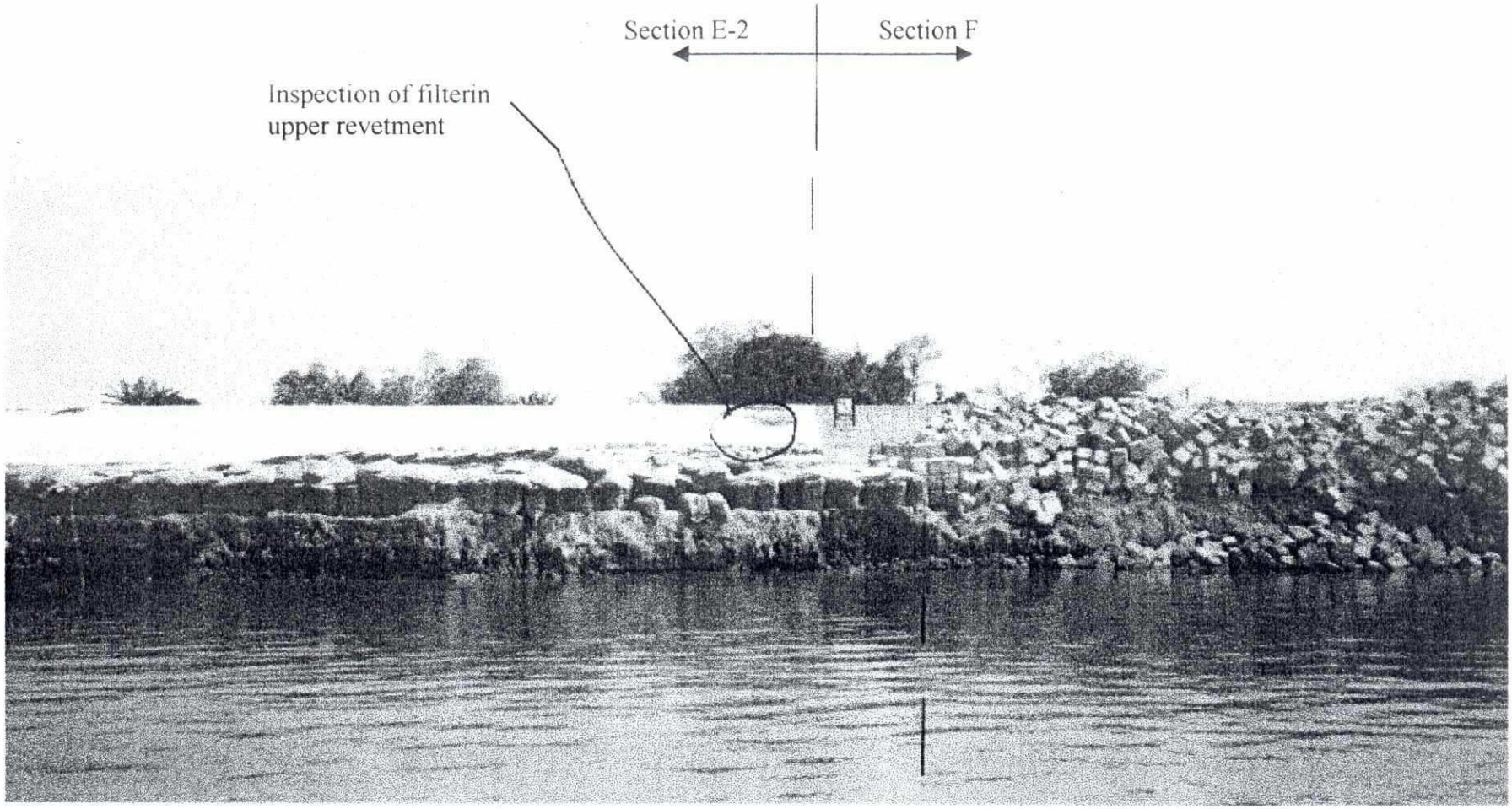


40 Section B: Launching apron of RENO-mattresses (15.02.98; WL~+13.0 m)
Articulated mattress system fully integrated, only a few box covers opened
Due to excessive deformation (likely due to inadequate wiring/tying of box covers after placing the stone fill)



33 Exposed articulated RENO-mattresses (Launching apron)
Falling apron of Section C (geo-sand container 900 kg/No. eroded away

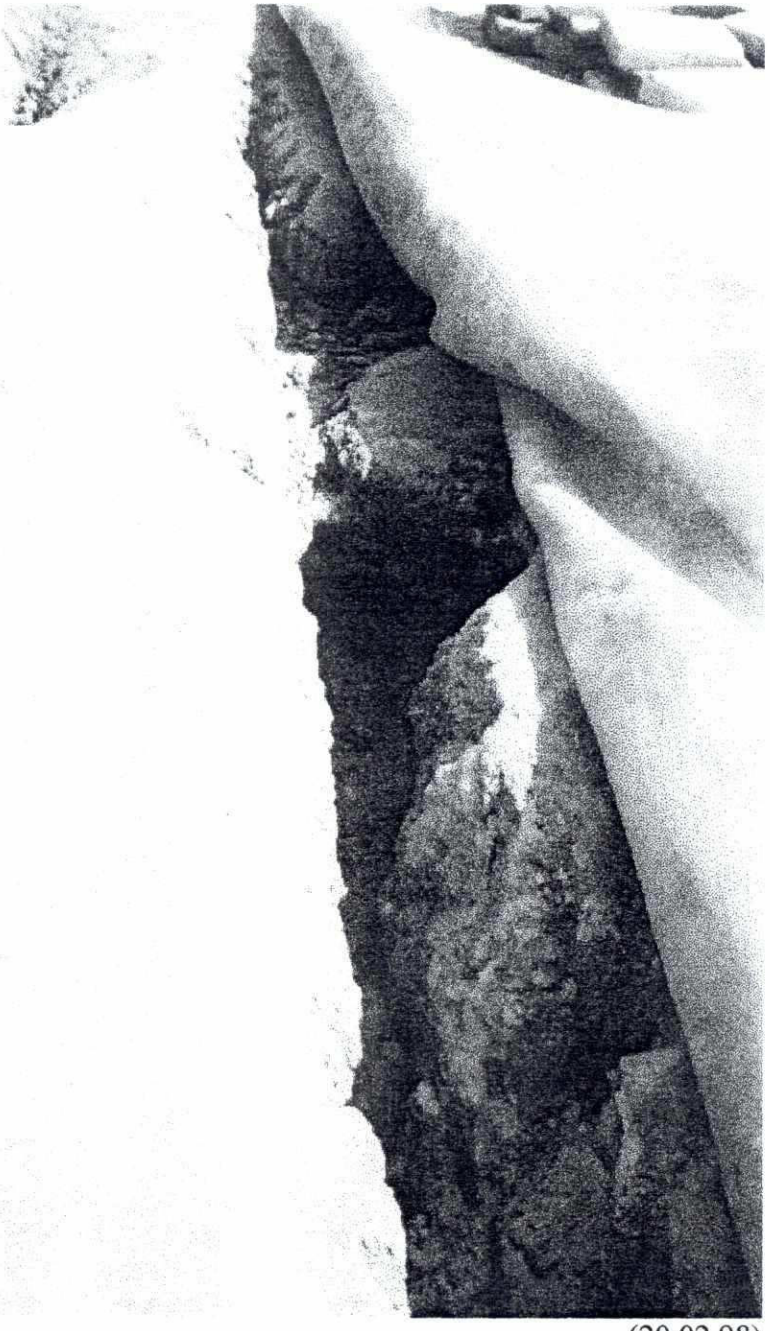
32 Exposed falling apron Sectin D / E-1 (cc-blocks size 40 * 40 * 40 cm)



15.02.98; WL~+13.0 m)

Section E-2:
Falling apron by
Geo-sand containers
(250/900 kg/No.

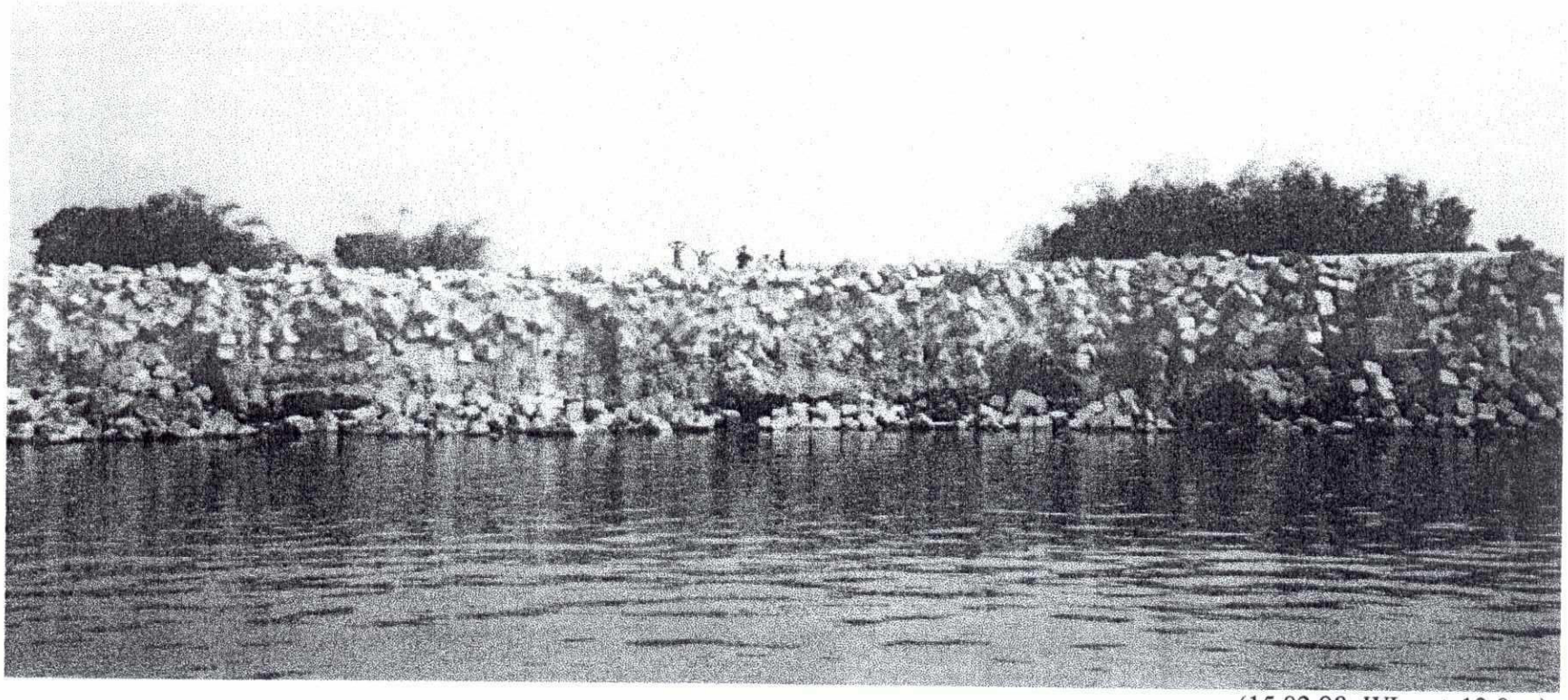
Section F:
Falling apron by
cc-blocks 40*40*40 cm
and 50*50*50 cm



(20.02.98)

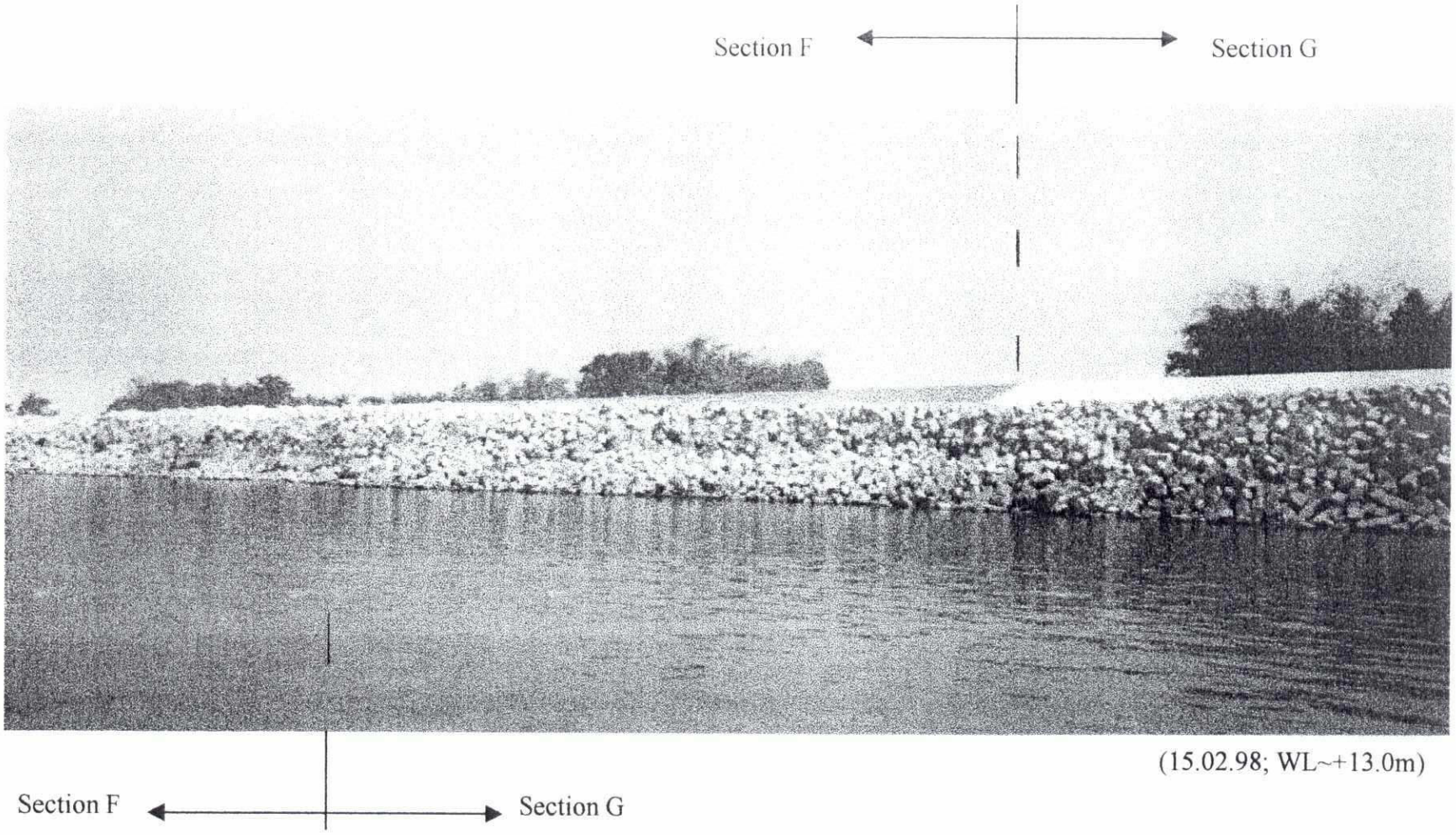
4 Section E-2:
Soil migration below composite geo-filter
J 9014 HaTe (placed wrongly – upside down)

5 Section E-2: - Ship-Lap type cc-slabes on composite geo-filter
- soil migration from crest to toe of slope (20.02.98)



(15.02.98; WL ~ + 13.0 m)

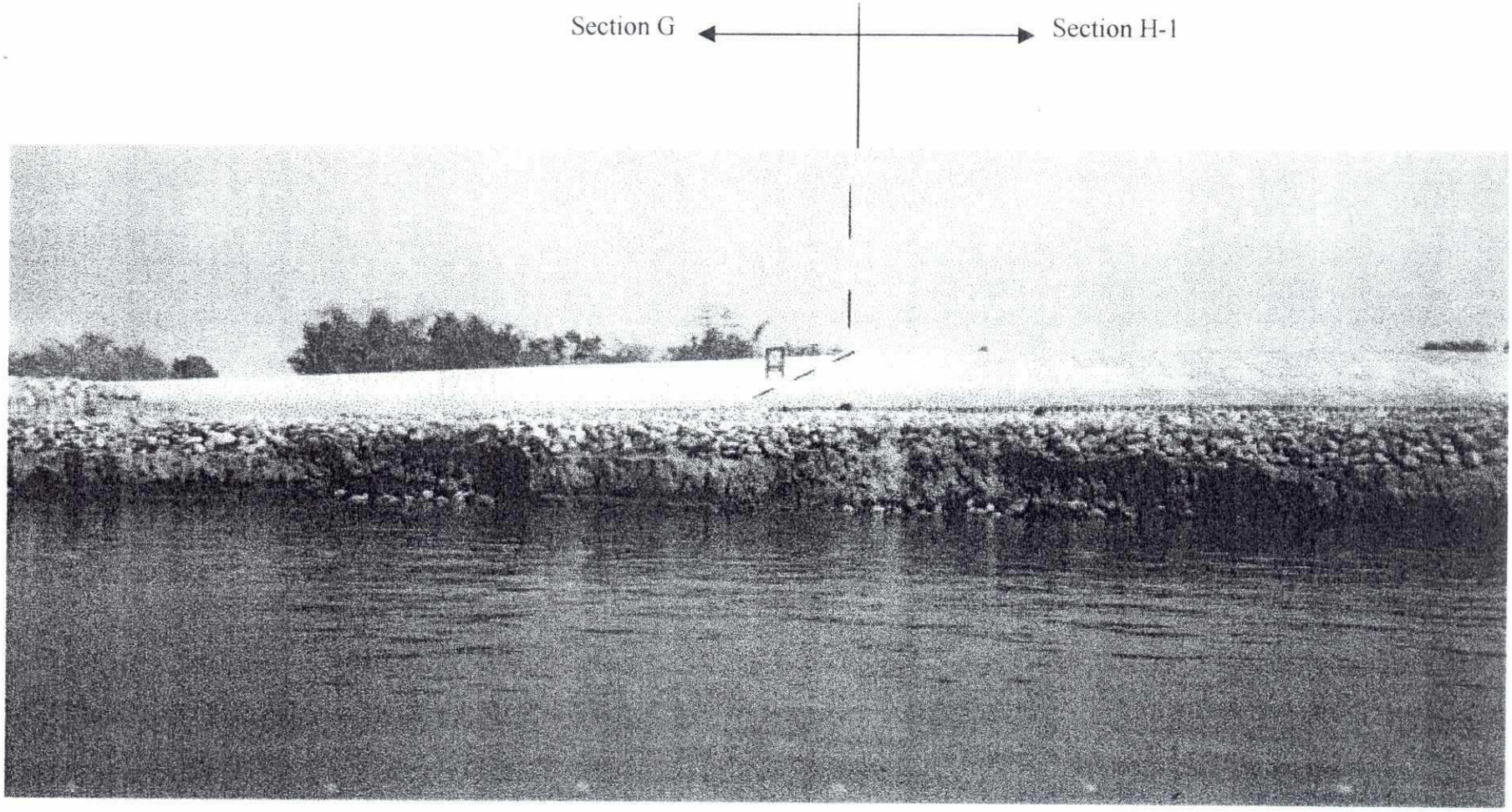
30 Section F:
- Exposed falling apron;
- cc-blocks 40*40*40 cm and 45*45*45 mm;
- upper part of bank less covered (as compared to Section G)



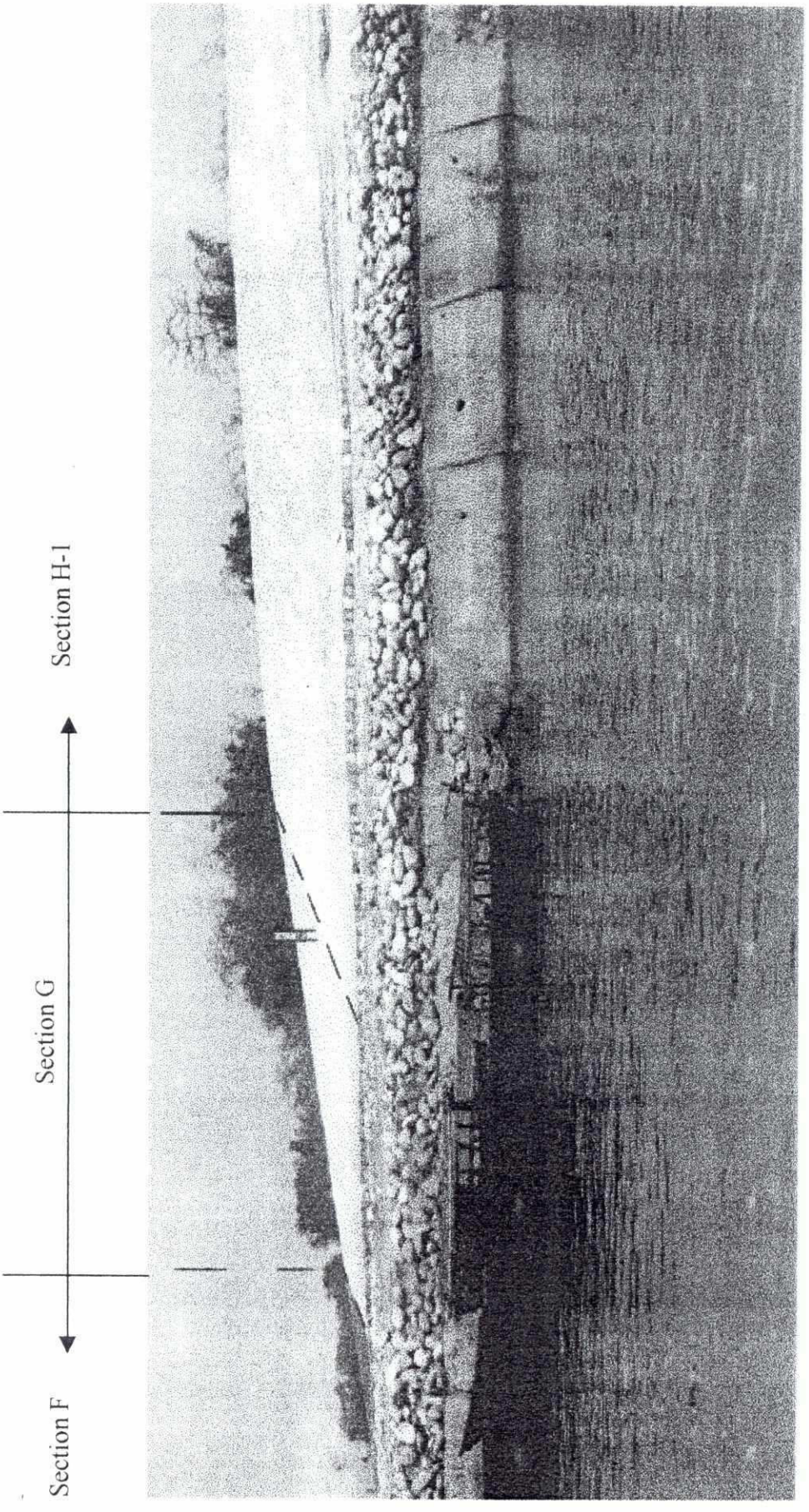
(15.02.98; WL~+13.0m)

Exposed falling apron:

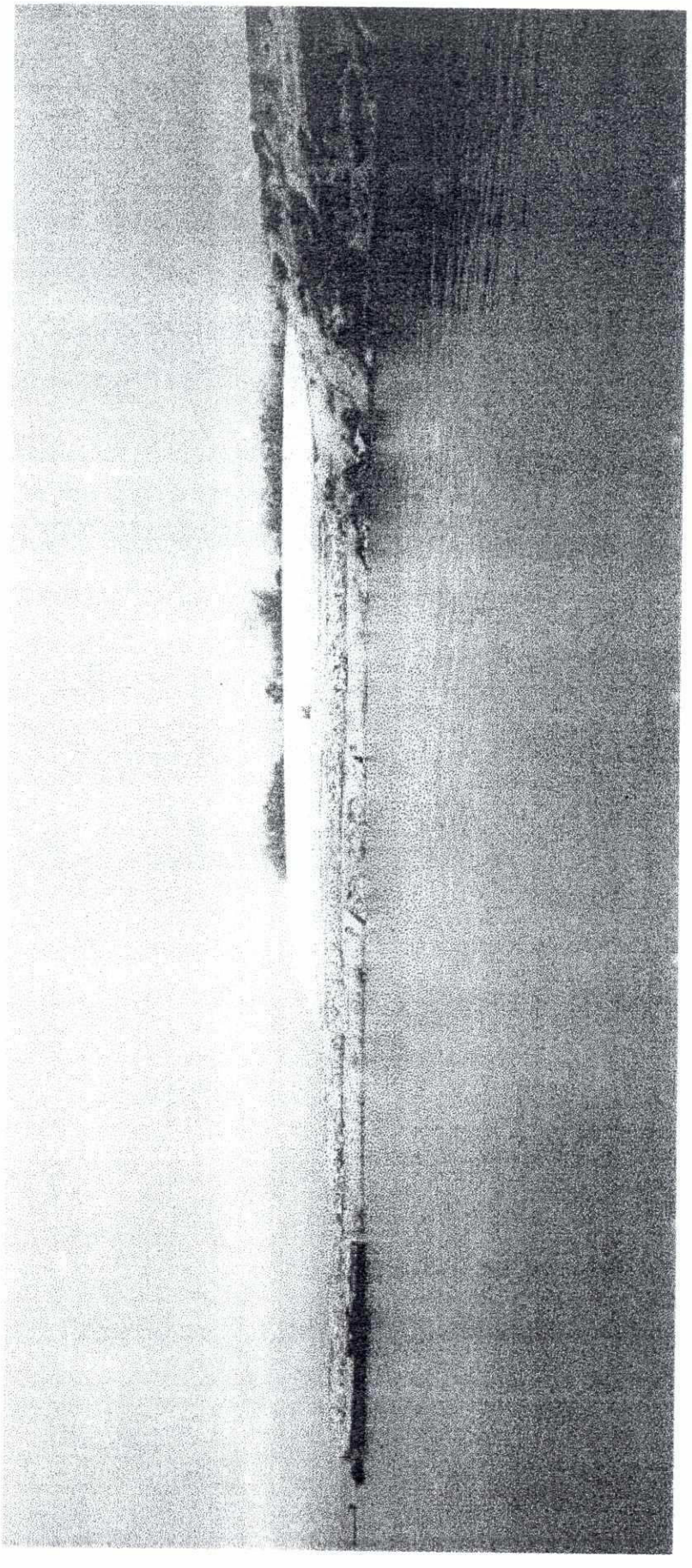
Section G: cc-blocks 35*35*35 cm and 40*40*40 cm (slope nicely covered)
Section F: cc-blocks 40*40*40 cm and 45*45*45 cm



28 Section H-1: Transition of falling apron from G into H-1 (15.02.98; WL~+13.0 m)



27 Downstream termination – Section H-1: close-up on exposed geotextile of launching apron (15.02.98; WL~+13.0m)



26 Downstream termination – Section H-1 / H-2 (view from south / downstream) (15.02.98; WL~+13.0 m)

ANNEX F.2

Technical Assessment of Sections

Section A-1

90

ASSESSMENT SHEET SECTION A-1
Total length along toe of upper slope: **74.70 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities	
			Filter	Cover Material
Revetment above berm level	GF-1 / BIDIM b 7	Brick mattress d = 15 cm (Site-made wiremesh)	1,840 m²	1,600 m²
Launching apron	GF-2 / BIDIM S 550	Dumped CC - blocks D_n = 30 cm (2,200 Nos./100m²)	5,500 m²	2,298 m³
Transition between launching apron and falling apron		CC - blocks D_n = 30 cm		413 m³
Falling apron		Dumped CC - blocks D_n = 30 cm D_n = 45cm (mixed)		1,435 m³
Exposed edge of falling apron				

VISUAL OBSERVATION **Date: 20.02.1998**

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section A-1 occurred during the flood season of 1997. No visible changes / damages to the structure could be detected. As compared to other, similar sections, the site-made wire mesh of the brick mattress shows some corrosion. Generally, the site-made wiremesh presents a poor and loose shape. Machine-made wiremesh should be the preferred option. At some points vegetation grows through the brick mattress.	273 / 9A
Launching apron	No severe attack of the river on this segment of Section A-1 occurred during the flood season of 1997. There has instead been some sedimentation which covers the dumped cc-blocks to some extend. Some low vegetation spread over the sediment can be found. Except the sedimentation no visible changes / damages of any kind could be detected.	
Transition between launching apron and falling apron	As before	
Falling apron	As before	
Exposed edge of falling apron	As before	

92

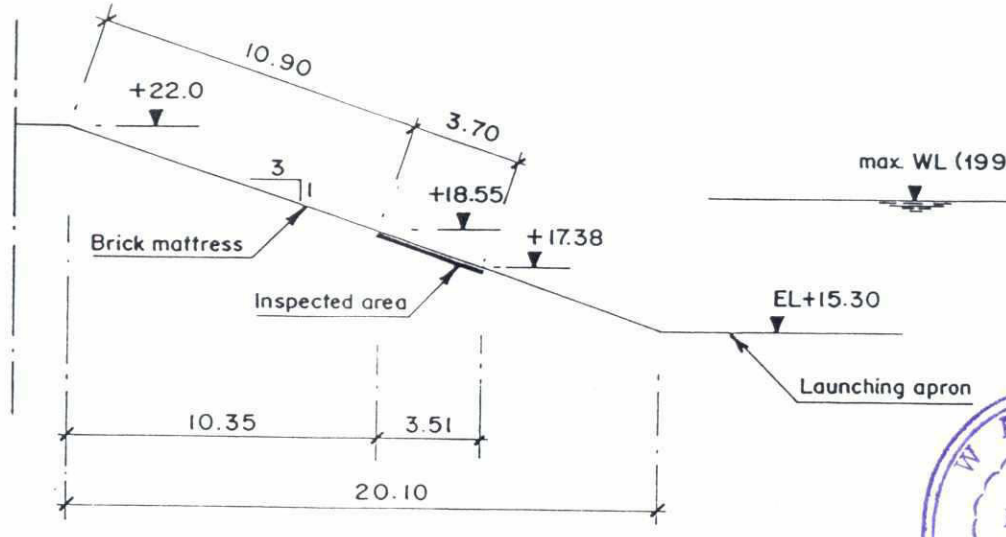
ASSESSMENT SHEET SECTION A-1

PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date: 21.02.1998
Selection of Location:	Photographs No.
There was no obvious upheaval or depression to be seen in Section A. The location for inspecting the geotextile and the underlaying subsoil has been chosen around the position where the highest waterlevel has left a mark on the revetment above berm level. So any differences between the water covered area and the dry area of the revetment (only exposed to rain and waves) can be detected after removing the cover layer of brick mattresses from the geotextile. Size and exact location of the inspected area can be seen in Figure 21-1 attached to this assessment sheet.	273 / 9A
Result of Physical Inspection - Type BIDIM b7:	
After removing a part of the mattress the geotextile was cut with a knife at three sides leaving a connection at the right side in flow direction. The geotextile was then lapped over to give sight on the subsoil which was in a good and moist condition. The water covered and dry area (only exposed to rain and waves) of the revetment above berm level are in the same condition, no differences were detected. The opened area was set into original condition after inspection by overlapping with an additional sheet of geotextile filter material.	273 / 10A

Special Notes / Comments
Non

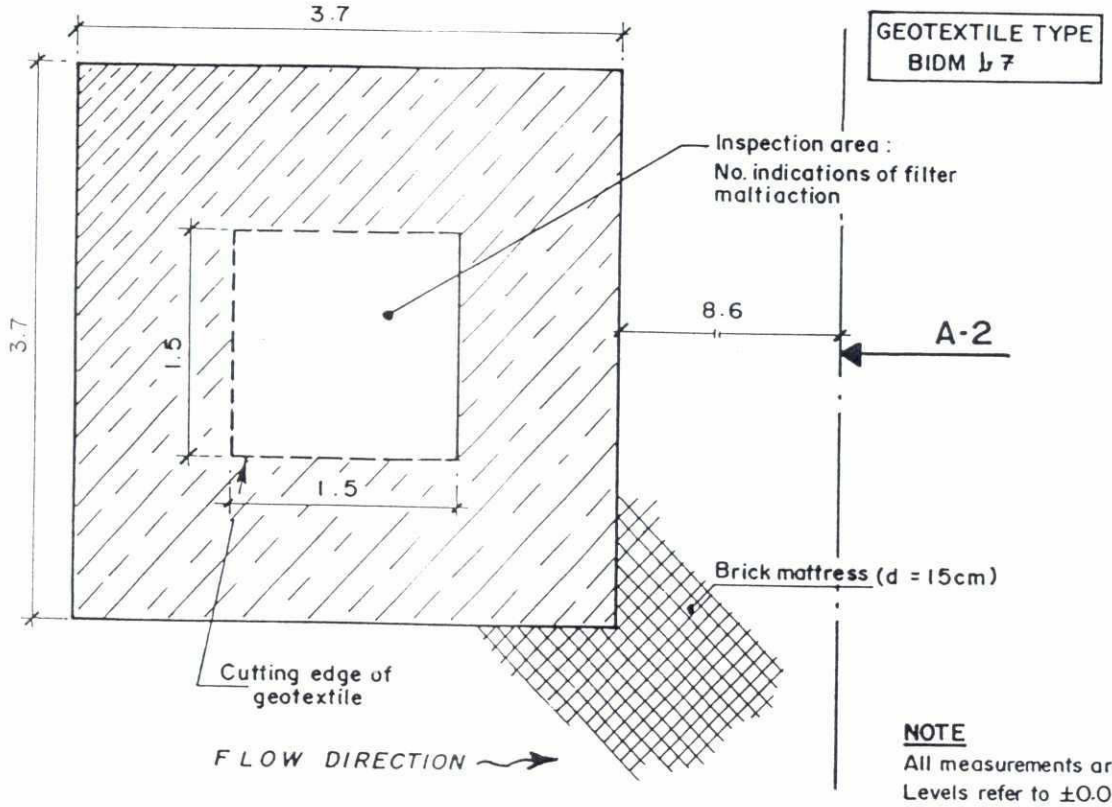
Laboratory Tests
No tests have been carried out

92



CROSS-SECTION

Scale. 1 : 250



TOP VIEW OF INSPECTION AREA

Scale. 1 : 50

NOTE

All measurements are in meter.
Levels refer to ±0.0m PWD.

