DGIS GOB

MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MES II
MEGHNA ESTUARY STUDY

MES PILOT PROJECTS

TECHNICAL NOTE MES-041

CHAR MONTAZ PERMEABLE CROSS DAM PILOT SCHEME

June 2001

DHV CONSULTANTS BV

in association with

DEVCONSULTANTS LTD
SURFACE WATER MODELLING CENTRE

DGIS

GOB

MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MES II
MEGHNA ESTUARY STUDY

MES PILOT PROJECTS

TECHNICAL NOTE MES-041

CHAR MONTAZ PERMEABLE CROSS DAM PILOT SCHEME

June 2001

DHV CONSULTANTS BV

in association with

DEVCONSULTANTS LTD
SURFACE WATER MODELLING CENTRE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

1. SITE DESCRIPTION

1.1 Location, site selection and time schedule

An open cross dam is a dam that allows water to flow through, thus reducing the overall current velocities in the channel and increasing sedimentation. The pilot in Char Montaz is located in the southern part of the Meghna Estuary in the distributaries of the Tetulia River. The cross dam trial was built in the channel between the islands of Char Montaz and Char Rustam in the Bhola district. The coordinates of the location are 559516 m east and 429608 m north for the northern end of the dam and 559605 m east and 429522m north for the southern end. The location is shown in Fig-1.

This location has been chosen for its relatively easy conditions as far as width, depth, tidal currents, maximum head differences and accessibility during execution and monitoring was concerned. The Char Montaz open cross dam location has fulfilled most of these requirements, except that the distance from Dhaka was relatively large.
The implementation of the permeable cross dam lasted from February until May 10 1999. The monitoring of the project has continued until December 2000.

1.2 Soils

The soils as defined by Brammer (ref. 19) can be classified as saline calcareous alluvium. This is the same type of soil as in Haimchar. The deposits in the channels though are still continuously submerged and will only become suitable for agriculture in the future. The median grainsize is 0.018 mm in the channel as measured by MES.

1.3 History

This whole area is in the accretion zone of the Meghna estuary, see fig- A2. The development of the bank lines in the area from 1973 to 2000 indicates a rapid growth of Char Rustam and Char Burham. In addition, Char Montaz has seen a small increase in surface area.

Char Rustam has grown from 1730 hectare in 1973 to 5670 in 2000, see table 4.
The annual growth changed from 203 to 177 hectares per year between the 1973-1984 and the 1984-1993 period. The formation of land in the 1993-2000 period was only 14 hectares per year.

	Surface in hectares.
1973	1730
1984	3970
1993	5570
2000	5670

Table 1, Growth of Char Rustam

In 1973, the cross dam channel was wider and more to the North compared to 1984, see fig- A2. From 1984 to 2000, the southern side of the channel has been stable, but the northern side has shifted more to the south.

The north side of Char Rustam has seen continuous growth for this whole period, although the rate of accretion slowed down in the 1993-2000 period. The southwestern side of Char Rustam has experienced some erosion since 1984.
To decrease the rate of erosion by stabilizing the banks and diminishing flow velocities the Forestry Department has planted mangrove forest in the area, as can be seen from fig- A2. The red color indicates the location of the mangroves.

1.4 Bathymetry

The large-scale bathymetry can be seen from fig-A3. The cross dam channel is bounded by a distributary of the Tetulia River in the West and a small tidal channel in the North. The west channel has its thalweg on the other bank with a inimum bottom level of -9 m PWD. The northern channel also has its thalweg along the opposite bank, but it is only -7 m PWD.
The cross dam channel is relatively shallow. The deepest part is not more than -3 m PWD. This can be seen from fig-A4. Change in bathymetry due to the construction of the dam is presented in the monitoring section.

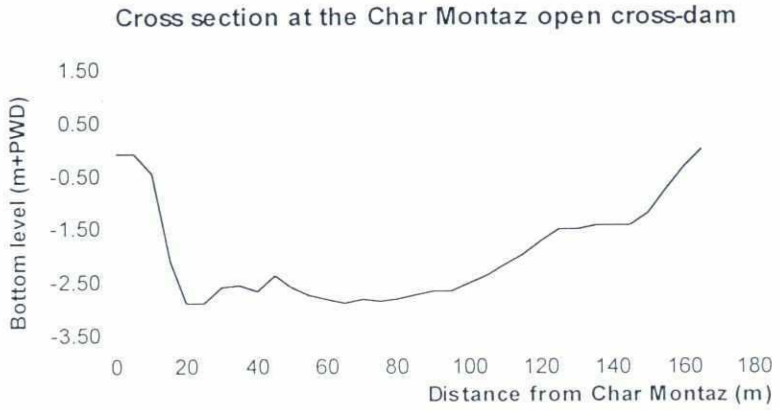


Fig-A4. Cross section at the Char Montaz open cross dam location

1.5 Flow

The channel knows a bi-directional current. The ebb current comes from the North and the flood current comes in from the South. No flow data were recorded.

The spring tidal range is 2.5 m in the dry period and 2 meters in the monsoon (from Galachipa station). Minimum neap tidal amplitude is 0.7 m in the dry period.

The head difference, as measured from the pressure sensors on both sides of the cross dam after completion of the installation, is maximum 0.5 meters. These measurements were done from May 26 to June 15 1999.

2. THE PILOT SCHEME

2.1 Objectives

The conventional method of cross dam construction in Bangladesh is to build a solid cross dam using earth-filled gunny bags with slope protections by use of concrete blocks through revetment work. During LRP projects designs have been prepared for Sandwip Cross Dam and South Hatia Cross Dam. South Hatia Cross Dam design does not include any provision to control erosion by current/wave action. In the design of Sandwip Cross Dam there is a provision of revetment work by concrete blocks. Cost of these concrete blocks was about 60% of the total cost of the cross dam it self.

During monitoring of the Haimchar and Khorki pilot schemes it was observed that synthetic bags filled with soil from local borrow pits were rapidly washed out by wave and currents. Similar will be the experience with gunny bags also. Further, gunny bags are less durable than synthetic bags under water. Even geobags manufactured with composite woven/non-woven fabric and filled with local soils although much more durable appeared to be gradually emptied under the constant action of waves or strong currents.

Based on these observations. synthetic bags may be used provided with a non-woven inner bag and filled with selected local sand if exposed to waves/currents for some time. Similarly geobags have to be filled with sufficiently coarse material to prevent gradual loss of fill material. Since coarse fill material is not available in the Char Montaz area. it has to be brought from far, thus increasing the cost of synthetic bags and geobags. As mentioned before wave protection with concrete blocks on fabric will also be very costly.

In order to reduce the overall cost of cross dam construction an innovative and cost effective design for cross dams has been developed. taking into account that the cross dam should not be damaged by wave action as long as sedimentation has not reduced the depth of the channel sufficiently. A few years after the closure, chars will have emerged in the channel that will dampen waves so that near the cross dam wave action will be limited. As soon as possible mangroves should be planted on the chars to reduce the wave height and to accelerate accretion so that the final earth dam can be built cheaply and in a safe place..

3. DESIGN

3.1 General bank protection design

Conventional principle of design normally followed in Bangladesh is a complete closure of the channel through constructing a solid cross dam..

Cross dam over tidal channels is designed as a closure dam with its core sections constructed through driving cluster of wooden bullahs and dumping of earth filled gunny bags. To protect the toe line including the berm and slope. a revetment is provided through placing/dumping of concrete blocks. Thus the cost of such solid cross dam goes very high.

3.2 The Pilot Scheme

With a view to reduce the construction cost of the cross dam the concept of gradual raising the river bed through induced accretion is used in the pilot scheme. Installation of a series of screens perpendicular to the flow initially with some opening in between will reduce the flow velocity and thus deposition of the coarser particles will occur. This will however cause increase in flow velocity through openings of the screens that will cause local scouring at downstream of the dam.

With the proceed of accretion process the flow through the dam can be adjusted through closing the opening in between the screens by flaps fitted with the screens. When the river bed will be raised about 2 meters along the dam to cover the sill portion. the flow through the screens may be completely closed through fixing the flaps. Thus the accretion process will be accelerated to raise the river bed sufficiently to construct a solid cross dam of small section over it.

To protect the riverbed from scour action a bed mattress is used to cover it upto certain distance both upstream and downstream of the dam as the channel is a tidal one and flow at both directions takes place alternately.

3.3 Design Description of Items

3.3.1 A - Frames

A-frames will be used to hold the screens in position against strong force of current flow. G.I. pipes. although 2.5 times more costly than wooden bullah. have been used as main members of the A-frames. This is because. from the experience of Khorki and Haimchar erosion control project it is learnt that bullah and bamboo cannot survive more than one season under water of dynamic forces as in the estuary.

Cross section of the channel shows minimum bed level of PWD-4 meter. The highest water level anticipated is 2.5 m PWD during short period of peak monsoon. Thus the height of the A-frame is determined to be 5.4 meter that will allow submergence and overflow of a portion of the dam during peak monsoon period. Size of A-frame will be adjusted according to the depth of bed level to attain an almost horizontal top level of the cross dam to give a better scenic view.

The arms of the A-frame will be made with 2 members 10 cm dia G.I. pipes. Both arms will be resting over anchor slabs at their bottom with a spacing of 4 meters. Cross connection will be made with 7.5 cm size u-channels of mild steel painted with anti corrosive paints (Fig-3). A pair of 7.5 cm size u-channels will be used both at top and bottom of the frame connected through nut-bolt system. A-frames will be installed at an interval of 1.5 meter connected at their top through a piece of M.S. angle 3" x 3" size.

3.3.2 Anchor base slab

The anchor base slab will be an RCC slab of size 1 m x 0.6 m x 0.15m doubly reinforced with 8 mm dia Mild steel rod 8 cm C/C both ways.

Arms of the A-frame will be attached to the base slab though a swivel joint to allow free rotation of the frame in all directions in case of uneven settlement of the base (Fig-4).

3.3.3 Bed mattress

The task of preparation and installation of bed mattress at Char Montaz was started with previous experience of such work at Haimchar and Khorki where maximum size of bed mattress laid was 15 m x 20 m. At Char Montaz Cross Dam the size of each bed mattress was selected to be 25 m x 50 m. The following reasons acted behind such selection.

a) More area of riverbed can be protected both at upstream and downstream by increasing the width from 20 meters to 25 meters. About 8 meters of bed mattress will be available both at upstream and downstream beyond the seal of the dam.
b) More length of the mattress will reduce number of lap joints. thus reducing the joint-failure risk.

A composite type of geotextile sheet each from woven and non-woven materials sewn together is used at bed mattress (Fig-2).

Initially bamboos at a spacing of 4 meters will be attached to the sheet. However; those will be released after laying at river bed.

Geo-bags of size 1 meter long and 25 cm dia made of composite type of geotextile. filled with coarse sand are used to stabilize the edges of the mattress. These are tied in two lines under water through diver.

Information about Geotextile materials

Item	Type of geotextile	Thickness mm (2 KN/m^2)	Mass/area gm/m^2	Tensile strength KN/m^1	Water permeability 100 mm water head l/m^2 sec.
Bed protection mattress	Woven propex 6284	1.10	330	65.0	14
	Woven propex 6288	1.70	500	100.0	18
	Non woven RIG-EDY 200.1	2.50	200	11.0	235
Geo-bags	Woven propex 6283	1.30	260	54.0	50
	Non woven RIG EDY 250.1	2.75	250	14.5	28

3.3.4 A frames screens

Vertical screens in between A-frames will be used perpendicular to flow to resist water passing through the dam. The size of screen for 5.4m high A-frames will be 1.2m x 3.6m. The height of each screen will be adjusted according to the height of A-frames. However, the width of screen in each case will remain as 1.2 m to provide 30 cm spacing in between screens to allow water to pass through (Fig.5).

Two pieces of 22 mm dia 6 mm thick PVC rods will be attached to the screen as per drawing to resist contraction of the screen during flow.

The screen will be attached to the cross channels of the A-frame both at top and bottom through two pieces of 7.5 cm dia G.I. pipes attached to the screen at its both ends. To avoid wear and tear action between the G.I. pipe surface and geotextile wrapping. an initial cover of the G.I. pipe is provided with another piece of composite geotextile sheet.

The attachment of the screen to the A-frame is done with nut and bolt system.

Geotextile material of woven propex 6088 type will be used for preparing screens. The specification of propex 6088 is similar to that of propex 6288. only difference is that 6288 is with loop and 6088 is without loop.

3.3.5 Ballast mattress

For initial ballast of the geotextile bed mattress earth-filled synthetic bags of 35 Kg wt. will be used. However. to prevent washout of the soil an inner layer of polythene sheet will be used. To lower the mattress at river bed initial dumping will be done at the rate on one bag/ m^2. Final ballasting will be done through dumping additional C.C. blocks of size 45 cm x 45 cm x 45 @ 1 no./m^2

To stabilize the A-frames ballasting will be done at their footings continuous along the dam alignment at a width of 8 meters. Initial ballasting will be done with earth-filled synthetic bags to provide a cover over the mattress to protect it form rupture through sharp edges of C.C. blocks.

Over this initial layer of synthetic bags C.C. blocks of size 45 cm x 45 cm x 45 cm will be dumped upto level below the lower cross channels of A-frames.

Care should be taken while dumping these blocks so that along midline of the dam where vertical screens will be fixed. the top level of block dumping should not touch the cross - channels. Otherwise there will be friction between the screen and C.C blocks damaging the screen. It is advised to lower the level of block dumping by 20 cm along mid line and raise it upto u-channel level at both upstream and downstream sides of the cross dam.

Block dumping should be completed prior to fixation of screens.

3.3.6 Connecting dike

At Char Bestin side there is a low dike near the dam that is used by local people as their footpath and rickshaw road. It leads to the Water Board high embankment (polder). The cross dam may be connected to the existing dam with 1.5m high. 1 m wide earthen dike of 1:1 side slope. Side slopes will be protected with concrete slabs.

At Char Rustam side there is no such embankment or high road. As such. an earthen dike will continue upto 80 meters from end of the dam. The section of the dike will be same as at Char Bestin side. Both the slopes will be protected with concrete slabs. Last end of the dike will be covered with C.C blocks to protect the tip from out flanking water pressure.

4. EXPECTED IMPACT

The channel for construction of cross dam at Char Montaz site flows between two islands Char Bestin and Char Rustam. Char Bestin is the name of part of greater Char Montaz where the cross dam will be built. The channel is a tidal one having its width about 200 meters and lowest bed level of PWD -3.00 m. Length of the channel is 5.5 Km.

Char Montaz is a stable island protected by a flood embankment. Permanent habitation is there. But on the other side Char Rustam is a comparatively new island and not yet sufficiently raised for construction of an embankment. The island has been brought under afforestation and thus the island is coming up gradually. Seasonal paddy crop grows at part of the island.