SCALES

0 0.5 1.0 m 1 : 50

0 1 2 3 4 5m 1 : 250

MONITORING OF TEST STRUCTURE

Test Section : A - 1

Location of Physical Inspection

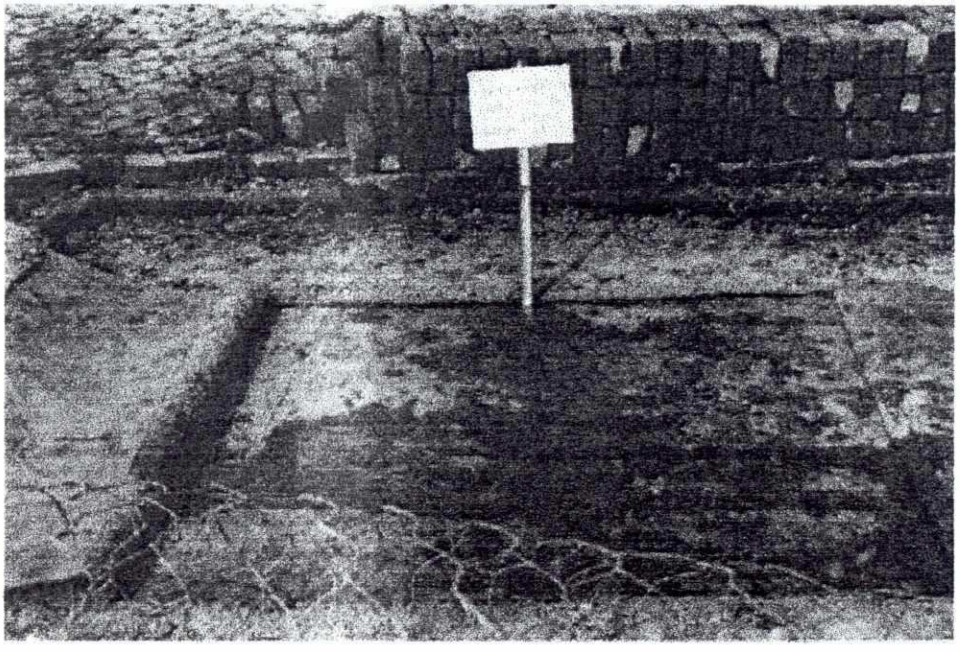
FAP - 21

BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

FIG. 21 - 1

273/9A: Sight on Section A-1 before inspection (21.02.1998)



273/10A: Sight on inspected area Section A-1 (21.02.1998)

Section A-2

9B

ASSESSMENT SHEET SECTION A-2
Total length along toe of upper slope: **74.70 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-5 / HaTe 0 2214 (composite geotextile)	Wiremesh mattress d = 23/36 cm with stone fill Grade B (D_{50} = 15 cm)	1,840 m²	1,600 m²
Launching apron	GF-2 / BIDIM S 550	Dumped CC - blocks D_n = 35 cm (2,450 Nos./100m²)	5,500 m²	4,991 m³
Transition between launching apron and falling apron		CC - blocks D_n = 30 cm		413 m³
Falling apron		Rip-rap Grade E (D_{50} = 30 cm)		2,602 m³
Exposed edge of falling apron		Rip-rap Grade F (D_n = 25/35/45 cm)		1,582 m³

VISUAL OBSERVATION **Date: 19.02.1998**

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section A-2 occurred during the flood season of 1997. No visible changes / damages to the structure could be detected. Some corrosion of the locally made wiremesh cages which are placed at the toe of the slope is apparent, possibly due to inadequate galvanizing of the used steel wire. The imported cages (RENO-mattresses) are of much better quality due to thicker and better assembled wires and a PVC coating for better protection against corrosion.	
Launching apron	No severe attack of the river on this segment of Section A-2 occurred during the flood season of 1997. There has instead been some sedimentation which covers this area. Some low vegetation spread over the sedimented area can be found which serves as food for cows / lambs which are lead there by the local people during the day. No visible changes / damages to the structure could be observed.	
Transition between launching apron and falling apron	As before	

ASSESSMENT SHEET SECTION A-2

VISUAL OBSERVATION (continued)		Date: 19.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	No severe attack of the river on this segment of Section A-2 occurred during the flood season of 1997. There has instead been some sedimentation which covers this area. Some low vegetation spread over the sediment can be found which serves as food for cows / lambs which are lead there by the local people during the day. No visible changes / damages to the structure could be detected.	
Exposed edge of falling apron	As before	

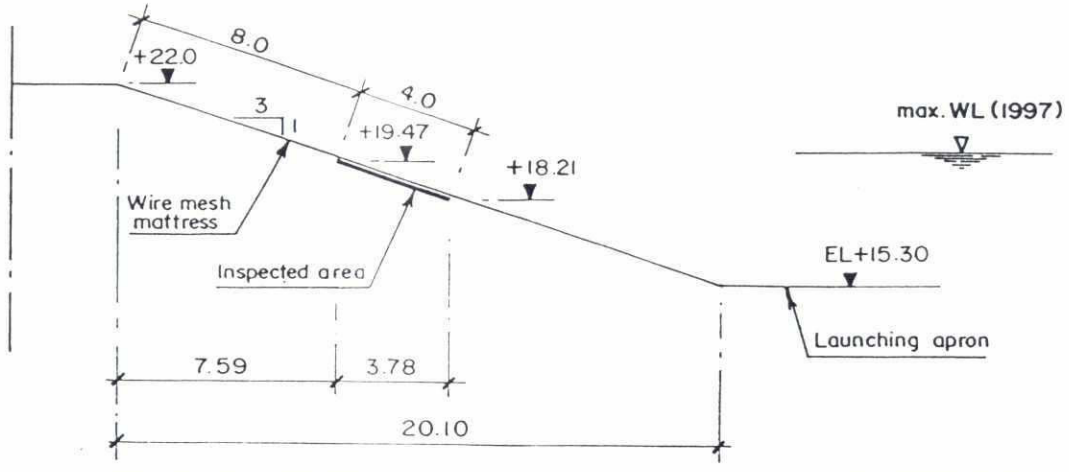
PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date: 20.02.1998
Selection of Location:	Photographs No.
There was no obvious upheaval or depression to be seen in Section A-2. Therefore, the location for inspecting the geotextile and the underlaying subsoil has been chosen around the position where the highest waterlevel has left a mark on the revetment above berm level. So any differences between the water covered area and the dry area of the revetment (only exposed to rain and waves) can be detected after removing the cover layer of wiremesh mattresses from the geotextile. Size and location of the inspected area can be seen in Figure 21-2 attached to this assessment sheet.	
Result of Physical Inspection - Type HaTe O 2214 (composite filter):	
After removing the cages the geotextile had to be cleared of a certain amount of sediments before it was cut with a knife at three sides leaving a connection at the right side in flow direction. The geotextile was then lapped over to give sight on the underlaying subsoil which was in good and overall moist condition. At this point of the inspection it was detected that the geotextile was placed in a way of wasting material and money. The overlapping of a geotextile at a joint (if not sewn together with a Prayer Seam as preferred) should have been around 50 cm. From picture 271/11 and also from Figure 21-2 it can be taken that with a supplying width of 5m for the geotextile HaTe O 2214 and a distance from joint to joint of 2,85 m there must be an overlapping by the adjacent sheet in downstream direction by 2,15 m. Also the upstream adjacent overlapping is with 1,27 m by fare larger than it should be. It is understood that placing geotextile in an bend must show a variation in the overlapping from top to toe of the slope but not in the way it has been done here. The water covered and dry area (only exposed to rain and waves) of the revetment above berm level are in the same condition, no differences were detected. The opened area was set into original condition after inspection by overlapping with an additional sheet of geotextile filter material.	271 / 11 271 / 12

99

ASSESSMENT SHEET SECTION A-2

Special Notes / Comments
Non

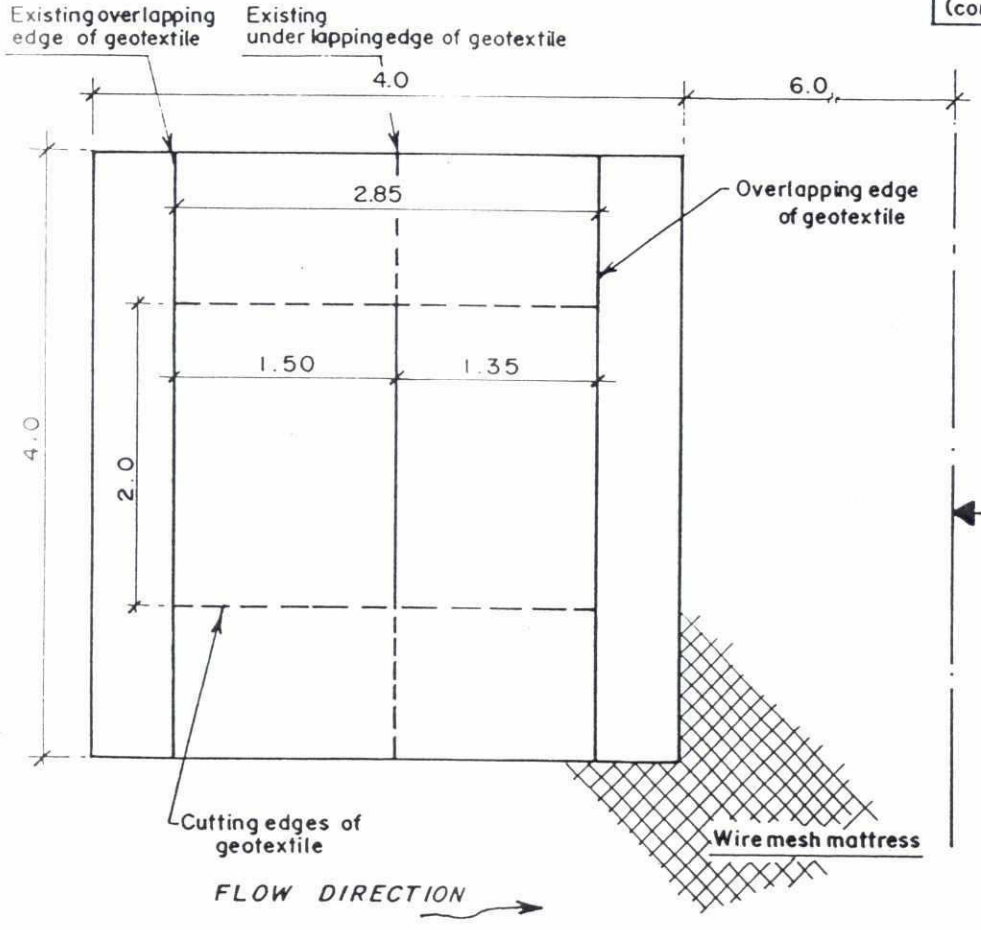
Laboratory Tests
No tests have been carried out



CROSS - SECTION

Scale. 1 : 250

GEOTEXTILE TYPE
Ha Te 0 2214
(composite filter)



TOP VIEW OF INSPECTION AREA

Scale. 1 : 50

NOTES

All measurements are in meter.
Levels refer to ± 0.0 m PWD.

SCALES

0 0.5 1.0 m 1 : 50

0 1 2 3 4 5m 1 : 250

MONITORING OF TEST STRUCTURE

Test Section : A - 2

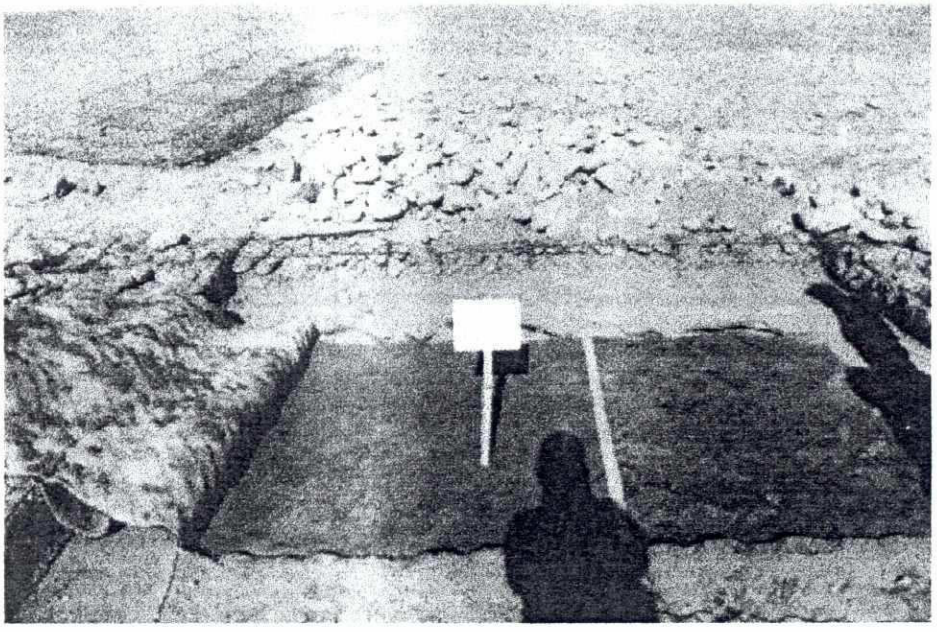
Location of Physical Inspection

FAP - 21

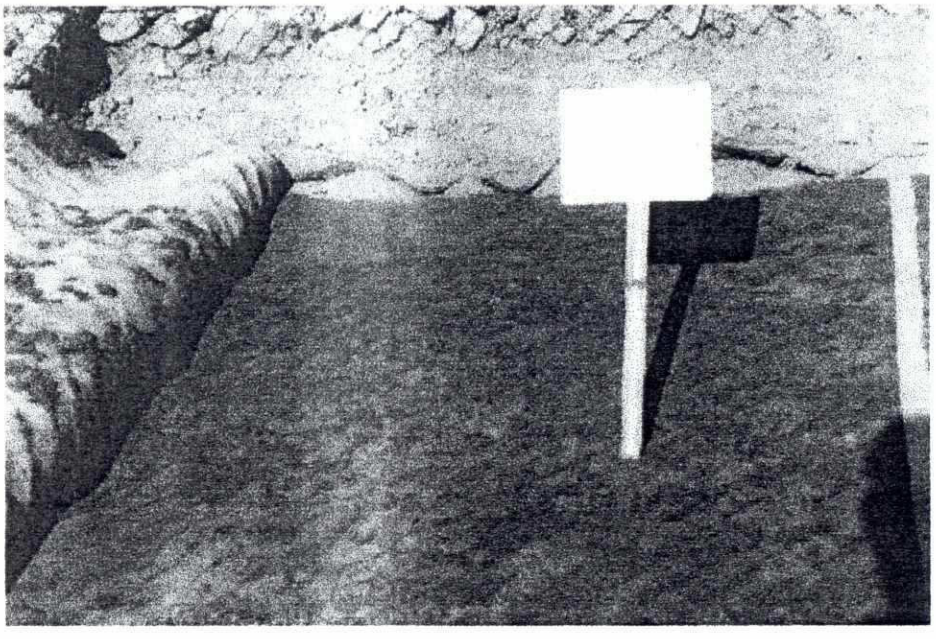
BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

FIG. 21 - 2



271/11: Sight on inspection area Section A-2 (20.02.1998)



271/12: Close up on inspected area Section A-2 (20.02.1998)

Section B

62

ASSESSMENT SHEET SECTION B
Total length along toe of upper slope: **99.10 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-2 / BIDIM S 550	Wiremesh mattress d = 23 cm with stone fill Grade B (D_{50}=15cm) on intermediate rubble layer (d = 25 cm)	2,671 m²	2,344 m²
Launching apron	GF-4 / HaTe K 251	Dumped CC-blocks Edge us: D_n = 50 cm Center : D_n = 35 cm Edge ds: D_n = 40 cm	6,525 m²	4,915 m³
Transition between launching apron and falling apron		CC-blocks D_n = 35 cm		
Falling apron		Geo-sand-container Type C (180 kg/No.)		15,603 Nos.
Exposed edge of falling apron		Geo-sand-container Type D (250 kg/No.)		5,850 Nos.

VISUAL OBSERVATION (see Drawings 21-3, 21-4) **Date: 19.02.1998**

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section B occurred during the flood season of 1997. No visible changes / damages could be detected but some corrosion of the cage structure of the wiremesh mattress. The wiremesh itself is in good condition.	271 / 4
Launching apron	There has been some significant sedimentation which covers the hole area. Some vegetation spread over the sediment can be found which serves as food for some cows / lambs which are lead there by local people during the day. As shown on Drawing 21-4 the launching apron has eroded at a length of 30 m along the waterline. As the eroded area is completely overtopped by sediments two trenches have been excavated to see how far the erosion has been going and in what condition the underlying structure is *(see Result of Physical Inspection)*.	
Transition between launching apron and falling apron	The Dutch Envelop completely eroded on a length of about 40 m along the waterline.	

ASSESSMENT SHEET SECTION B

VISUAL OBSERVATION (continued)		Date: 19.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	The falling apron completely eroded to its full extend on a length of 30 m along the waterline. But after the erosion took place some significant sedimentation especially around the bankline took place as only at some points the remaining parts of the falling apron can be seen. In those exposed areas the geo-sand containers have been cut or removed by local people. If and to which extend the underwater slope is now protected by the vanished material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*, however, the river bed slope has remained quite stable during the past months. Beside this survey it has been successfully tried to locate / identify some cc-blocks under water at a distance of up to 5 m from the waterline using a bamboo stick.	273 / 2A 273 / 1A
Exposed edge of falling apron	It can be assumed from Drawing 21-4 that some 80% have completely eroded.	

PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date: 20.02.1998
Selection of Location:	Photographs No.
There was no obvious upheaval or depression to be seen in the upper part of Section B. Therefore the location for inspecting the geotextile and the underlaying subsoil has been chosen around the position where the highest waterlevel has left a mark on the revetment above berm level. So any differences between the water covered area and the dry area of the revetment (only exposed to rain and waves) can be detected after removing the cover layer of wiremesh mattresses off the geotextile. Size and exact location of the inspected area can be seen in Figure 21-3 attached to this assessment sheet.	
Result of Physical Inspection:	Photographs No.
After removing the cages and the intermediate rubble layer the geotextile was cut with a knife at three sides leaving a connection at the right side in flow direction. The geotextile was then lapped over to give sight on the underlaying subsoil which was in good and overall moist condition. The water covered and dry area (only exposed to rain and waves) of the revetment above berm level are in the same condition, no differences were detected. The opened area was set into original condition after inspection by overlapping with an additional sheet of geotextile filter material. Apart from inspecting the revetment above berm level it has been tried to locate at what depth under the enormous sedimentation in this section the launching apron or even parts of it can be found. To do so two trenches have been excavated starting from the waterline towards the embankment. CC-blocks of the launching apron could be found near the waterline at 2 m from ground level in the first trench and at 2,2 m in the second. The exact location of the trenches and a cross-section to show were cc-blocks were found can be seen in Drawing 21-4a.	271/4 271/8

ASSESSMENT SHEET SECTION B

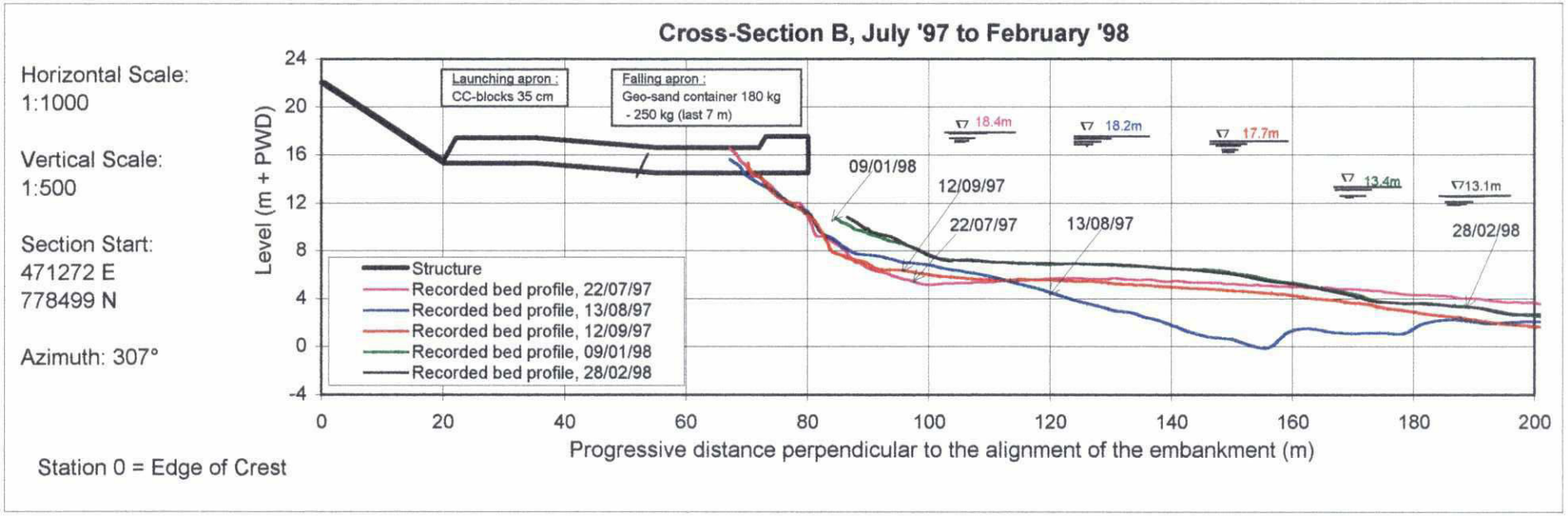
Special Notes / Comments

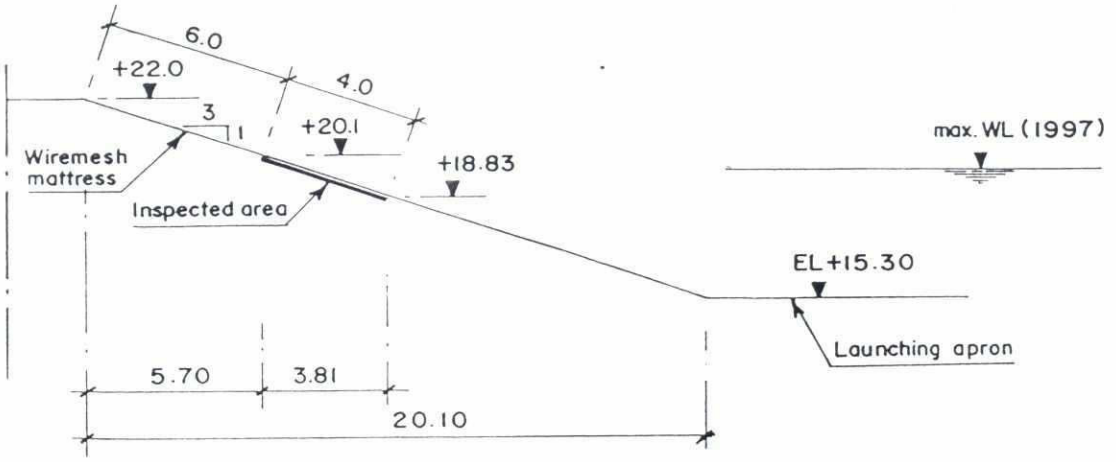
SIDE SCAN SONAR SURVEY:
Side Scan Sonar investigations have not produced evidence of the existence of scattered geo-sand-containers at the eroded slope. It is likely that the sand-filled containers do not produce backscatters, adequate for recording. Considering that the river bed slope remained reasonably stable since August'97 it may be assumed that scattered geo-sand-containers protect the bed from further erosion.

Laboratory Tests

No tests have been carried out

BAHADURABAD (FAP 21) - TEST SITE II

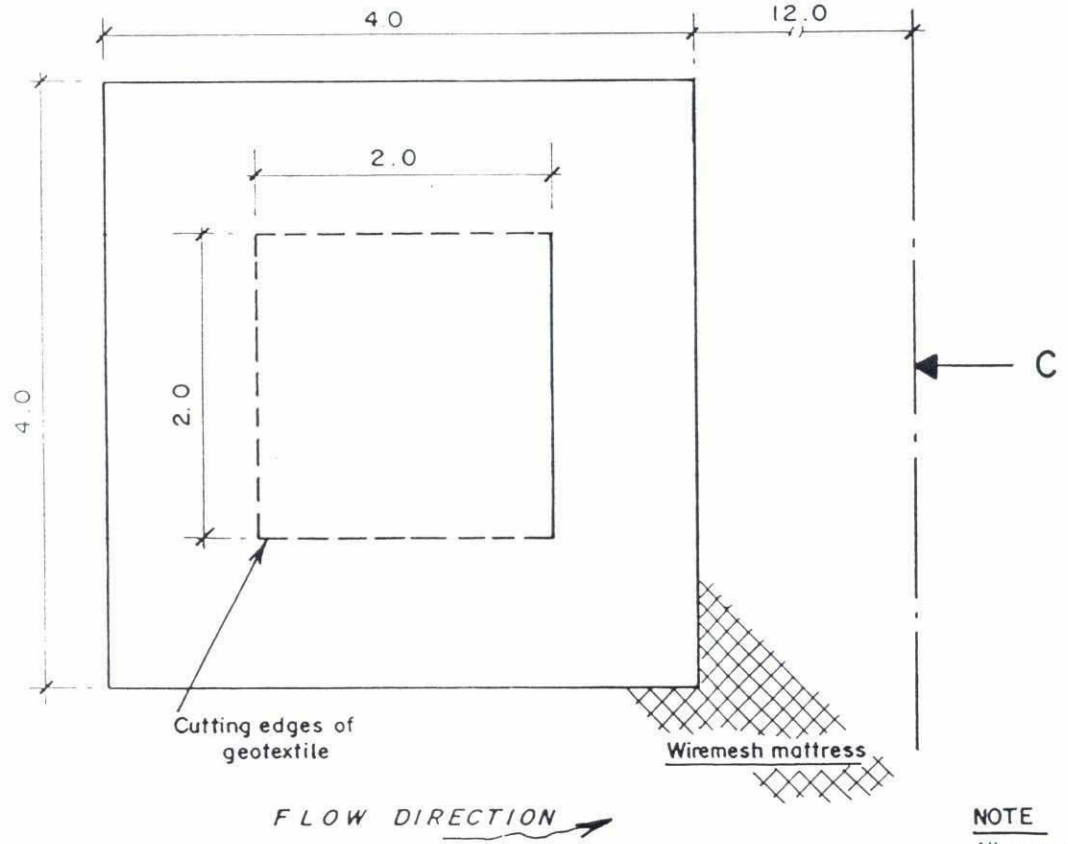




CROSS - SECTION

Scale. 1 : 250

GEOTEXTILE TYPE
BIDIM 5550



TOP VIEW OF INSPECTION AREA

Scale. 1 : 50

NOTE

All measurements are in meter.
Levels refer to ±0.0m PWD.

SCALES

0 0.5 1.0 m 1 : 50

0 1 2 3 4 5m 1 : 250

MONITORING OF TEST STRUCTURE

Test Section : B

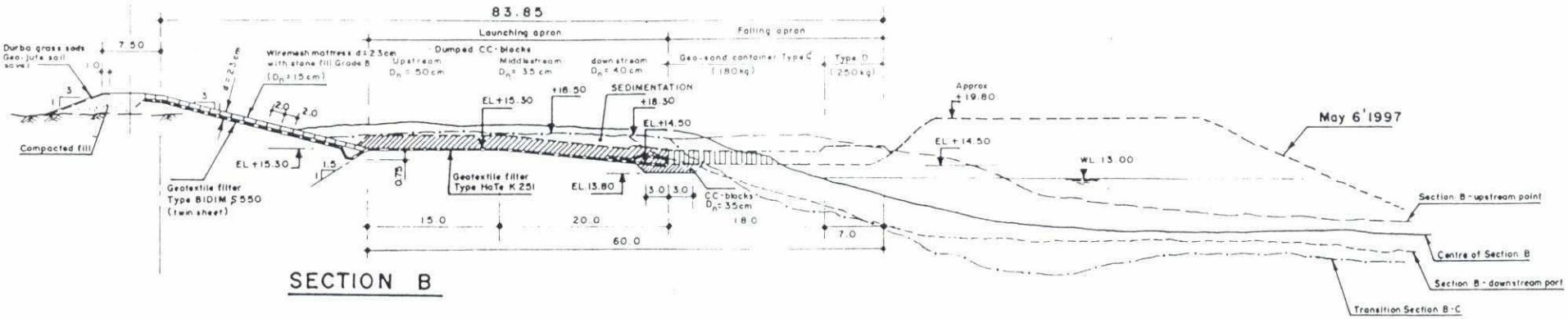
Location of Physical Inspection

FAP - 21

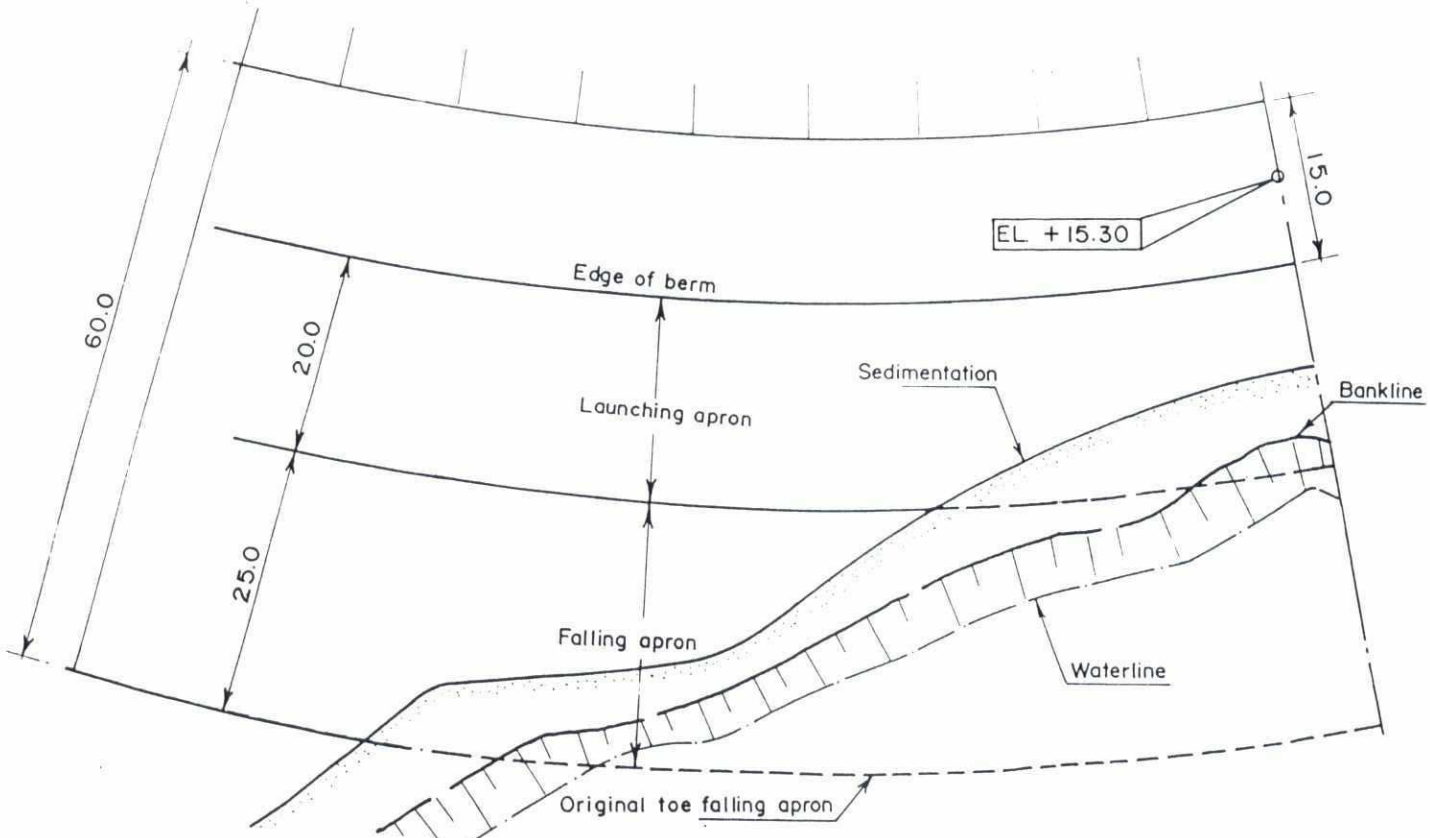
BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

FIG. 21 - 3



SECTION B



LAYOUT PLAN B

NOTE.
Levels refer to ±0.00 m PWD
Bed profiles as on Feb.18'1998
Bankline/waterline as on 08.03.98

0 5 10 20 m

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

FAP-21 BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

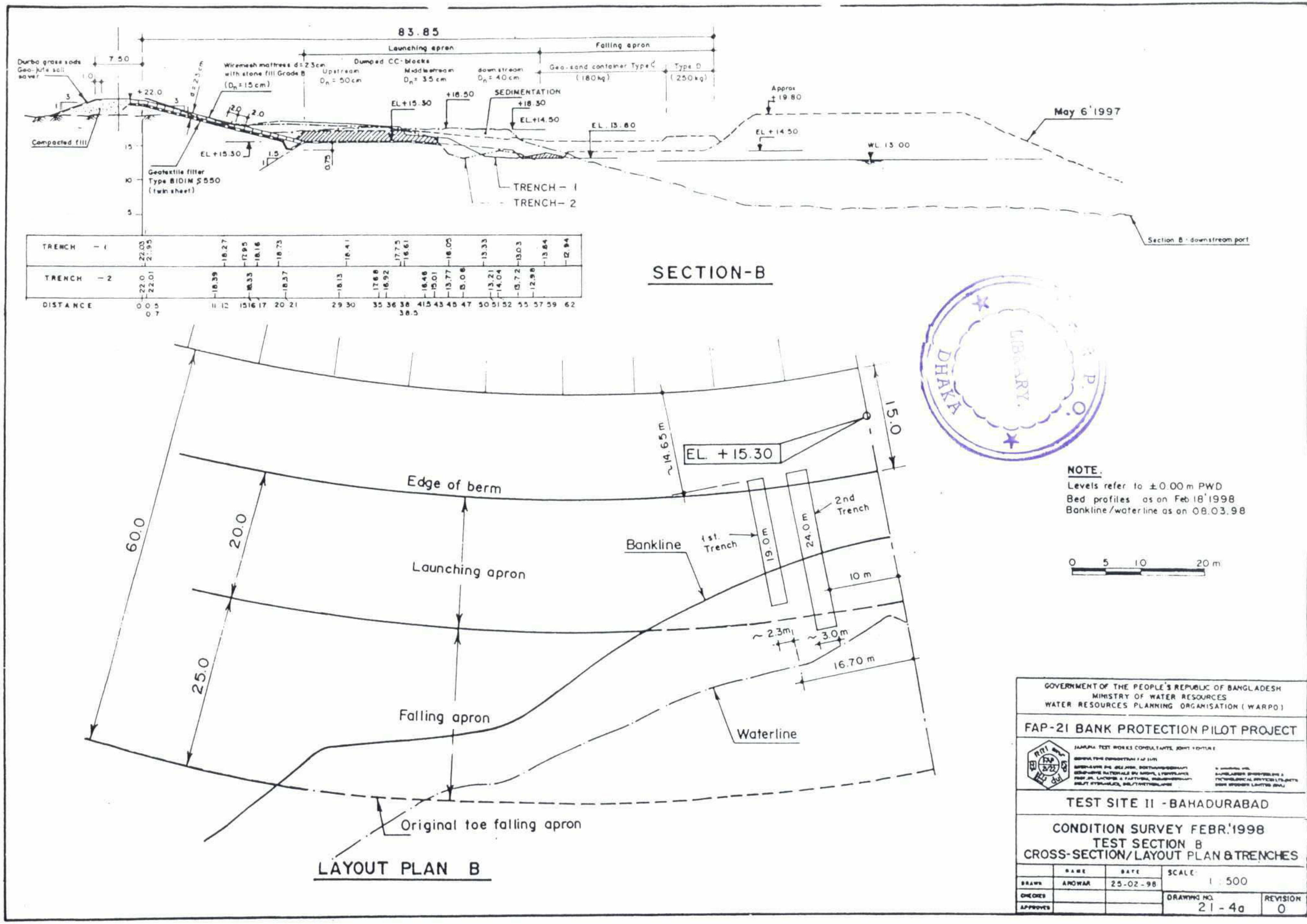
CONDITION SURVEY FEBR.'1998
TEST SECTION B
CROSS-SECTION/LAYOUT PLAN

	NAME	DATE
DRAWN	ANOWAR	25-02-98
CHECKED		
APPROVED		

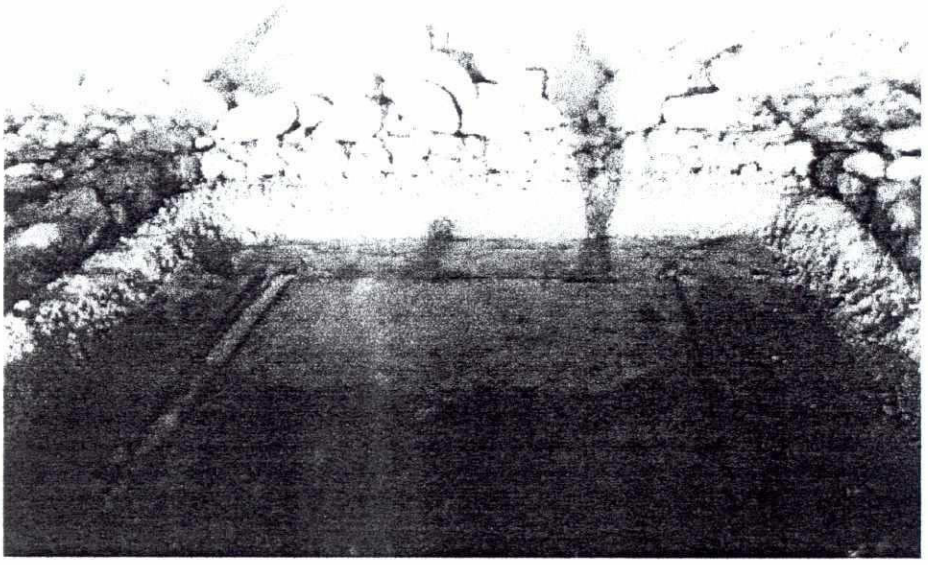
SCALE: 1 : 500

DRAWING NO. 21-4

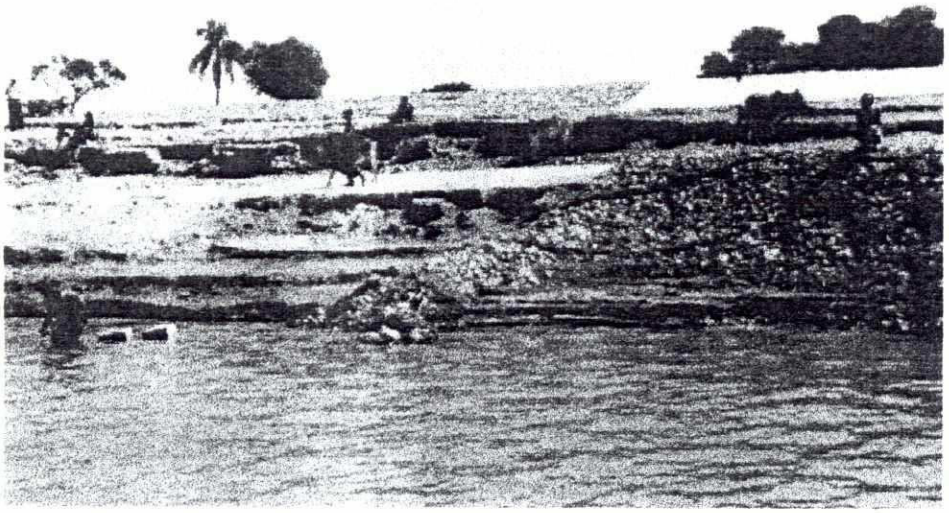
REVISION 0



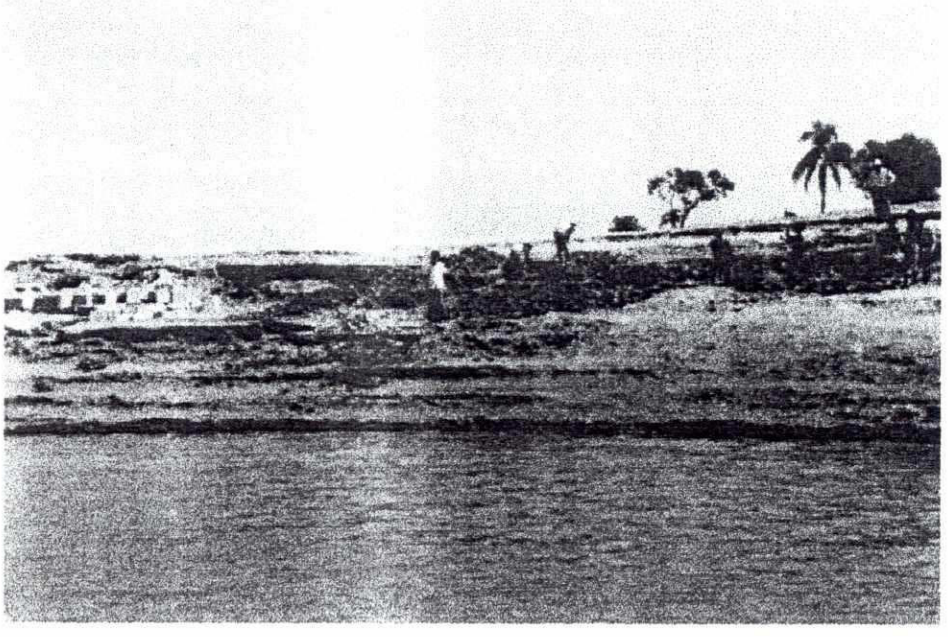
271/4: sight on Section B before inspection (20.02.98)