Construction of a permeable cross dam will reduce the flow velocity of the channel in between the two islands that will induce accretion in the area. Thus the bed level of the channel will be raised and expectedly within five years the channel bed will be sufficiently high to stop flow. Both the islands will be merged up into an integrated single landmass through siltation of the channel in between them.

5. COST ESTIMATE

The cost estimate can be itemized as follows:
1. Supply (Local and Foreign material)
2. Equipment
3. Manpower

Item	Foreign [NLG]	Local [Tk]	Total [NLG]
Supply	104.166	9.000.000	479.166
Equipment		2.070.000	86.250
Twin Hull Pontoon (20% of manufacturing cost)		1.085.000	45.208
Person Power		3.630.000	151.250
Total	**104.166**	**15.785.000**	**761.874**

6. IMPLEMENTATION

6.1 Implementation period

January to March, 1999.

6.2 Preparation and installation

6.2.1 Bed protection mattress

- Preparation of bed protection mattress

Bed protection mattresses, consisting of woven and non-woven geotextile materials, are sewn together by textile workers. The composite woven and non-woven material are imported on rolls with a length of 100m and a width of 5.2m. Five strips with a length of 50m are sewn together to prepare a bed mattress of size 25m x 50m.

The mattress consists of two types of woven geotextile. Propex 6284 is used on the sides of the mattress while a stronger Propex 6288 is used underneath the A-frame slabs (Fig.2.1) Non-woven material with a limited permeability prevents out-washing of sediment.

Bamboos are tied to the mattress every 4 meters over the entire width of the mattress to keep it in its stretched position.

The mattresses have been prepared on site at Hanarchar (Chandpur area) and were transported to Char Montaz by ship. Preparation of one bed protection mattress takes about 100 man-days.

- Installation of bed protection mattress

The mattress is carried to shore in a bundled form. Before slack tide it is unrolled on the water surface (Picture-1). The force of the current on the mattress is felt but does not pose a problem as it is tightly secured. On slack tide it is towed into position by the tender boat. Six moored small pontoons hold the mattress in place. It would be difficult to lower the mattress in right position in other than a slack tide condition (current velocities less than 0.1m/s).

From small rafts synthetic bags with inner polyethylene lining filled with local soil are dumped on top of the mattress to lower it. The filled bags weigh about 35kg.
Information about the bed protection lowering is as follows.

Bed protection (from Char Bestin side)	Installation date	Size	Tidal condition	Number of synthetic bags to lower the mattress
Number 1	16-02-1999	25m x 50m	High tide slack (12:00)	2500
Number 2	17-02-1999	25m x 50m	High tide slack (12:30)	4000
Number 3	21-02-1999	25m x 50m	Low tide slack (8:00)	2500
Number 4	22-02-1999	25m x 50m	Low tide slack (8:30)	2500

Installation scheme bed protection

While lowering the second bed mattress some synthetic bags are floating and carried away by wind and current because of the additional buoyancy force due to the trapped air in the inner polyethylene bag. To prevent this small holes are pinched in the bags so that air will escape. An additional amount of synthetic bags with soil is used to lower mattress number 2.
Each bed protection has a 5m overlap with the previously installed mattress.

Eight regular fishing boat anchors with a weight of 15kg. are attached to the mattresses. Additionally two lines of geobags are tied to the edge of the bed protection with nylon rope (Fig-2.1). The bags are made of woven geotextile with an inner bag of non-woven material. They are filled with 0.04m^3 coarse Sylhet sand.

In the days after lowering the mattress divers notice at several occasions that outer parts of the bed protection are 'flapping'. With the use of the tenderboat the mattress is pulled into its original position. Synthetic bags filled with local soil are dumped on top of the mattress to secure its position. Additionally more geobags are tied to the bed protection.

In the two months following the lowering of the bed protection 6350 concrete blocks (0.45m x 0.45m x 0.45m) were dumped scattered on the mattress. Additionally concrete anchor blocks (0.30m x 0.30m x 0.40m) are dumped next to the mattress and tied to it with nylon rope (Fig.2.1) to secure the edge of the mattress. The blocks sink into the riverbed pulling the edge of the mattress with it. The divers found it difficult to find the edge of the mattress because some areas were covered with a layer of silt of 10-30cm. Especially close to both shores silt deposited on the mattress. Anchor blocks are therefore tied to loops further from the edge of the mattress.

A view on the bed protection mattress on the Char Bestin side during low tide is found in (Picture-2).

To decrease the buoyancy force on the mattress and to enable the side of the mattress to adjust to the location of the soil when scouring holes emerge close to the mattress. attempts are made to remove the bamboo tied to the mattress. By this time however shellfish are attached to the bamboo and it was overgrown by saline plants. making it virtually impossible for the divers to remove it (Picture-3).

Both connecting the anchor blocks and removing the bamboo should be carried out soon after deployment of the bed protection. In the long term however this is not expected to pose any problems. The strength of the bamboo will most likely be affected by the natural growth and break under the pressure of the geobags and anchor blocks.

6.2.2 A-frames

- Preparation of A-frames

The A-frames consist of 2 galvanized 10 cm dia steel pipes which are connected to 2 concrete foundation slabs (1.0m x 0.6m x 0.15m) by a D-shackle and a nut bolt (Fig.4). The pipes are connected by a double steel U-channel 1.5 to 2m above the concrete slabs. The two channels are clamped to each pipe by two nut bolts. On the channel an adjustment is made to easily connect a D-shackle to hang the screen. Near the top of the frame. where the G.I. pipes meet. clamping U-channels have been provided similar to the middle beam.

Three types of A-frames are produced with sizes shown in table below.

A-frame type	Distance from concrete slab to middle beam	Distance from middle beam to top of the G.I. pipes	Total height of A-frame
Type A	2.0m	3.6m	5.6m
Type B	1.7m	3.4m	5.1m
Type C	1.5m	2.5m	4.0m

A-frame sizes

Eight skilled workers produced on average 9 A-frames each day. Production was not up to capacity.

- Installation of A-frames

The THP is kept in position by 6 small pontoons that are moored to the river bed by 250kg steel anchors. The two I-beams hanging between the hulls are equipped with connections for 9 A-frames with 1.5m spacing.

The small pontoons are positioned so that the THP can maneuver to lower two sets of 9 A-frames without having to reposition any small pontoons. After deploying 18 frames the anchors of 4 small pontoons are lifted and the pontoons are shifted to reposition the THP. Repositioning the small pontoons is sensitive to current. wind and waves. On several occasions delays occurred for this reason. Much depends on the skills of the boat driver and the person on the small pontoon handling the anchor. Increasing the length of the steel wire rope connecting the small pontoon and the THP will minimize the number of moves of the small pontoons.

The frames are fabricated on land and are transported to the THP on two rafts. made out of PVC pipes (Picture-4). One by one the frames are transported and lifted until 9 frames hang in the two I-beams of the THP (Picture-5). Transportation of the frames takes more time when the distance between the frame installation location and the shore increases.

This method of transporting the frames is sensitive to waves and high current velocities. At Char Montaz the distance from shore is rather limited (up to about 165m). Because installation took place in February. current velocities did not rise above 0.2m/s and did not pose any serious problems. Wave action was also limited.

When the frames hang in the THP. bamboos are tied to the G.I. pipes in longitudinal direction to ensure its stability perpendicular to the flow. The top of the frames are connected by a steel angle of 3" x 3" and two D-shackles. The concrete slabs are connected with chains. After lowering these chains are attached to the slabs of previously installed frames.

The THP is maneuvered into position so that the distance between the last installed frame and the first frame hanging in the THP is exactly 1.5m. The set of 9 frames is carefully lowered until the concrete slabs gain stability on top of the bed protection. The last previously installed frame and the first frame hanging in the THP are connected by a steel angle and two D-shackles. Divers put geobags filled with coarse sand between the concrete slabs of two different A-frames and tie them to the chains.

From February 20th to March 4th (13 days) 110 A-frames were installed creating the cross dam at Char Montaz (Picture-6). The last A-frames. installed with the THP. on the Char Rustam side are shown in Picture-7. Installation took place regardless the tidal condition. Some frames are manually installed because of limited water depth.

Date	Day number	Manually installed A-frames	A-frames Installed with THP	Total number of A-frames installed
February 20	1	-	9	9
February 21	2	-	-	9
February 22	3	-	8	17
February 23	4	-	9	26
February 24	5	-	9	35
February 25	6	-	9	44
February 26	7	-	9	53
February 27	8	-	9	62
February 28	9	-	9	71
March 1	10	3	9	83
March 2	11	-	15	98
March 3	12	10	-	108
March 4	13	2	-	110

Installation schedule A-frames

In Appendix-3 is indicated which installed frame is of which type. Distances from A-frame slab to middle beam and from middle beam to the top of the frame are provided. The changes in A-frame design become apparent when looking at the level of the top of the installed A-frames.

On March 2 an attempt is made to lower two sets of A-frames. Positioning of the THP is completed on March 1. Transportation of A-frames from shore to the THP. a distance of about 165m. determines the progress. It takes about 7.5 hours to lower the two sets. The second set consists out of 6 frames providing space between Char Rustam and the last installed frames to turn the THP away from the cross dam.

Transportation on the PVC-pipe rafts is slow and vulnerable to waves and current. Using a flat top pontoon with provisions to accommodate 9 frames in standing position will make the process less dependent on weather conditions. quicker and easier for the THP crew.

Activities on the THP are carried out by one crew. More than one crew is required when deploying two sets of frames routinely.

Immediately after installing A-frames synthetic bags with an inner polyethylene bag filled with local soil are dumped on top of the newly installed concrete slabs to ensure stability. The synthetic bags are transported by country-boat. About 700 bags (40/m^3) are dumped in each gap between two A-frames.

Two layers of concrete blocks of size 0.45m x 0.45m x 0.45m are dumped on top of the synthetic bags during the following two months. About 35-40 blocks are initially deployed between two frames. Bamboo sticks are used to verify the level of the concrete blocks and to check if any areas with considerably less blocks are present.
The underwater dike which is formed increases current velocities locally. No considerable scouring around the mattress is observed.

During the two months of casting and dumping concrete blocks at least two ships have had nightly collisions with the structure. The damage occurring is shifting of the top double U-channel which connects the two G.I. pipes on the top of the A-frame. On the Char Rustam side about 13 frames are tilted. Additional concrete blocks are dumped near the frames. In the middle of the river about 5 A-frames are affected.

To correct the shape of the frames one G.I. pipe is pulled horizontally while hitting the double U-bar to shift it vertically. The nut bolts are retightened. After repair it becomes obvious that the A-frame slabs have not moved in the collision. Nightly collisions can be prevented by hanging lamps in the A-frames on both sides of the screens as well as having watchmen on duty each night.

Bamboo is scarce in the area. Most bamboo crossbars are stolen. Additionally one steel top angle has disappeared. Some A-frames tilt slightly to the Char Rustam side. To prevent this movement the stability of the frames in the direction of the cross dam should be improved in future design. This is possible by installing diagonal G.I. pipes between adjacent frames in several locations along the length of the cross dam.

6.2.3 A-frame screens

❑ Preparation of A-frame screens

The screens are made out of geotextile. of type propex 6088. Top and bottom are connected to a steel G.I. pipe (Fig.5). A cover of non-woven geotextile material is put around the G.I. pipe. It takes one person eight days to produce a screen (Appendix ....). Most preparations are carried out in Hanarchar.
The spacing in between two screens is 0.3m that may be closed through use of the flaps as per requirement.

The table shows the quantity of screens fabricated and their height. 4 extra screens are produced just in case. These are noted between brackets. The location of the screens becomes clear in Appendix-4.

Type	Height	Width	Quantity
1	2.1m	1.2m (with flap: ±1.75m)	3
2	2.2m	1.2m (with flap: ±1.75m)	1
3	2.4m	1.2m (with flap: ±1.75m)	4
4	2.5m	1.2m (with flap: ±1.75m)	29 (+2)
5	2.7m	1.2m (with flap: ±1.75m)	1
6	3.0m	1.2m (with flap: ±1.75m)	9
7	3.2m	1.2m (with flap: ±1.75m)	1
8	3.6m	1.2m (with flap: ±1.75m)	61 (+2)
		Total	109 (113)

Quantity of each type of screen

- Installation of A-frame screens

The screens are installed from May 4 to May 10. 1999. First they are connected with the topside of the frames using D-shackles. Steel wire rope (D = 3mm) connects the shackle with the bolt preventing them from being un-tightened. Steel wire rope is also attached to the shackles holding the steel top angles between the A-frames. These activities are executed regardless the tidal condition.

During slack tide divers connect the bottom G.I. pipe of the screen with the A-frame. Whenever concrete blocks prevent the bottom side of the screen to move freely these are replaced by several divers. Natural growth creates sharp edges on the blocks. making them difficult to handle. Gloves made out of non-woven geotextile works well. The sharp edges are not likely to damage screens because contact between screens and blocks has been minimized. Some skilled workers are able to connect the bottom side of the screen to the A-frame at low tide.

In some locations. like at the Char Rustam side of the dam where many blocks were dumped after the ship collision. a lot of time is spent removing or sometimes crushing the blocks. Replacing blocks in the deeper middle part of the river is difficult. Several times divers do not succeed. In these cases chains are used to overcome the distance between the screens and the frames.

One screen is found damaged and has been replaced. It has a longitudinal cut in the middle of the screen of about 20cm. It is unknown whether it is damaged in Char Montaz or in Hanarchar. Dumping of concrete blocks needs close supervision. It can be carried out more accurately with the help of divers who perform regular checks and give directions. As is done with the last 250 blocks (0.45m x 0.45m x 0.45m) which are dumped on the upstream side while installing the screens.

Concrete blocks with size 0.3m x 0.3m x 0.4m are deployed in gaps close to the screens. 700 geo-bags are pushed into the smaller gaps between the concrete blocks near the bottom side of the screens. Pictures 8 and 9 show the Char Bestin side of the cross dam and the entire completed dam respectively.

On May 9 and 10 the maximum water level difference between the upstream and downstream side of the dam is about 13cm. Despite the neap tidal condition confidence is gained in the stability of the structure when resisting water pressure. The flaps are closed on May 10. When in a later stage the stability of the A-frames is threatened the gaps can be re-opened by removing the flap (temporarily).

The effects of the dam are obvious. Close to the dam water flows through the gaps between concrete blocks. 30m from the dam however flow velocities are highly reduced. Up until three days after closure of the cross dam scouring holes close to the mattress are not observed.

6.2.4 Connecting dikes

On the Char Bestin side the dam is connected to an earthen dike. After 20m the dike makes a 90 degrees angle towards an existing low dike. Both the dike and walking path are about 1.5m above ground level. Both sides of the 40m dike are protected by concrete slabs.