271/8: Sight on inspected area Section B (20.02.98)



273/1A: View at bank-/ waterline transition Section B/C (21.02.98; W.L. = 12.97 m PWD)



273/2A: View at bank-/ waterline transition Section B/C (21.02.98; S.L.=12.97 m PWD)

Section C

ASSESSMENT SHEET SECTION C
Total length along toe of upper slope: **93.20 m**

STRUCTURE BUILT-UP

Segment	Filter (Spec. Type / Brand Name)		Cover Material	Built-in Quantities: Filter		Built-in Quantities: Cover Material
Revetment above berm level	Filter III on filter II	Khoa on filter II	CC-blocks D_n = 30 cm hand-laid in single, diagonal lines	1,007 m³	812 m³	504 m³
Launching apron	GF-2 / DATEX AD 1600		Articulated Renomattress d = 23/36 cm; stone fill grade B,C,D (D_{50} = 25 cm) with inter-connecting steel wire ropes and anchor piles at berm level	5,787 m²		5,480 m²
Transition between launching apron and falling apron						
Falling apron			Geo-sand-container Typ E (900 kg/No.)			4,467 Nos.
Exposed edge of falling apron						

VISUAL OBSERVATION — Date: 19.02.1998

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section C occured during the flood season of 1997. No visible damages to the structure could be observed. But it can be clearly seen that the diagonal placed cc-blocks might not be a favourable solution because interlocking is not the best and especially at the top of the slope where the cc-blocks bend to the top of the embankment large joints open up and blocks might be easily moved in some direction. In addition to that not only the river current but also heavy rain falls occuring each monsoon have an easier access to the underlying filter and subsoil.	
Launching apron / transition between launching and falling apron	There has been some significant sedimentation which covers the hole area. Some vegetation spread over the sediment can be found which serves as food for some cows / lambs which are lead there by local people during the day. Referring to Drawing 21-5 the launching apron eroded to some extend over its total length of 93.20m along the waterline. During the process of erosion the Articulated Reno-Mattress has adjusted itself very good and flexible to the subsoil and is forming a good bankline protection. **(continues on next page)**	

ASSESSMENT SHEET SECTION C

VISUAL OBSERVATION (continued)		Date: 19.02.1998
Observed Area	**Comments**	Photographs No.
Launching apron / transition between launching and falling apron	The wiremesh is of very good quality (imported RENO-mattress) and of the type used in Sections A-2 and B. Corrosion is not apparent. Nevertheless some single cages around the waterline seem to have burst due to too heavy stresses. But it also has to be considered that one or two of them have been opened by local people to get access to the stone filling. If and to which extend the mattresses can be found on the underwater slope might be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*.	273 / 1A 273 / 0A 271 / 36 271 / 31
Falling apron / exposed edge of falling apron	Only a couple of geo-sand containers are left and can be seen at the transition to Section D on a length of some 5 m along the waterline. If and to which extend the underwater slope is now protected by the vanished material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*. Beside this survey it has been successfully tried to locate / identify some geo-sand containers under water at a distance of up to 5 m from the waterline using a bamboo stick. No ongoing erosion has been detected so far, and the river bed slope remained reasonable stable during the past months.	271 / 31

PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date:
Selection of Location:	Photographs No.
No inspection was carried out	

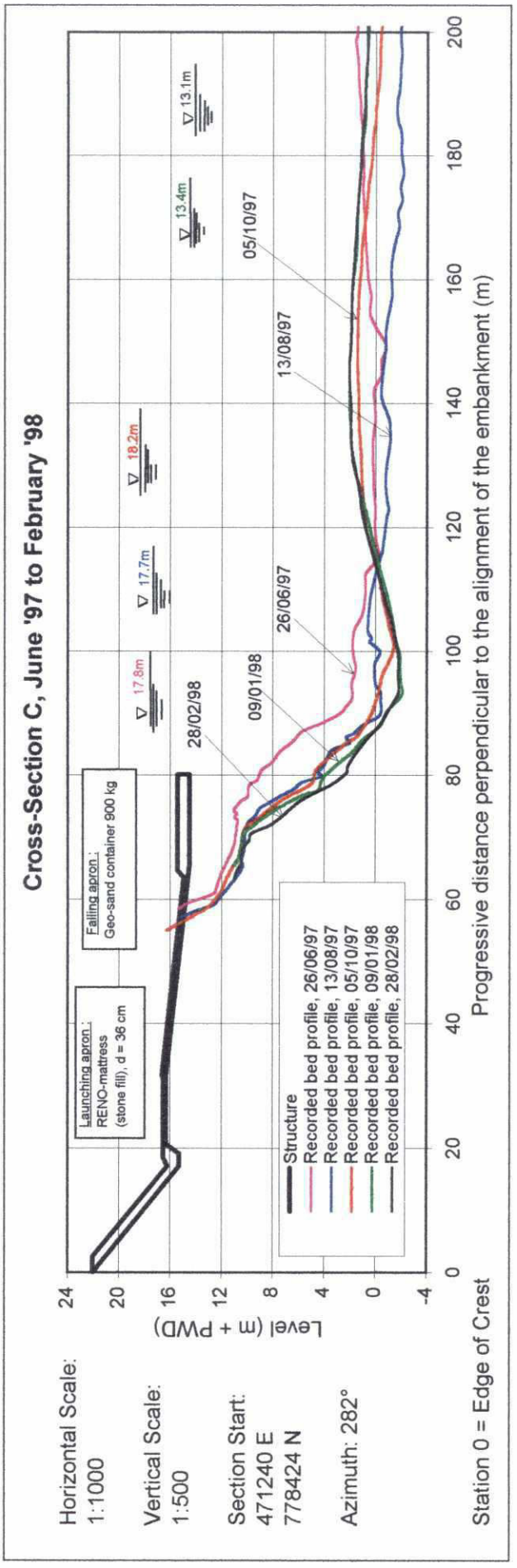
Special Notes / Comments

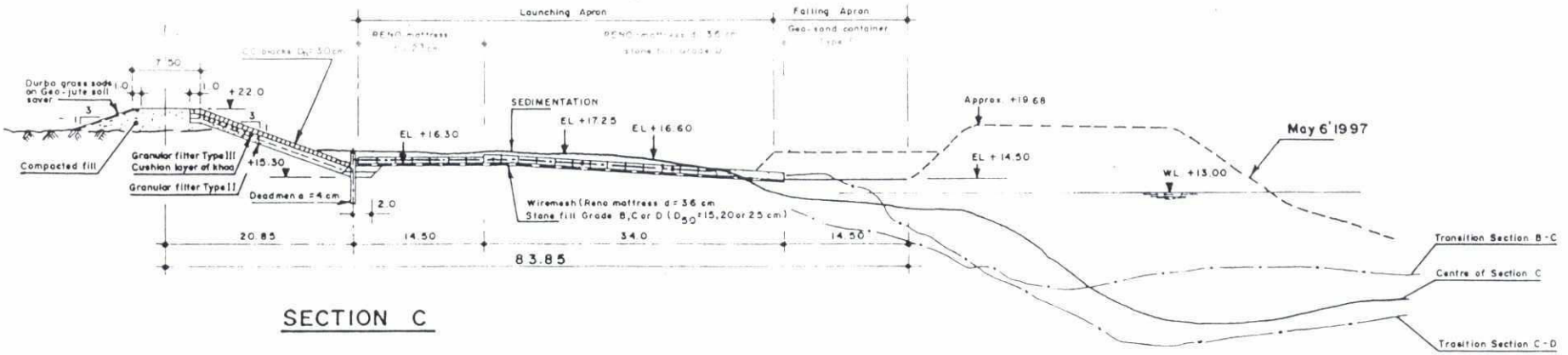
Side Scan Sonar investigations have not produced evidence of the existence of scattered geo-sand containers along the eroded slope. It is likely that these materials do not produce backscatters adequate for recording.
The eroded river bank remained reasonably stable since August '97. Thus it can be assumed that the scattered containers protect the river bed from further erosion.
It is to be noted that the bank slope in Section B (geo-sand container of 180/250 kg) is more gentle and the scour depth much less as compared to this Section C (geo-sand container of 900 kg each).

Laboratory Tests

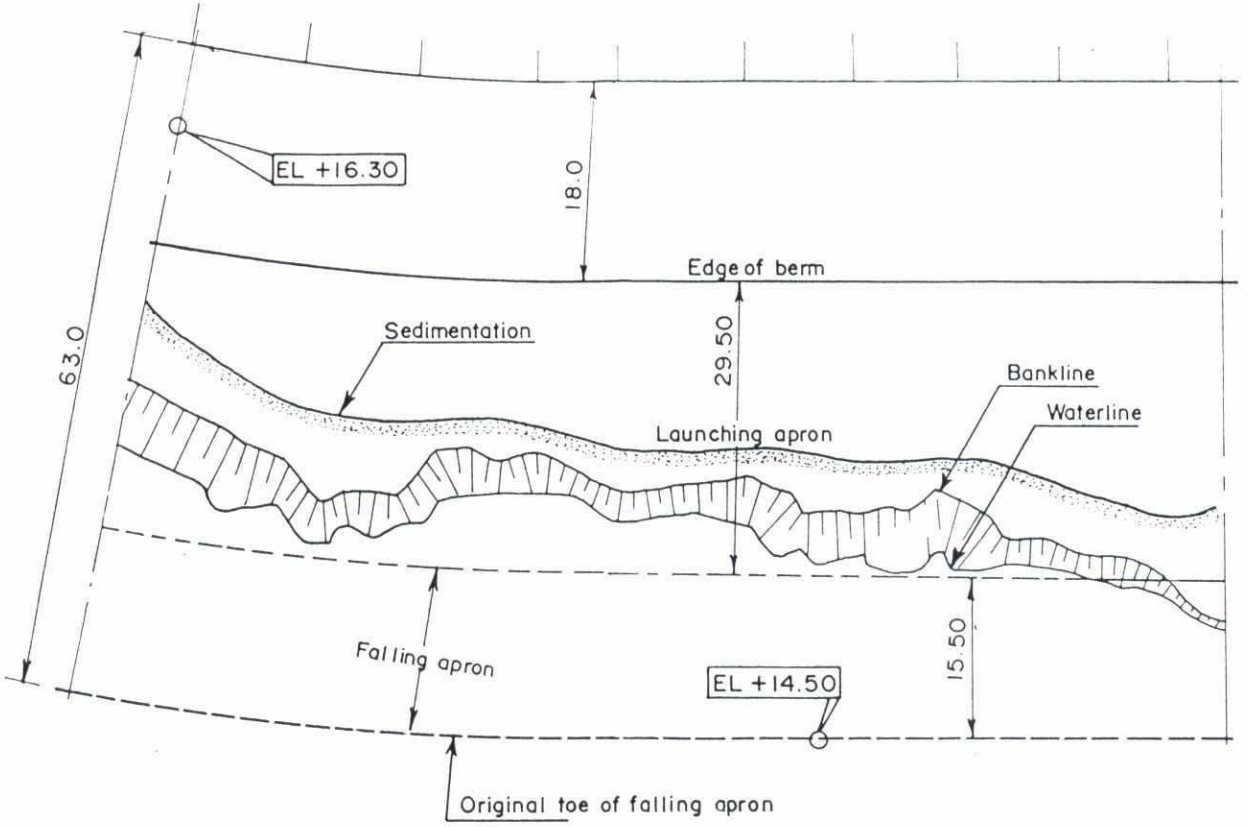
No tests have been carried out

BAHADURABAD (FAP 21) - TEST SITE II





SECTION C



LAYOUT PLAN C

NOTE.
Levels refer to ±0.00 m PWD
Bed profiles as on Feb.18'1998
Bankline/water line as on Feb.18'1998.

0 5 10 20 m

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

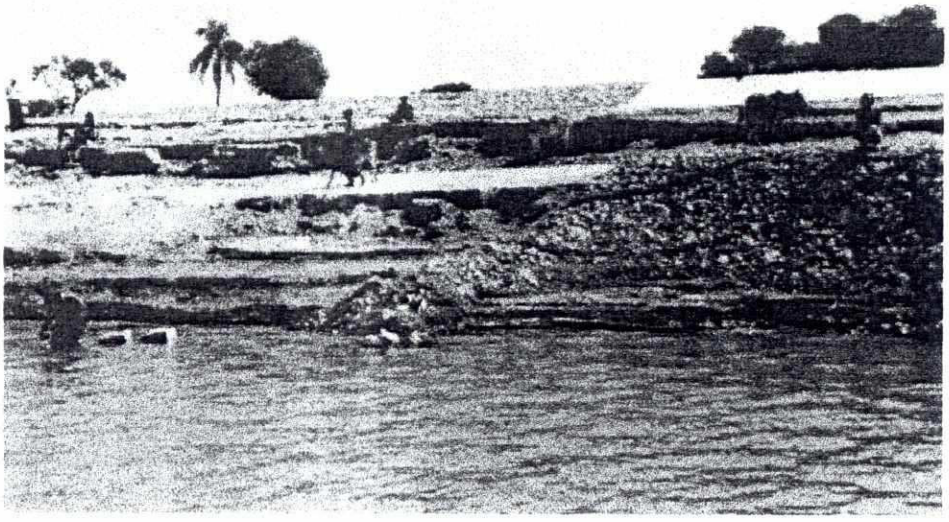
FAP-21 BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

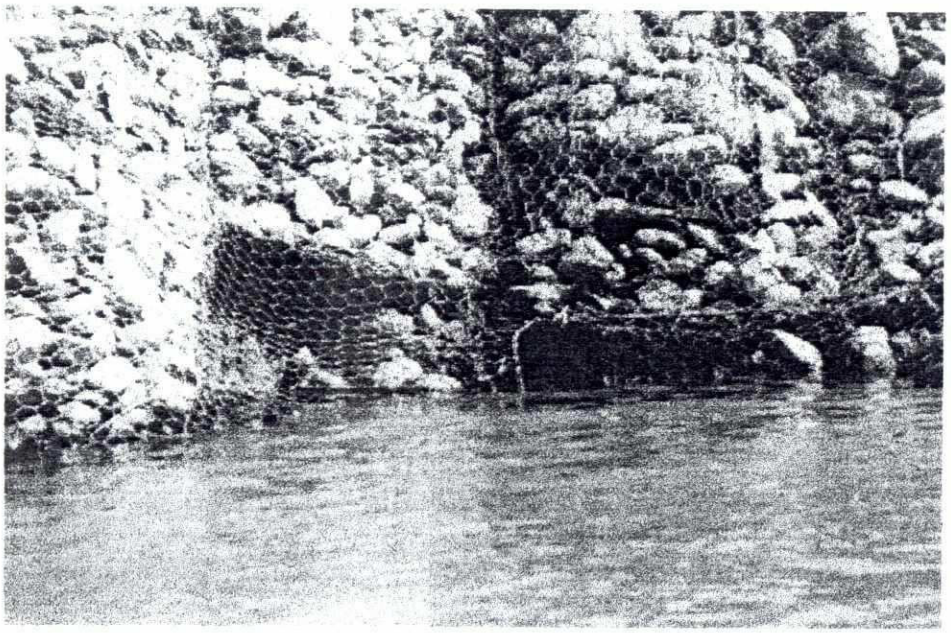
CONDITION SURVEY FEBR.'1998
TEST SECTION C
CROSS-SECTION/LAYOUT PLAN

	NAME	DATE	SCALE: 1 : 500
DRAWN	ANOWAR	25-02-98	
CHECKED			DRAWING NO. 21-5
APPROVED			REVISION 0

273/0A: View at bank-/ waterline of Sectin C (21.02.98; W.L. = 12.97 m PWD)



273/1A: View at bank-/ waterline of Sectin B/C (21.02.98; W.L. = 12.97 m PWD)



271/36: View at waterline of Section C (21.02.98; W.L.=12.97 m PWD)

271/31: View at bank-/ waterline transition Section C/D (21.02.98; S.L.=12.97 m PWD)

Section D

ASSESSMENT SHEET SECTION D
Total length along toe of upper slope: **88.00 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-2 / BIDIM S 550	cc-blocks D_n = 30 cm, hand-laid in single parallel lines	3,014 m²	531 m³
Launching apron	GF-4 / BIDIM S 700	Articulated cc-block mattress with interconnecting steel wireropes and anchorpiles at berm level	6,375 m²	4,673 m²
Transition between launching apron and falling apron				
Falling apron		cc-blocks D_n = 40 cm		1,820 m³
Exposed edge of falling apron		cc-blocks D_n = 45 cm		1,002 m³

VISUAL OBSERVATION **Date: 18.02.1998**

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section D occurred during the flood season of 1997. No visible changes / damages to the structure could be observed.	
Launching apron	This area is covered with an even, thin layer of sediment. Some vegetation spread over the sediment can be found which serves as food for some cows / lambs which are lead there by local people during the day. The articulated cc-block mattress used here can only be seen at some points but clearly at the transition to Section E-1 where larger dimensioned cc-blocks have been used to strengthen the mattress transition. No visible changes / damages of any kind could be observed in this area.	
Transition between launching apron and falling apron		

ASSESSMENT SHEET SECTION D

VISUAL OBSERVATION (continuing)		Date: 18.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	The falling apron in this Section has eroded to quite some extend and has therefore served its purpose very well. The cc-blocks which have been falling done towards the river during erosion show now a very well interlocked slope above the waterline. If and to which extend the underwater slope is now protected by the material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*. Beside this survey it has been successfully tried to locate / identify some cc-blocks under water at a distance of up to 5 m from the waterline using a bamboo stick. No ongoing erosion has been detected so far and the eroded slope remained quite stable during the past months.	271 / 31 271 / 29
Exposed edge of falling apron	Exposed edge has eroded to its full extend and should now be stabilizing the underwater slope.	

PHYSICAL INSPECTION (see Drawings 21-6, 21-7)	Date: 19.02.98
Selection of Location:	Photographs No.
There was no obvious upheaval or depression to be seen in Section D. But an area for inspection was selected where some repair was carried out during the season around the point where the highest waterlevel has left a mark on the revetment above berm level. Size and exact location of the inspected area can be seen in Figure 21-6 attached to this assessment sheet.	272 / 31 272 / 33
Result of Physical Inspection:	
After removing the CC-blocks in the specified area the granular filter which has been used to repair the depressed area was excavated. The geotextile was cut with a knife at three sides leaving a connection at the right side in flow direction. The geotextile was then lapped over to give sight on the underlaying subsoil. Depression could be seen very clearly with a square size of 1,2 * 1,2 m and a depth of up to 100 mm. The opened area was covered with silt (2-3 mm). There was fine sand underneath. The soil was overall in moist condition being wet at point of the deepest depression. There were no drainage channels visible. The depressed area was refilled with sand and compacted. In the end the Section was set into original condition after inspection by overlapping with an additional sheet of geotextile filter material.	

ASSESSMENT SHEET SECTION D

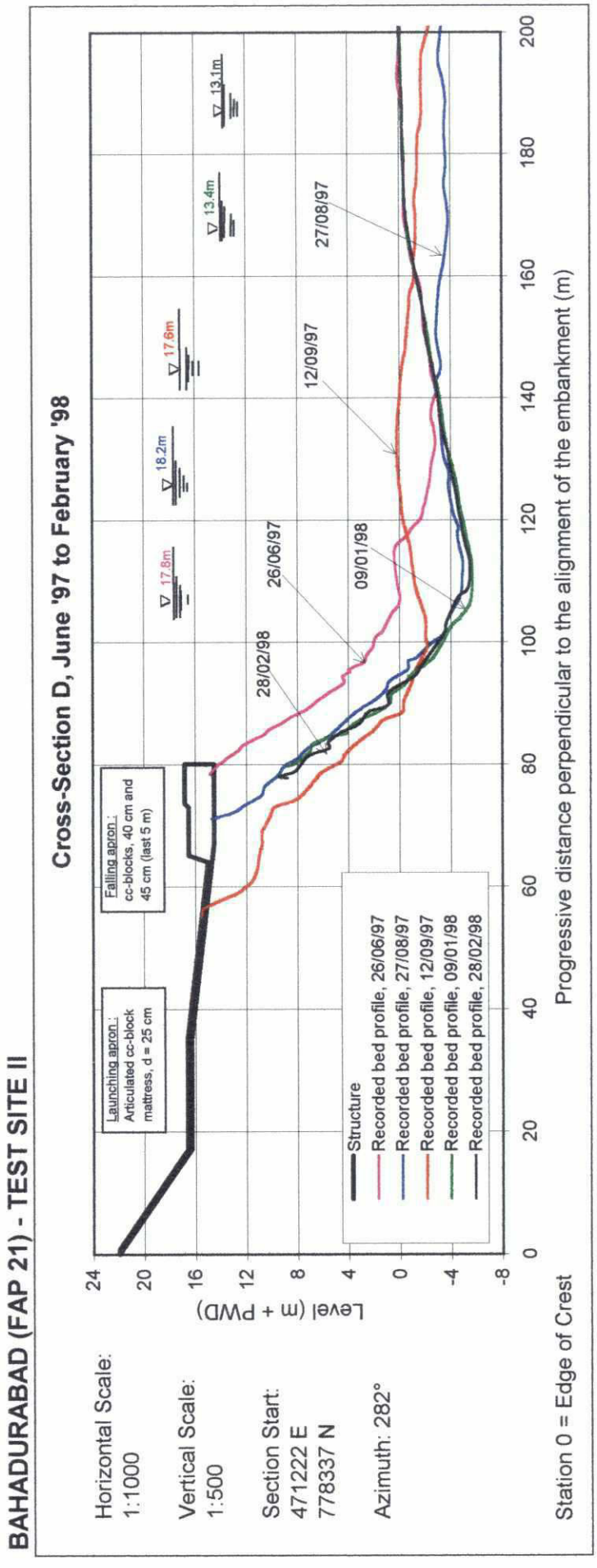
Special Notes / Comments

SIDE SCAN SONAR SURVEY:
Side Scan Sonar investigations have produced a continuous strong scatter along the bank immediate to the water line. Beyond, for about 30m in front of the bankline a strong scatter indicates that the slope is partly covered with cc-blocks throughout the Section.
From bathymetric surveys it is confirmed that the river bed slope in this Section remained reasonably stable since August'97.

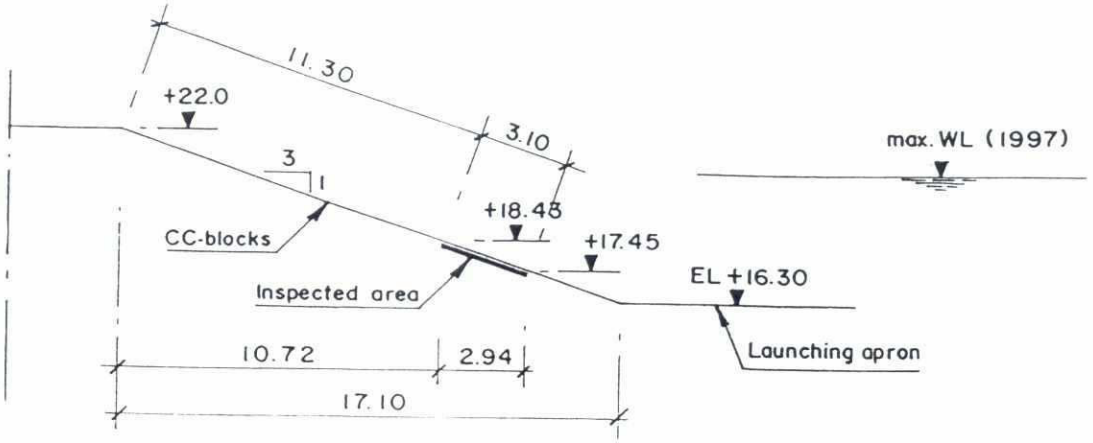
Laboratory Tests

No tests have been carried out

202


BAHADURABAD (FAP 21) - TEST SITE II
Cross-Section D, June '97 to February '98
Horizontal Scale: 1:1000
Vertical Scale: 1:500
Section Start: 471222 E 778337 N
Azimuth: 282°
Launching apron : Articulated cc-block mattress, d = 25 cm
Falling apron : cc-blocks, 40 cm and 45 cm (last 5 m)
17.8m
18.2m
17.6m
13.4m
13.1m
28/02/98
26/06/97
09/01/98
12/09/97
27/08/97
Structure
Recorded bed profile, 26/06/97
Recorded bed profile, 27/08/97
Recorded bed profile, 12/09/97
Recorded bed profile, 09/01/98
Recorded bed profile, 28/02/98
Level (m + PWD)
24
20
16
12
8
4
0
-4
-8
0
20
40
60
80
100
120
140
160
180
200
Station 0 = Edge of Crest
Progressive distance perpendicular to the alignment of the embankment (m)

202

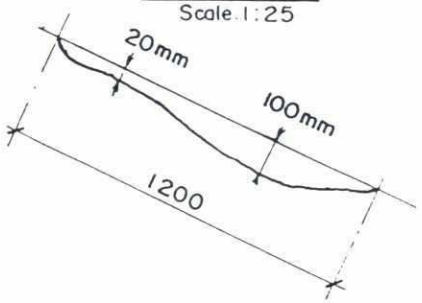


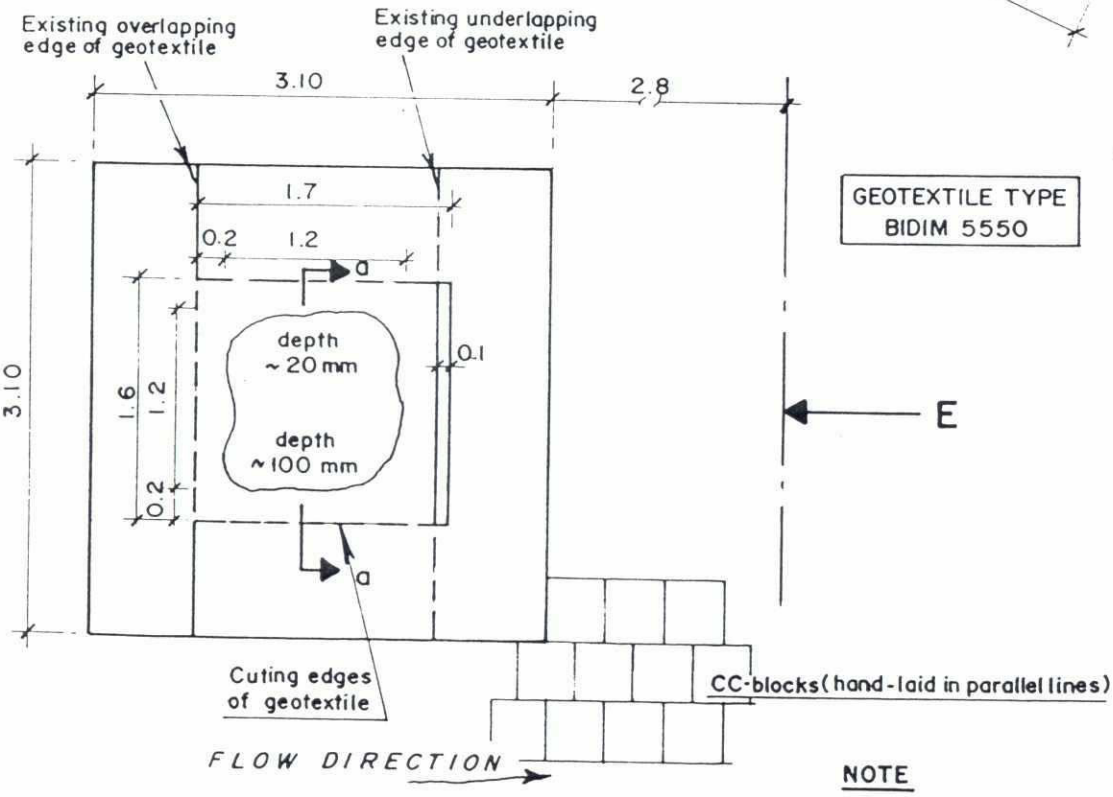
CROSS-SECTION

Scale. 1 : 250

SECTION a-a

Scale. 1:25





GEOTEXTILE TYPE
BIDIM 5550

TOP VIEW OF INSPECTION AREA

Scale. 1 : 50

NOTE

All measurements are in meter.
Levels refer to ±0.0m PWD.

SCALES

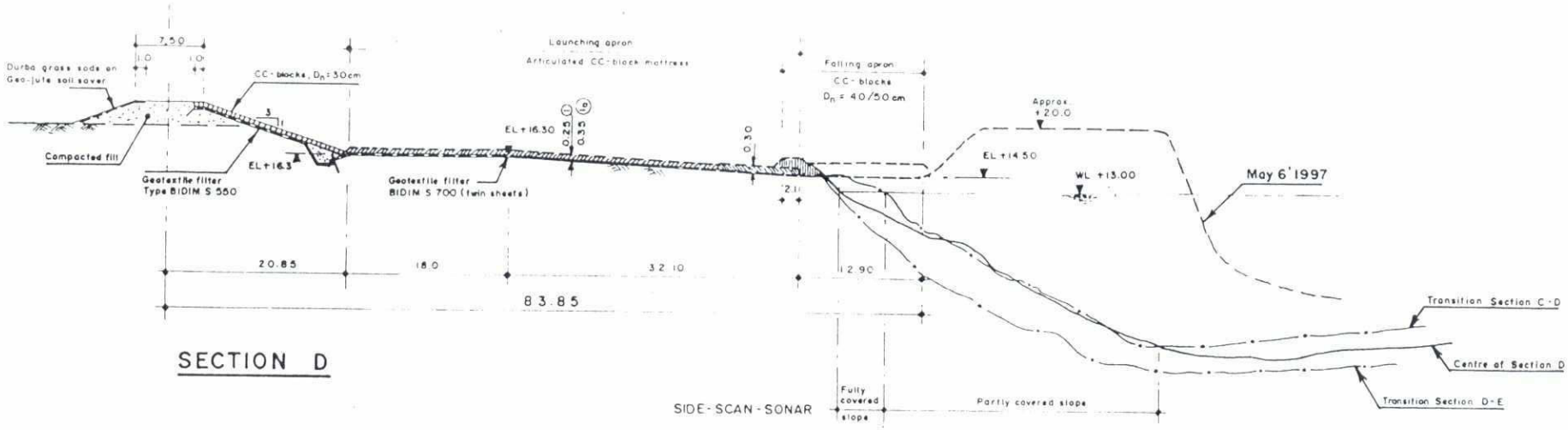
0 0.5 1.0 m — 1 : 50

0 1 2 3 4 5m — 1 : 250

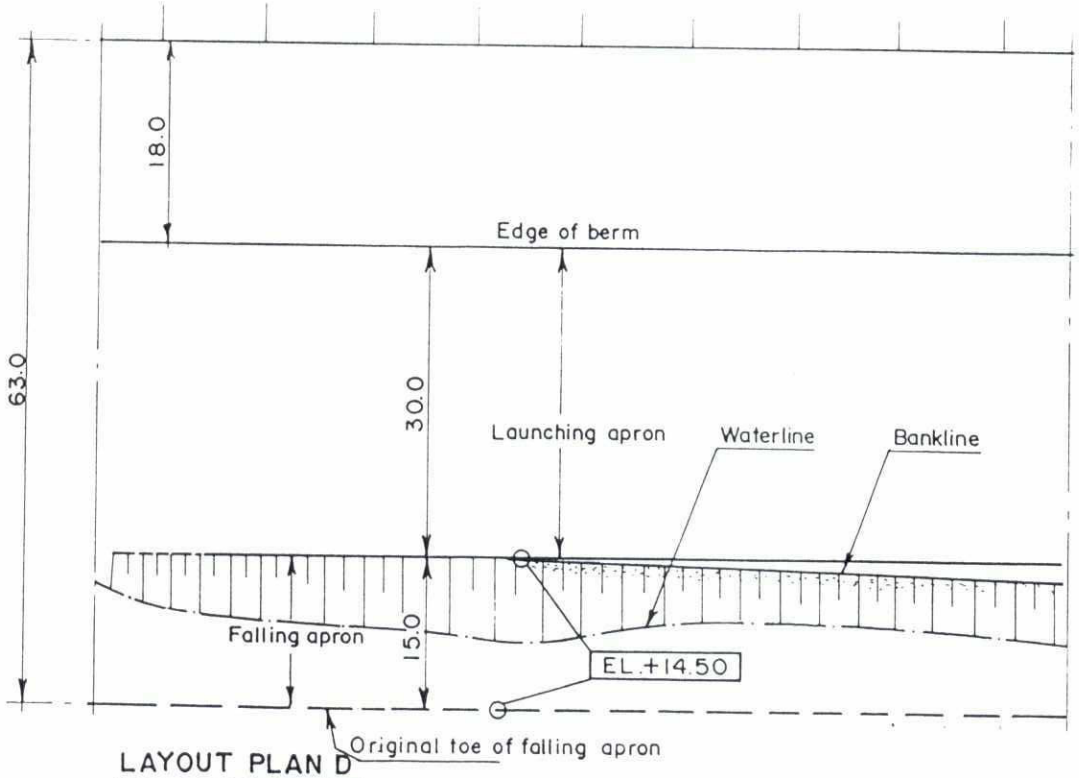
0 0.1 0.3 0.5m — 1 : 25

MONITORING OF TEST STRUCTURE
Test Section : D
Location of Physical Inspection

FAP - 21
BANK PROTECTION PILOT PROJECT
TEST SITE II - BAHADURABAD
FIG. 21-6



SECTION D



LAYOUT PLAN D

NOTE.
Levels refer to ±0.00 m PWD
Bed profiles as on Feb.18'1998.
Bankline/water line as on 08.03.98