Due to limited slope in between the river bed and adjacent land the earthen dam on the Char Rustam side has a length of 80m. The 50m closest to the A-frames are protected by concrete blocks and concrete slabs on both sides. The last 30m is unprotected. The top level of both dikes is the same as the level of the walking path on the opposite side of the river.

Soon after construction it was noticed that rats dig small tunnels in the earthen dikes. This is not expected to undermine stability of the dikes.

7. MONITORING SURVEY AND EVALUATION

7.1 Monitoring

After installation of the Char Montaz cross dam the behavior of the structure as well as the accretion in the closed off channel has been monitored regularly. Field visit reports have been filed in the MES office. Some repair work has been done until the end of 1999. thereafter no more funds were available for the necessary repair.
After completion of the installation works the cross dam has been guarded by local people paid by the project until the end of the year 2000.

The following was observed during monitoring:

- The clamp connections of the A-frames slipped. As much as possible the A-frames have been adjusted as per design but this was not always possible.

- At the foot of A-frame a concrete slab is connected through a hinge joint. A number of A-frames has subsided at this footing. This may have been caused by consolidation under increased loading of the soft muddy bottom of the river channel. Another cause will have been washout of the fine soils through the composite bed mattress or through holes punched in the geotextile by the sharp edges of concrete blocks.

- A number of the screens have been more or less seriously damaged but these screens could be repaired or replaced easily in 1999. The rope used for fixing of the flaps deteriorated rather quickly so that several flaps broke loose.

- The connection of the steel end pipe of the screens to the A-frames started breaking at the bottom end after more than a year. Apparently the connection was weak and was further weakened by corrosion of the metal parts in the saline water during the winter season.

- The maximum head difference measured across the dam was about 0.35 m. The strength of the screens was sufficient to bear this loading by water pressure.

- At high water levels the cross dam overtopped over a length of 10m – 20m where the height of the frames by mistake had been reduced abruptly during installation. This overtopping was not harmful to the structure

- The cross dam was not damaged when a cyclone passed the southwestern part of Bangladesh in October 2000. Wind speeds between 70 and 90 km per hour have been measured near the cross dam.

- Before a number of screens broke loose at the bottom. very limited scouring was found on both sides of the A-frames. However after some holes opened up as mentioned above, scour holes developed with a depth of about 3m below the original bed of the river channel. The most extensive scour occurred during incoming tide.

- One deep scour hole is found where the cross dam may overtop but it was noticed that at the same location 2 screens had been displaced and the flow through the hole was quite strong.

The accretion has been monitored by very accurate echo sounding before and after the monsoon flooding. The result is a steady increase of the volume of sediment deposits which is very well noticeable at both ends of the closed channel. At the southwestern end a new char has been accreted and was already brought under cultivation by the local people. The results of the surveys are given in Appendix –1.

7.2 Evaluation

Permeable cross dam at Char Montaz has been quite successful in acceleration of accretion in a tidal channel. During two monsoon periods and one winter season a volume of 2.200.000 m^3 has been deposited mainly at both ends of the closed channel Fig-6. shows the results of detailed bed level measurements in areas where accretion was expected.

In the same period natural accretion would have taken place also. in particular at both ends of the channel as was observed before construction of the cross dam. However it was also observed that the outer bank still eroded. an indication of relatively strong currents. Taking into account the accretion that would have occurred naturally. it is estimated that a net volume of 2.000.000 m^3 has been deposited as a result of cross dam construction.

A detailed analysis of the sedimentation processes is not possible because of lack of data. It was not possible within the scope of MES II to continuously measure sediment concentration as well as velocities in the closed off channel. The permeability of the cross dam is also not known.

8. OVERALL IMPACT AND LESSON LEARNED

8.1 Overall Impact

Construction of Char Montaz cross dam across a tidal channel has induced accretion as anticipated. The river bed has raised up to about 2 meters height within 2 years of construction of the dam and the process will continue if time to time maintenance of the cross dam is done.

Emergence of new land in the estuary brings hope & aspiration to the landless people, specially to those who have taken shelter in the area as pauper after losing their land in the eroding areas of islands.

Construction of the cross dam and rapid accretion in the river bed has caused navigation problem for Galachipa bound launches those used to ply over this channel. However, the local people have solved the problem through selecting an alternative route for the purpose.

The local people have expressed their deep satisfaction observing the rapid induced accretion over the channel that will eventually be filled-up to connect both Char Bestin (Char Montaz) and Char Rustom to create a single land mass. This additional land of more than 150 hectares will be added to the fertile agriculture land around and part of it may be used as homestead also.

With this hope in mind the local people have co-operated during execution of the project. They expect more such small cross dams to be built up to connect islands in the area to raise more land for agriculture and dwelling purpose.

8.2 Lessons Learned

Lessons learned from installation of the cross dam are listed below:

- The cross dam has functioned as anticipated. The flow through the dam was relatively small even after a number of screens got loose. Sufficient accretion has taken place at both upstream and downstream ends of the channel. Within 20 months of installation a total volume of 2,200,000 m^3 of accretion has developed in the channel of length 5.5 Km (Appendix-6). However, no accretion is observed near the cross dam alignment creating a pool in the area. The cause may be that the opening in between the A-frame screens is to small allowing much flow through bottom seal of the dam.

- The A-frame design consisting of GI pipe clamped together needs revision. The clamps slipped and a number of A-frames pulled out of true. The A-frame was made out of 2 nos. 4" dia G.I. pipes as its two arms (Fig-3). At top of the pipes they were connected through use of a pair of U-channels bolted together to press the G.I. pipes. No bolt connection was applied through drilling holes in the pipes considering reduction of their strength. But this system caused problem to the structure as was observed during monitoring.

  While there was a horizontal force from flowing water the downstream pipe slipped up and thus the stabilization of the dam was affected (Picture-10). A nut bolt connection with a drilled hole through the G.I. pipes will solve this problem.

- The footing of the A-frame may have been too small or unequally ballasted with concrete blocks.

- Based on these observations it is deemed advisable to redesign the A-frames with enlarged footings to transfer the loads (head differences and waves) acting on the geotextile screens to the foundation. The size of the present footing under A-frames is 1 m x 0.6m x 0.15 m (Fig-4) where the spacing in between A-frames is 1.5m.

  The footing may cover the full distance between the A-frames and the dimension of the footing across the dam also may be increased.

- The GI pipe and other steel parts were liable to corrosion in the brackish to saline water in the estuary. Some connections appear to have broken for this reason.

  The screens were attached to the A-frame through use of two mild steel plates. Corrosion was observed on those mild steel attachments. Avoiding use of any mild steel or painting them with anti corrosive paints may solve the problem. Such paint may be applied to all G.I. members also.

- Since part of the A-frame may have been pulled out of true because of wash out of the soil under the footings measures have to be taken to reduce this risk.

  Use of double layer of bed mattress along the dam alignment and staggering the overlap joints in between mattresses of both layers will reduce this risk.

- Ripping of the geotextile by sharp edges of concrete blocks or slabs should be prevented as much as possible by rounding off sharp edges or by locally doubling the geotextile.

  Smooth surfaced circular or elliptical concrete blocks roll down or slip easily. Proper anchoring without sharp edge of blocks can be achieved through casting of concrete cubes with fillet at edges and corners. It should be kept in mind that inter anchorage of concrete blocks plays a vital role against any force effective for their displacement. The edges and corners of concrete blocks act as inter anchoring elements in between them.

- During execution of the works much more attention has to be paid to dumping as per design. Detailed planning of block dumping., strict supervision of dumping as well as detailed recording of number and location of dumped blocks are essential to ensure that the works are carried out according to the design.

- All bamboos used to straighten the bed mattresses during installation have to be removed after initial ballasting so that bed mattress can follow the bed profile of the channel to cover it properly.

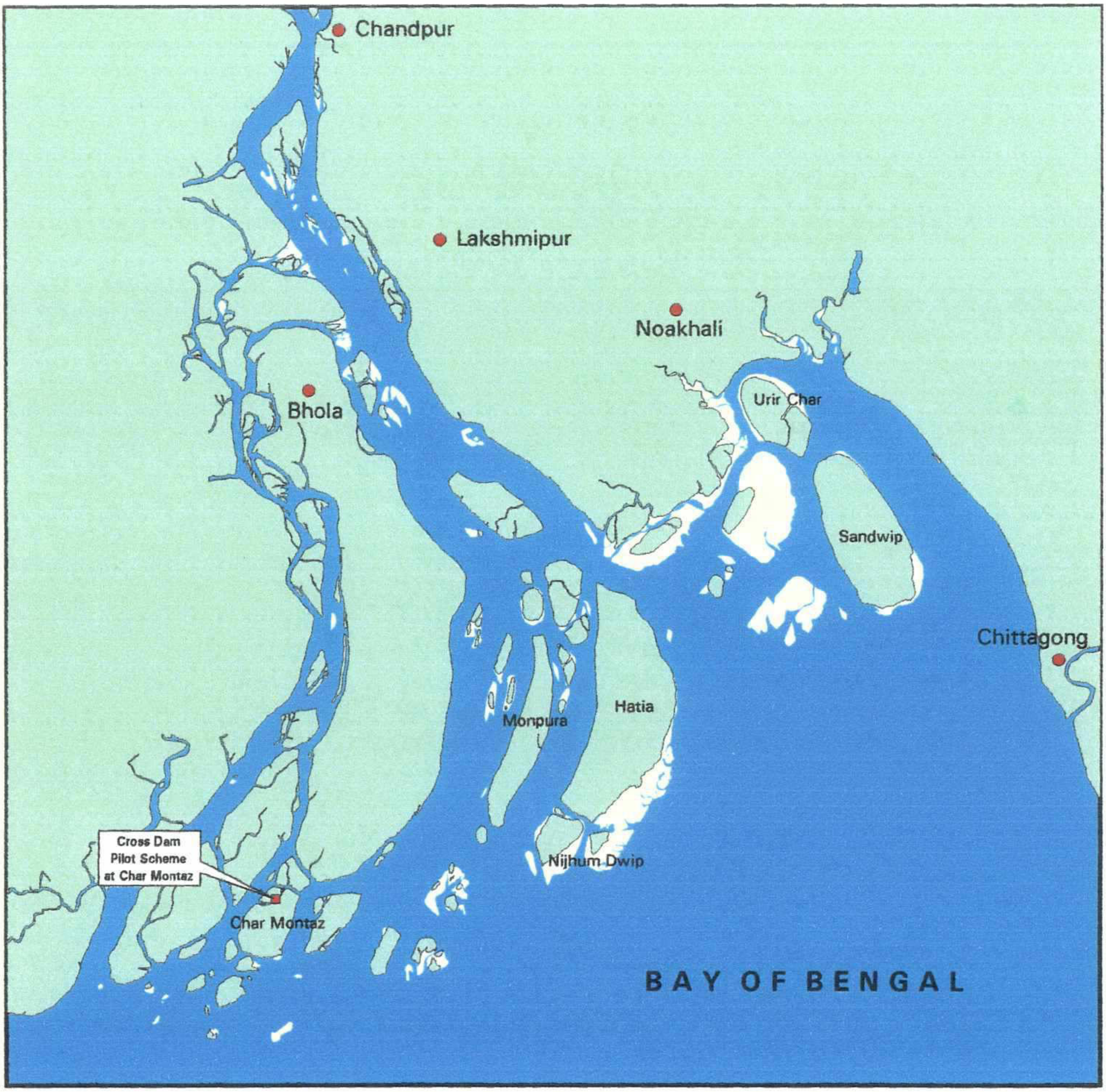
- The edges of the bed mattress have to be ballasted as per design

- Independent checking of the under water components is required to ensure execution as per design
- Special attention should be paid to secure the overlap in the bed protection mattresses as well as proper ballasting in the area of the overlaps.
- The design of the geotextile screens has to be strengthened and improved in particular when larger head differences and stronger waves are expected than prevailing at Char Montaz. As much as possible stitching of the screens should be done by machine to improve the quality and strength of the joints.
- To prevent stealing of the above water parts of the cross dam sufficient day and night guards should be appointed.
- Flat top pontoon should be used for carrying A-frames from shore to installation point.
- Diagonal pipe connection should be attached to every alternative group of 3 A-frames to prevent tilting of the dam.

FIGURES

Location map of pilot scheme at Char Montaz

Figure - 1



Legend:

- Land of 2000
- Mudflat
- Water body
- Location of Pilot Scheme(s)
- District HQ