0 5 10 20 m

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

FAP-21 BANK PROTECTION PILOT PROJECT

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

TEST SITE II - BAHADURABAD

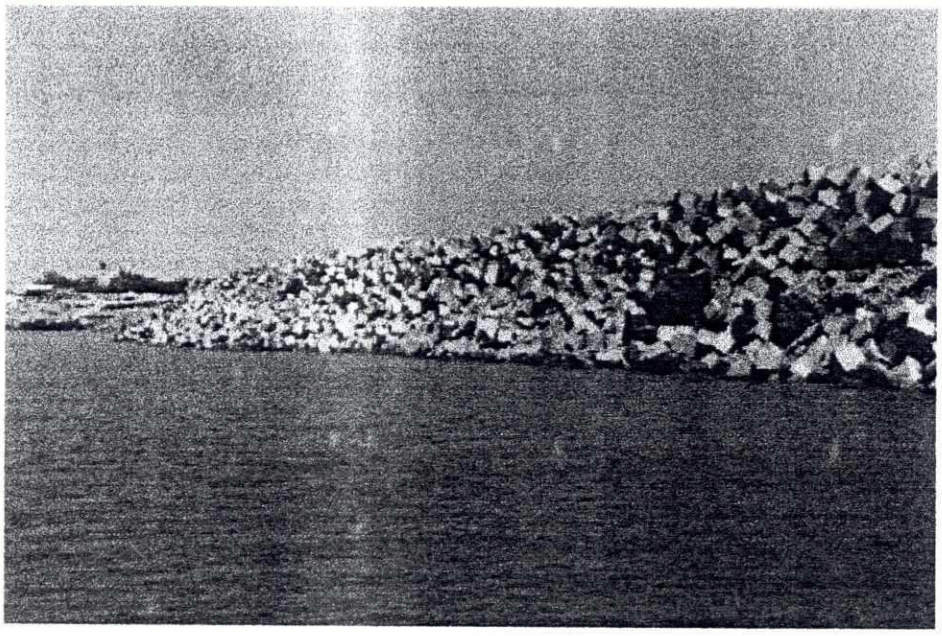
CONDITION SURVEY FEBR.'1998
TEST SECTION D
CROSS-SECTION/LAYOUT PLAN

	NAME	DATE	SCALE: 1 : 500
DRAWN	ANOWAR	25-02-98	
CHECKED			DRAWING NO. 21-7
APPROVED			REVISION 0

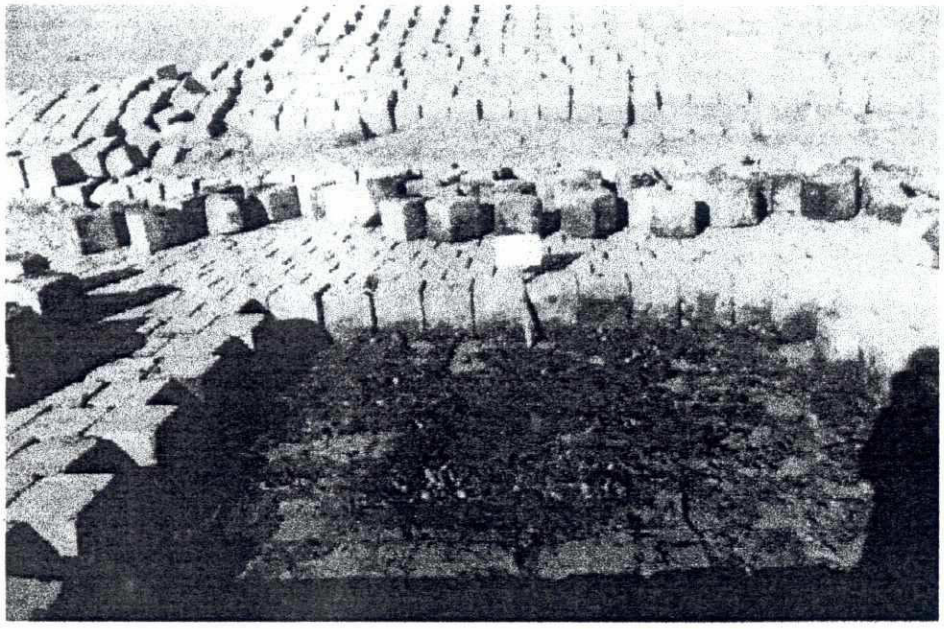
F-47

206

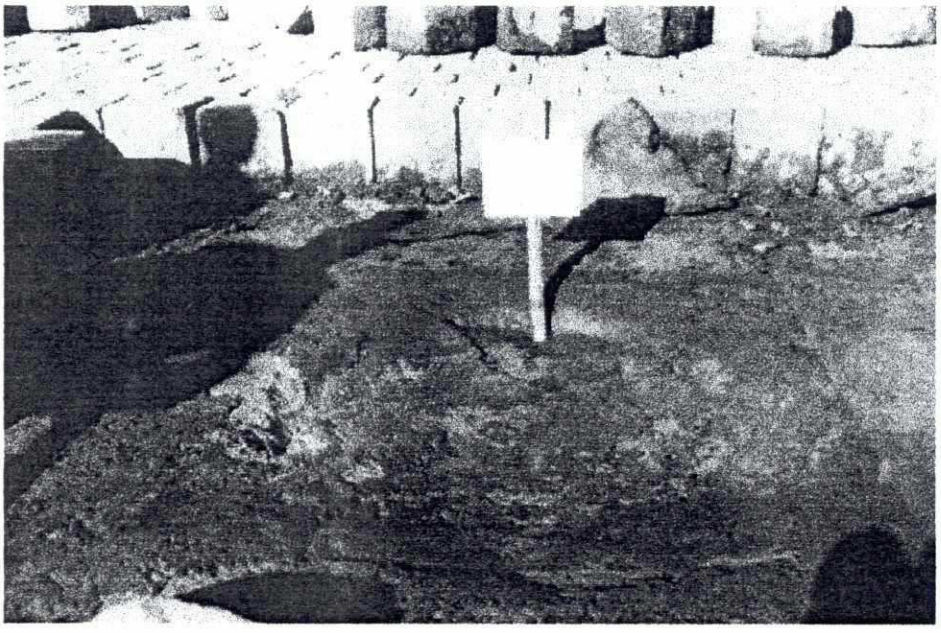
271/31: View at bank-/ waterline transition Section C/D (21.02.98; W.L. = 12.97 m PWD)



271/29: View at bank-/ waterline of Sections D+E-1 (21.02.98; W.L. = 12.97 m PWD)



272/31: Sight on inspected area Section D before removing geotextile (19.02.98)



272/33: Sight on inspected are Section D (19.02.98)

Section E-1

ASSESSMENT SHEET SECTION E-1
Total length along toe of upper slope: **30.0 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-1 / DATEX AD 1300	Inter-locking CC-slabs (ship-lap type)	714 m²	860 m²
Launching apron	FORSHORE-mattress (collapsible fabric block mattress with cement grout fill)		3,267 m²	
Transition between launching apron and falling apron				
Falling apron		CC-blocks D_n = 40 cm		767 m³
Exposed edge of falling apron		CC-blocks D_n = 45 cm		617 m³

VISUAL OBSERVATION

Date: 17.02.1998

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section E-1 occurred during the flood season of 1997. No visible changes / damages could be observed. But it has to be mentioned that the interlocking cc-slabs have not been lai according to the Specifications. They were laid in parallel rows but not with staggered joints between the layers to get a better interlocking. With this not only flow attack but also heavy rain falls occurring each monsoon might have a greater impact on the structure than they should.	272 / 15
Launching apron	In this Section some sedimentation is apparent which due to a slight inclination accumulated more at the direct transition to the falling apron. Some vegetation spread over the sediment can be found which serves as food for some cows / lambs which are lead there by local people during the day. The Foreshore mattress itself is in very good condition *(see also Special Notes / Comments Section F)* . No visible changes / damages of any kind ~~could be observed in this area.~~	
Transition between launching apron and falling apron		
Falling apron	The falling apron in this part of Section E has eroded to quite some extend and has therefore served its purpose very well. The cc-blocks which have been falling done towards the river bed slope during erosion show now a quit well interlocked slope coverage above the waterline (see Special Notes /Comments). **(continuous next page)**	

ASSESSMENT SHEET SECTION E-1

VISUAL OBSERVATION (continued) — Date: 17.02.1998

Observed Area	Comments	Photographs No.
Falling apron	If and to which extend the underwater slope is now protected by the material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes/Comments)*. Beside this survey it has been successfully tried to locate / identify some cc-blocks under water at a distance of up to 5 m from the waterline using a bamboo stick. No ongoing erosion has been detected so far, and the underwater slope remained quite stable after initial erosion during the previous months.	271 / 29
Exposed edge of falling apron	Exposed edge has eroded to its full extend and should be stabilizing the underwater slope now.	

PHYSICAL INSPECTION OF FILTER BEHAVIOUR — Date: 18.02.98

Selection of Location:	Photographs No.
Two different types of geotextile are used in Section E hence two areas for inspection had to be selected. There was no obvious depression or upheaval to be seen in Section E-1 before removing the cover layer of CC-slabs. In this part of the Section it has been decided to open the revetment above berm level from top to toe because severe damage occurred in the last flood season in Section E-2 which had to be repaired instantly at that time. So the purpose was to see if similar erosion could be identified under the cover layer in this part of Section E as well. To get to know whether the damage in Section E-2 is caused by poor soil, soil samples have been taken for investigation in Section E-1 at the top and the bottom for comparison with those taken in Section E 2. The results are shown under Laboratory Test further down. Size and exact location of the inspected area can be seen in Figure 21-8 attached to this assessment sheet.	272 / 15 272 / 16 272 / 18
Result of Physical Inspection:	
After removing the cc-slabs only at the toe of the revetment obvious depression could be seen through the geotextile. The geotextile was opened there and at the top of the slope by cutting three sides with a knife leaving a connection at the right side in flow direction. It was then lapped over to give sight on the subsoil. At the top location some minor drainage channels channels of 2-3 mm in depth could be observed. The location at the toe on the other hand showed some depression. The area was of around 40 cm in square size with a depth of up to 4 cm and in an overall wet condition. The depressed location was refilled and compacted before Section E-1 was set into original condition by overlapping with an additional sheet of geotextile filter material.	

ASSESSMENT SHEET SECTION E-1

Special Notes / Comments

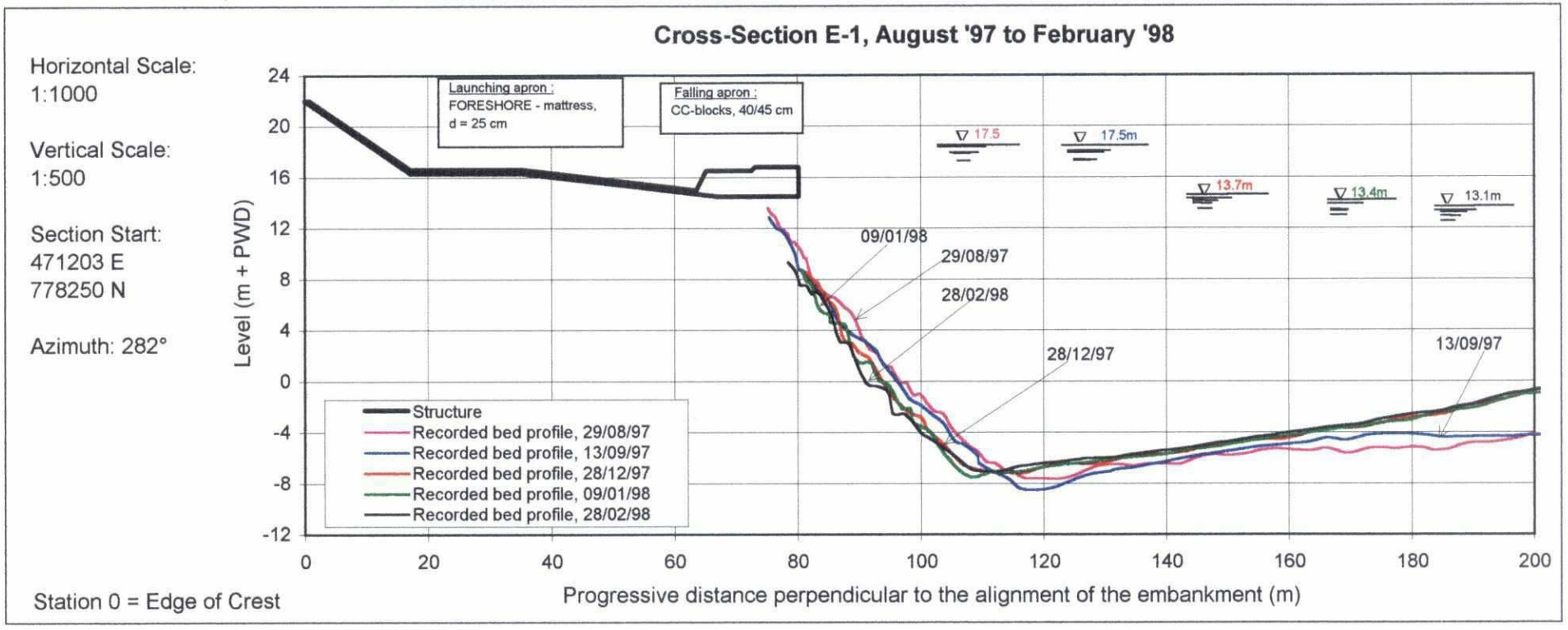
FALLING APRON:
By comparing the behaviour of the cc-blocks used as falling apron in Sections D, E-1, F and G it can be said that the smaller cc-blocks [D_n = 35cm and D_n = 35 / 40cm (mixed)] used in Section G show a better interlocking slope than the bigger ones used in the other sections.

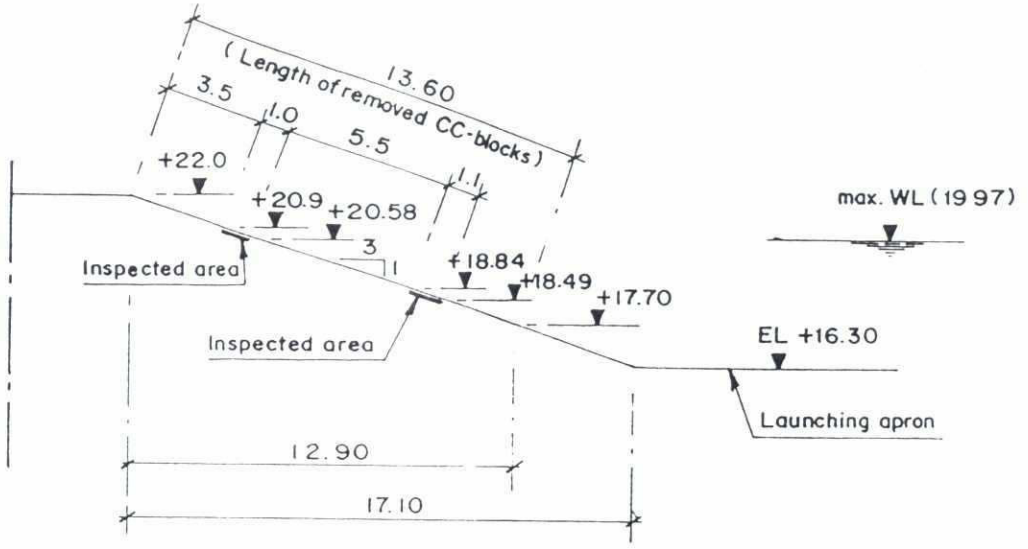
SIDE SCAN SONAR SURVEY:
Within Section E-1 (falling apron of cc-blocks sizes 40*40*40 cm and 45*45*45 cm) "continuous strong" to "strong" backscatters during the Side Scan Sonar investigations suggested reasonable coverage of the eroded river bank.

Laboratory Tests

One soil sample taken from the lower inspected area has been analyzed in the soil mechanical laboratory of the University of Applied Sciences Hamburg according to which the soil is to be classified as silt with fine sand. The grain size distribution is attached to this assessment sheet

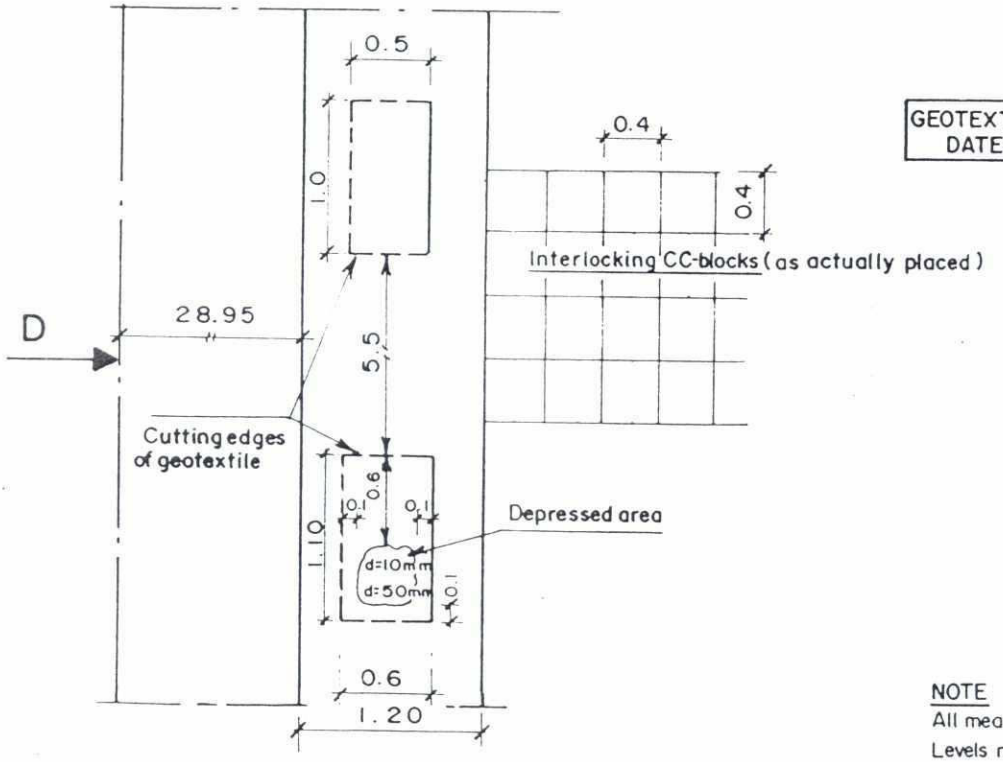
BAHADURABAD (FAP 21) - TEST SITE II





CROSS-SECTION

Scale. 1 : 250



GEOTEXTILE TYPE
DATEX AD1300

NOTE
All measurements are in meter.
Levels refer to + 0.0m PWD.

TOP VIEW OF INSPECTION AREA

Scale. 1 : 50

SCALES

0 0.5 1.0 m — 1 : 50

0 1 2 3 4 5m — 1 : 250

MONITORING OF TEST STRUCTURE
Test Section : E - 1
Location of Physical Inspection

FAP - 21
BANK PROTECTION PILOT PROJECT
TEST SITE II - BAHADURABAD
FIG. 21 - 8

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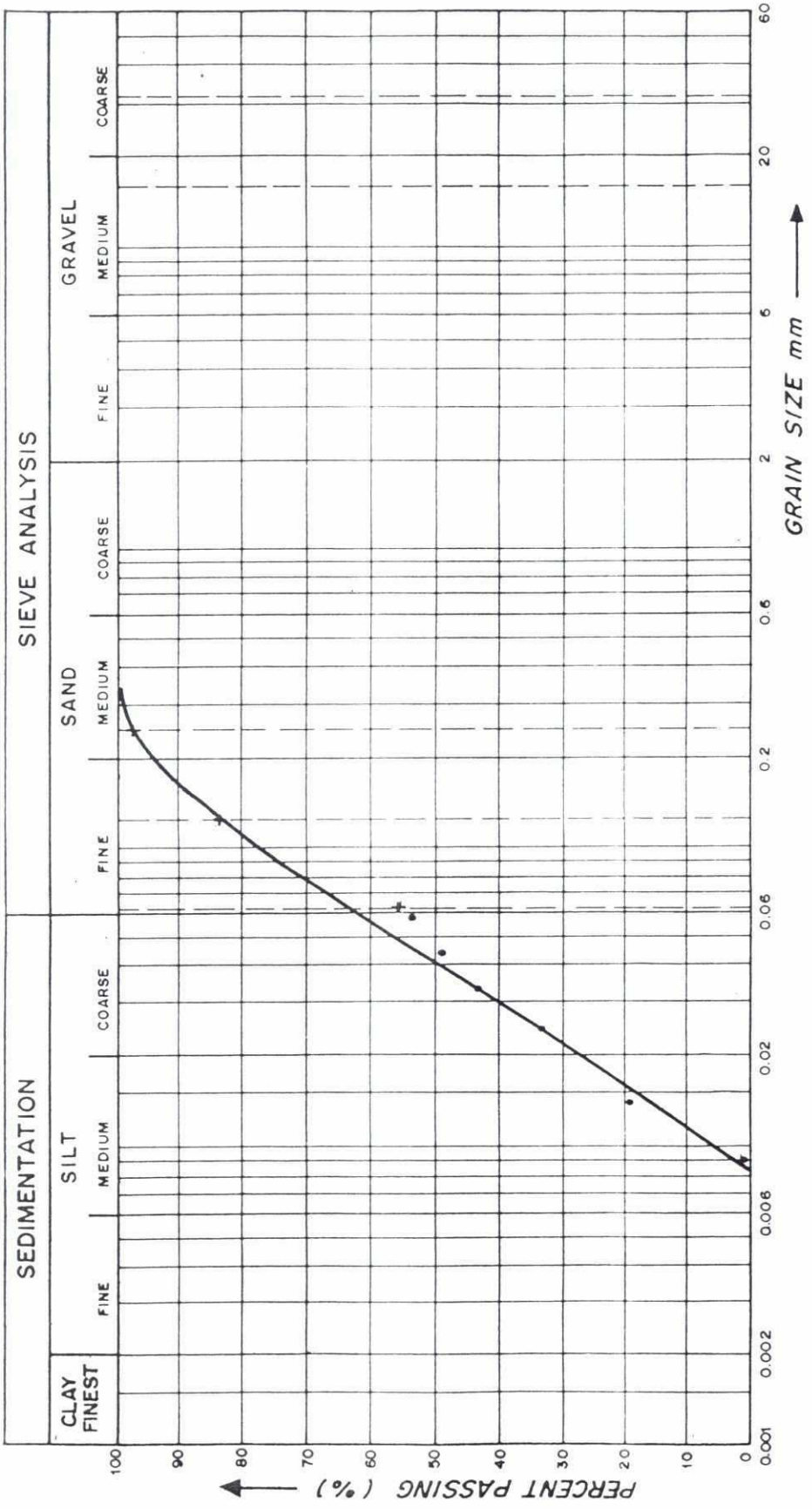
INSTITUTE OF SOIL MECHANICS AND FOUNDATION ENGINEERING

GRAIN SIZE DISTRIBUTION

ANNEX

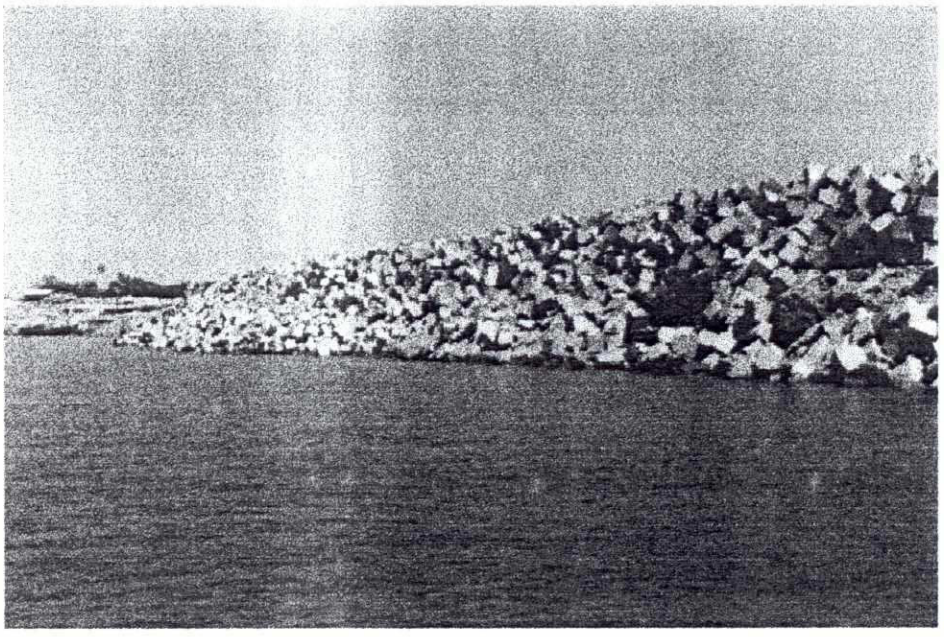
PREPARED BY ANOWAR



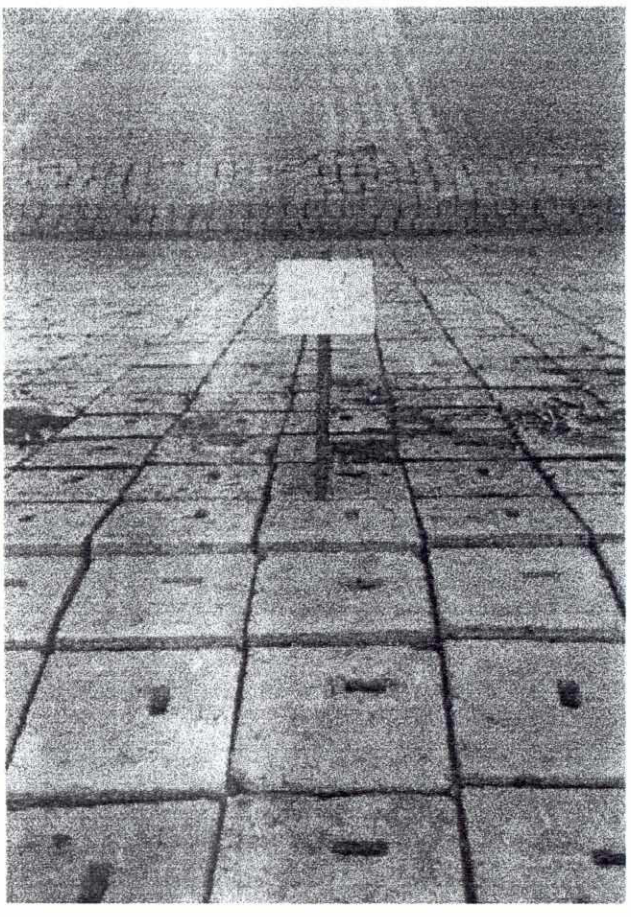
Sample No.	Type	Bore Hole	Depth (m)	Classification of Soil	W (%)	W_L(%)	W_P(%)	I_C	Condition	V_{CO}(%)	V_{gl}(%)	TS	AA	KA
1	●	E-1	–	Silt with fine sand	–	–	–	–	——	–	–	–	–	–
		(bottom)												

● disturbed ■ undisturbed

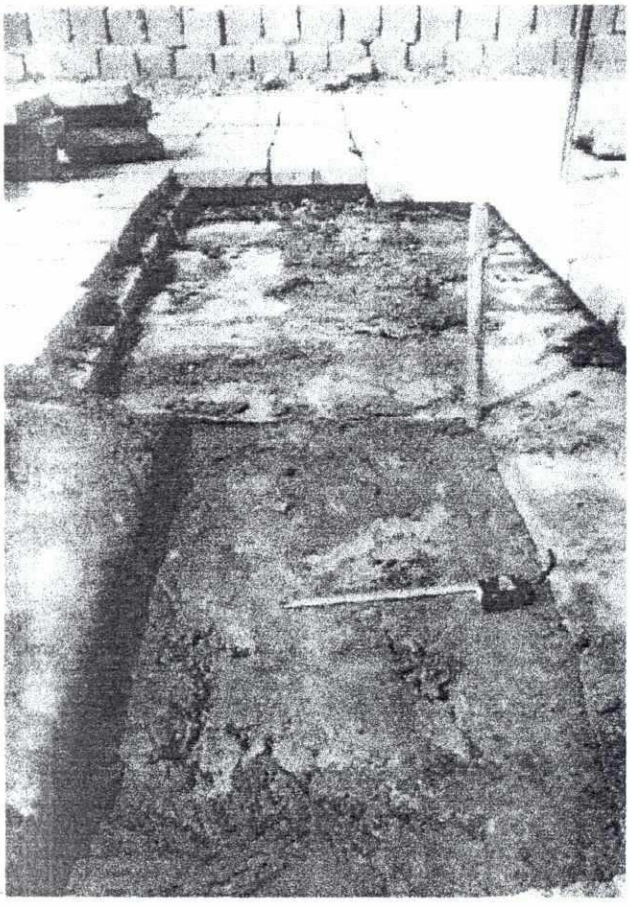
Fig. No.	Approved by HK	Date 08-07-98



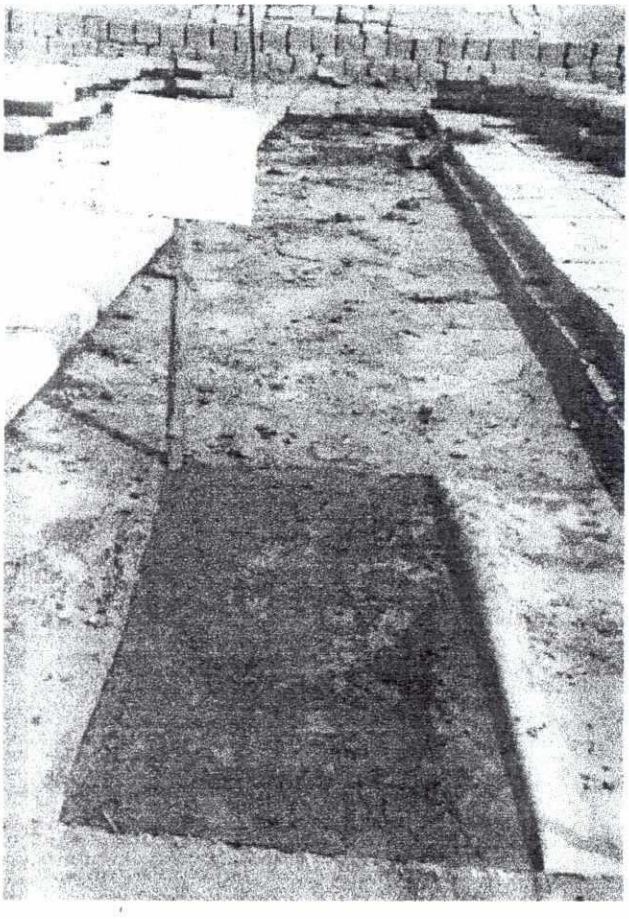
271/29: View at bank-/ waterline of Sections D+E-1 (21.02.98; W.L. = 12.97 m PWD)



272/15: Section E-1 before opening (18.0298)



272/16: Inspected area at toe of E-1
(18.02.98)



272/18: Inspected area at top of E-1
(18.02.98)

Section E-2

ASSESSMENT SHEET SECTION E-2
Total length along toe of upper slope: **60.0 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-5 / Hate J 9014 (composite filter)	Inter-locking CC-slabs (ship-lap type)	1,600 m²	860 m²
Launching apron	FORSHORE-mattress (collapsible fabric block mattress with cement grout fill)		3,267 m²	
Transition between launching apron and falling apron				
Falling apron		Geo-sand container Type D (250 kg/No.)		2,903 Nos.
Exposed edge of falling apron		Geo-sand container Type E (900 kg/No.)		2,343 Nos.

VISUAL OBSERVATION **Date: 18.02.1998**

Observed Area	Comments	Photographs No.
Revetment above berm level	In this segment of Section E-2 clear damage to the structure could be observed. At the end of the slope some significant upheaval of the cc-slabs was visible which seemed to be the result of soil migration. CC-blocks have been put on these areas in the last monsoon season for ballasting. In the upper part no damage or changes to the cc-slab surface which could have been expected was visible because provisional repair work was already done. As in Section E-1 the cc-slabs have not been laid with staggered joints between the layers to get a better interlocking. With this not only flow attack but also heavy rain falls occurring each monsoon might have a greater impact on the structure than they should.	272 / 13
Launching apron	In this part of Section E some sedimentation is apparent which due to a slight inclination accumulated more at the direct transition to the falling apron. Some vegetation spread over the sediment can be found which serves as foo for some cows / lambs which are lead there by local people during the day. The Foreshore mattress itself is in very good condition *(see also Special Notes / Comments Section F)*. No visible changes / damages of any kind could be observed in this area.	
Transition between launching apron and falling apron		

ASSESSMENT SHEET SECTION E-2

VISUAL OBSERVATION (continued)		Date: 18.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	The falling apron in this part of Section E has eroded to quite some extent and has obviously served its purpose not as well as the cc-blocks in part E-1. From the taken pictures it can be clearly seen that the sand containers failed to form a proper interlocking slope. The bankline slope is almost vertical and the underlaying soil totally exposed to flow attack. But it has to be mentioned that there has been made a mistake by placing the geo-sand containers different from Specifications. All containers should have been laid horizontally by overlapping each other to some extend. The explanation for placing the containers vertically one beside the other might be for executional convenience. Whether or not this has any impact on the protection of the underwater slope has to be seen from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*. Beside this survey it has been successfully tried to locate / identify some protection material under water at a distance of up to 5 m from the waterline using a bamboo stick.	271 / 26 271 / 25
Exposed edge of falling apron	Exposed edge has eroded to its full extent and should be stabilizing the underwater slope now.	

PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date: 19.02.98
Selection of Location:	Photographs No.
Two different types of geotextile are used in Section E hence two areas for inspection had to be selected. An upheaval deformation could be clearly seen at the lower part of Section E-2 where the interlocking CC-slabs have been pushed up significantly. At the upper part some slabs settled during the last flood season. During the season some repair was done in the upper part by filling granular filter between geotextile and cover layer. The position for inspecting the geotextile and the subsoil in Section E-2 has therefore been selected in that area. It was decided to open the revetment above berm level from top to bottom to get an exact view of what has been going on. Two soil samples were taken for analysis. The results of it are shown below. Size and exact location of the inspected area can be seen on page 4 of this assessment sheet.	272 / 13 271 / 1 271 / 3
Result of Physical Inspection:	
After removing the CC-slabs the granular filter which has been used to refill temporarily the depressed areas in the upper part was removed. As the to be opened area of the section was at the joint of the geotextile it was only needed to fold it back to each side to give sight on the subsoil. **(continues on the next page)**	

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ASSESSMENT SHEET SECTION E-2

PHYSICAL INSPECTION (continued)

Date: 19.02.98

Result of Physical Inspection:

There were three eroded main channels with a depth of up to 700 mm *(see Figure 21-10)*. The outwashed (migrated) soil formed an upheaval at the toe of the slope where the geotextile has been tightly secured in an anchor trench. The average height of the upheaval was 200 mm. Soil samples were taken from one of the drainage channels and from the upheaval for analysis. The results of the tests can be seen under Laboratory Tests further down of this assessment sheet. It has to be recorded that the composite geotextile filter has been placed with the wrong side up. *(see Special Notes)*

Special Notes / Comments

REVETMENT ABOVE BERM LEVEL:

Section E-2 was provided with a composite geotextile filter, particularly suitable for soils susceptible to downslope migration which was however placed with the wrong side down, keeping the coarse fibre layer at the top side. It can only be assumed that this supported the appearance of the rain-cuts which have been observed at two occasions (June 15th and 19th&20th) during massive continuous rainfall (117 mm).

It has been furthermore assumed that due to poor quality pre-cast CC-slabs (thickness varies from one to another) there might be a "bridge" action under a group of blocks when interlocked. As such surface pressure between the cc-slabs and geotextile was inadequate. It is noted that (being the lightest slope cover material) the ship-lap type cc-slabs in its present design are unsuitable.

In addition to those assumptions it must be said again that due to laying the cc-slabs not in parallel rows with staggered joints between the layers the impact of heavy rain falls occurring each monsoon might have had an Due to the false laying there are joints running every 220 mm (width of one slab) from top of the embankment to the toe of the slope giving the water the chance of fast infiltration and run off in between the slabs. To know in which condition the geotextile is after the last monsoon season in terms of permeability two soil samples one from the upper part and one from the lower part have been taken for analysis. The results are shown under Laboratory Tests further down of this assessment sheet.

To stabilize the slope excessive repair work has been done in Section E-2 by removing all cc-slabs, cutting and removing the geotextile, excavating the whole slope to a depth of 20 cm, refilling the rain-cut channels true to slope, attaching a granular filter (as done in Section G), replacing the geotextile with the right dark/coarse side down and finally placing the cc-slabs in parallel rows with staggered joints between the layers on top.