MES II Meghna Estuary Study - II

10 0 40km

SCALE

Prepared by: GIS/RS/CAD Section of Meghna Estuary Study II

Note: Bankline were digitized from the Landsat TM imagery of January 2000

File- E:\MES-II\Civil\Emdad\Montz-loc.cdr

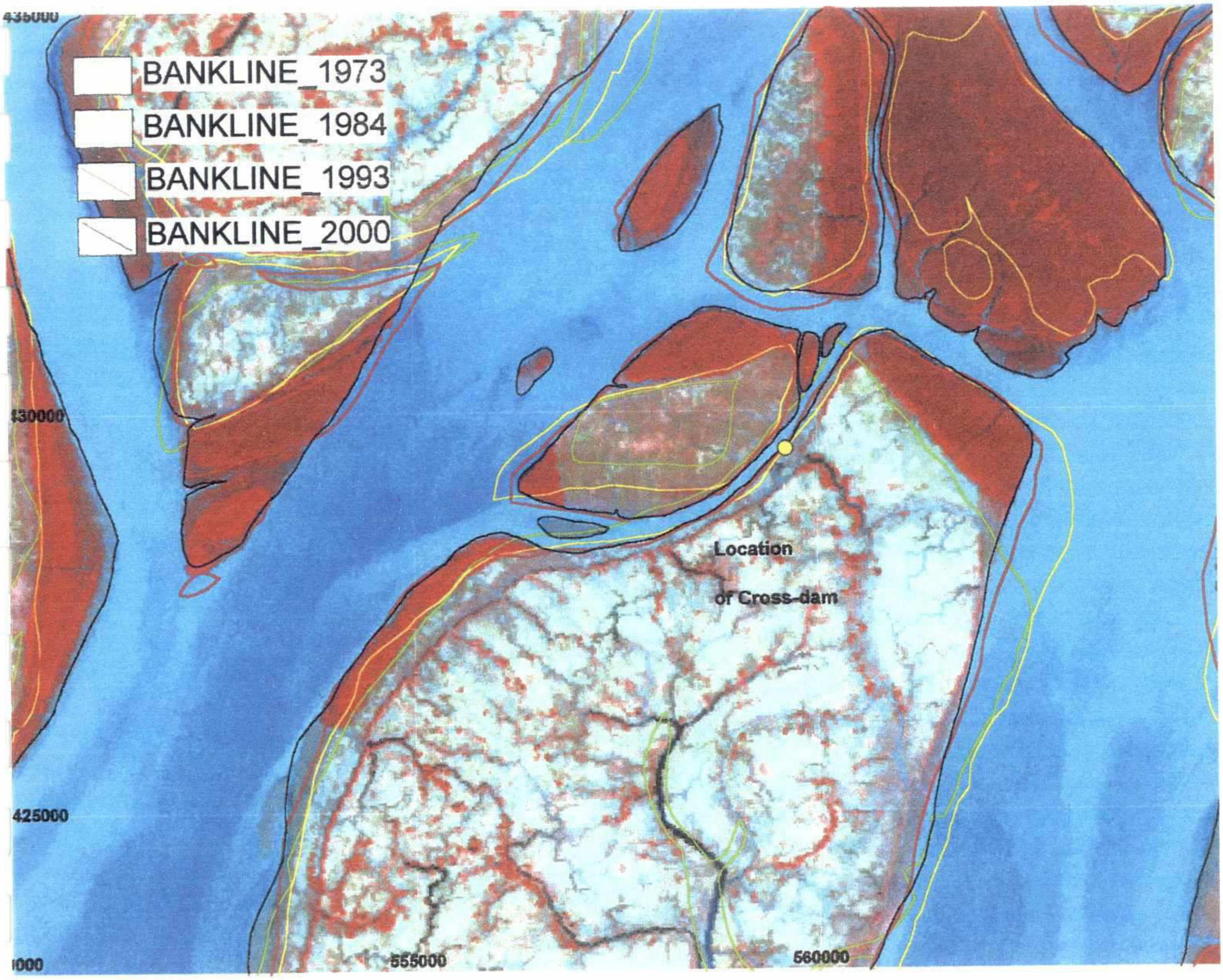


Figure A 2: Bankline changes in different years at Char Montaz

Figure A3. **Bathymetry at Char Montaz 2000**

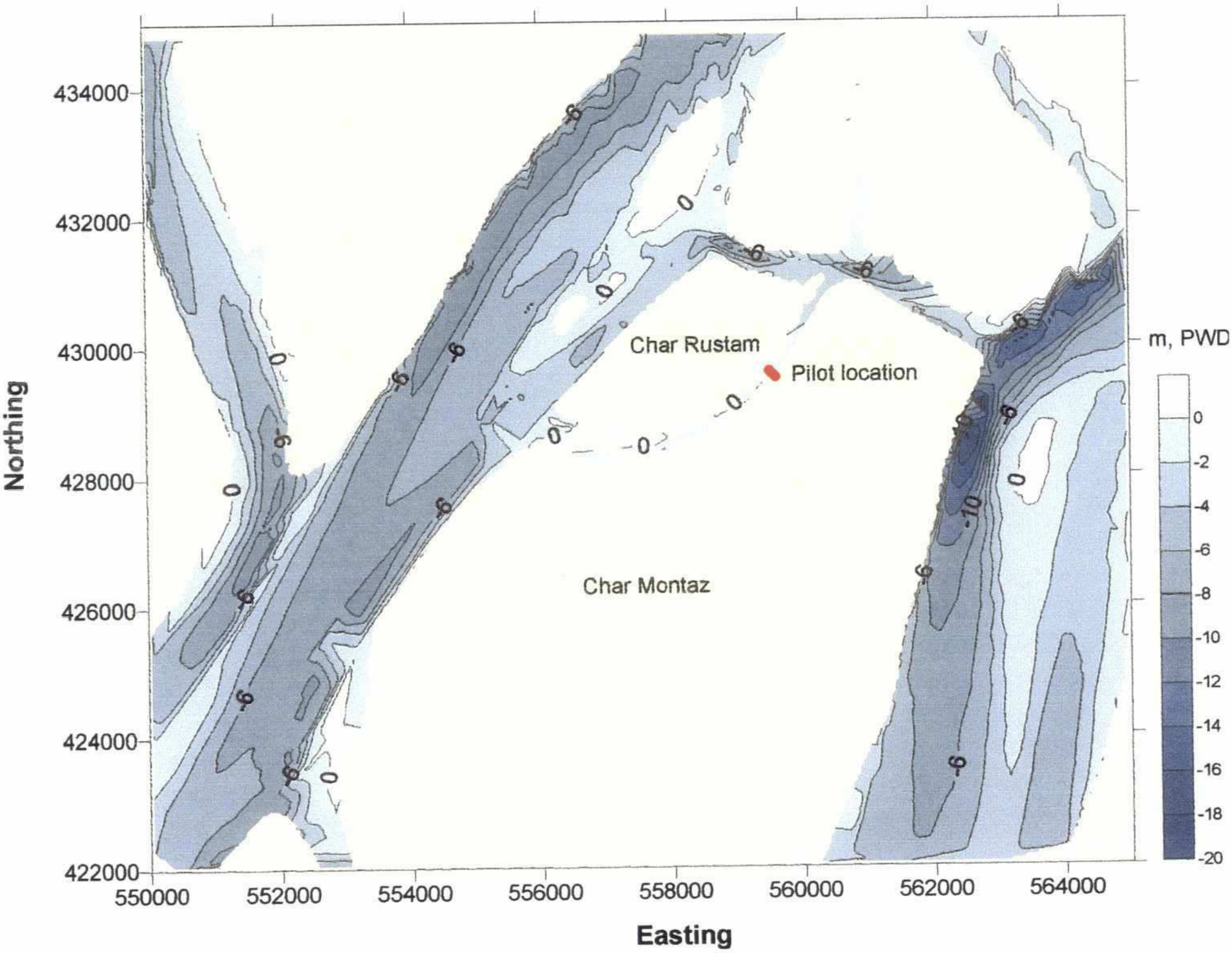


Figure 2 : BED PROTECTION MATTRESS FOR CHAR MONTAZ CROSS DAM

Figure - 2

File D:\Sanden\Geo mats dwg

Figure - 2.1

Figure 2.1: BED PROTECTION MATTRESS FOR CHAR MONTAZ CROSS DAM

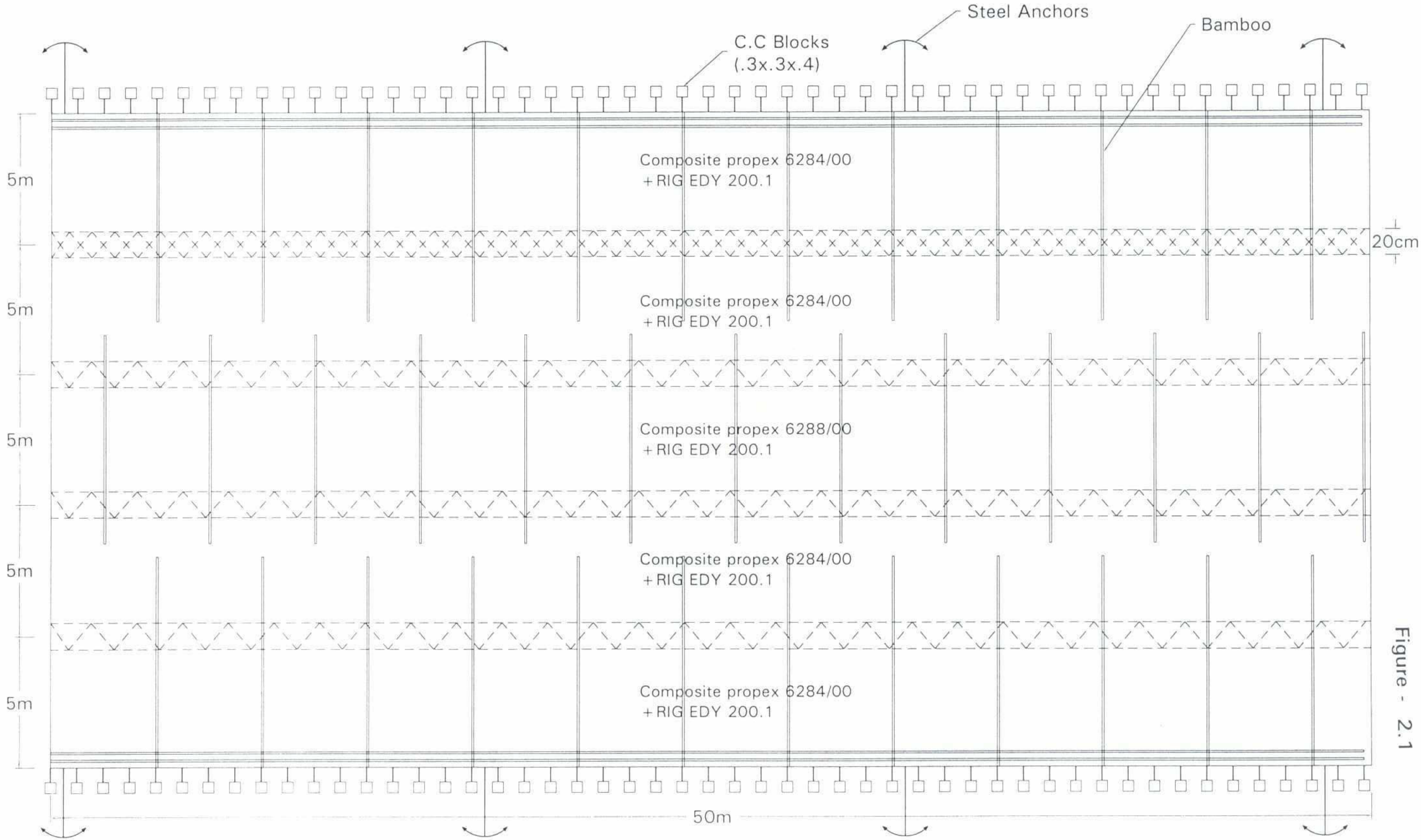
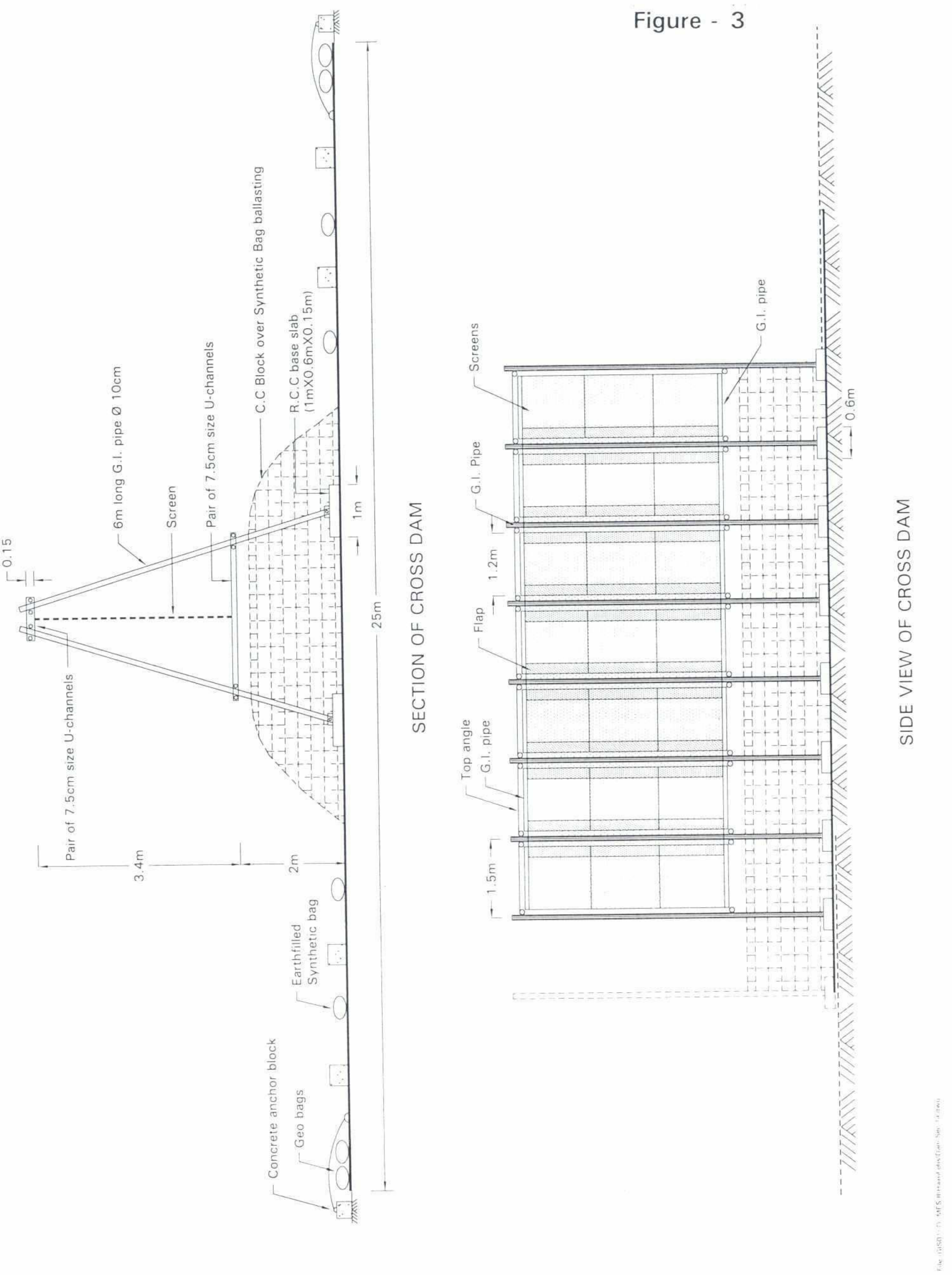
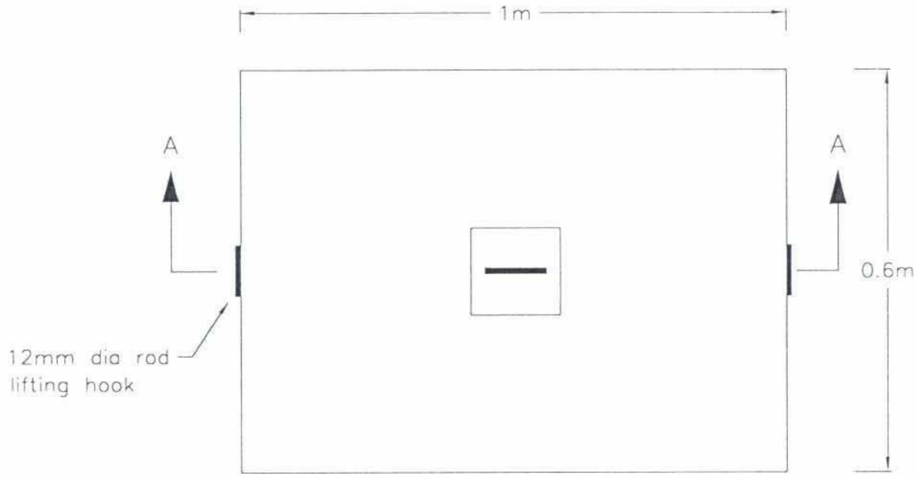


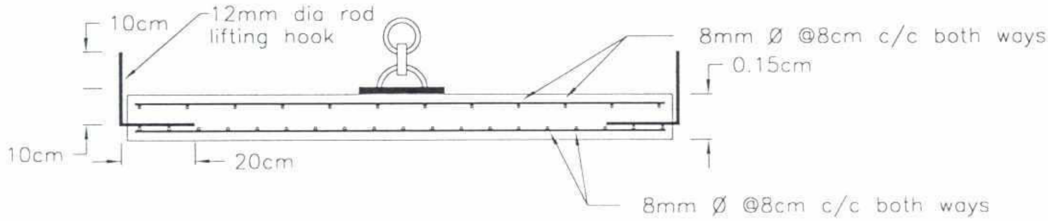
Figure 3 : Section and side view of Char Montaz cross dam



DESIGN OF CONCRETE BASE SLAB
(For A-Frame footing)



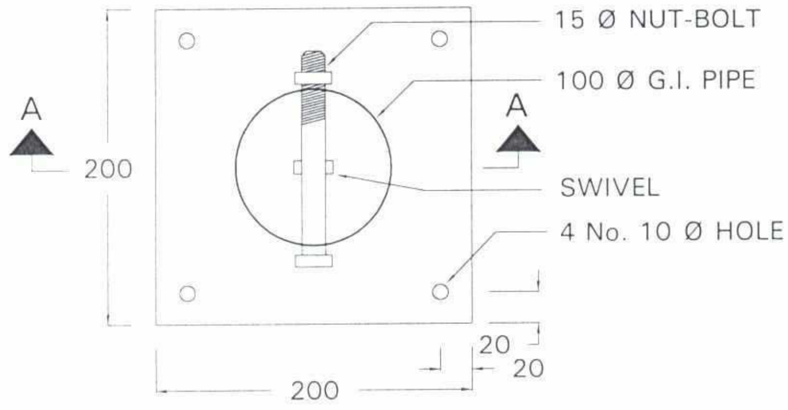
PLAN



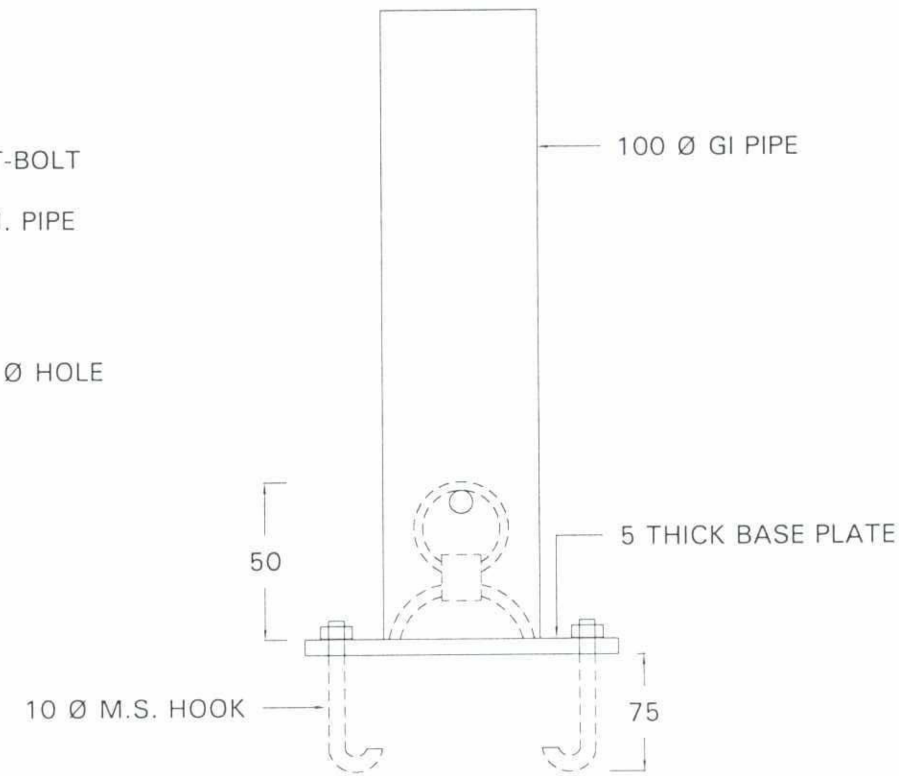
SECTION A-A

Note: Special anchoring system to be provided

A-FRAME ANCHORING DETAIL

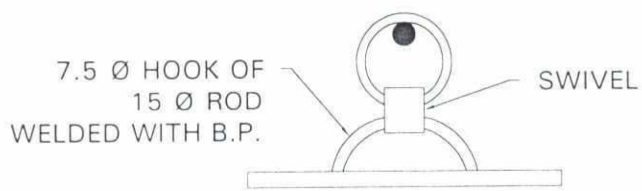


10 THICK BASE PLATE
PLAN



SECTION A-A

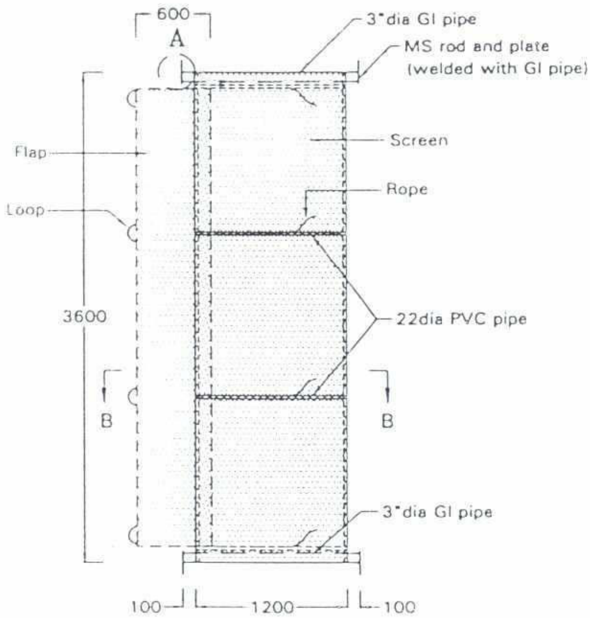
NOTE: ALL DIMENSIONS ARE IN MM EXCEPT OTHERWISE MENTIONED



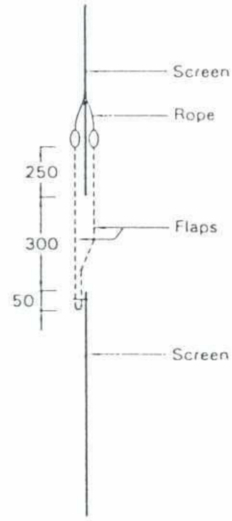
DETAIL OF ANCHORING

Figure - 4.1

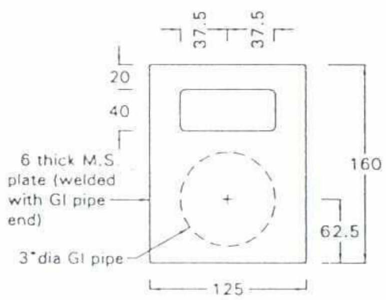
Figure 5: GEOTEXILE SCREEN FOR A-FRAMES IN CHAR MONTAZ CROSS DAM



GEOTEXTILE SCREEN FOR 6m A-FRAME

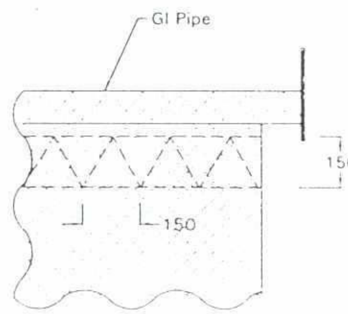


SECTION OF B-B



DETAIL OF 'A'

SIDE VIEW OF SCREEN (6m A-FRAME)



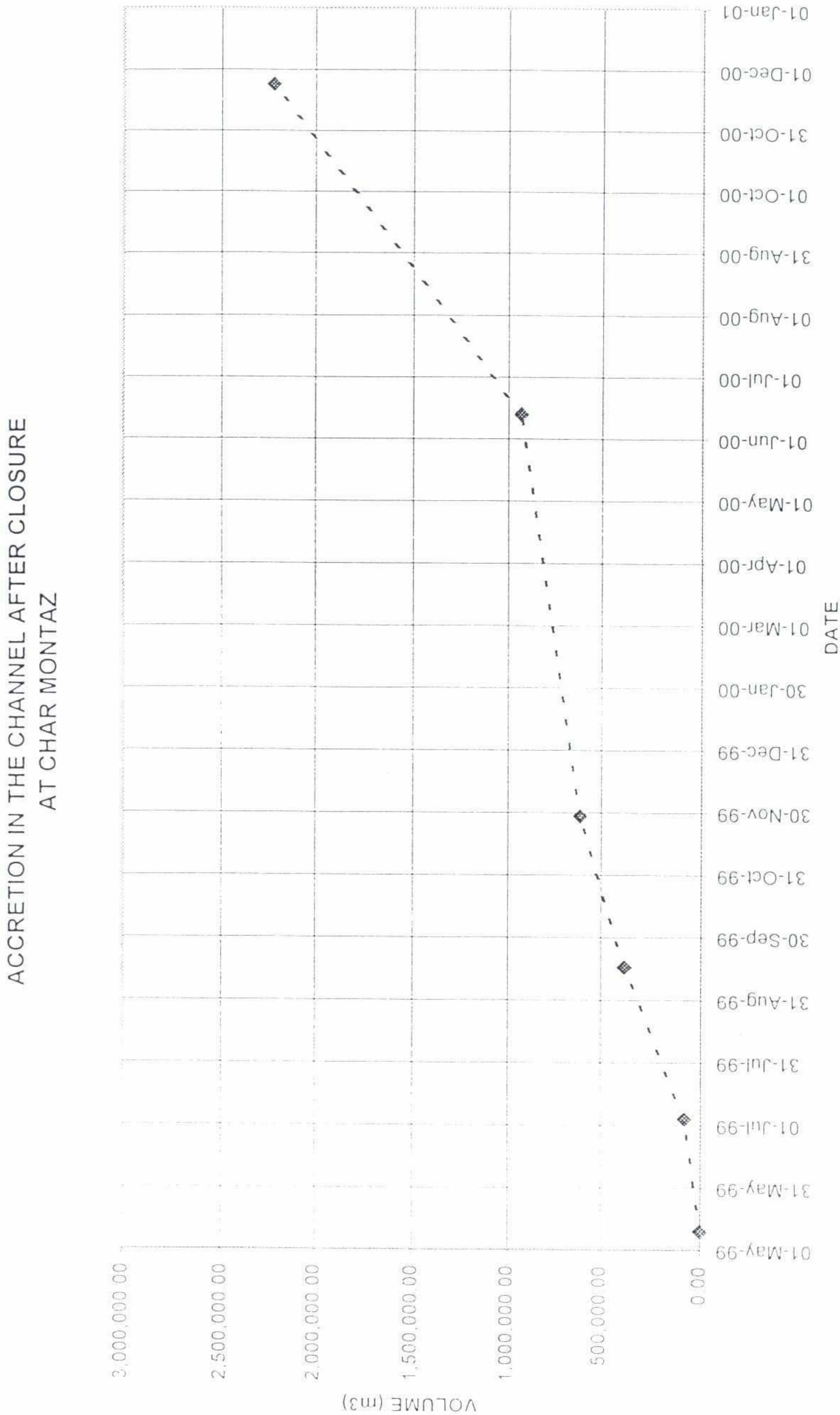
DETAIL OF ATTATCHMENT OF GI PIPE WITH GEO-TEXTILE THROUGH SEWING

Note: * ALL DIMENSIONS ARE IN mm EXCEPT OTHERWISE EXCLUSIVELY MENTIONED
* 8mm THICK NYLON ROPE SHALL BE USED ALONG EDGES OF SCREEN DURING SEWING.