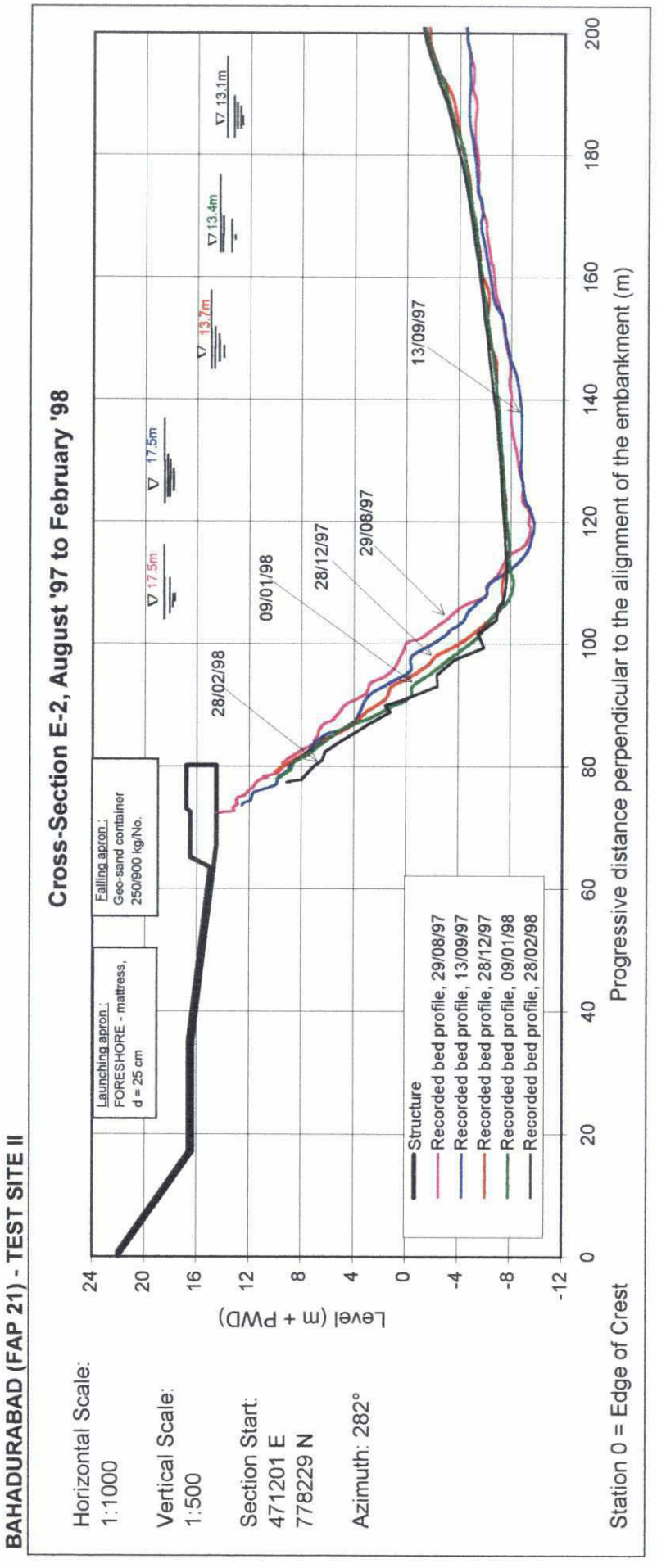
SIDE SCAN SONAR SURVEY:

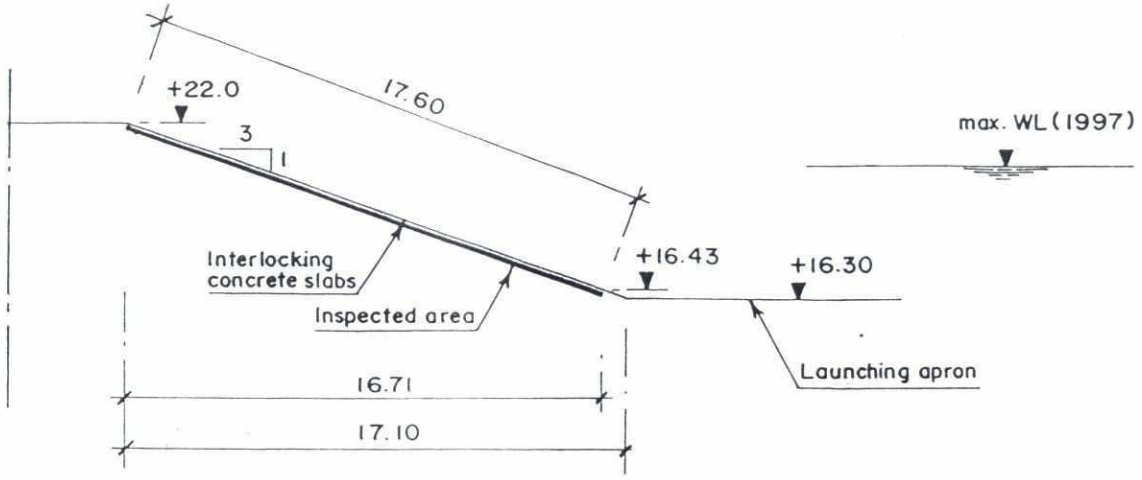
Within Section E-2 (geo-sand container 250/900 kg each) only immediate along the waterline a continuously strong backscatter indicated full cover of the slope. Except a local spot, however, the remaining area in front of this section E-2 has not produced measurable backscatters.

Comparing the measured slope profiles of these two sections it is obvious that the river bed profiles remained stable since August'98, and also the slope angle and scour depth is practically identical. Thus it may be assumed that geo-sand containers in Section E-2 are existent, but can obviously not be detected by side scan sonar tools.

Laboratory Tests

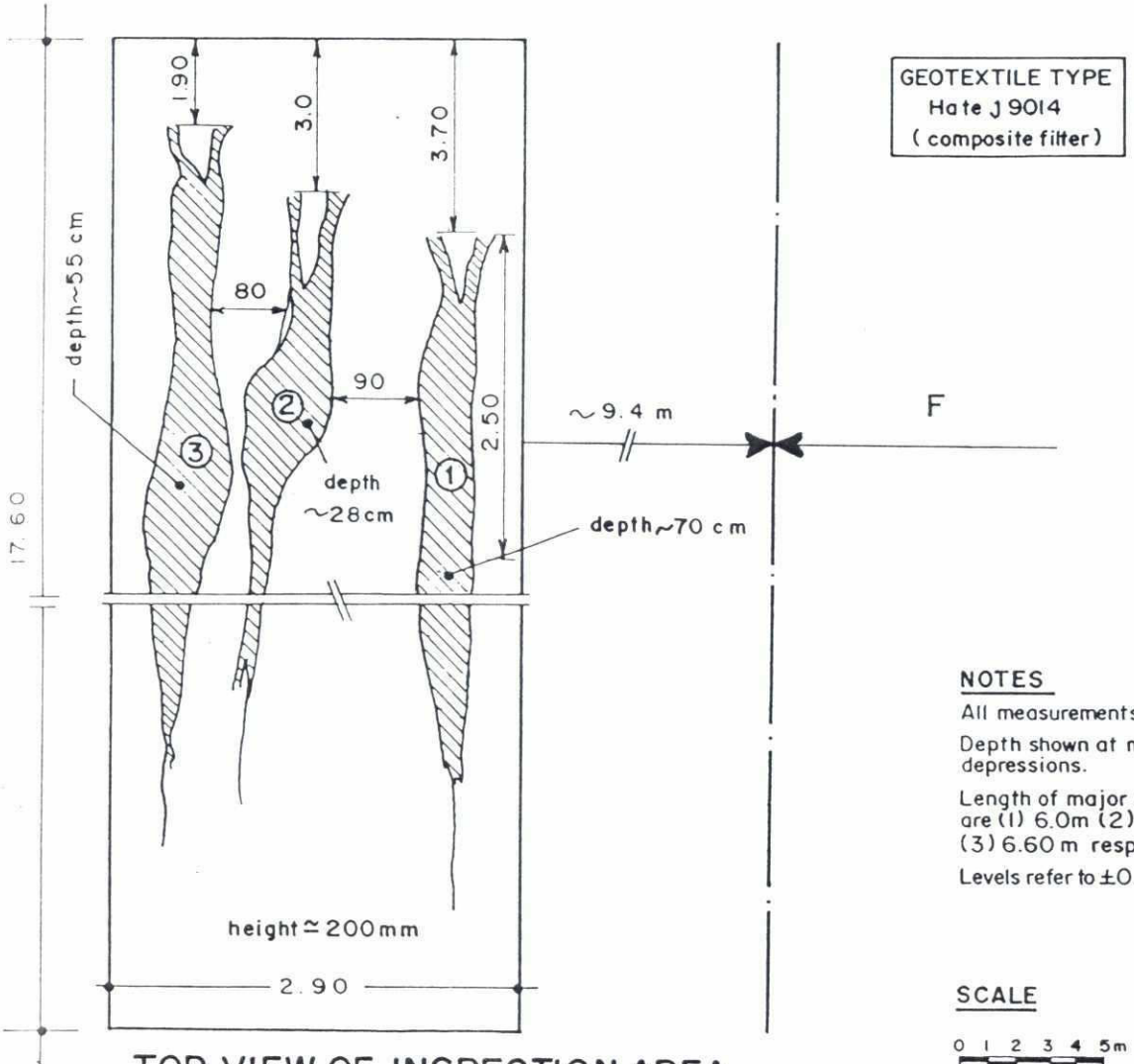
One soil sample each taken from the upper part and the lower part of the inspected area have been analyzed in the soil mechanical laboratory of the University of Applied Sciences Hamburg. The grain size distribution is attached to this assessment sheet.


BAHADURABAD (FAP 21) - TEST SITE II
Cross-Section E-2, August '97 to February '98
Horizontal Scale: 1:1000
Vertical Scale: 1:500
Section Start: 471201 E 778229 N
Azimuth: 282°
Launching apron : FORESHORE - mattress, d = 25 cm
Falling apron : Geo-sand container 250/900 kg/No.
17.5m
17.5m
13.7m
13.4m
13.1m
28/02/98
09/01/98
28/12/97
29/08/97
13/09/97
Structure
Recorded bed profile, 29/08/97
Recorded bed profile, 13/09/97
Recorded bed profile, 28/12/97
Recorded bed profile, 09/01/98
Recorded bed profile, 28/02/98
Level (m + PWD)
24
20
16
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
120
140
160
180
200
Station 0 = Edge of Crest
Progressive distance perpendicular to the alignment of the embankment (m)



CROSS-SECTION

Scale. 1 : 250



GEOTEXTILE TYPE
Hate J 9014
(composite filter)

TOP VIEW OF INSPECTION AREA

Not to Scale

NOTES

All measurements are in meter.

Depth shown at maximum depressions.

Length of major rain-cuts are (1) 6.0m (2) 4.20m and (3) 6.60 m respectively.

Levels refer to ±0.0 m PWD.

SCALE

0 1 2 3 4 5m 1 : 250

MONITORING OF TEST STRUCTURE

Test Section : E-2

Location of Physical Inspection

FAP - 21

BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

FIG. 21 - 9

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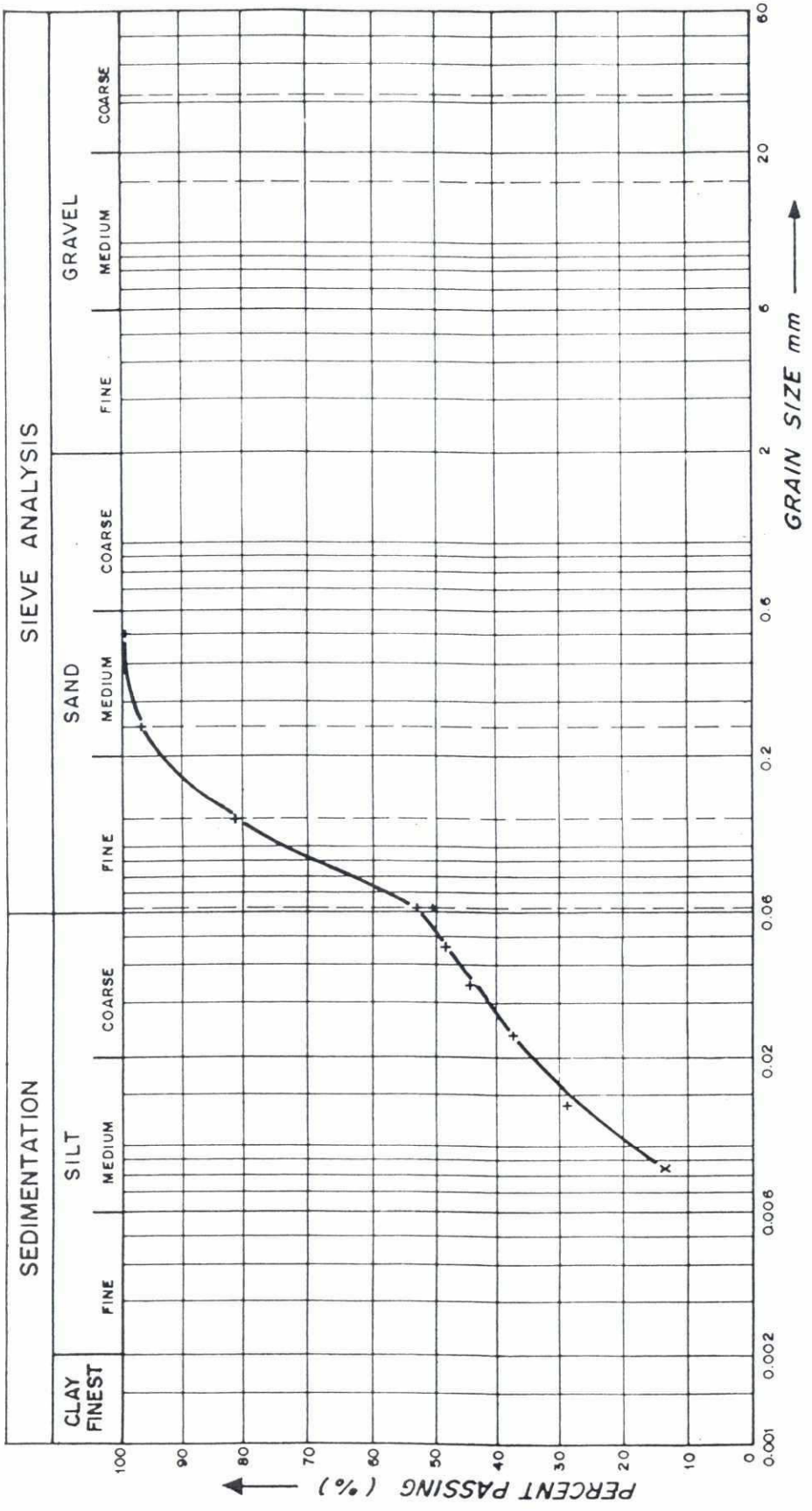
INSTITUTE OF SOIL MECHANICS AND FOUNDATION ENGINEERING

GRAIN SIZE DISTRIBUTION

ANNEX

PREPARED BY ANOWAR



Sample No.	Type	Bore Hole	Depth (m)	Classification of Soil	W (%)	W_L(%)	W_P(%)	I_C	Condition	V_{CO}(%)	V_{gl}(%)	TS	AA	KA
2	●	E-2	—	Silt and fine sand	—	—	—	—	—	—	—	—	—	—
		(top)												

● disturbed ■ undisturbed

Fig. No. | Approved by HK | Date 08-07-98

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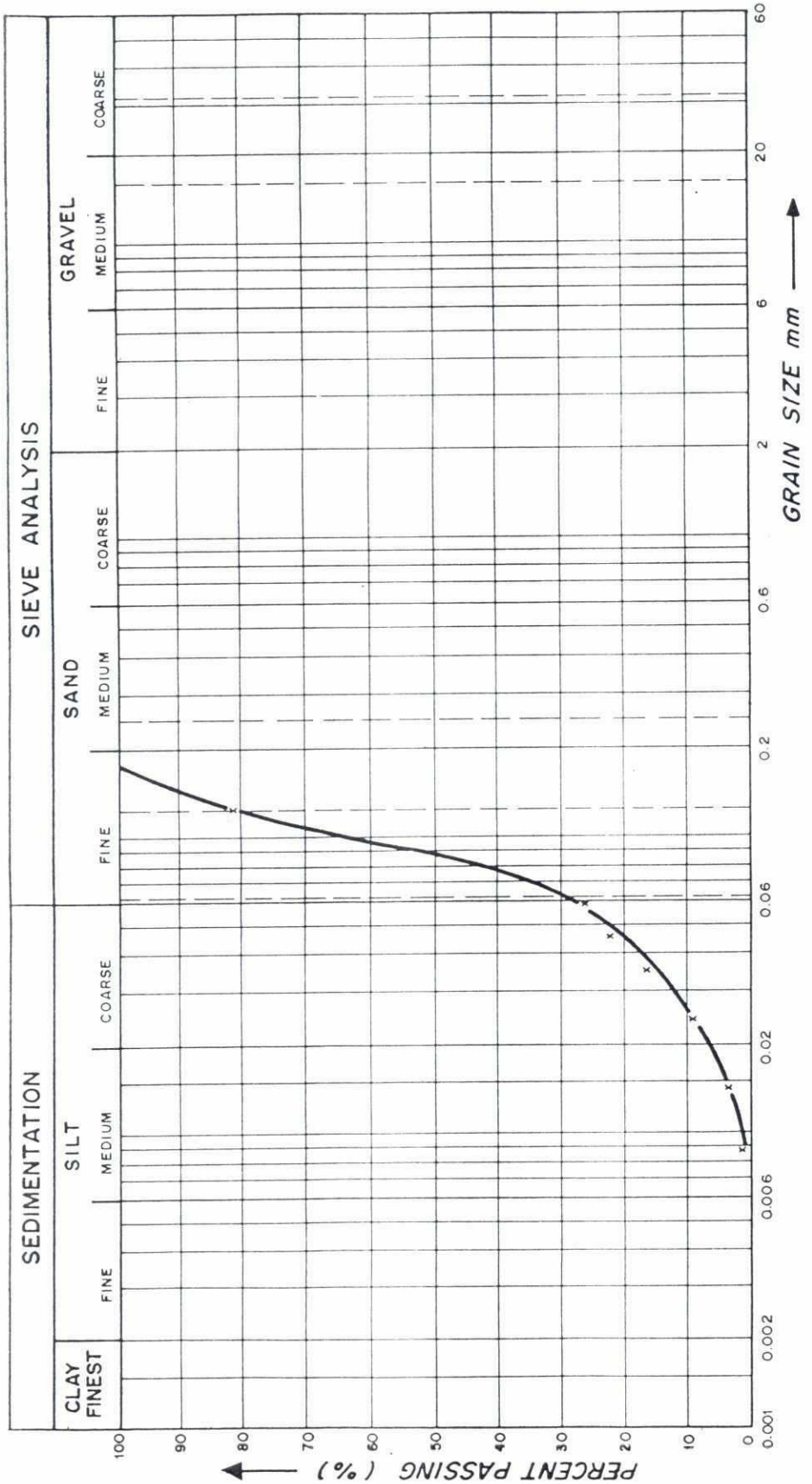
INSTITUTE OF SOIL MECHANICS AND FOUNDATION ENGINEERING

GRAIN SIZE DISTRIBUTION

ANNEX

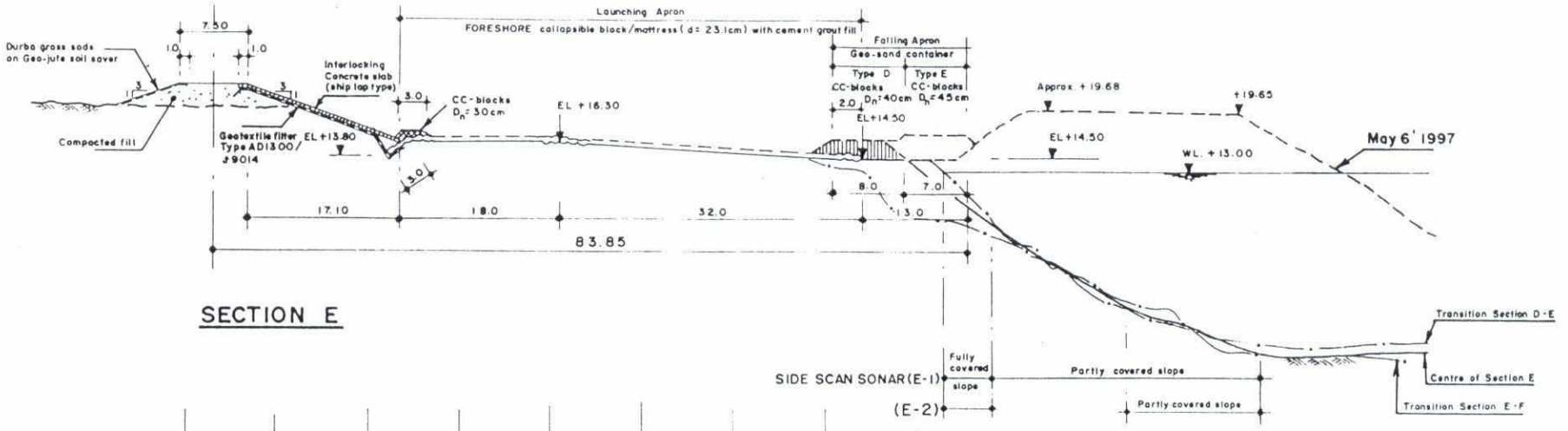
PREPARED BY ANOWAR



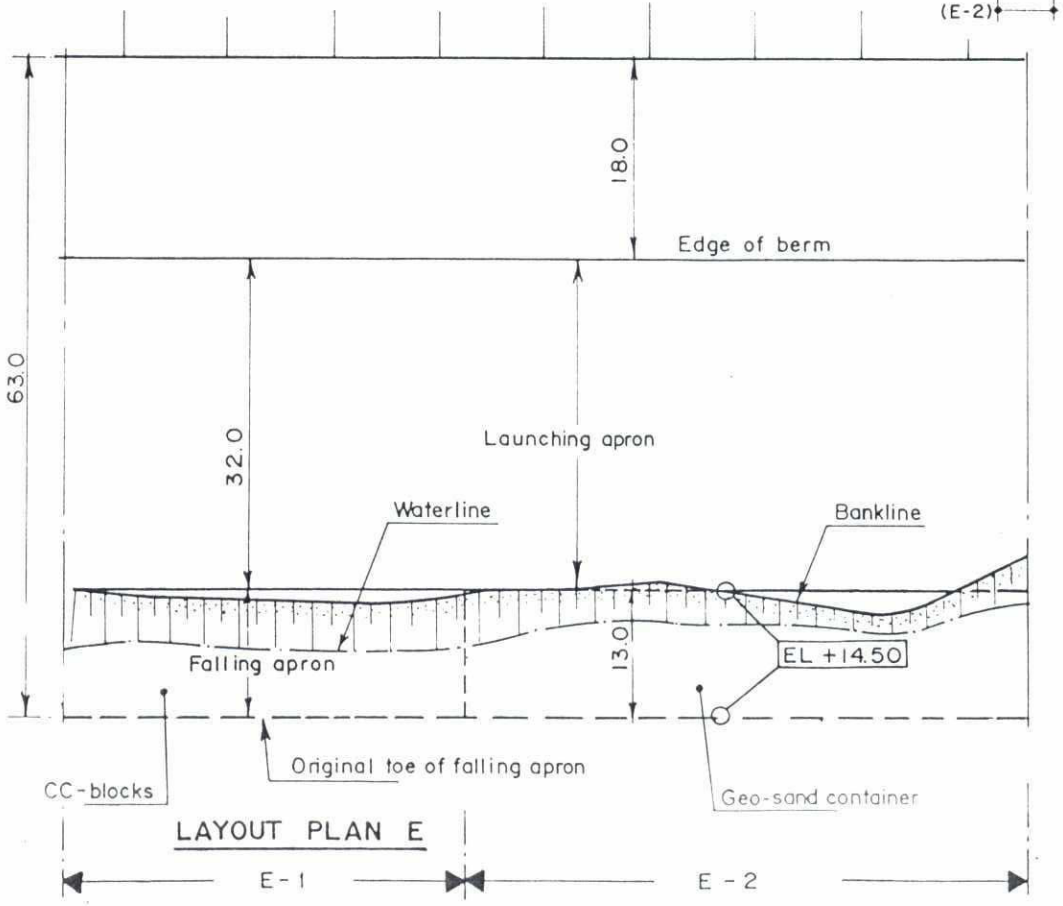
Sample No.	Type	Bore Hole	Depth (m)	Classification of Soil	W (%)	W_L(%)	W_P(%)	I_C	Condition	V_{CA}(%)	V_{gl}(%)	TS	AA	KA
3	●	E-2	—	Silty fine sand	—	—	—	—	—	—	—	-	-	X
		(bottom)												

● disturbed ■ undisturbed

Fig. No.	Approved by HK	Date 08-07-98



SECTION E



LAYOUT PLAN E

NOTE.
Levels refer to ±0.00 m PWD
Bed profiles as on Feb.18' 1998
Bankline/waterline as on 08.03.98

0 5 10 20 m

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

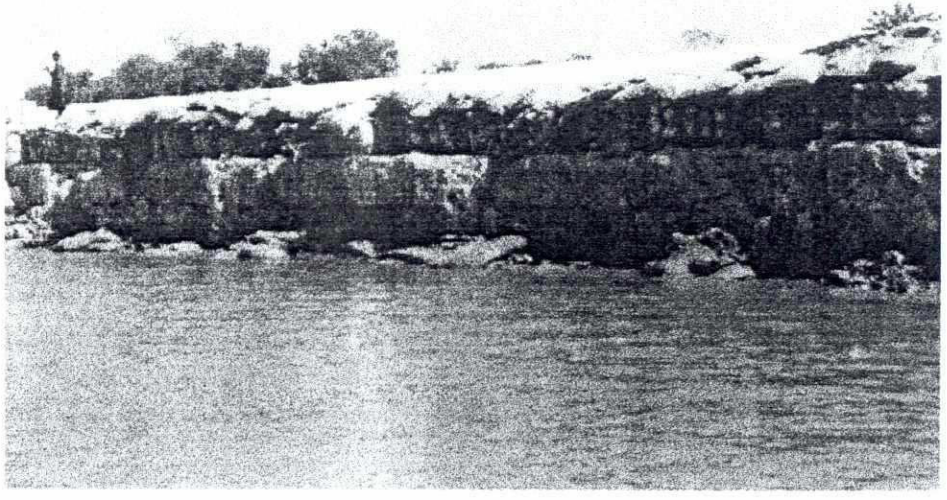
FAP-21 BANK PROTECTION PILOT PROJECT

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

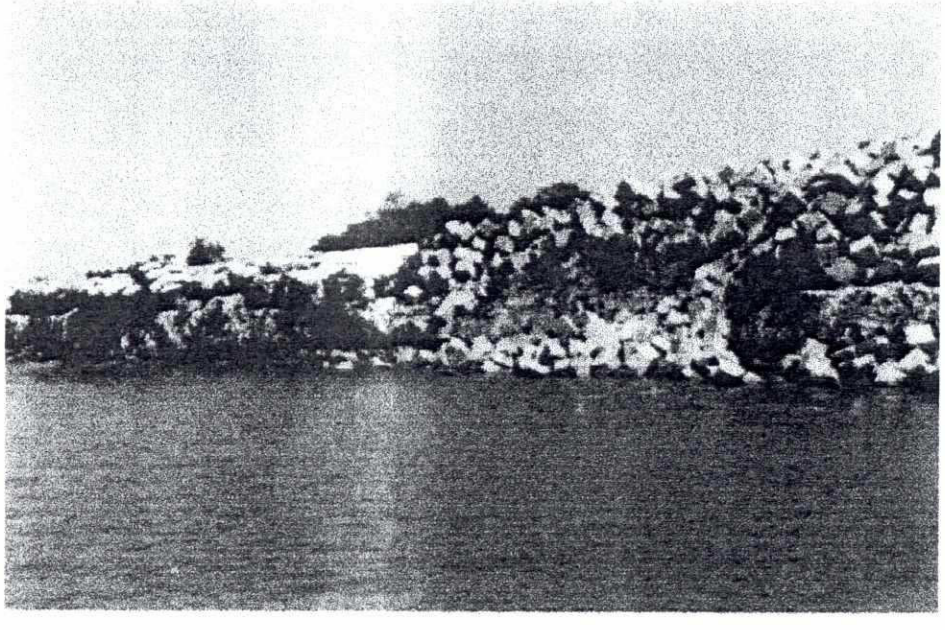
TEST SITE II - BAHADURABAD

CONDITION SURVEY FEBR'1998
TEST SECTION E
CROSS-SECTION/LAYOUT PLAN

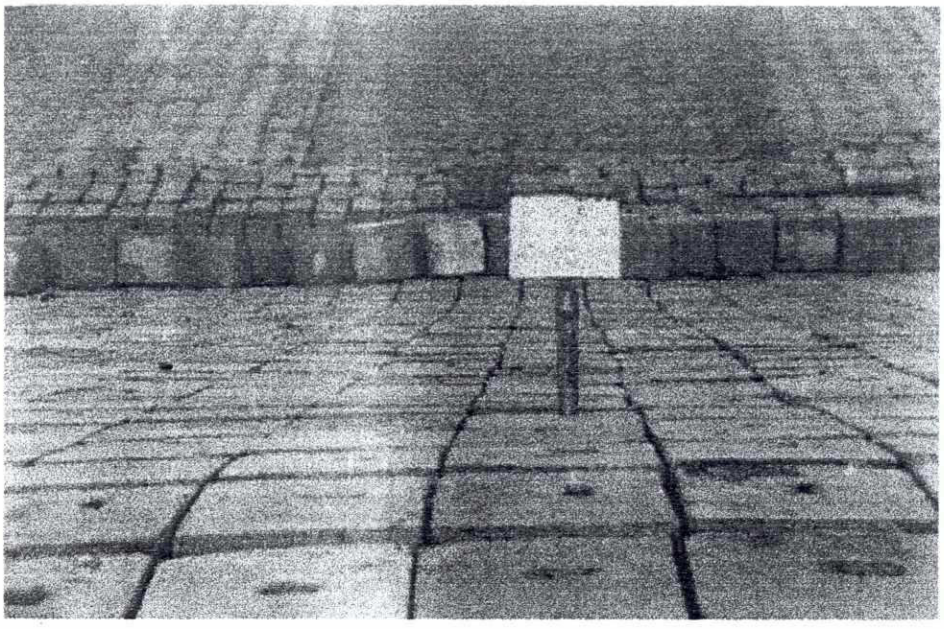
	NAME	DATE	SCALE: 1 : 500
DRAWN	ANOWAR	25-02-98	
CHECKED			DRAWING NO. 21 - 10
APPROVED			REVISION 0



271/26: View at bank-/ waterline of Sections E-2 (21.02.98; W.L. = 12.94 m PWD)



271/25: View at bank-/ waterline of Section E-2/F (21.02.98; W.L. = 12.94 m PWD)



272/13: Section E-2 before opening (19.02.98)

271/1 **271/3**

Both pictures: Sight on rain-cuts Section E-2 (19.02.1998)

Section F

ASSESSMENT SHEET SECTION F
Total length along toe of upper slope: **88.0 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-1 / BIDIM S 390	Wiremesh mattress d = 36 cm with brick fill	2,419 m²	1,960 m²
Launching apron	PROFIX-mattress (tubular fabric mattress with sand and sand-bitumen fill)		1,822 m²	
Transition between launching apron and falling apron		Rip-rap Grade E, CC-blocks, D_n = 30 cm		880 m³
Falling apron		CC-blocks D_n = 40/45 cm (mixed)		2,844 m³
Exposed edge of falling apron		Gabion sacks with stone fill Grade B (D_{50} = 15 cm) (1300 kg/No.)		3,103 Nos.

VISUAL OBSERVATION

Date: 16.02.1998

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section F occurred during the flood season of 1997. No visible changes / damages to the structure could be observed but some significant corrosion of the local-made wiremesh mattress in the whole Section which is astonishing because it is the same kind of mattress used also in Section A-2.	272 / 3
Launching apron	Some slight sedimentation in between the tubular profile of the Profix mattress is apparent. Some low vegetation has settled directly on the fabric of the mattress. The mattress itself has been repaired at several points with woven geotextile pads. Those damages presumably relate to the fact that during high water levels small boats with bamboo sticks for maneuvering have been used in this area *(see Special Notes / Comments)*.	280 / 13A 280 / 14A
Transition between launching apron and falling apron	No visible changes / damages could be observed as this segment is covered by the end of the launching apron and a part of the falling apron which still exists to some extent.	

ASSESSMENT SHEET SECTION F

VISUAL OBSERVATION (continued)		Date: 02.03.1998
Observed Area	**Comments**	Photographs No.
Falling apron	The falling apron in this Section has eroded to quite some extend and has therefore served its purpose very well. The cc-blocks which have been falling down towards the river during erosion show now a quit well interlocked slope above the waterline. If and to which extend the underwate slope is now protected by the material has to be taken from the result of the Side Scan Sonar Survey (see Special Notes / Comments). Beside this survey it has been successfully tried to locate / identify some cc-blocks under water at a distance of up to 5 m from the waterline using a bamboo stick. No ongoing erosion has been detected so far, which is confirmed by bathymetric surveys.	271 / 25 271 / 24 271 / 21
Exposed edge of falling apron	Exposed edge has eroded to its full extend and should be stabilizing the underwater slope now.	

PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date: 17.02.98
Selection of Location:	Photographs No.
There was no obvious upheaval or depression to be seen in Section F. Therefore the location for inspecting the geotextile and the underlaying subsoil has been chosen around the position where the highest waterlevel has left a mark on the revetment above berm level. So any differences between the water covered area and the dry area of the revetment (only exposed to rain and waves) can be detected after removing the cover layer of the geotextile. Size and exact location of the inspected area can be seen in Figure 21-11 attached to this assessment sheet.	272 / 3 272 / 7
Result of Physical Inspection:	
After removing two wiremesh mattress cages the geotextile was cut with a knife at three sides leaving a connection at the right side in flow direction. The geotextile was then lapped over to give sight on the subsoil which was in a good and overall moist condition. Erosion was not apparent. There was one "channel" visible, the shape very straight and even from top to bottom of opening which didn't appear to be a drainage channel but an imprint from the wiremesh mattress. The size was some 5 cm in width and about 1-2 cm in depth. The water covered and the dry area of the revetment (only exposed to rain and waves) are in the same condition, no differences were detected. The opened area was set into original condition after inspection by overlapping with an additional sheet of geotextile filter material.	

ASSESSMENT SHEET SECTION F

Special Notes / Comments

LAUNCHING APRON:
There have been tested three different types of geotextile mattresses as a launching apron within the overall test structure. In Section E and G the fabric of the block mattress used are of strong woven geotextile and the damage, if observed, is minimum. Therefore it may be concluded that the PROFIX mattress material is less resistant to mechanical damages. This is not a disqualifying aspect since (a) PROFIX mattresses are much cheaper, can even be produced locally, and (b) a stronger woven geotextile can be used at little extra cost.

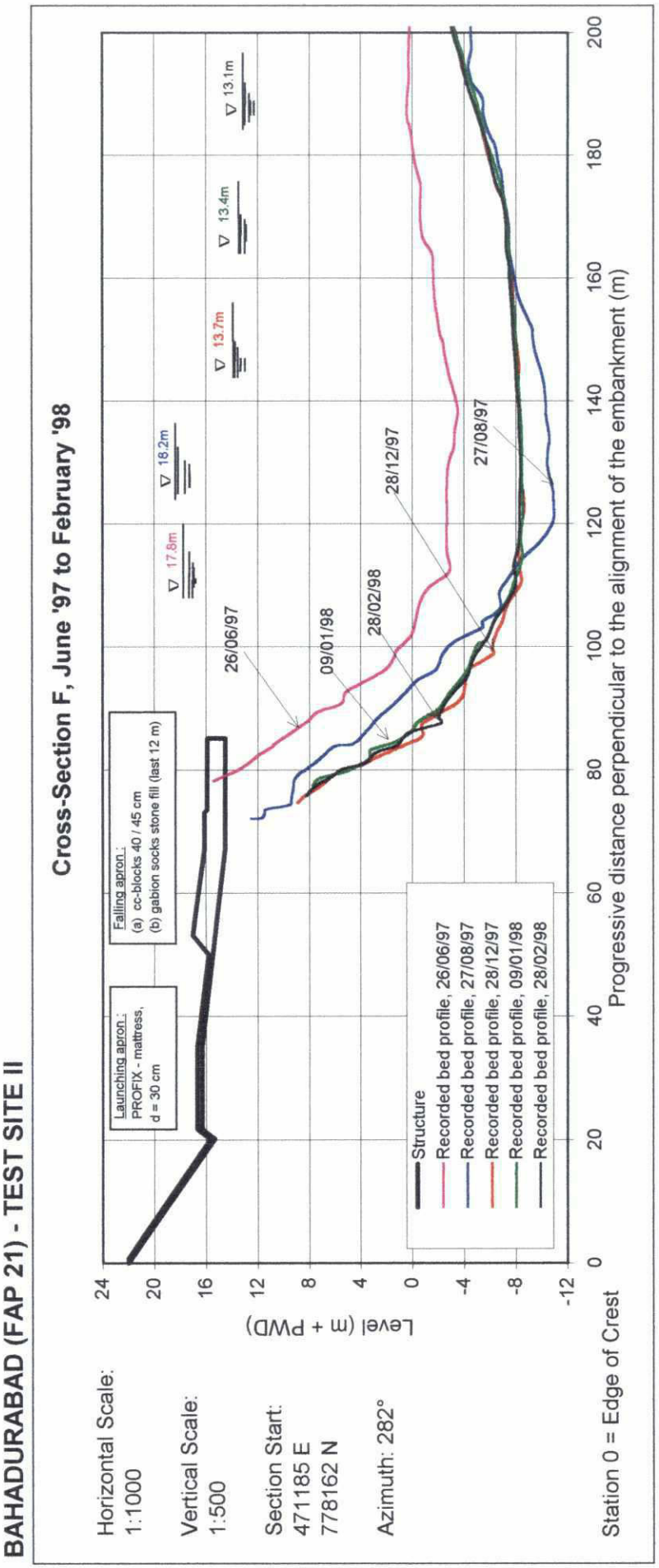
FALLING APRON:
The underwater slope developed differently in this Section F: after some initial erosion until June'97, it progressed further into the structure until August'97 and stabilized only by December'97. (by comparison: other section profiles remained reasonable stable after August'97.