Legend:
- - - - - - - - LINE OF SEWING

Figure - 6

Accretion in the tidal channel at Char Montaz after closure

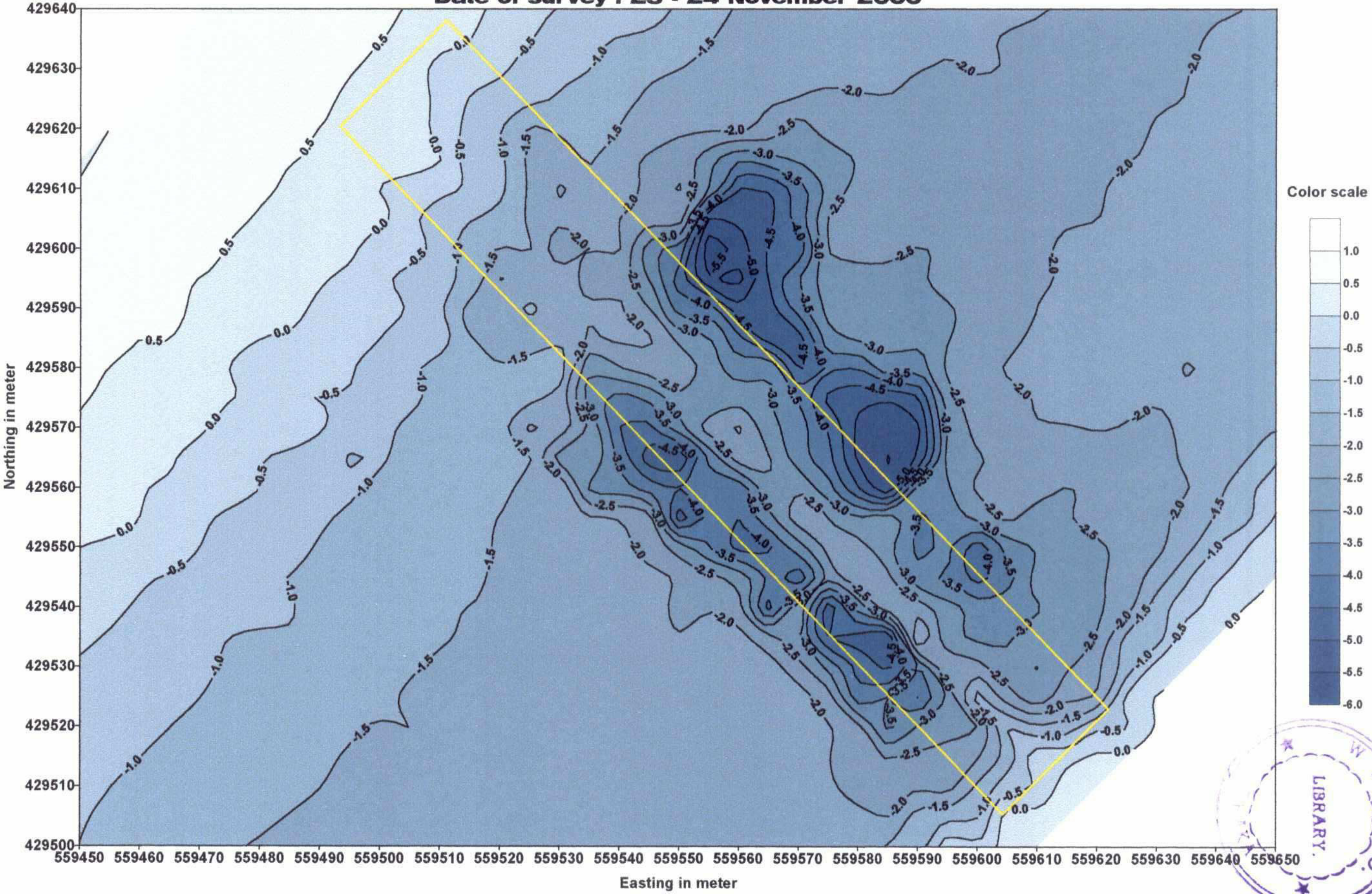


APPENDICES

Appendix-1

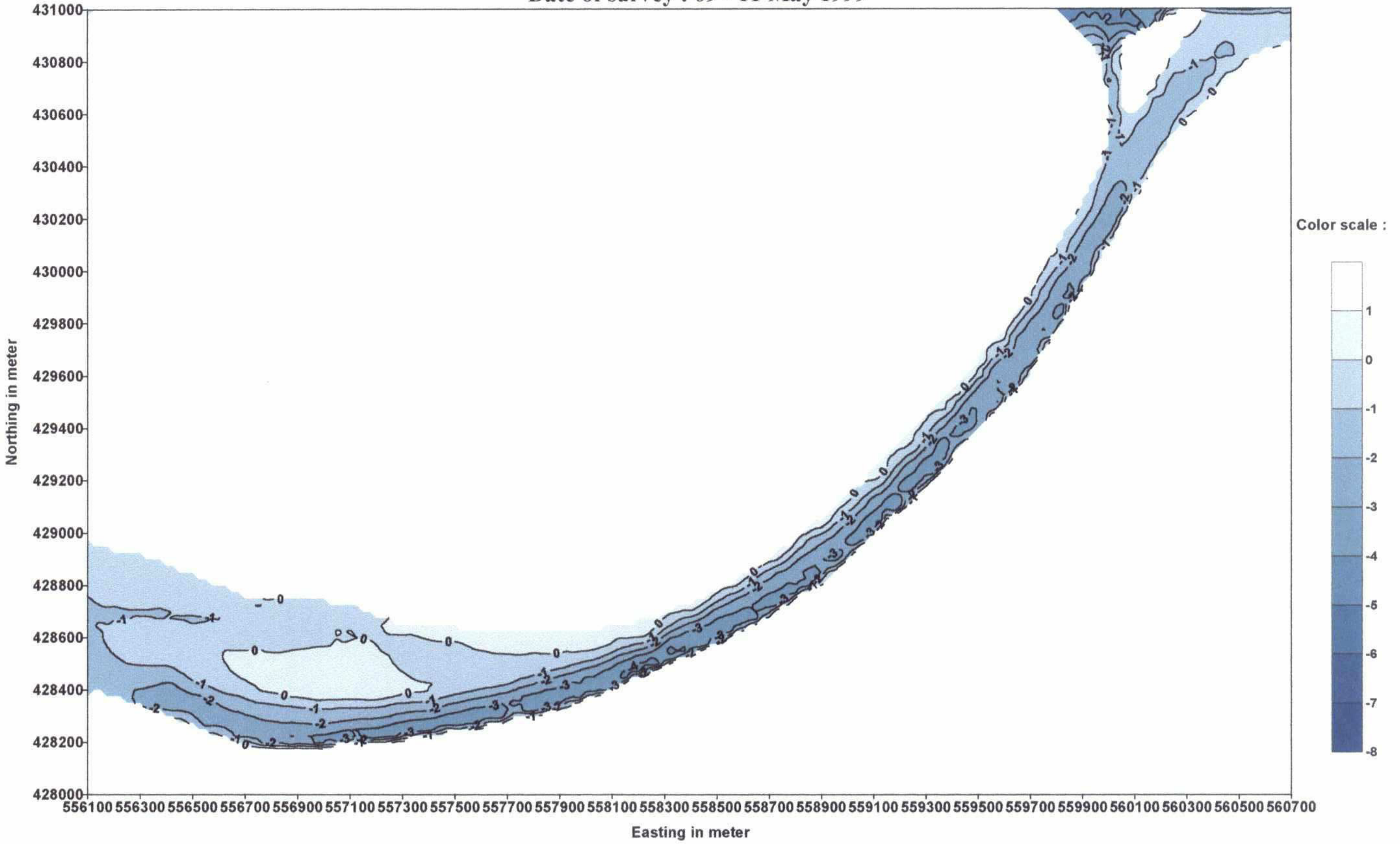
Char Montaz Permeable Cross Dam
Bathymetric Maps

Location : Char Montaz
Date of survey : 23 - 24 November 2000

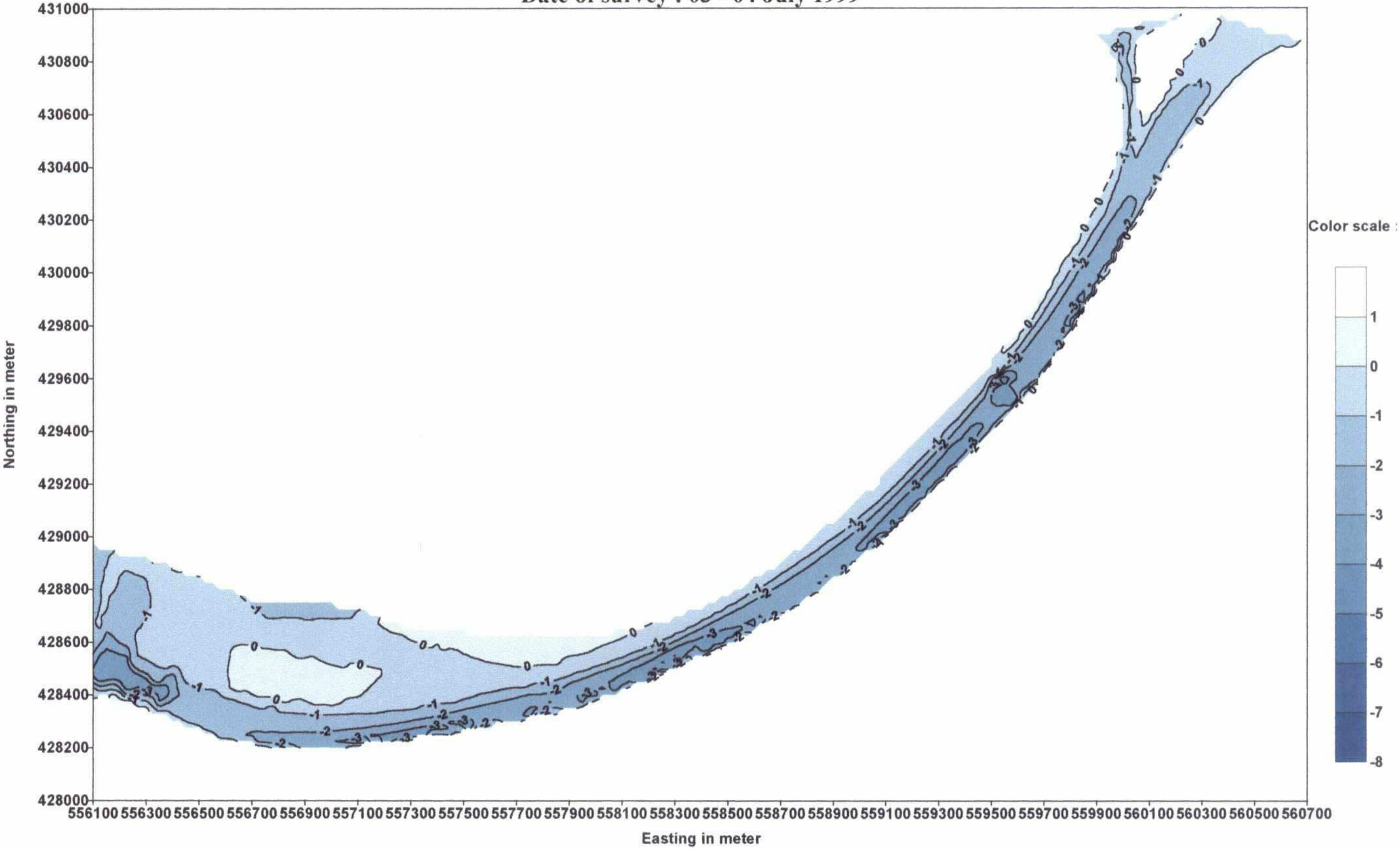


08

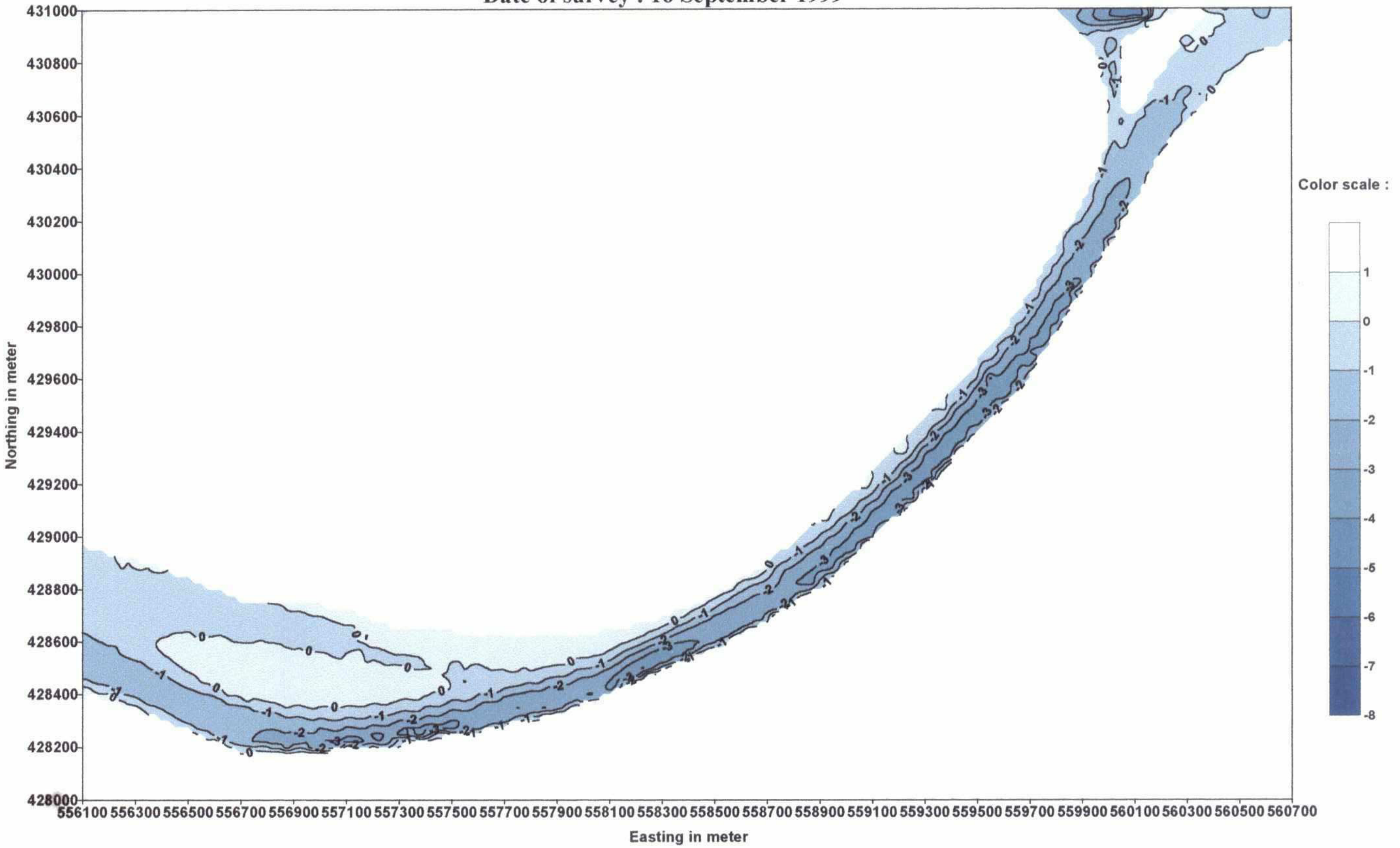
CRUISE 4
Location : Char Montaz
Date of survey : 09 - 11 May 1999



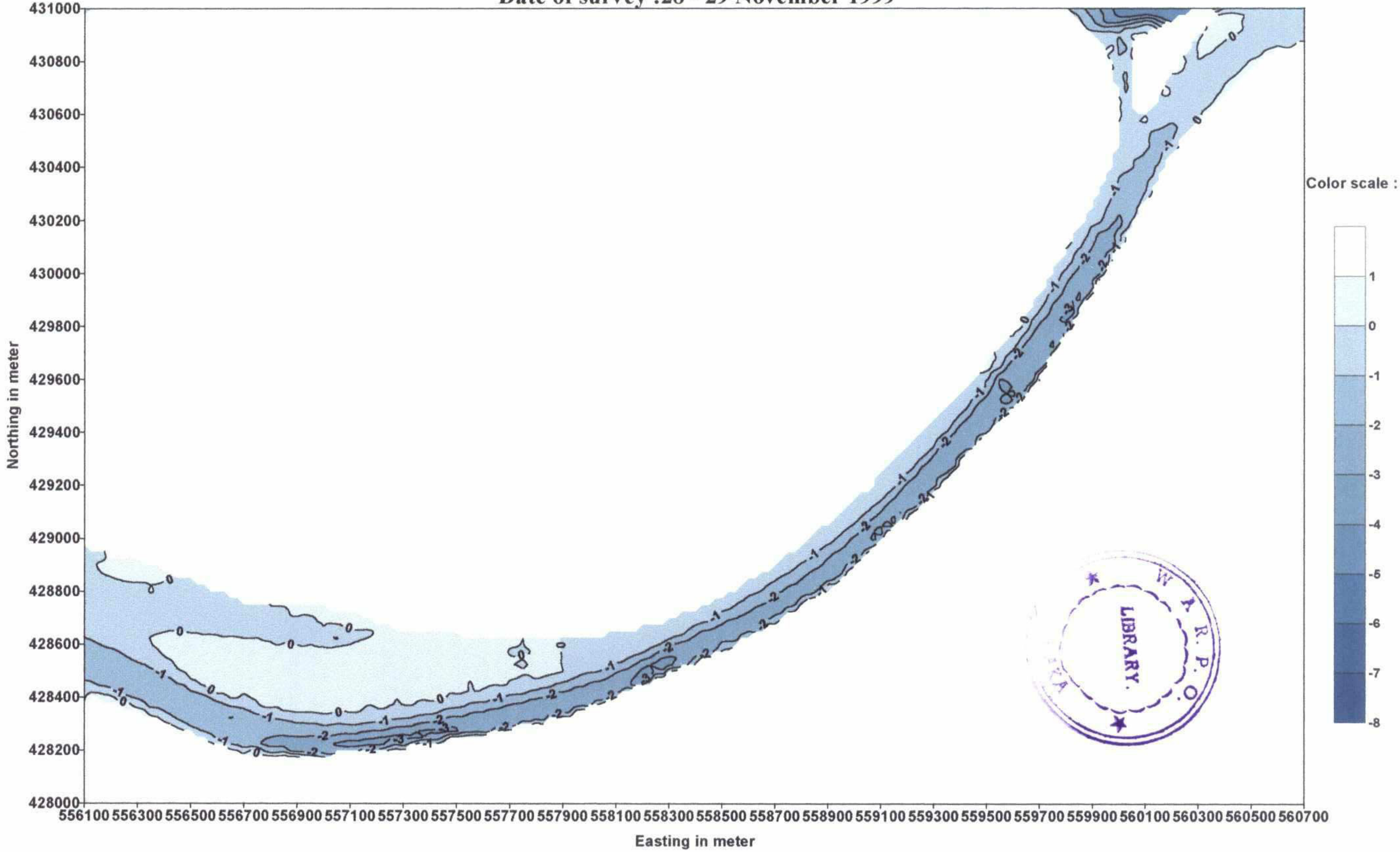
CRUISE 6
Location : Char Montaz
Date of survey : 03 - 04 July 1999



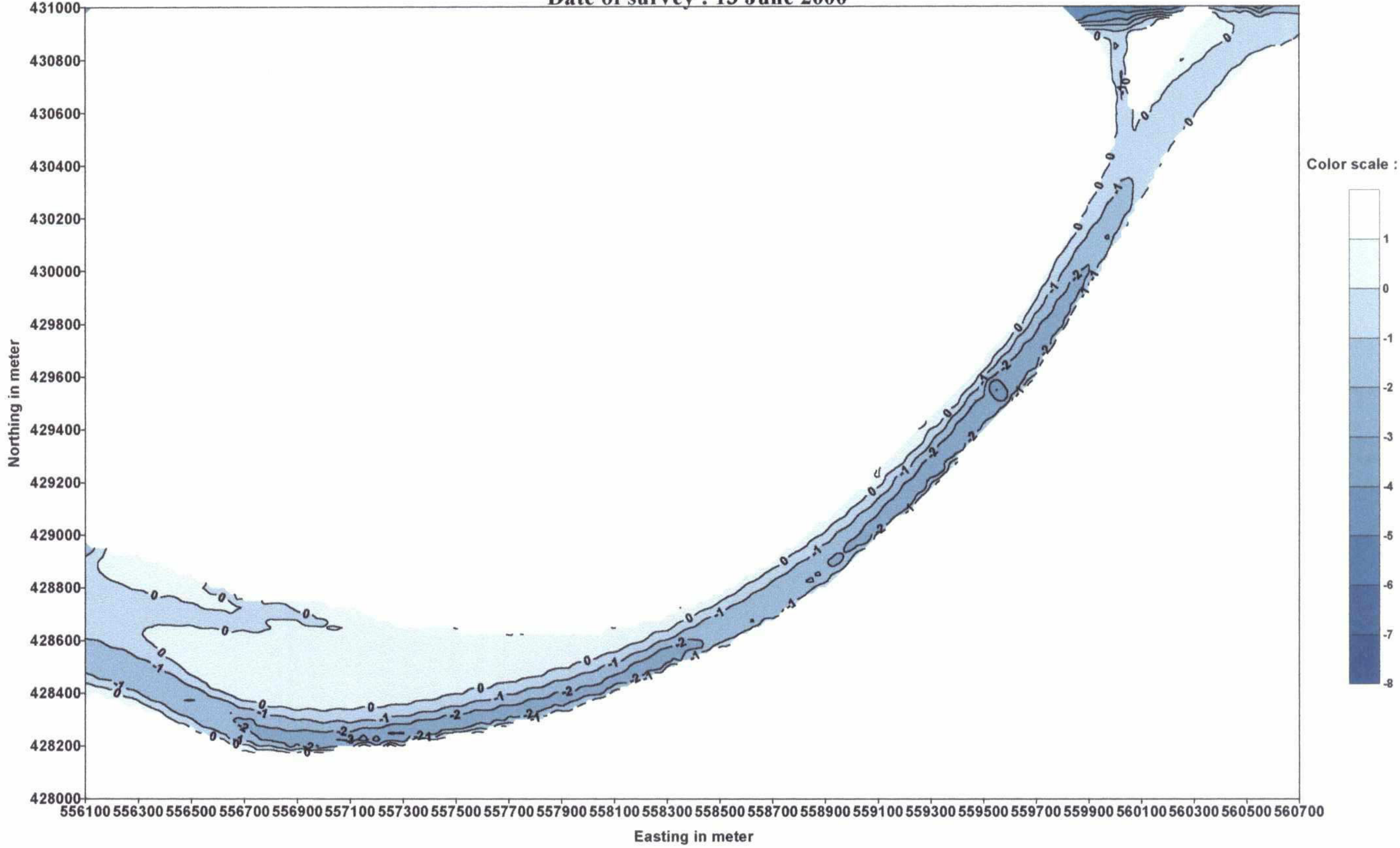
CRUISE 10
Location : Char Montaz
Date of survey : 16 September 1999



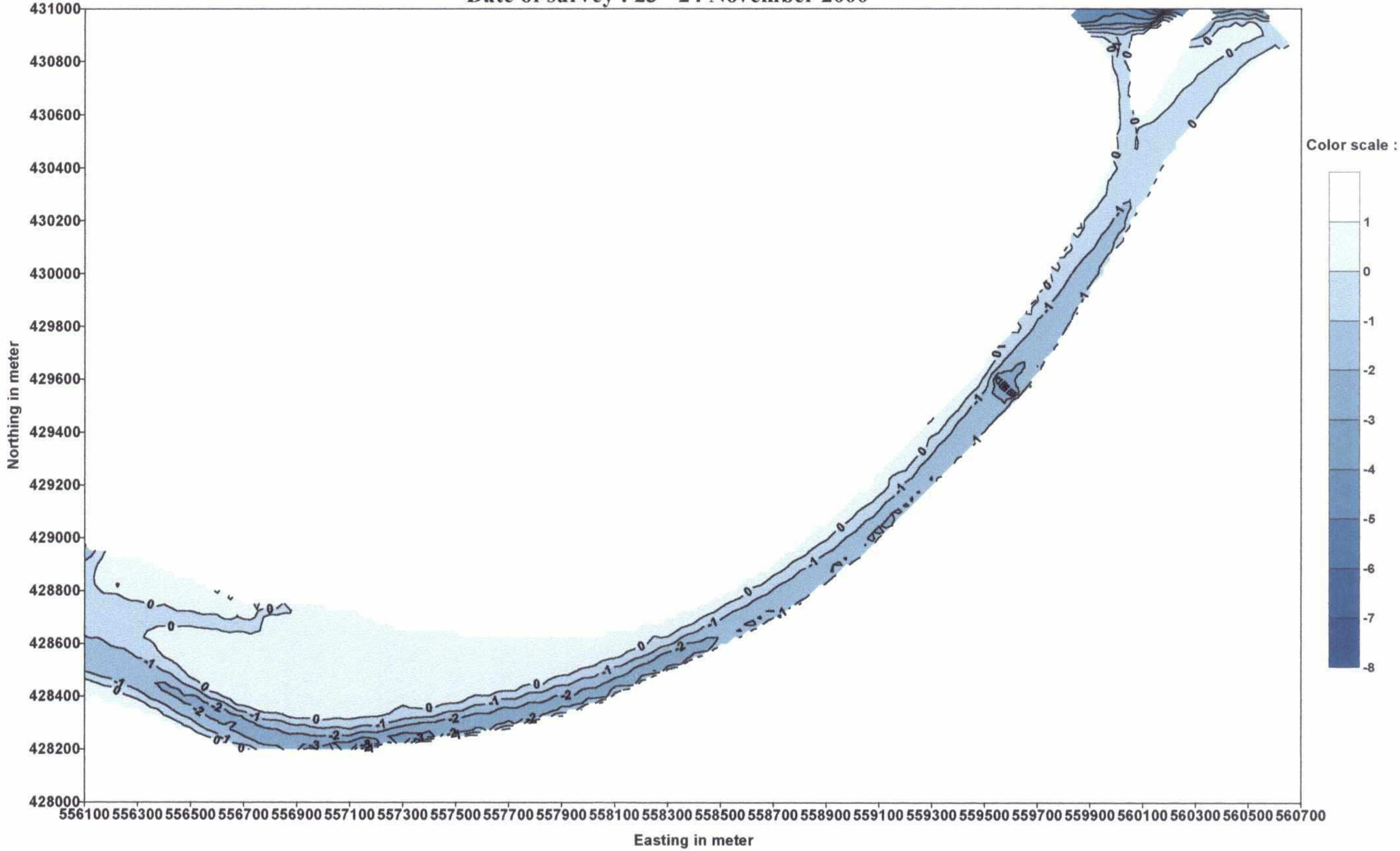
CRUISE 13
Location : Char Montaz
Date of survey :28 - 29 November 1999



CRUISE 2000/07
Location : Char Montaz
Date of survey : 13 June 2000



CRUISE 2000/13
Location : Char Montaz
Date of survey : 23 - 24 November 2000



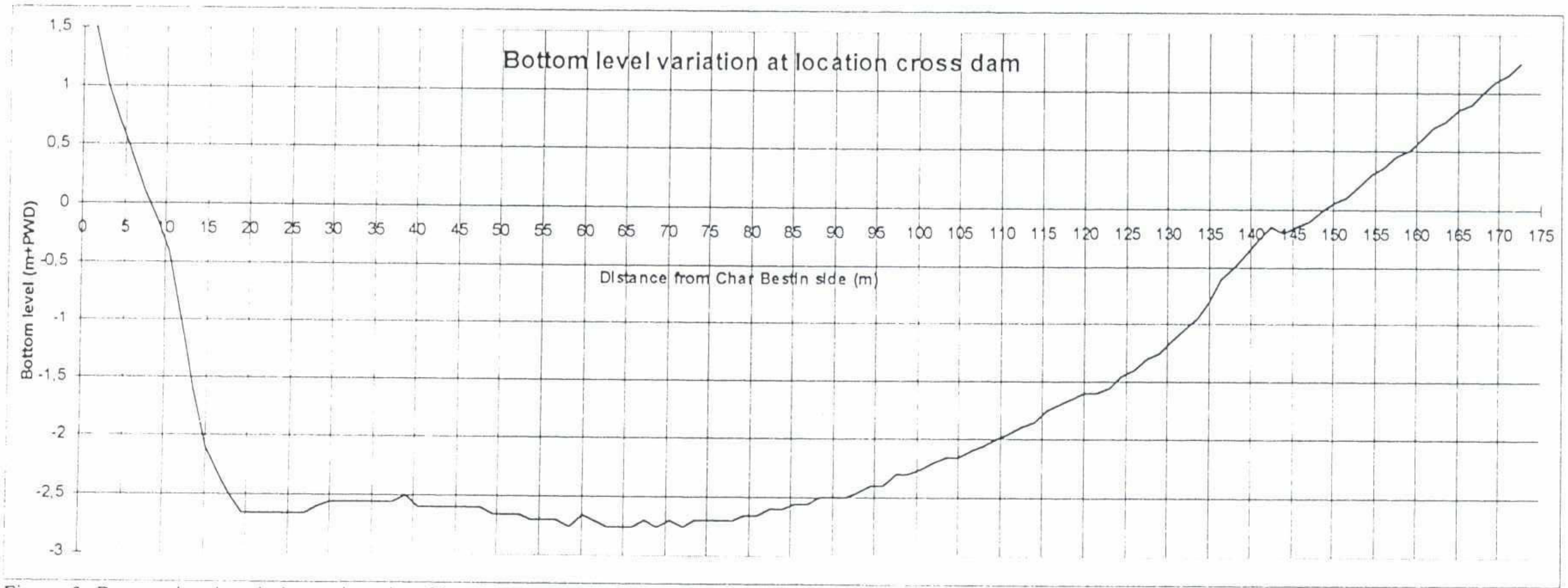


Figure 3 Bottom level variation at location Char Montaz cross dam before construction

File: sander/Char Montaz/Installation~cross

Appendix 2: **Information about geotextile items**

Item	Woven material	Non-woven material	Size	Quantity	Velocity of stitching	Man days needed for production
Bed protection in river	Propex 6284/00 or 6288/00	RIG EDY 200.1	25m x 50m	4	2,05m/day	100
Screens between A-frames	Propex 6088/00	-	width 1,5m	113	-	8
Geotextile bags	Propex 6283/00	RIG EDY 250.1	0,25m x 1,00m	3100	-	0,07