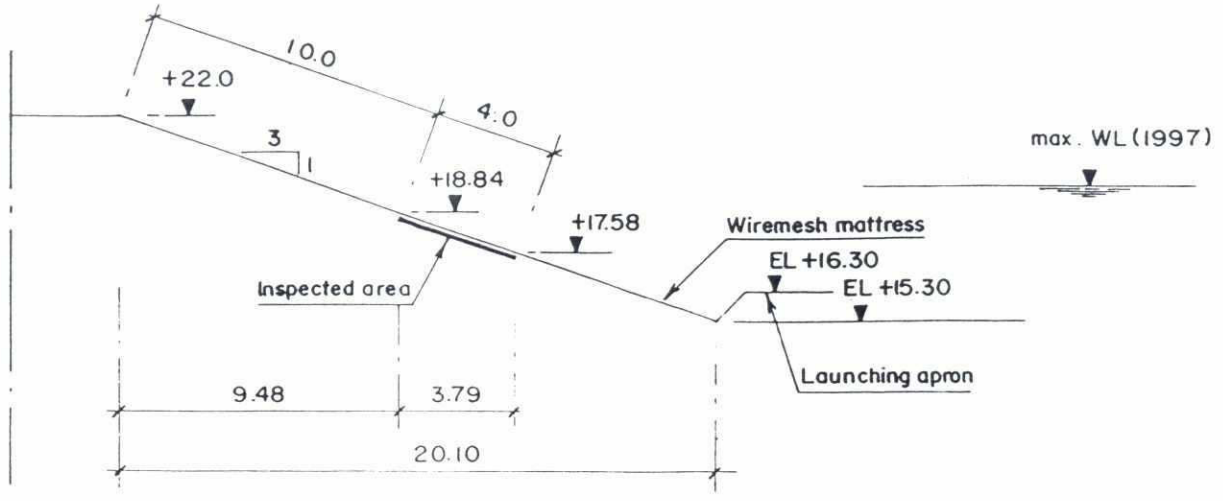
SIDE SCAN SONAR SURVEY:
The side scan sonar investigations have produced a very strong, continuous backscatter along this Section F over a width of up to 20m from the prevailing water level in front of the section.
However, different to other sections, no further evidence of scattered protection material could be produced. One explanation may be that the stone-filled Gabion-sacks (1,300 kg/sack) have not been shifted away substantially due to ongoing erosion, rather have well supported in place a thick coverage of cc-blocks in the areas above.

Laboratory Tests

No tests have been carried out

260

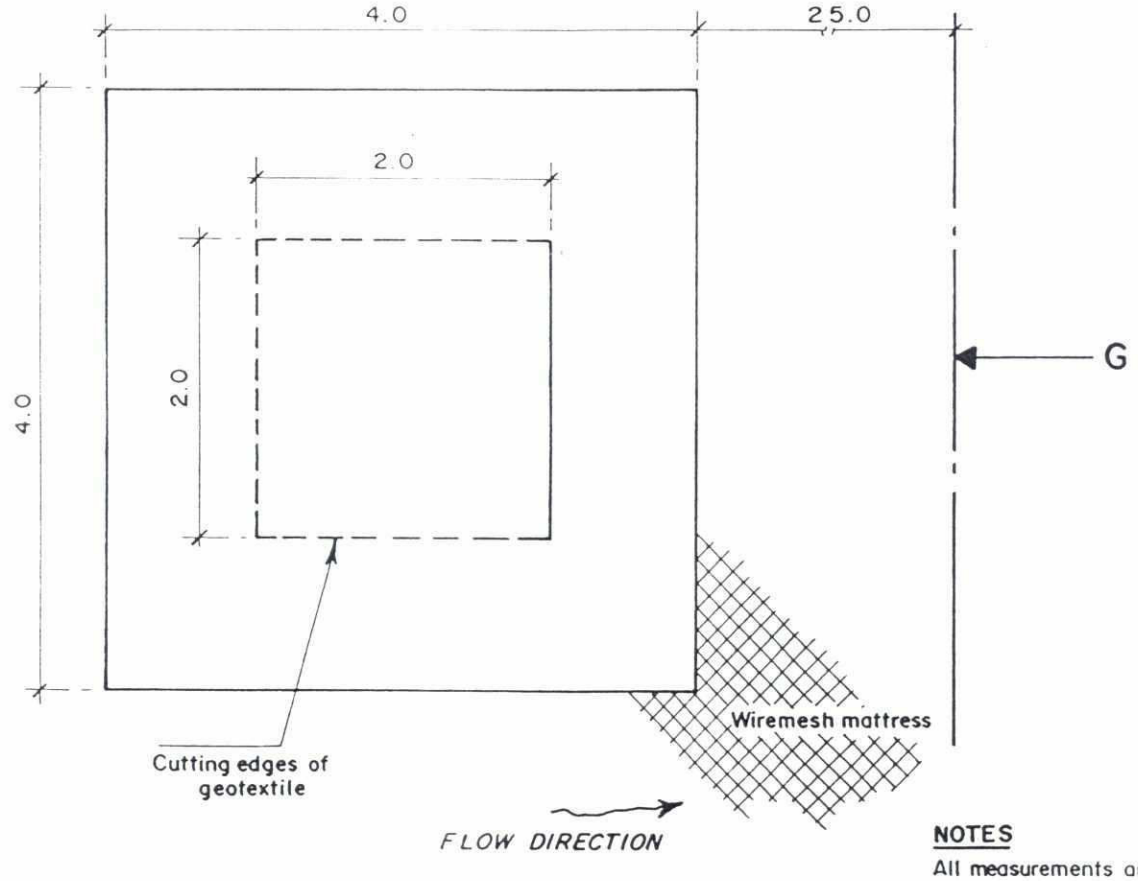

BAHADURABAD (FAP 21) - TEST SITE II
Cross-Section F, June '97 to February '98
Horizontal Scale: 1:1000
Vertical Scale: 1:500
Section Start: 471185 E 778162 N
Azimuth: 282°
Launching apron : PROFIX - mattress, d = 30 cm
Falling apron : (a) cc-blocks 40 / 45 cm (b) gabion socks stone fill (last 12 m)
17.8m
18.2m
13.7m
13.4m
13.1m
26/06/97
09/01/98
28/02/98
28/12/97
27/08/97
Structure
Recorded bed profile, 26/06/97
Recorded bed profile, 27/08/97
Recorded bed profile, 28/12/97
Recorded bed profile, 09/01/98
Recorded bed profile, 28/02/98
Level (m + PWD)
24
20
16
12
8
4
0
-4
-8
-12
0
20
40
60
80
100
120
140
160
180
200
Station 0 = Edge of Crest
Progressive distance perpendicular to the alignment of the embankment (m)



CROSS-SECTION

Scale. 1 : 250

GEOTEXTILE TYPE
BIDIM S 390



TOP VIEW OF INSPECTION AREA

Scale. 1 : 50

NOTES

All measurements are in meter.
Levels refer to ±0.0m PWD.

SCALES

0 0.5 1.0 m — 1 : 50

0 1 2 3 4 5m — 1 : 250

MONITORING OF TEST STRUCTURE

Test Section : F

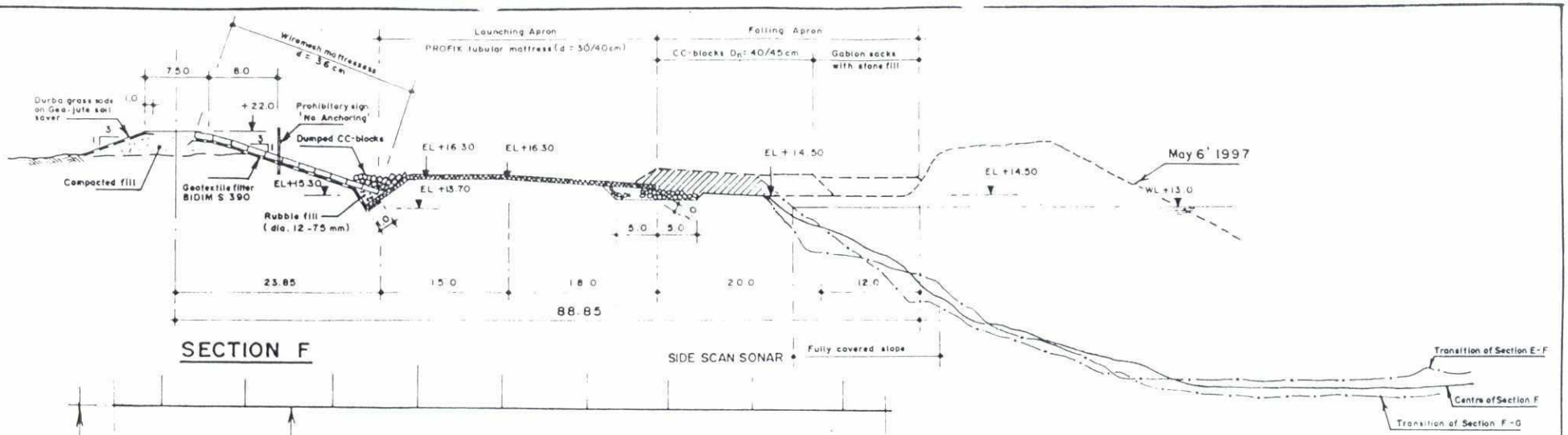
Location of Physical Inspection

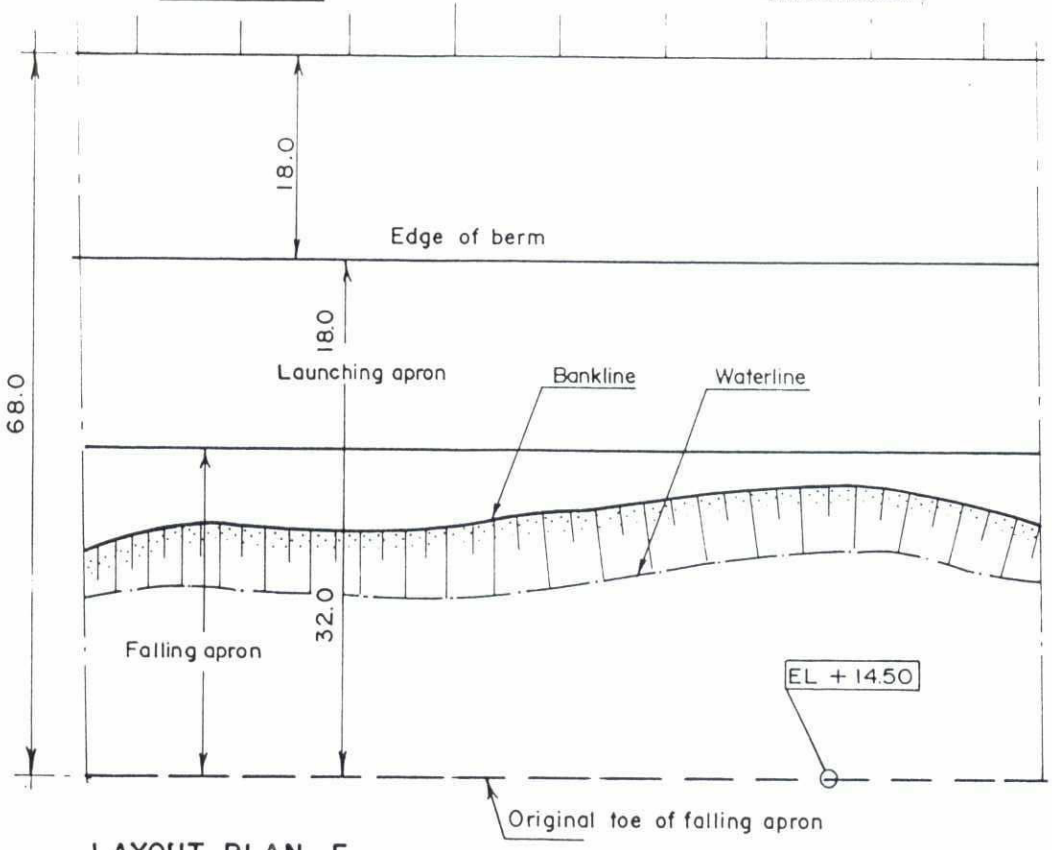
FAP - 21

BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

FIG. 21 - 11





LAYOUT PLAN F

NOTE.
Levels refer to ±0.00 m PWD
Bed profiles as on Feb. 18' 1998
Bankline/waterline as on 08.03.98

0 5 10 20 m

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MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANISATION (WARPO)

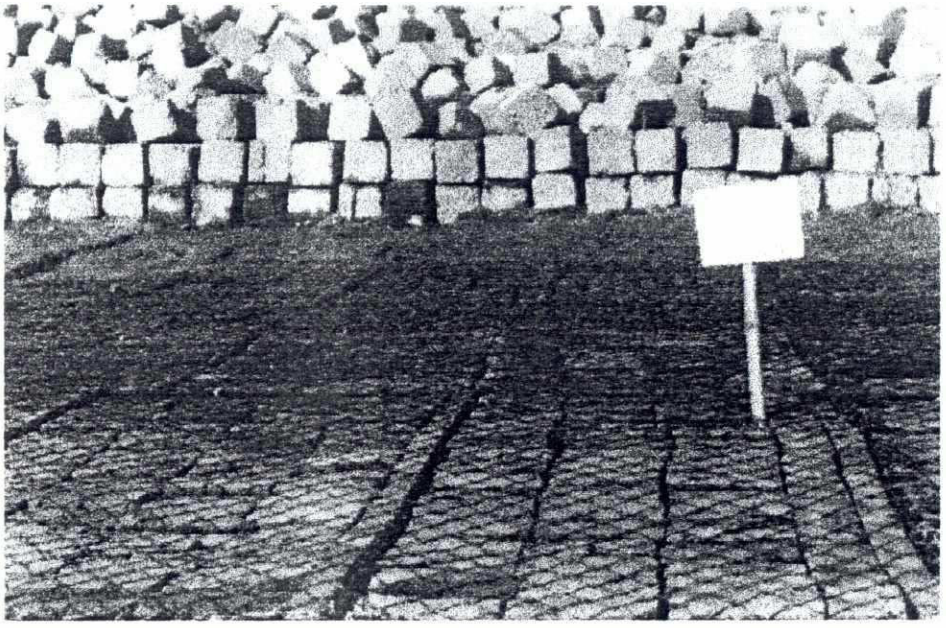
FAP-21 BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

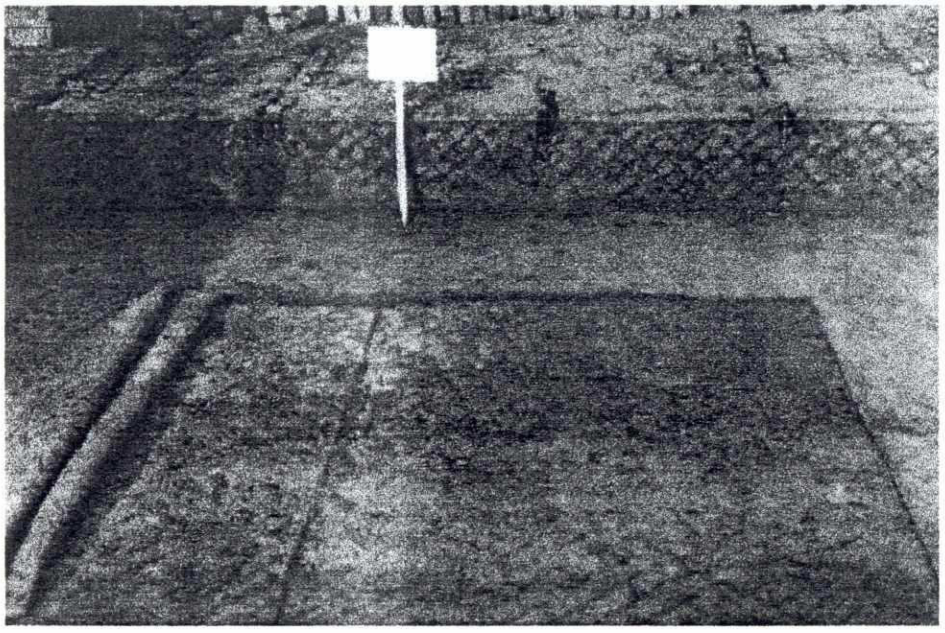
CONDITION SURVEY FEBR.'1998
TEST SECTION F
CROSS-SECTION/LAYOUT PLAN

	NAME	DATE	SCALE: 1 : 500
DRAWN	ANOWAR	25-02-98	
CHECKED			DRAWING NO. 21-12
APPROVED			REVISION 0

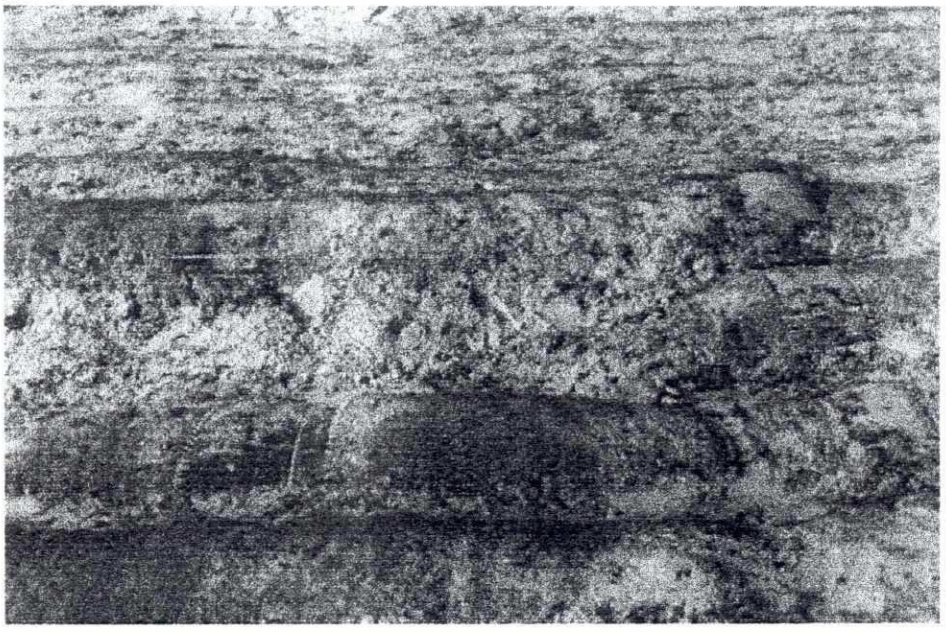
302



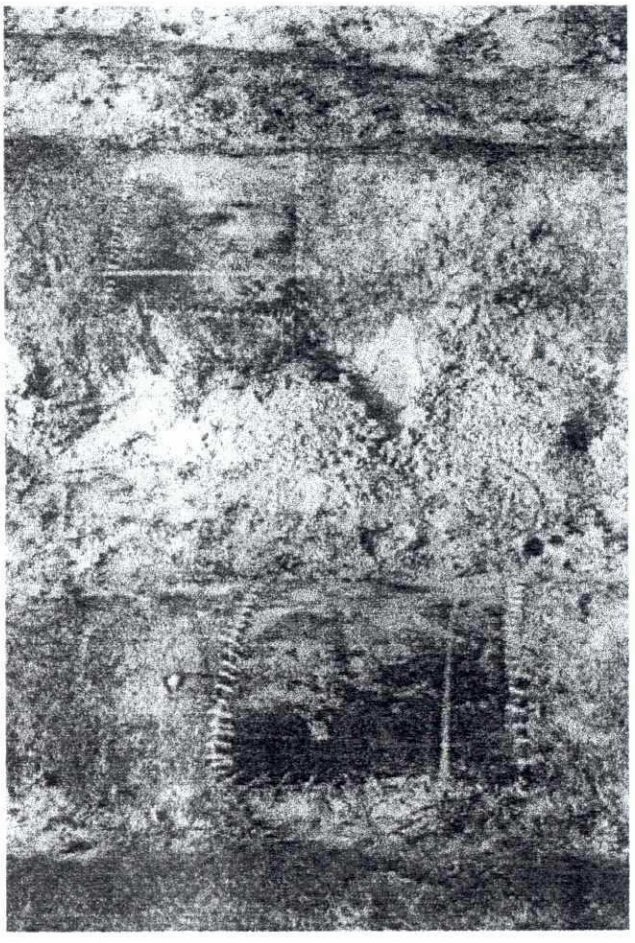
272/3: Sight on Section F before inspection (17.02.1998)



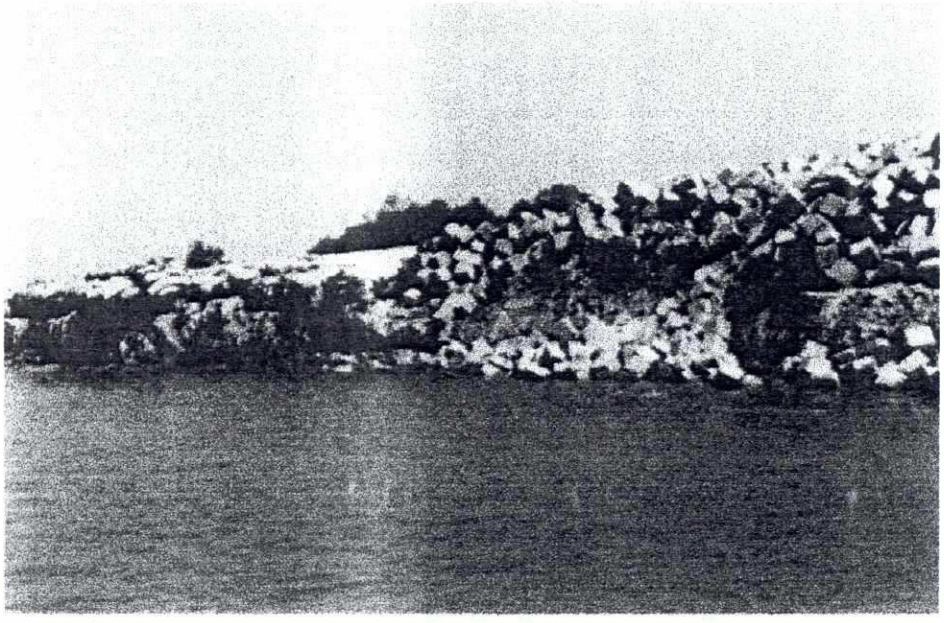
272/7: Sight on inspected area Section F (17.02.1998)



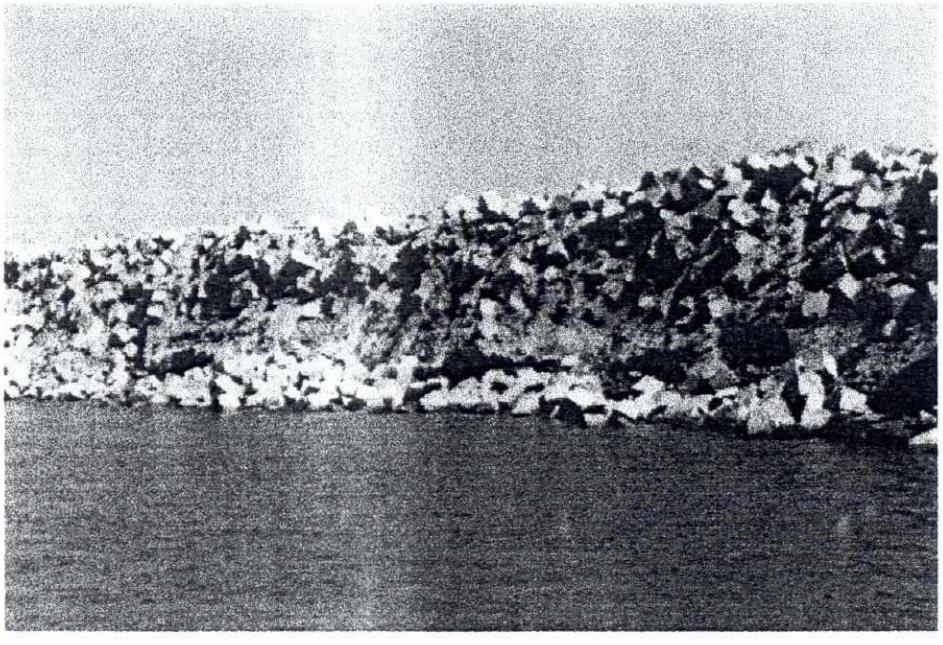
280/13A: View on repaired PROFIX-mattress of launching apron Section F (02.03.98)



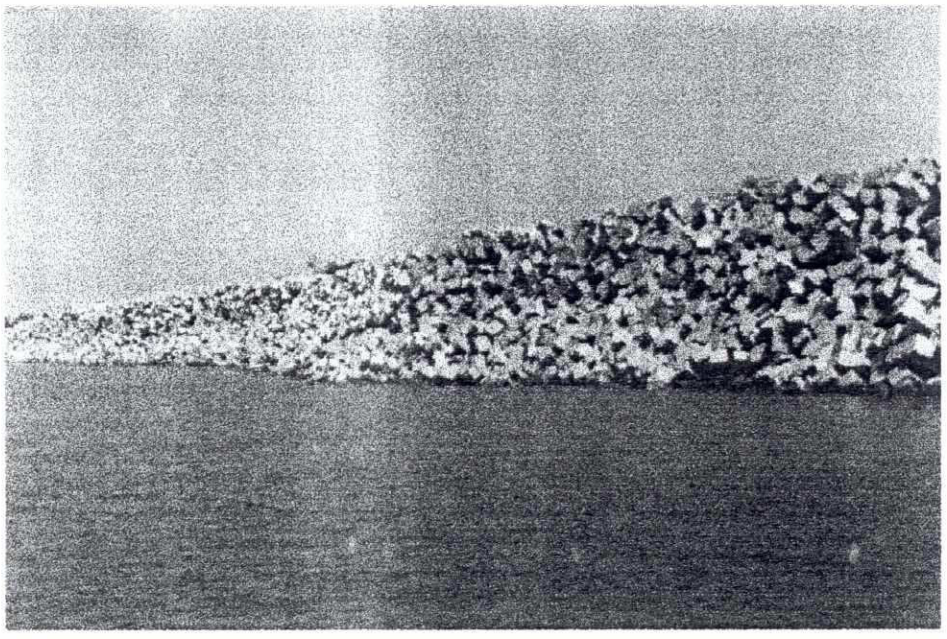
280/14A: View on repaired PROFIX-mattress of launching apron Section F (02.03.98)



271/25: View at bank-/ waterline transition Section E-2/F (21.02.98; W.L. = 12.947 m PWD)



271/24: View at bank-/ waterline of Section F (21.02.98; W.L. = 12.94 m PWD)



271/21: View at bank-/waterline of Section F+G (21.02.98; W.L. = 12.94 m PWD)

Section G

ASSESSMENT SHEET SECTION G

Total length along toe of upper slope: **100.0 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-1 / DATEX AD 1300	Interlocking cc-slabs (tongue-groove type) on intermediate layer	2,917 m²	2,250 m²
Launching apron	GF-1 / BIDIM b 7	INCOMAT- sandflex (collapsible block mattress with sand fill)	4,452 m²	3,550 m²
Transition between launching apron and falling apron		Rip-rap Grade F, CC-blocks D_n = 35 cm		1,000 m³
Falling apron		CC-blocks D_n = 35/40 cm (mixed)		1,732 m³
Exposed edge of falling apron		CC-blocks D_n = 45 cm		1,349 m³

VISUAL OBSERVATION

Date: 15.02.1998

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section G occurred during the flood season of 1997. No visible changes / damages could be observed. But as in sections E-1 and E-2 the cc-slabs have not been laid in parallel rows with staggered joints between the layers. With this not only flow attack but also heavy rain falls occurring each monsoon might have a greater impact on the structure than they should.	272 / 4
Launching apron	Some slight sedimentation can be found on the Incomat mattress. The collapsible block mattress itself is in very good condition. Only a minor number (2-3) of blocks show some damage which presumably relate either to the fact that during high water levels small boats with bamboo sticks for maneuvering have been used in this area or to th cutting by local people to get access to the filling.	
Transition between launching apron and falling apron	No visible changes / damages could be observed as this segment is covered by the end of the launching apron material and a part of the falling apron which still exists to some extent.	

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ASSESSMENT SHEET SECTION G

VISUAL OBSERVATION (continued)		Date: 15.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	The falling apron in this Section has eroded to quite some extend and has therefore served its purpose very well. The cc-blocks which have been falling down towards the river during erosion show now a quit well interlocked slope above the waterline *(see Special Notes /Comments)* . If and to which extend the underwater slope is now protected by the material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)* . Beside this survey it has been successfully tried to locate / identify some cc-blocks under water at a distance of up to 5 m from the waterline using a bamboo stick. No ongoing erosion has been detected so far, and the underwaterslope remained reasonably stable since August'97.	271 / 21 271 / 22
Exposed edge of falling apron	Exposed edge has eroded to its full extend and should be stabilizing the underwater slope now.	

PHYSICAL INSPECTION OF FILTER BEHAVIOUR	Date: 16.02.98
Selection of Location:	Photographs No.
There was no obvious upheaval or depression to be seen in Section G. Therefore the location for inspecting the geotextile and the underlaying subsoil has been chosen around the position where the highest waterlevel has left a mark on the revetment above berm level. So any differences between the water covered area and the dry area of the revetment (only exposed to rain and waves) can be detected after removing the cover layer of interlocking cc-slabs off the geotextile. Size and exact location of the inspected area can be seen in Figure 21-13 attached to this assessment sheet.	272 / 4 272 / 5
Result of Physical Inspection:	
First the cover layer was removed. The inspected area was at an overlapping joint of the geotextile. The geotextile was cut with a knife at three sides leaving a connection at the right side in flow direction. The geotextile was then lapped over to give sight on the underlaying subsoil which was in a good and overall moist condition. No differences were detected between the water covered and the dry area of the revetment. The opened area was set into original condition after inspection by overlapping with an additional sheet of geotextile filter material.	

ASSESSMENT SHEET SECTION G

Special Notes / Comments

FALLING APRON:

By comparing the behaviour of the cc-blocks used as falling aprons in Sections D, E-1, F and G it can be said that the smaller cc-blocks [D_n = 35cm and D_n = 35 / 40cm (mixed)] used in this Section G show a better interlocking slope above water level than the bigger ones used in the other sections.

Erosion of bank slope and scouring progressed between June and August'97. Thereafter, the bed profile remained more stable than in other sections. This may be a result of improved behaviour of a falling apron with a larger number of blocks, but of smaller sizes.

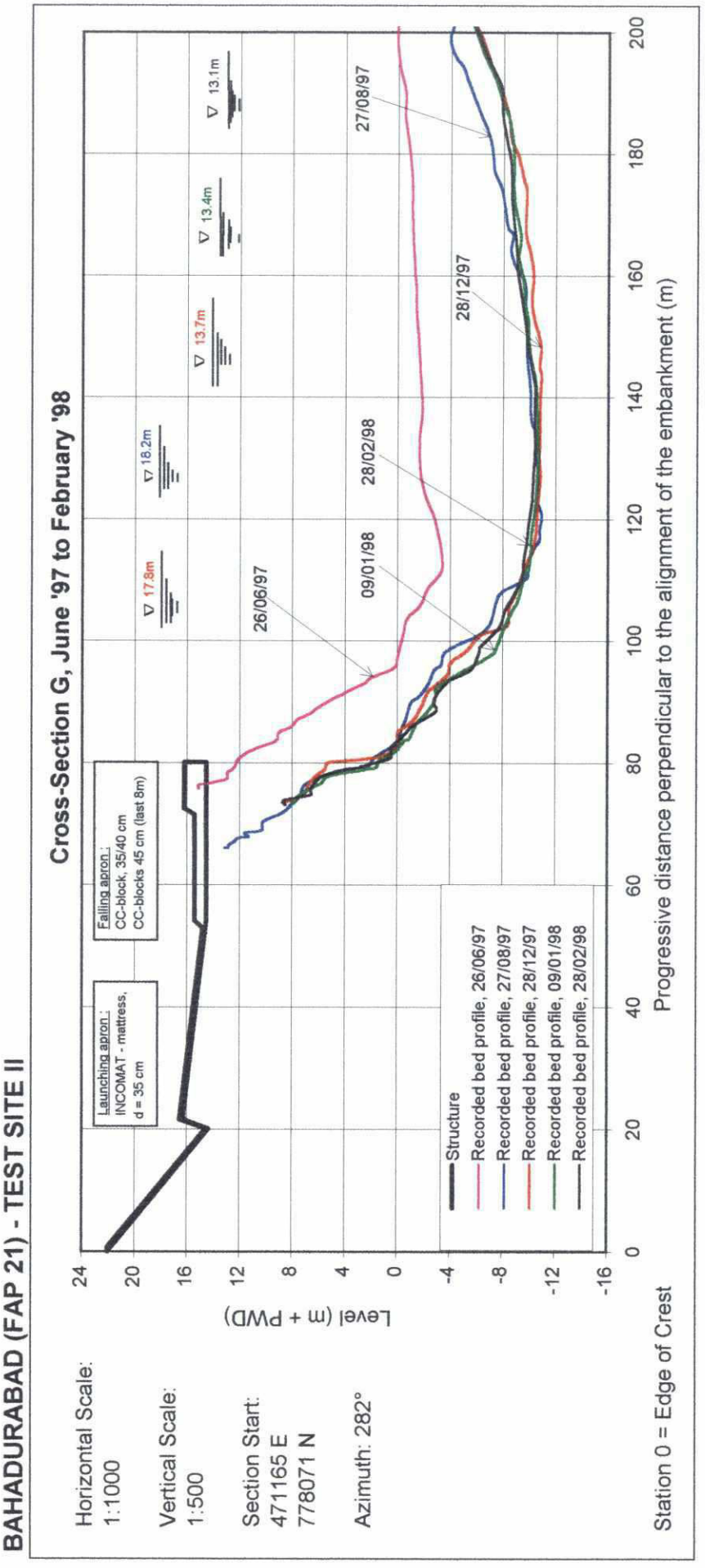
SIDE SCAN SONAR SURVEY:

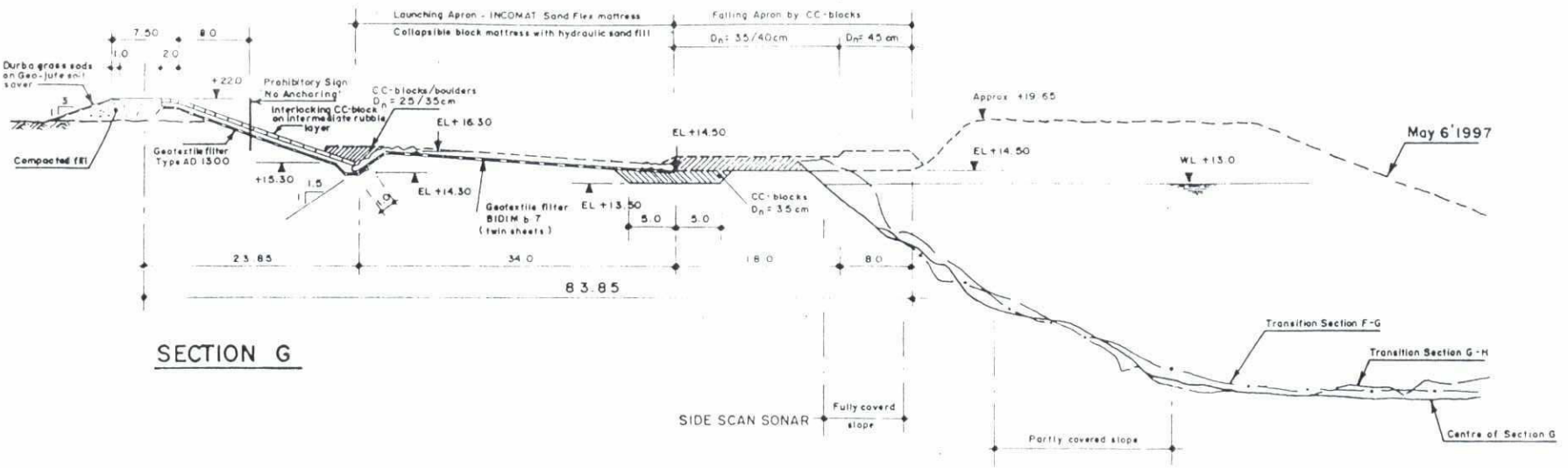
The investigations have provided evidence of a fully covered slope for about 5m to 10m width parallel to the waterline. Beyond, up to about 40m distance from the waterline, larger but discontinues areas of partly covered slopes were identified by the side scan sonar.

As said before, the entire slope remained very stable since August'97. Therefore, it would be reasonable to assume that areas without strong backscatter are also covered, but possibly with less numbers of cc-blocks, which apparently are still sufficient for protecting the bank against erosion under the given hydraulic loads.

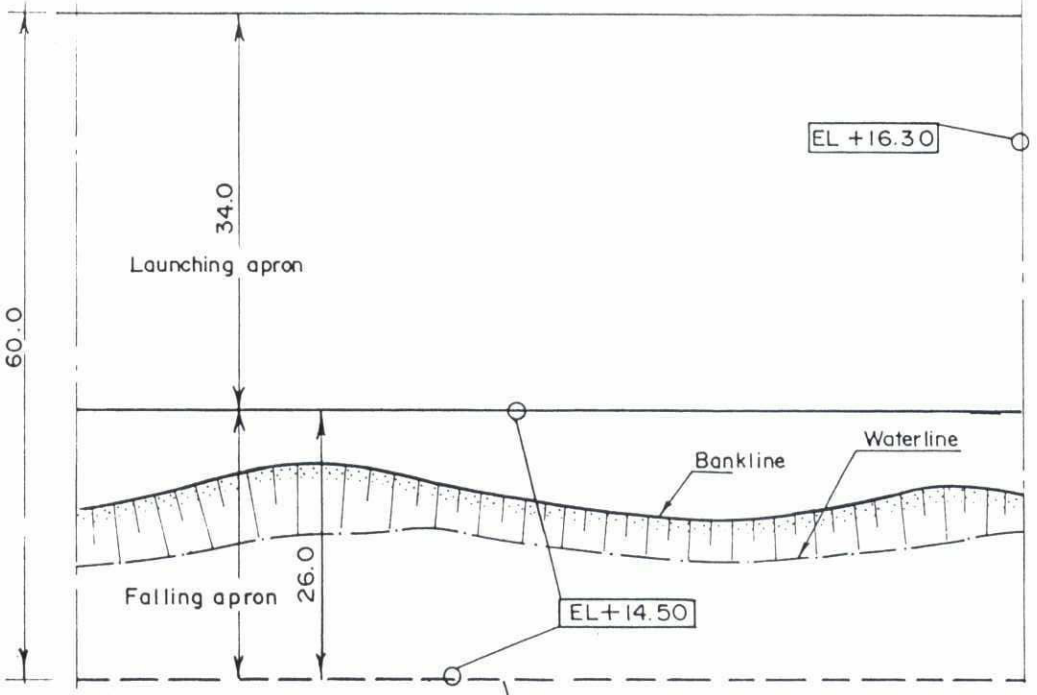
Laboratory Tests

No tests have been carried out


BAHADURABAD (FAP 21) - TEST SITE II
Cross-Section G, June '97 to February '98
Horizontal Scale: 1:1000
Vertical Scale: 1:500
Section Start: 471165 E 778071 N
Azimuth: 282°
Launching apron : INCOMAT - mattress, d = 35 cm
Falling apron : CC-block, 35/40 cm CC-blocks 45 cm (last 8m)
17.8m
18.2m
13.7m
13.4m
13.1m
26/06/97
09/01/98
28/02/98
28/12/97
27/08/97
Structure
Recorded bed profile, 26/06/97
Recorded bed profile, 27/08/97
Recorded bed profile, 28/12/97
Recorded bed profile, 09/01/98
Recorded bed profile, 28/02/98
Level (m + PWD)
24
20
16
12
8
4
0
-4
-8
-12
-16
0
20
40
60
80
100
120
140
160
180
200
Progressive distance perpendicular to the alignment of the embankment (m)
Station 0 = Edge of Crest



SECTION G



LAYOUT PLAN G

NOTE.
Levels refer to ±0.00 m PWD
Bed profiles as on Feb. 18.'1998
Bankline/water line as on 08.03.98

0 5 10 20 m

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MINISTRY OF WATER RESOURCES
WATER RESOURCES PLANNING ORGANISATION (WARPO)

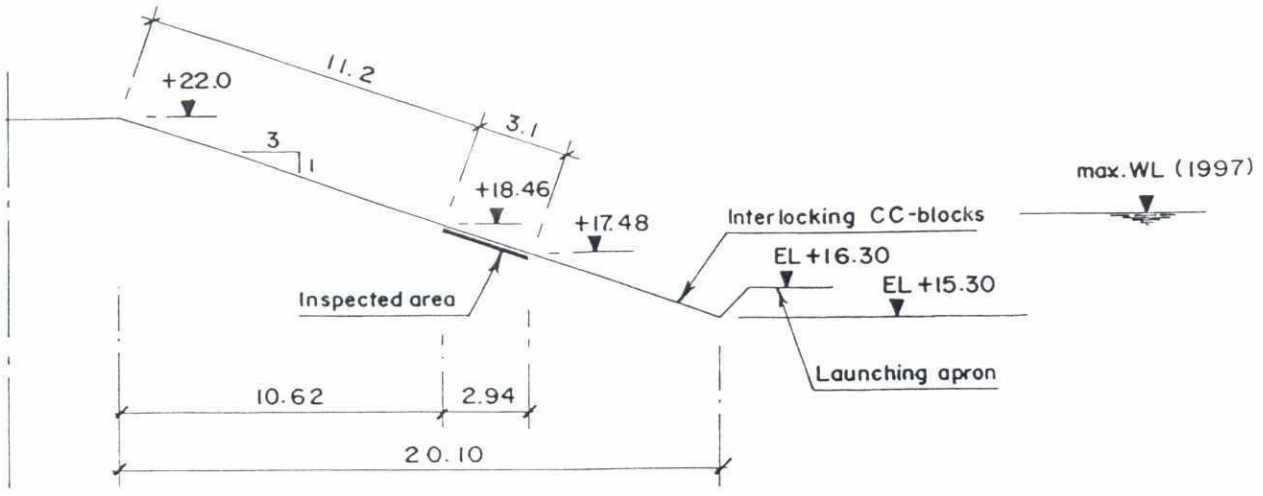
FAP-21 BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

CONDITION SURVEY FEBR.'1998
TEST SECTION G
CROSS-SECTION/LAYOUT PLAN

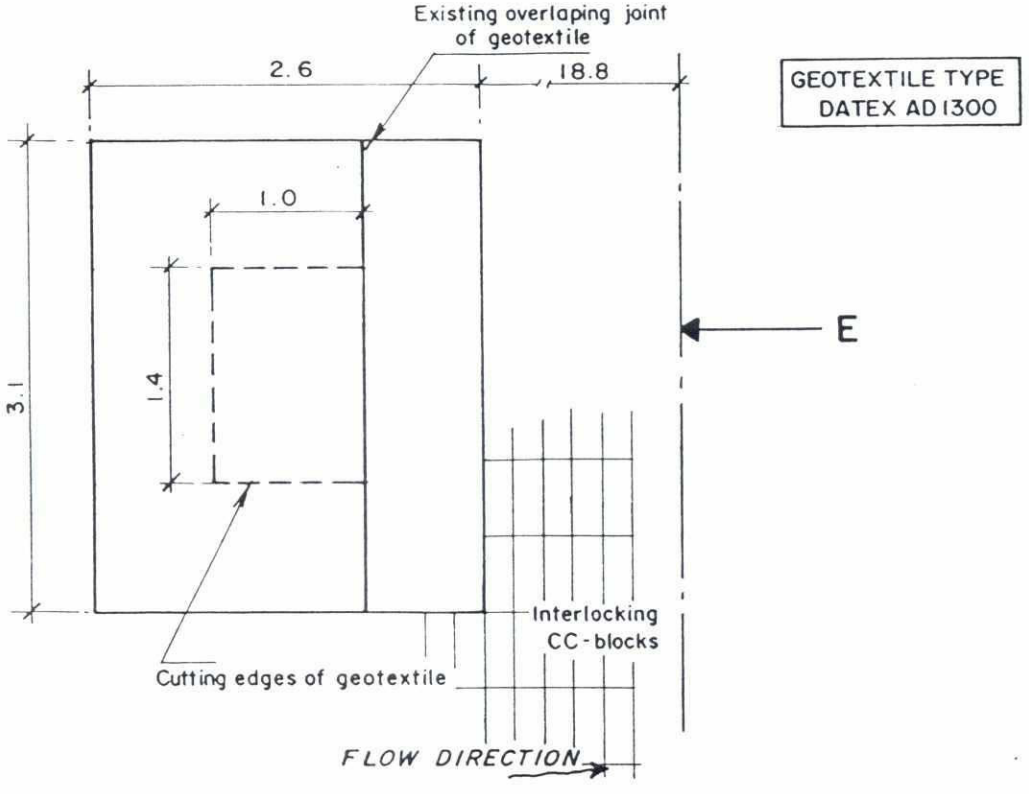
	NAME	DATE	SCALE: 1 : 500
DRAWN	ANOWAR	25-02-98	
CHECKED			DRAWING NO. 21 - 14
APPROVED			REVISION 0

C 82



CROSS-SECTION

Scale 1 : 250



TOP VIEW OF INSPECTION AREA

Scale 1 : 50

NOTES

All measurements are in meter.
Levels refer to ±0.0 m PWD

SCALES

0 0.5 1.0 m 1 : 50

0 1 2 3 4 5 m 1 : 250

MONITORING OF TEST STRUCTURE

Test Section : G

Location of Physical Inspection

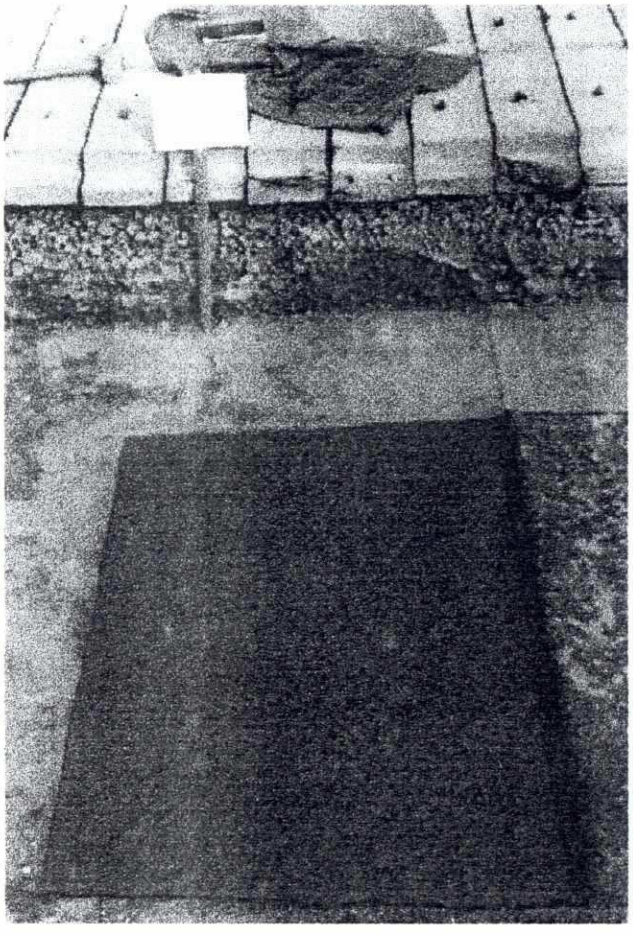
FAP - 21

BANK PROTECTION PILOT PROJECT

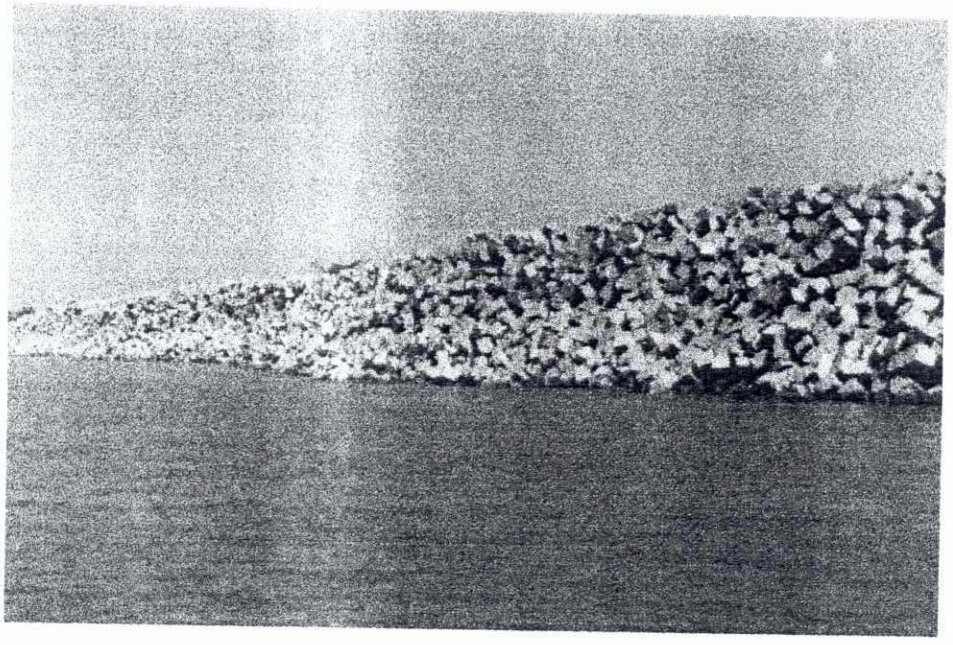
TEST SITE II - BAHADURABAD

FIG. 21-13

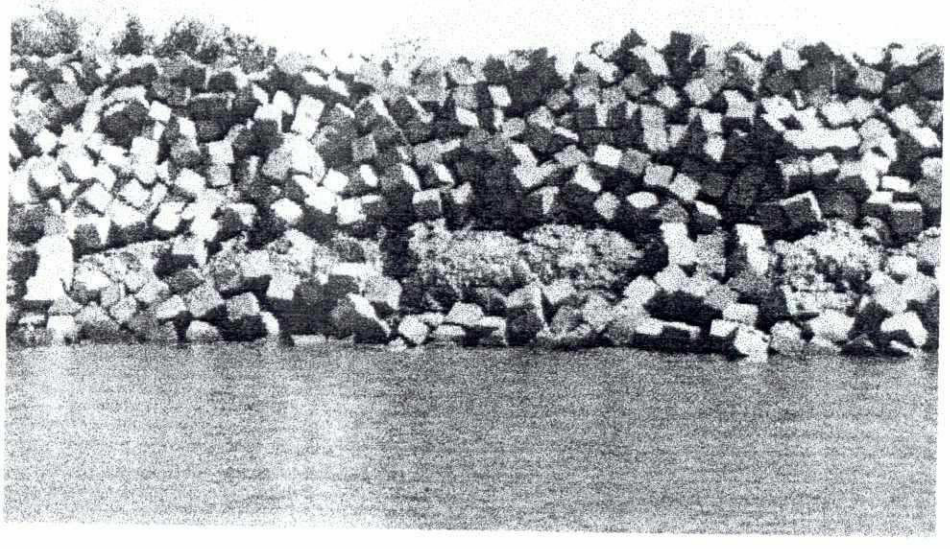
272/4: Section G before inspection (16.02.1998)



272/5: Inspected area Section G



271/21: View at bank-/ waterline of Section F+G (21.02.98; W.L. = 12.94 m PWD)



271/22: View at bank-/ waterline of Section G (21.02.98; W.L. = 12.94 m PWD)

Section H-1

ASSESSMENT SHEET SECTION H-1
Total length along toe of upper slope: **100.0 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-4 / BIDIM S 700	Rip-rap Grade C (D_{50} = 20 cm) Top 20 cm with stone pitching (d = 50 cm)	1,745 m²	620 m³
Launching apron	GF-1 / BIDIM S 390	Rip-rap Grade F (D_n = 25-35-45 cm)	4,000 m³	5,401 m³
Transition between launching apron and falling apron				
Falling apron				
Exposed edge of falling apron		Selected boulders D_n = 35-45 cm		2,320 m³

VISUAL OBSERVATION

Date: 15.02.1998

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section H-1 occurred during the flood season of 1997. No visible changes / damages of any kind could be observed.	
Launching apron	This area of Section H-1 has been designed only as the falling apron with a varying width getting less as the section turns around to the end of the Test Structure. Over the hole width of the falling apron erosion has occurred which can be described more or less significant if compared to the as built length of the falling apron in each part of the Section. It seems to be clear from the pictures taken that the geotextile underlaying the falling apron material has lead to the effect that most boulders slid done the geotextile exposing the soil of the river bank. If and to which extend the underwater slope is now protected by the eroded material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*. **(continuous on next page)**	271 / 20 271 / 17
Transition between launching apron and falling apron		

ASSESSMENT SHEET SECTION H-1

VISUAL OBSERVATION (continued)		Date: 15.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	On the second half of this Section adjacent to Section E-2 some significant sedimentation can be found. Near the toe of the revetment above berm level one big crack starts running along it from the point where sedimentation can be found and continuous through Section H-2. The nature of it was not quit clear at the date of inspection *(see Special Notes / Comments)*.	
Exposed edge of falling apron	Exposed edge has eroded to its full extent and should be stabilizing the underwater slope now.	

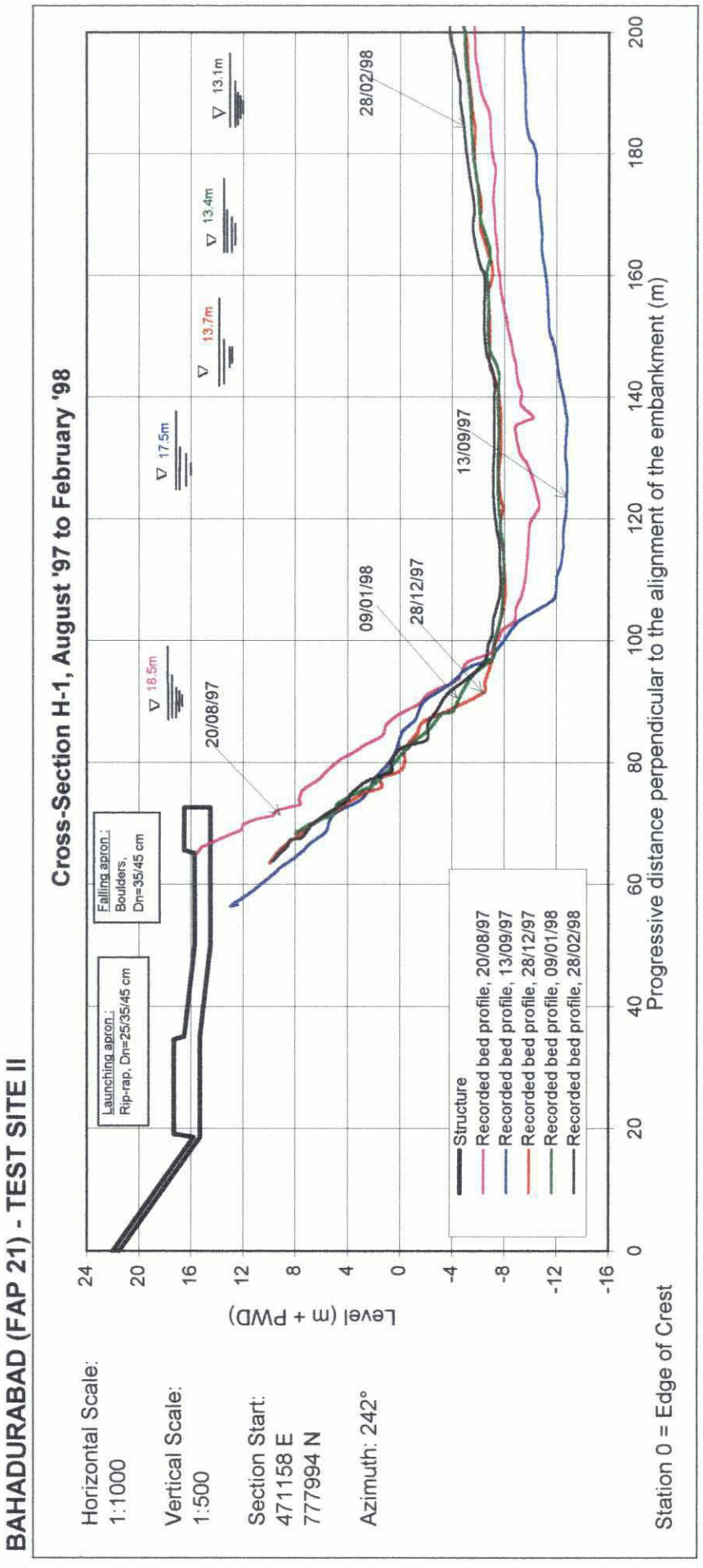
PHYSICAL INSPECTION:	Date:
Selection of Location:	Photographs No.
No physical inspection was carried out within the above berm area of this section	

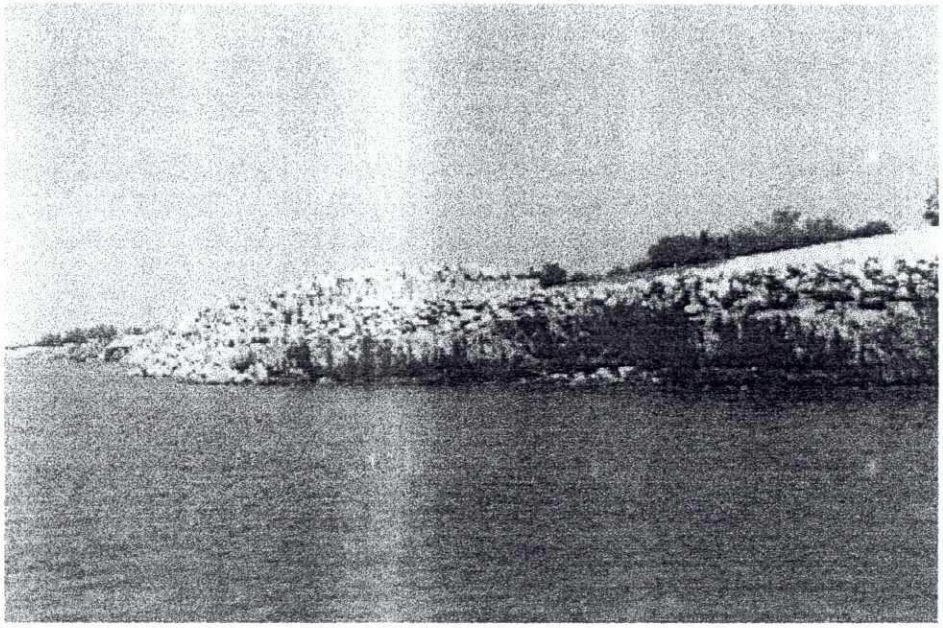
Special Notes / Comments:

FALLING APRON:
The crack which was of some concern and could not be explained has been observed over a period of time by measurement at three defined and marked positions of Sections H-1 and H-2. No movement could be measured. Test excavation revealed that this crack extends only through the thickness of sediment overlaying the cover material.
SIDE SCAN SONAR SURVEY:
For one part of Section H-1 a continuous strong backscatter suggests that up to about 40m from the waterline the slope is fully covered by protective material (boulders).

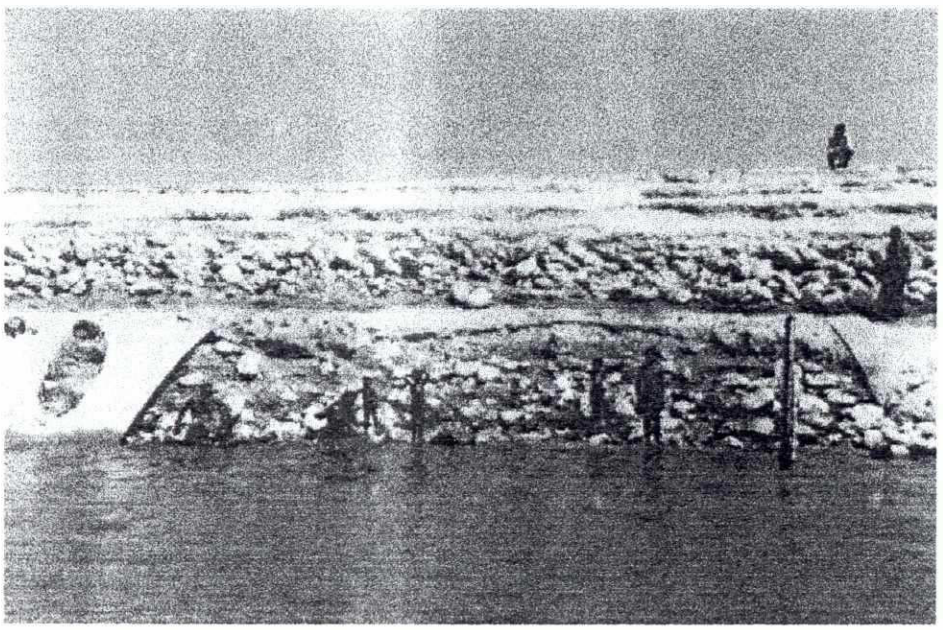
Laboratory Tests

No tests have been carried out





271/20: View at bank-/ waterline of Section H-1 (21.02.98; W.L. = 12.94 m PWD)



271/17: View at bank-/ waterline of Section H-1 (21.02.98; W.L. = 12.94 m PWD)

Section H-2

ASSESSMENT SHEET SECTION H-2
Total length along toe of upper slope: **100.0 m**

STRUCTURE BUILT-UP

Segment	Filter Spec. Type / Brand Name	Cover Material	Built-in Quantities Filter	 Cover Material
Revetment above berm level	GF-1 / HaTe E 650 + K251	Rip-rap Grade C (D_{50} = 20 cm) Top 20 cm with stone pitching (d = 40 cm)	2,132 m²	758 m³
Launching apron	GF-1 / BIDIM S 390	cc-blocks D_n = 30 cm D_n = 35 cm (mixed)	2,556 m²	1,910 m³
Transition between launching apron and falling apron				
Falling apron				
Exposed edge of falling apron				

VISUAL OBSERVATION

Date: 15.02.1998

Observed Area	Comments	Photographs No.
Revetment above berm level	No severe attack of the river on this segment of Section H-2 occurred during the flood season of 1997. No visible changes / damages of any kind could be observed.	
Launching apron	Only a small area of erosion can be observed in this segment but it seems to be clear from the pictures that the geotextile somehow has lead to the effect that most cc-blocks slid down the geotextile and therefore could not protect the soil of the exposed river bank. If and to which extend the underwater slope is now protected by the eroded material has to be taken from the result of the Side Scan Sonar Survey *(see Special Notes / Comments)*. Near the toe of the revetment above berm level one big crack runs along it starting in Section H-1. *(see Special Notes / Comments to Section H-1 in this regard)*.	271 / 16 271 / 15
Transition between launching apron and falling apron		

ASSESSMENT SHEET SECTION H-2

VISUAL OBSERVATION (continued)		Date: 15.02.1998
Observed Area	**Comments**	Photographs No.
Falling apron	(this section was provided only with a launching apron)	
Exposed edge of falling apron		

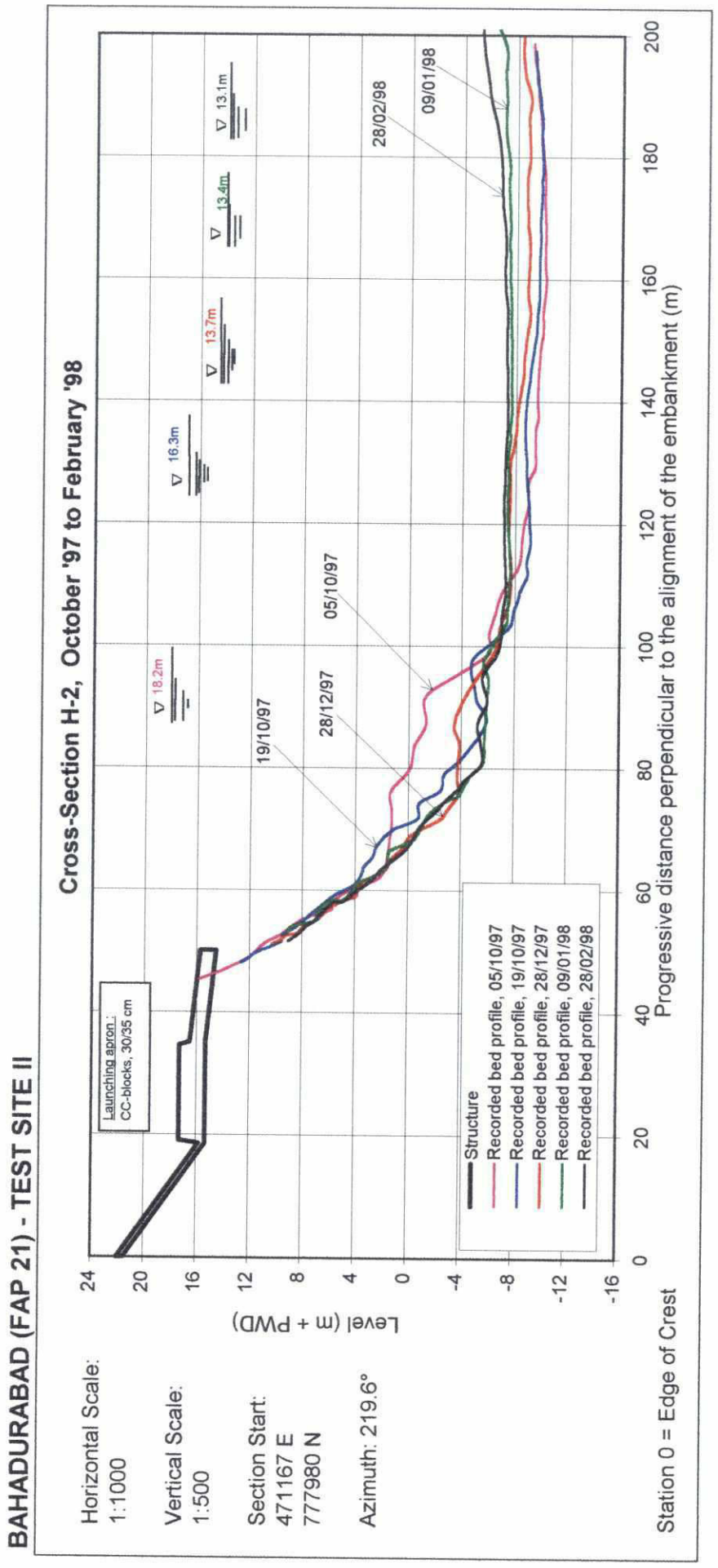
PHYSICAL INSPECTION OF FILTER BEHAVIOUR:	Date:
Selection of Location:	Photographs No.
No physical inspection was carried out within the above berm area of this Section	

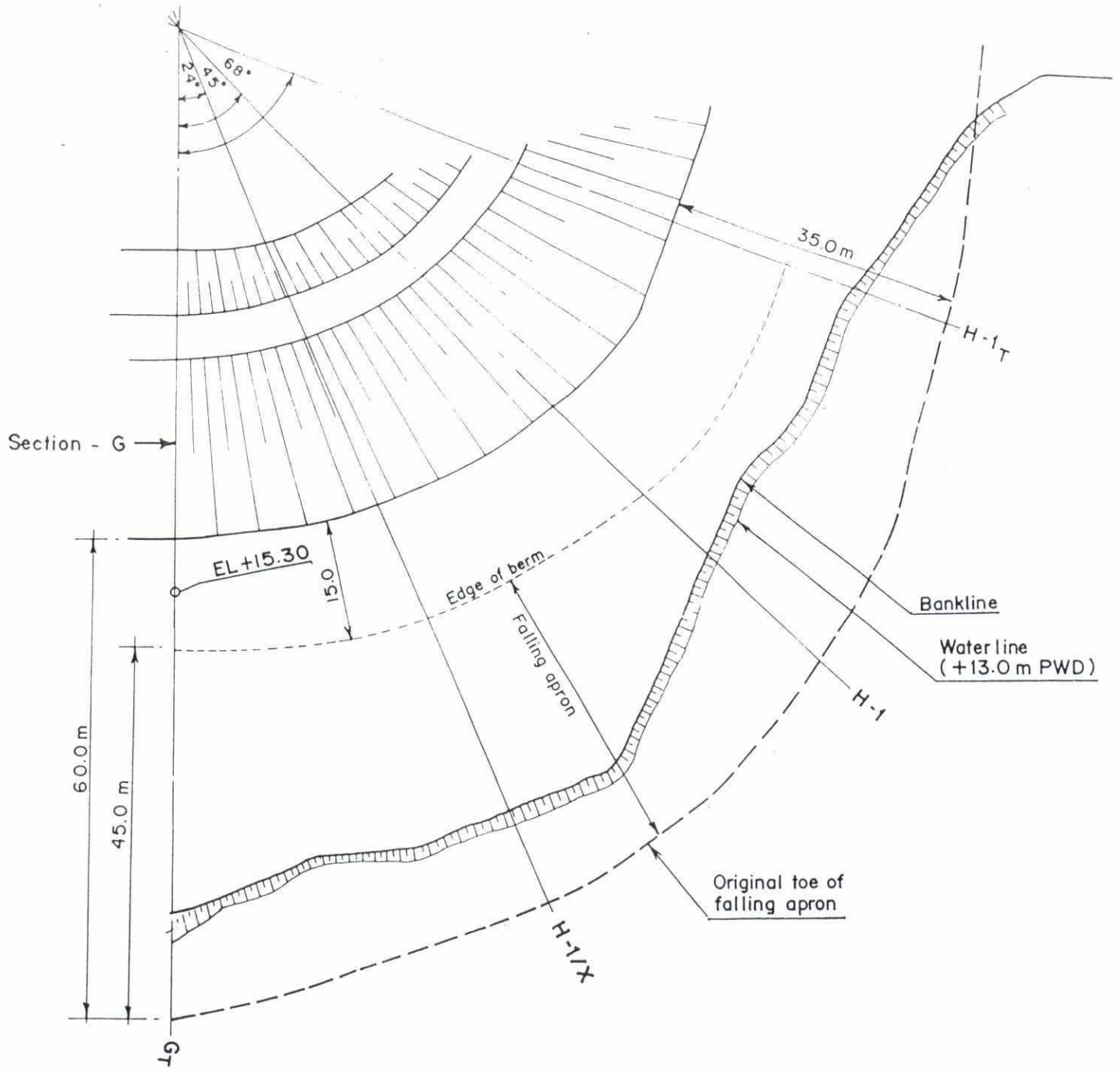
Special Notes / Comments:

SIDE SCAN SONAR SURVEY:
The backscatter during side scan sonar investigation indicated only a very limited area along waterline to be fully covered with protective material.
On the other hand, bathymetric surveys indicate quite stable cross-sections, wherefore the side scan sonar survey in this part of the Section may not be representative.

Laboratory Tests

No tests have been carried out


BAHADURABAD (FAP 21) - TEST SITE II
Cross-Section H-2, October '97 to February '98
Horizontal Scale: 1:1000
Vertical Scale: 1:500
Section Start: 471167 E 777980 N
Azimuth: 219.6°
Launching apron : CC-blocks, 30/35 cm
18.2m
16.3m
13.7m
13.4m
13.1m
19/10/97
28/12/97
05/10/97
28/02/98
09/01/98
Structure
Recorded bed profile, 05/10/97
Recorded bed profile, 19/10/97
Recorded bed profile, 28/12/97
Recorded bed profile, 09/01/98
Recorded bed profile, 28/02/98
Level (m + PWD)
Progressive distance perpendicular to the alignment of the embankment (m)
Station 0 = Edge of Crest



NOTE.
Levels refer to ±0.00 m PWD
Bankline/waterline as on Feb.18'1998

0 5 10 20 m

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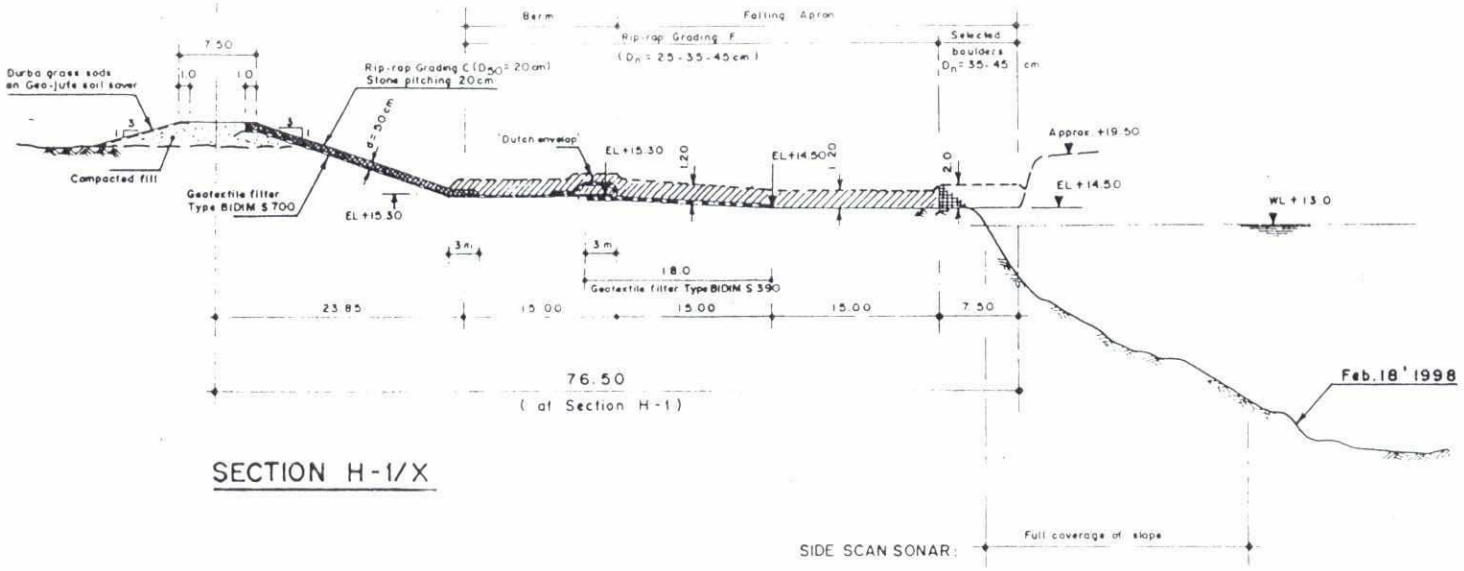
FAP-21 BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD

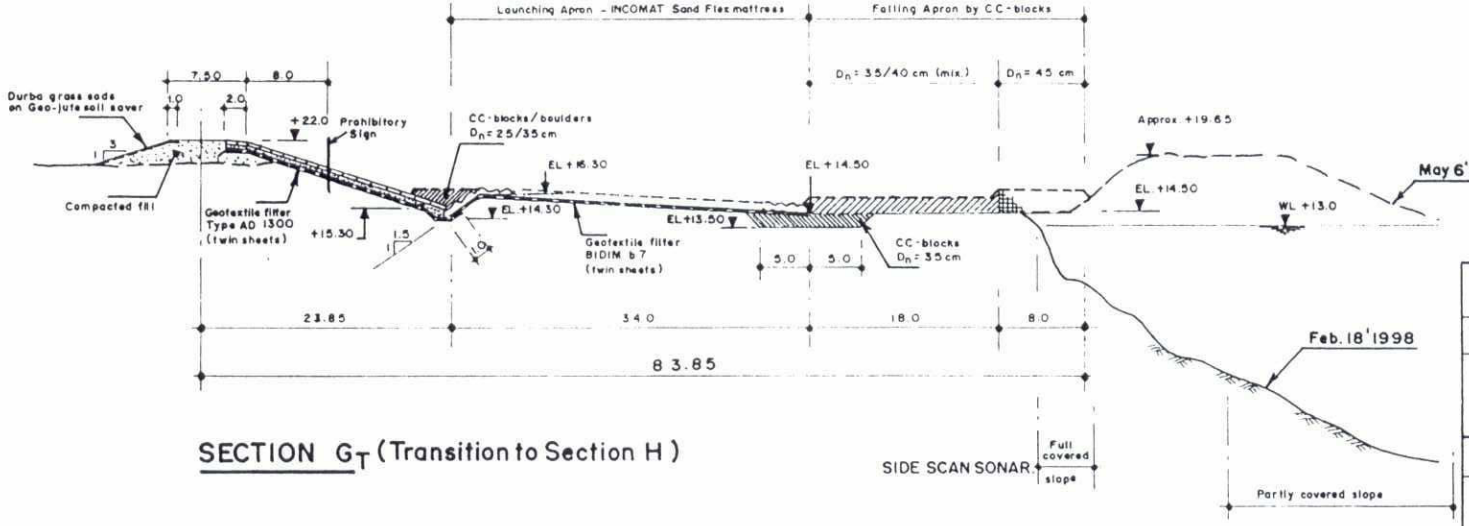
CONDITION SURVEY FEBR.'1998
LAYOUT PLAN SECTION - H

	NAME	DATE	SCALE:
DRAWN	ANOWAR	25-02-98	1 : 500
CHECKED			DRAWING NO. 21-15
APPROVED			REVISION 0

F - 93



SECTION H-1/X



SECTION G_T (Transition to Section H)

NOTE.
Levels refer to ± 0.00 m PWD

0 5 10 20 m

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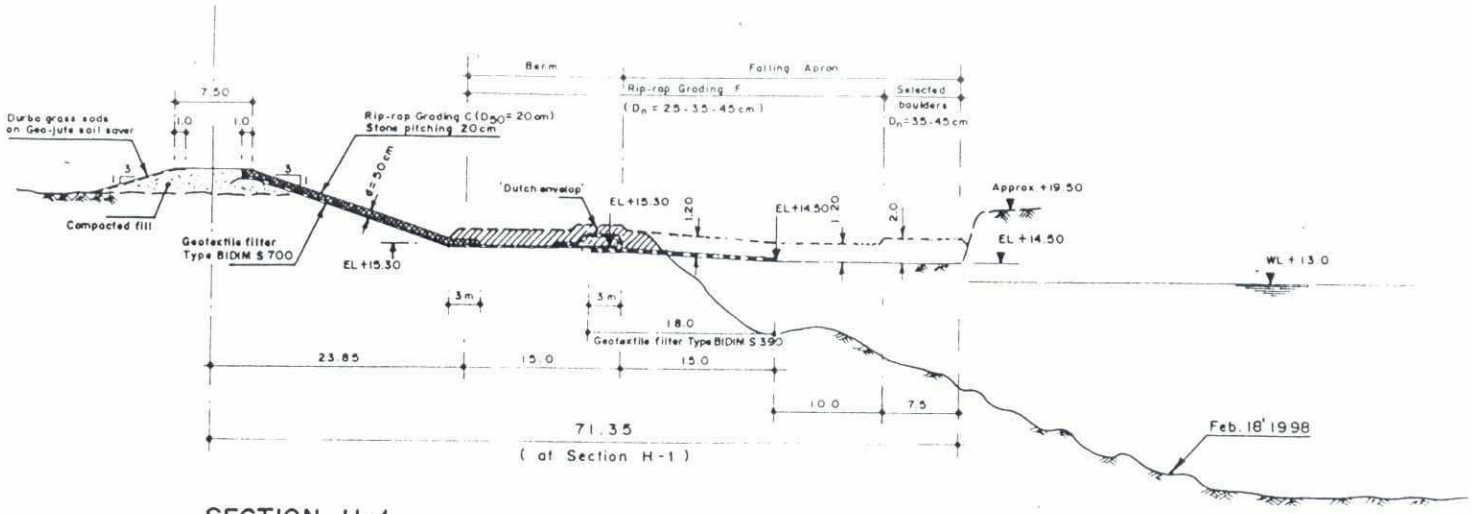
JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

TEST SITE II - BAHADURABAD

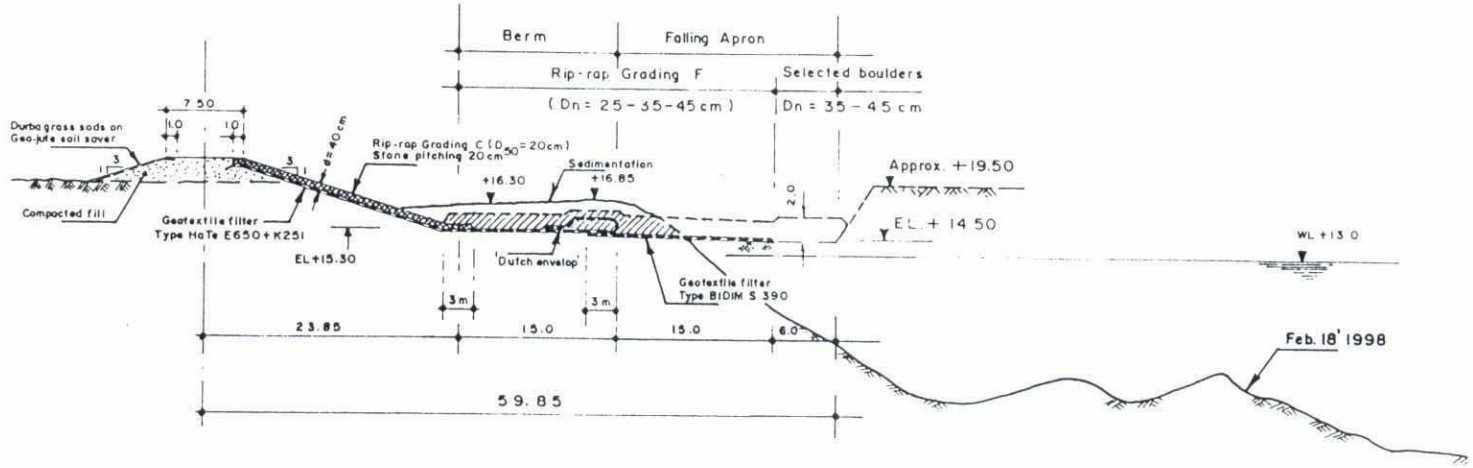
CONDITION SURVEY FEBR.'1998
TEST SECTION - H
CROSS-SECTION H-1/X AND G_T

	NAME	DATE	SCALE:
DRAWN	ANOWAR	24-02-98	1 : 500
CHECKED			
APPROVED			DRAWING NO. 21-16 / REVISION 0

F - 94



SECTION H-1



SECTION H-1T (Transition to Section H-2)

NOTE.
Levels refer to ±0.00m PWD

0 5 10 20m

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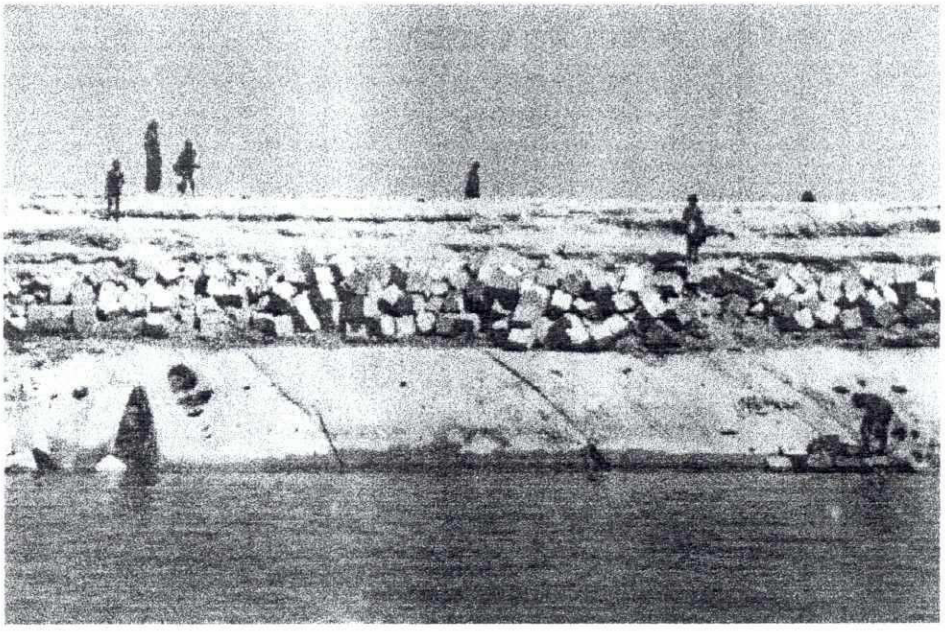
FAP-21 BANK PROTECTION PILOT PROJECT

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

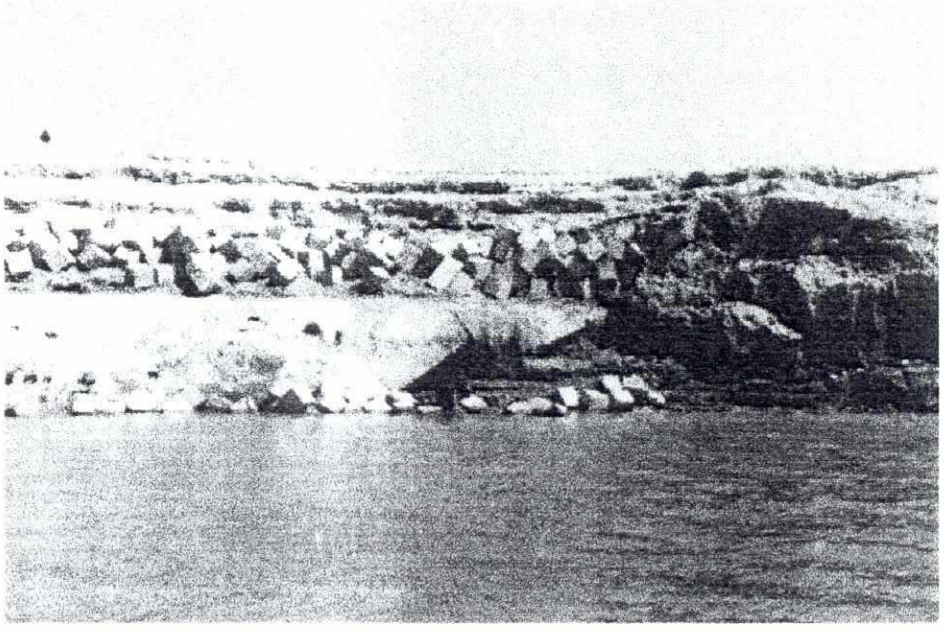
TEST SITE II - BAHADURABAD

CONDITION SURVEY FEBR.'1998
TEST SECTION - H
CROSS-SECTION H-1 AND H-1T

	NAME	DATE	SCALE:
DRAWN	ANOWAR	25-02-98	1 : 500
CHECKED			DRAWING NO. 21 - 17
APPROVED			REVISION 0



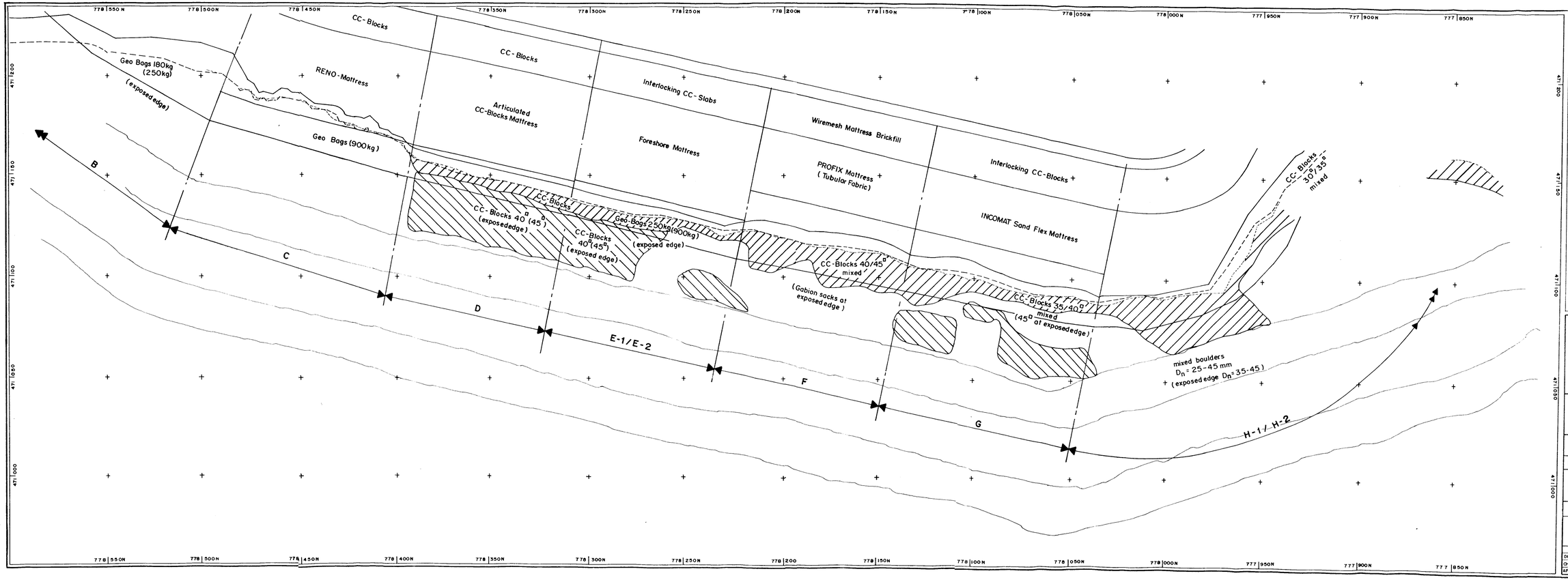
271/16: View at bank-/ waterline of Section H-2 (21.02.98; W.L. = 12.94 m PWD)

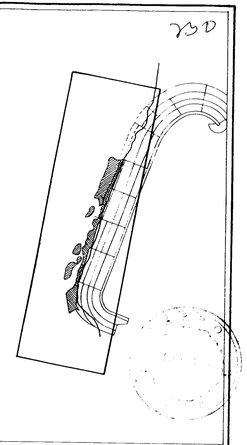


271/15: View at bank-/ waterline of Section H-2 (21.02.98; W.L. = 12.94 m PWD)

ANNEX F.3

Results of Side Scan Sonar





LEGEND

- Waterline From Side Scan Sonar
- Continuous Strong Backsc (Full Covered Slope)
- Strong Backsc (Partly Covered Slope)

SCALE

0 5 10 20 30 40 50 m 1 :1000

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JAMUNA TEST WORKS CONSULTANTS JOINT VENTURE

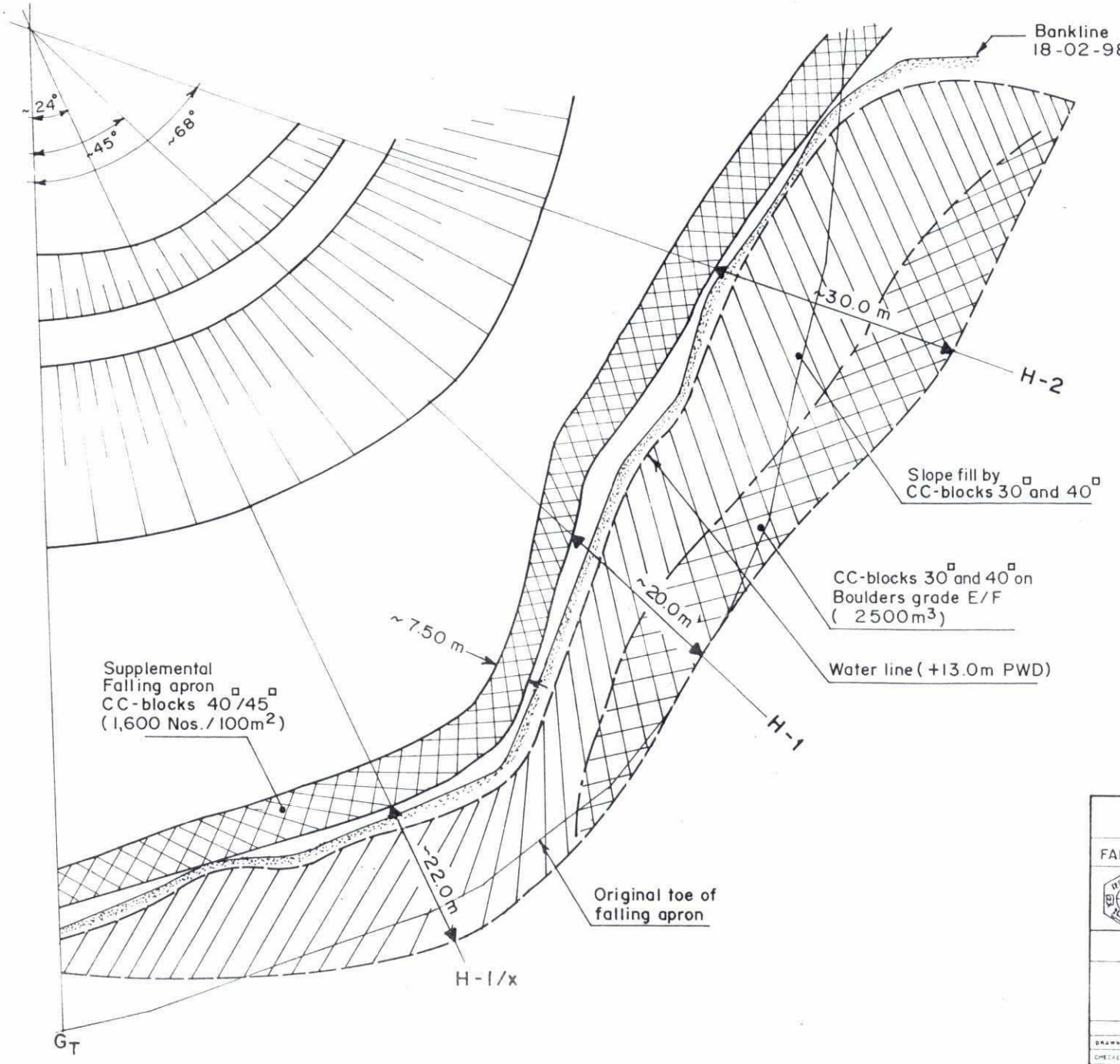
TEST SITE II - BAHADURABAD

Scan Side Sonar Results March'1998

	NAME	DATE	SCALE.
DRAWN	Anowar	30-07-98	1 : 1000
CHECKED			DRAWING NO.
APPROVED			REVISION

ANNEX G

Adaptation in Section H



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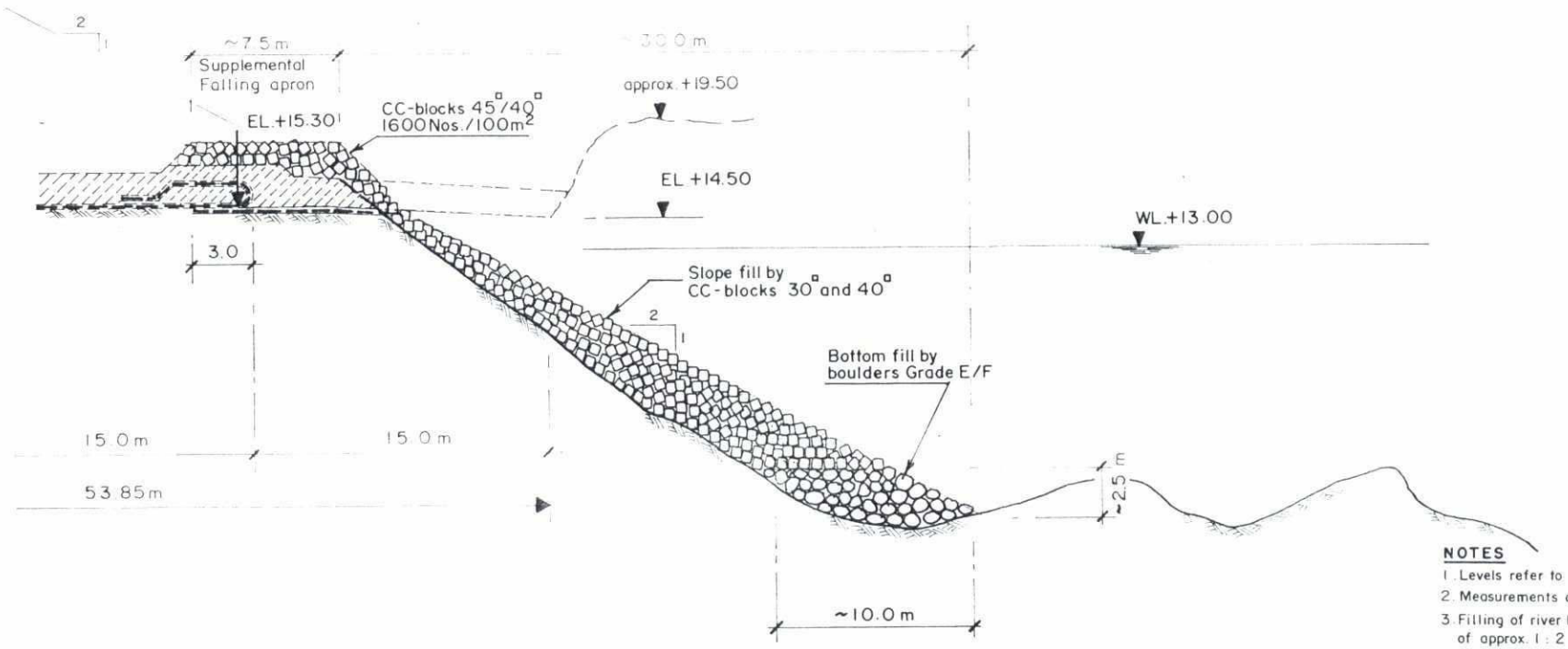
FAP-21 BANK PROTECTION PILOT PROJECT

TEST SITE II - BAHADURABAD
ADAPTATION

LAYOUT PLAN
SECTION H

	NAME	DATE	SCALE
DRAWN	ANOWAR	22-03-99	1 : 500
CHECKED			DRAWING NO. R-AD - 01
APPROVED			REVISION 0

G - 1



NOTES

1. Levels refer to ±0.00 m PWD.
2. Measurements are shown in meter.
3. Filling of river bed slope to profile of approx. 1 : 2 (V : H)
4. Reference Drawing : R - AM - 01

0 5 10m

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FAP-21 BANK PROTECTION PILOT PROJECT

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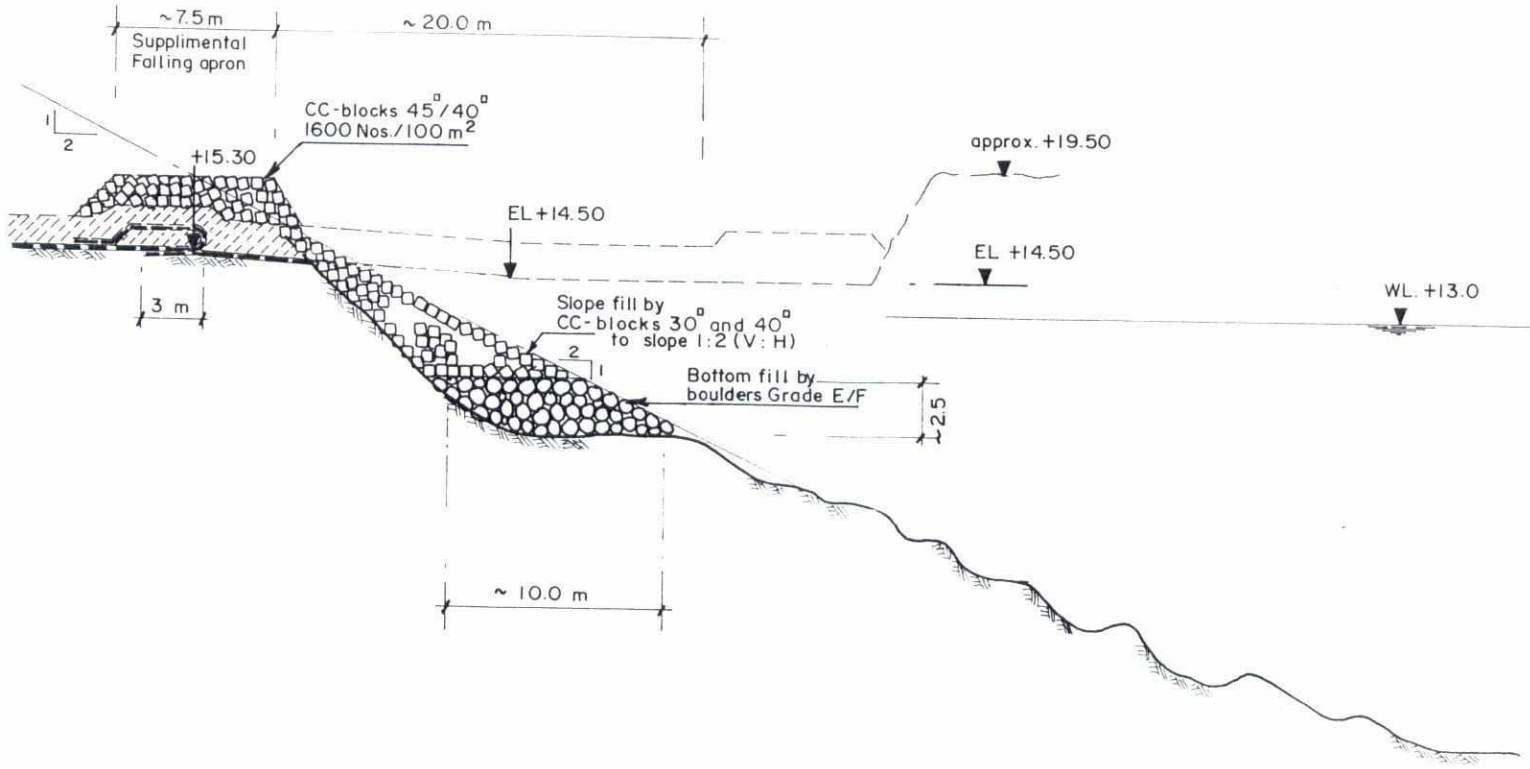
CONSULTING CONSORTIUM FAP 21/22

TEST SITE II - BAHADURABAD ADAPTATION

DETAILS SECTION H-2

	NAME	DATE	SCALE:
DRAWN	ANOWAR	21-03-98	1 : 250
CHECKED			DRAWING NO. R-AD-02
APPROVED			REVISION 0



NOTES

1. Levels refer to ±0.00 m PWD.
2. Measurements are shown in meter.
3. Filling of river bed slope to profile of approx. 1 : 2 (V : H)
4. Reference Drawing
   R - AM - 01

0 5 10 m

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FAP-21 BANK PROTECTION PILOT PROJECT

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

TEST SITE II - BAHADURABAD
ADAPTATION

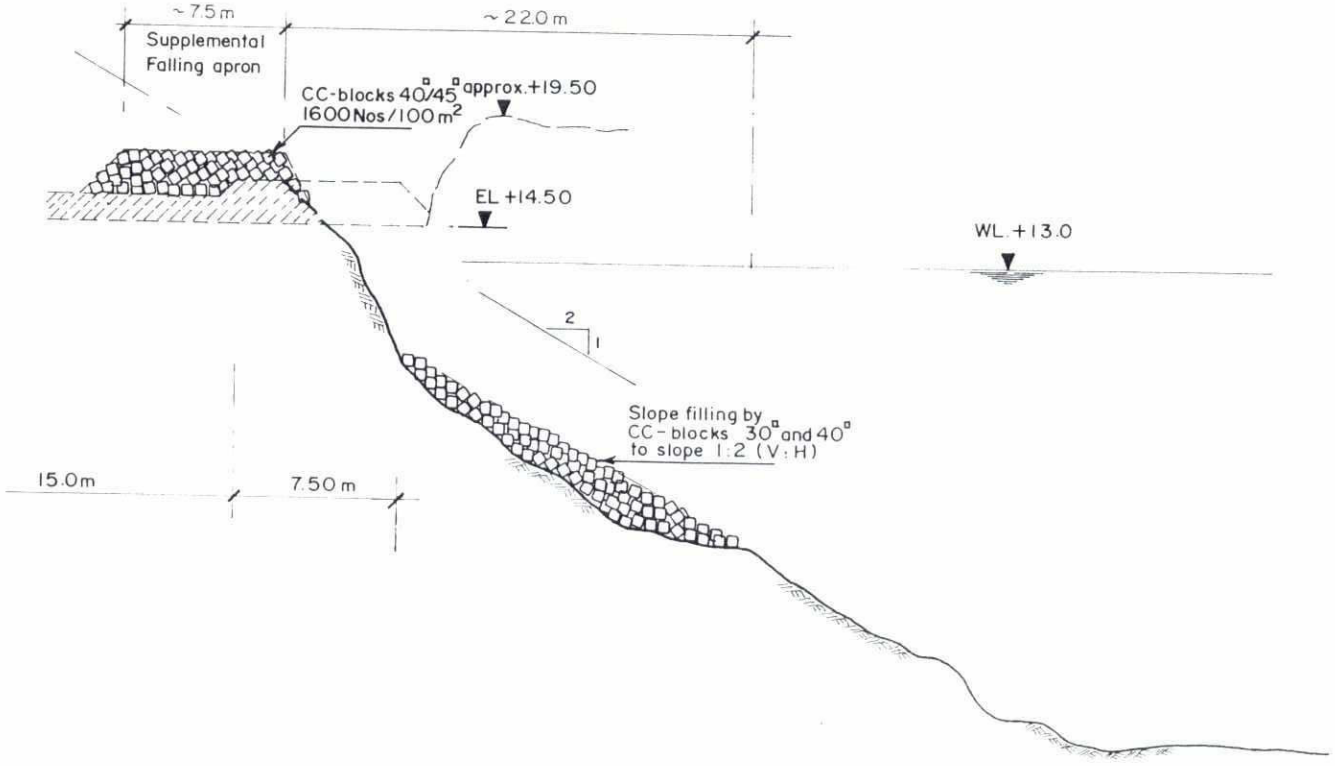
DETAILS SECTION H-1

	NAME	DATE
DRAWN	ANOWAR	21-03-98
CHECKED		
APPROVED		

SCALE 1 : 250

DRAWING NO. R - AD - 03

REVISION 0



NOTES

1. Levels refer to ± 0.00m PWD.
2. Measurements are shown in meter.
3. Filling of river bed slope to profile of approx 1 : 2 (V : H).
4. Reference Drawing
   R-AM-01

0 5 10m

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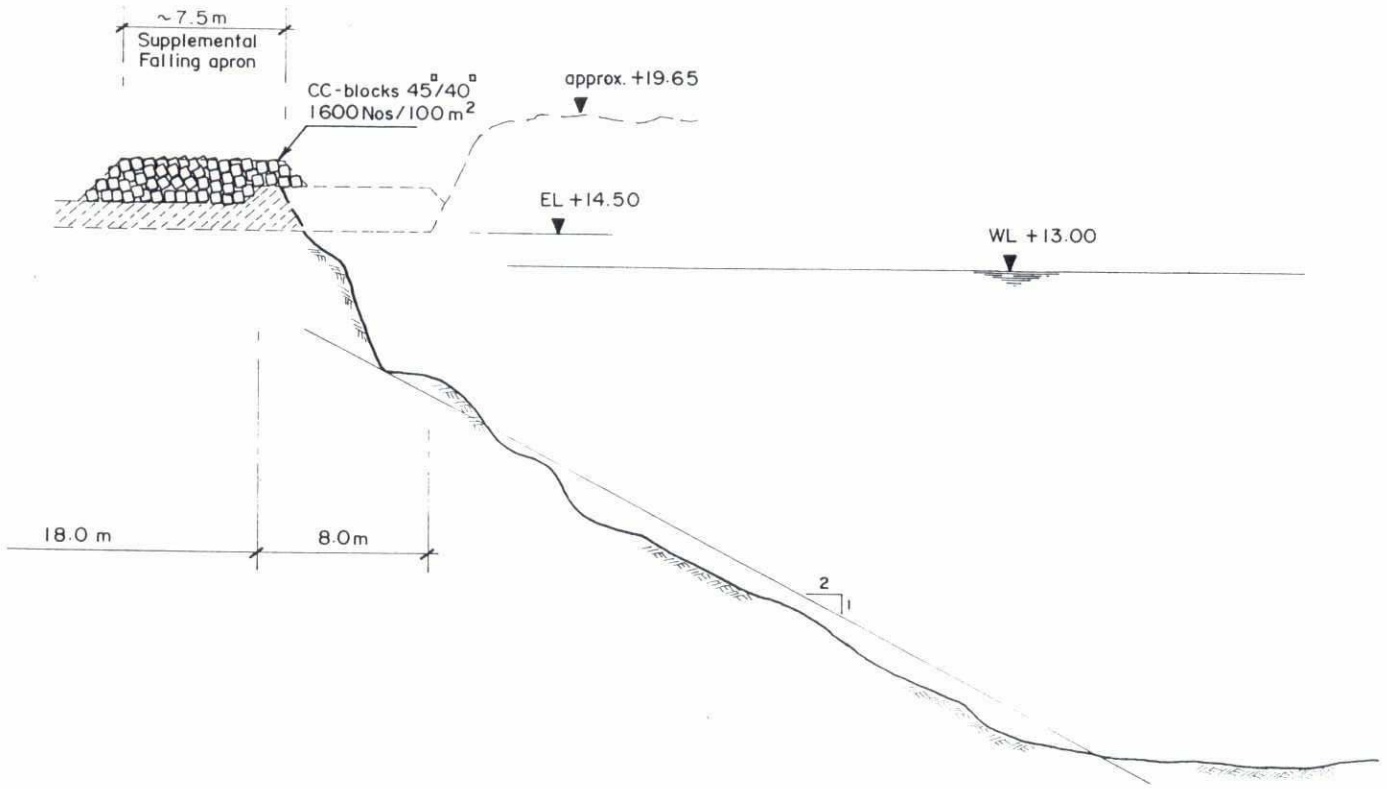
FAP-21 BANK PROTECTION PILOT PROJECT

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

TEST SITE II - BAHADURABAD ADAPTATION

DETAILS SECTION H-1/x

	NAME	DATE	SCALE
DRAWN	ANOWAR	21-03-98	1 : 250
CHECKED			DRAWING NO. R-AD-04
APPROVED			REVISION 0



NOTES

1. Levels refer to ±0.00m PWD.
2. Measurements are shown in meter.
3. Filling of river bed slope to profile of approx. 1 : 2 (V : H)
4. Reference Drawing
   R - AM - 01

0 5 10 m

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FAP-21 BANK PROTECTION PILOT PROJECT

JAMUNA TEST WORKS CONSULTANTS, JOINT VENTURE

TEST SITE II - BAHADURABAD
ADAPTATION

DETAILS SECTION G_T

	NAME	DATE	SCALE
DRAWN	ANOWAR	21-03-98	1 : 250
CHECKED			DRAWING NO. R - AD - 05
APPROVED			REVISION 0