Appendix – 3

Char Montaz Permeable Cross Dam
Information on A-frames

Appendix 3 Overview installed A-frames

A-frame # (from Char Bestin side)	A-frame type	Distance from A-frame slab to middle beam	Distance from middle beam to top frame
1	C	1.5m	2.5m
2	C	1.5m	2.5m
3	C	1.5m	2.5m
4	C	1.5m	2.5m
5	C	1.5m	2.5m
6	C	1.5m	2.5m
7	B	1.7m	3.4m
8	B	1.7m	3.4m
9	A	2m	3.4m
10	A	2m	3.4m
11	A	2m	3.4m
12	A	2m	3.4m
13	A	2m	3.4m
14	A	2m	3.4m
15	A	2m	3.4m
16	A	2m	3.4m
17	A	2m	3.4m
18	A	2m	3.4m
19	A	2m	3.4m
20	A	2m	3.4m
21	A	2m	3.4m
22	A	2m	3.4m
23	A	2m	3.4m
24	A	2m	3.4m
25	A	2m	3.4m
26	A	2m	3.4m
27	A	2m	3.4m
28	A	2m	3.4m
29	A	2m	3.4m
30	A	2m	3.4m
31	A	2m	3.4m
32	A	2m	3.4m
33	A	2m	3.4m
34	A	2m	3.4m
35	A	2m	3.4m
36	A	2m	3.4m
37	A	2m	3.4m
38	A	2m	3.4m
39	A	2m	3.4m
40	A	2m	3.4m
41	A	2m	3.4m
42	A	2m	3.4m
43	A	2m	3.4m
44	A	2m	3.4m
45	A	2m	3.4m
46	A	2m	3.4m
47	A	2m	3.4m
48	A	2m	3.4m
49	A	2m	3.4m
50	A	2m	3.4m
51	A	2m	3.4m
52	A	2m	3.4m
53	A	2m	3.4m
54	A	2m	3.4m
55	A	2m	3.4m
56	A	2m	3.4m
57	A	2m	3.4m
58	A	2m	3.4m
59	A	2m	3.4m
60	A	2m	3.4m
61	A	2m	3.4m
62	A	2m	3.4m
63	A	2m	3.4m
64	A	2m	3.4m
65	A	2m	3.4m
66	A	2m	3.4m
67	A	2m	3.4m
68	A	2m	3.4m
69	A	2m	3.4m
70	A	2m	3.4m
71	A	2m	3.4m
72	B	1.7m	3.4m
73	B	1.7m	3.4m
74	B	1.7m	3.4m
75	B	1.7m	3.4m
76	B	1.7m	3.4m
77	B	1.7m	3.4m
78	B	1.7m	3.4m
79	B	1.7m	3.4m
80	B	1.7m	3.4m
81	C	1.5m	2.5m
82	C	1.5m	2.5m
83	C	1.5m	2.5m
84	C	1.5m	2.5m
85	C	1.5m	2.5m
86	C	1.5m	2.5m
87	C	1.5m	2.5m
88	C	1.5m	2.5m
89	C	1.5m	2.5m
90	C	1.5m	2.5m
91	C	1.5m	2.5m
92	C	1.5m	2.5m
93	C	1.5m	2.5m
94	C	1.5m	2.5m
95	C	1.5m	2.5m
96	C	1.5m	2.5m
97	C	1.5m	2.5m
98	C	1.5m	2.5m
99	C	1.5m	2.5m
100	C	1.5m	2.5m
101	C	1.5m	2.5m
102	C	1.5m	2.5m
103	C	1.5m	2.5m
104	C	1.5m	2.5m
105	C	1.5m	2.5m
106	C	1.5m	2.5m
107	C	1.5m	2.5m
108	C	1.5m	2.5m
109	C	1.5m	2.5m
110	C	1.5m	2.5m

Appendix – 4

Char Montaz Permeable Cross Dam
Information on A-frame Screens

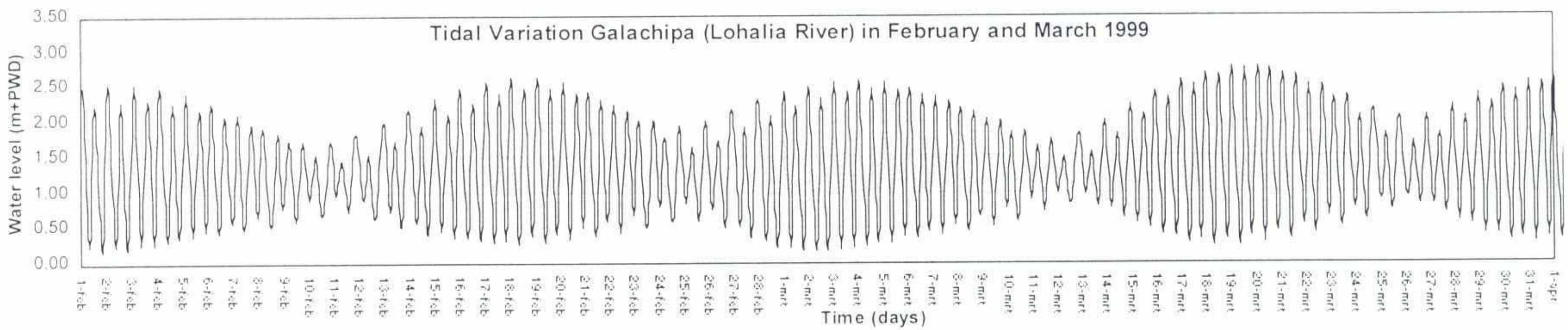
Appendix 4 Overview installed screens

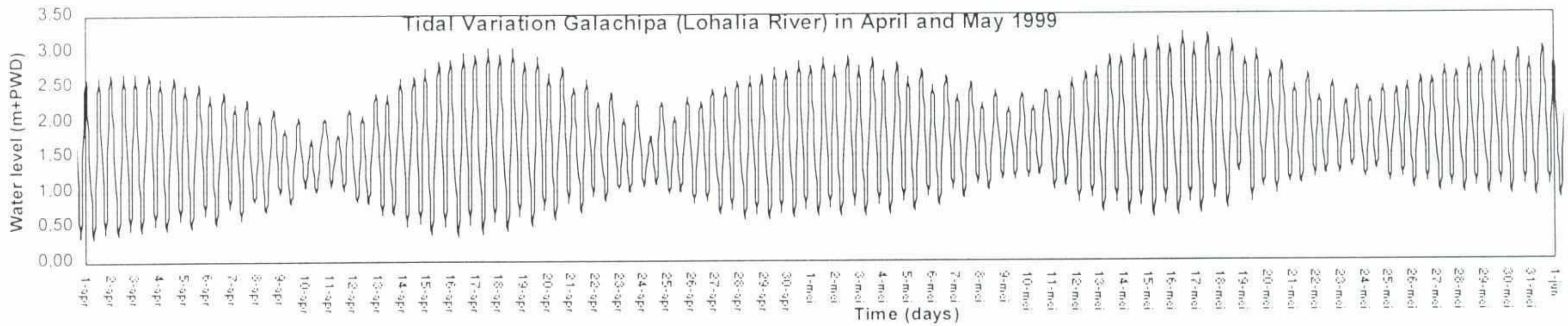
Screen number	Between A & frame numbers (from Char Bestin side)	Height screen
1	1 & 2	2.2m
2	2 & 3	2.5m
3	3 & 4	2.5m
4	4 & 5	2.5m
5	5 & 6	2.5m
6	6 & 7	2.3m
7	7 & 8	2.3m
8	8 & 9	3.1m
9	9 & 10	3.2m
10	10 & 11	3.5m
11	11 & 12	3.6m
12	12 & 13	3.6m
13	13 & 14	3.6m
14	14 & 15	3.6m
15	15 & 16	3.6m
16	16 & 17	3.6m
17	17 & 18	3.6m
18	18 & 19	3.6m
19	19 & 20	3.6m
20	20 & 21	3.6m
21	21 & 22	3.6m
22	22 & 23	3.6m
23	23 & 24	3.6m
24	24 & 25	3.6m
25	25 & 26	3.6m
26	26 & 27	3.6m
27	27 & 28	3.6m
28	28 & 29	3.6m
29	29 & 30	3.6m
30	30 & 31	3.6m
31	31 & 32	3.6m
32	32 & 33	3.6m
33	33 & 34	3.6m
34	34 & 35	3.6m
35	35 & 36	3.6m
36	36 & 37	3.6m
37	37 & 38	3.6m
38	38 & 39	3.6m
39	39 & 40	3.6m
40	40 & 41	3.6m
41	41 & 42	3.6m
42	42 & 43	3.6m
43	43 & 44	3.6m
44	44 & 45	3.6m
45	45 & 46	3.6m
46	46 & 47	3.6m
47	47 & 48	3.6m
48	48 & 49	3.6m
49	49 & 50	3.6m
50	50 & 51	3.6m
51	51 & 52	3.6m
52	52 & 53	3.6m
53	53 & 54	3.6m
54	54 & 55	3.6m
55	55 & 56	3.6m
56	56 & 57	3.6m
57	57 & 58	3.6m
58	58 & 59	3.6m
59	59 & 60	3.6m
60	60 & 61	3.6m
61	61 & 62	3.6m
62	62 & 63	3.6m
63	63 & 64	3.6m
64	64 & 65	3.6m
65	65 & 66	3.6m
66	66 & 67	3.6m
67	67 & 68	3.6m
68	68 & 69	3.6m
69	69 & 70	3.6m
70	70 & 71	3.6m
71	71 & 72	2.8m
72	72 & 73	3.1m
73	73 & 74	3.1m
74	74 & 75	3.1m
75	75 & 76	3.1m
76	76 & 77	3.1m
77	77 & 78	3.1m
78	78 & 79	3.1m
79	79 & 80	3.1m
80	80 & 81	2.3m
81	81 & 82	2.6m
82	82 & 83	2.6m
83	83 & 84	2.6m
84	84 & 85	2.6m
85	85 & 86	2.6m
86	86 & 87	2.6m
87	87 & 88	2.6m
88	88 & 89	2.6m
89	89 & 90	2.6m
90	90 & 91	2.6m
91	91 & 92	2.6m
92	92 & 93	2.6m
93	93 & 94	2.6m
94	94 & 95	2.6m
95	95 & 96	2.6m
96	96 & 97	2.6m
97	97 & 98	2.6m
98	98 & 99	2.6m
99	99 & 100	2.6m
100	100 & 101	2.6m
101	101 & 102	2.6m
102	102 & 103	2.6m
103	103 & 104	2.6m
104	104 & 105	2.6m
105	105 & 106	2.6m
106	106 & 107	2.6m
107	107 & 108	2.6m
108	108 & 109	2.6m
109	109 & 110	2.6m

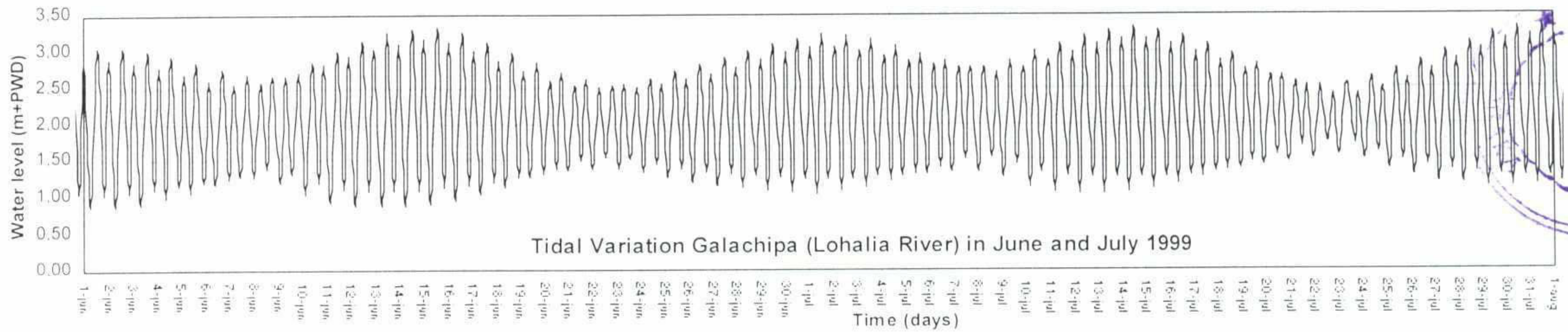
Appendix – 5

Char Montaz Permeable Cross Dam
Tidal Variation Chart

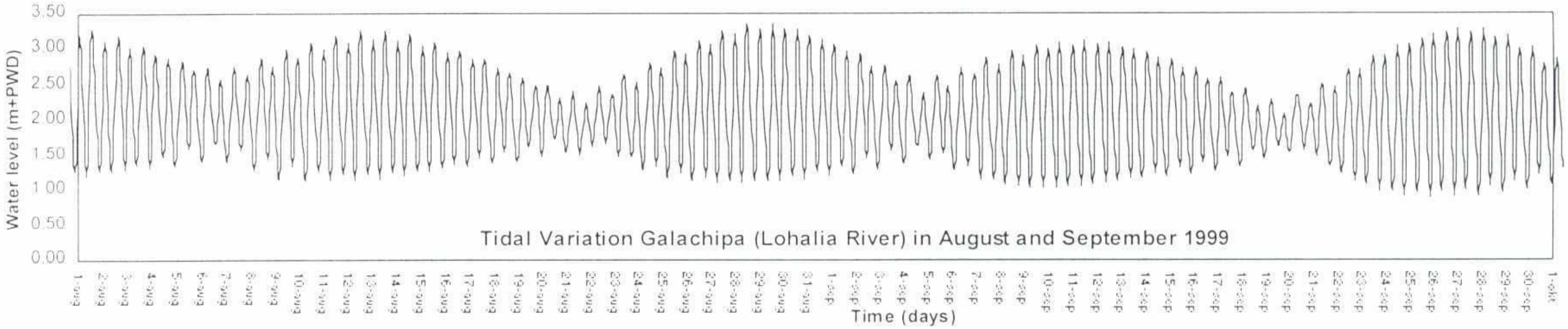
Appendix –5: Tidal variations in Galachipa (Bangladesh tide tables 1999)

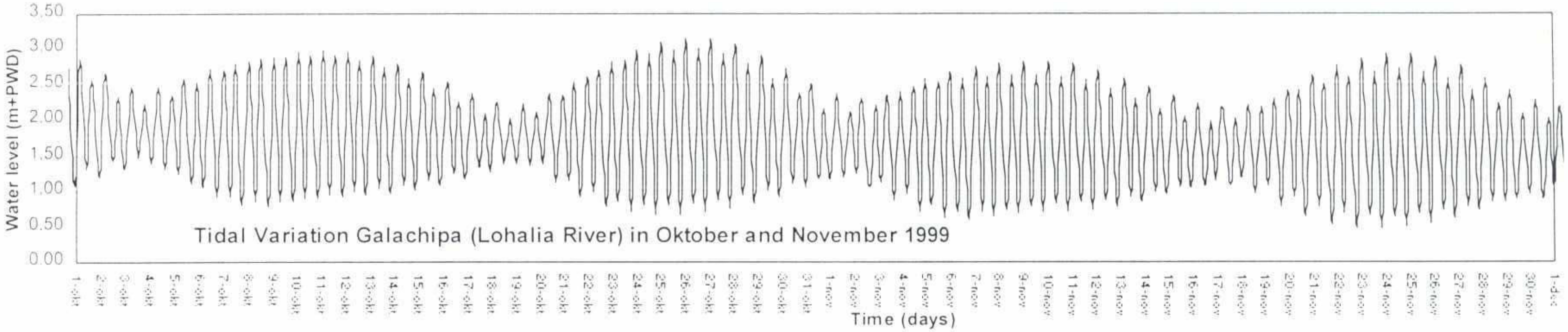


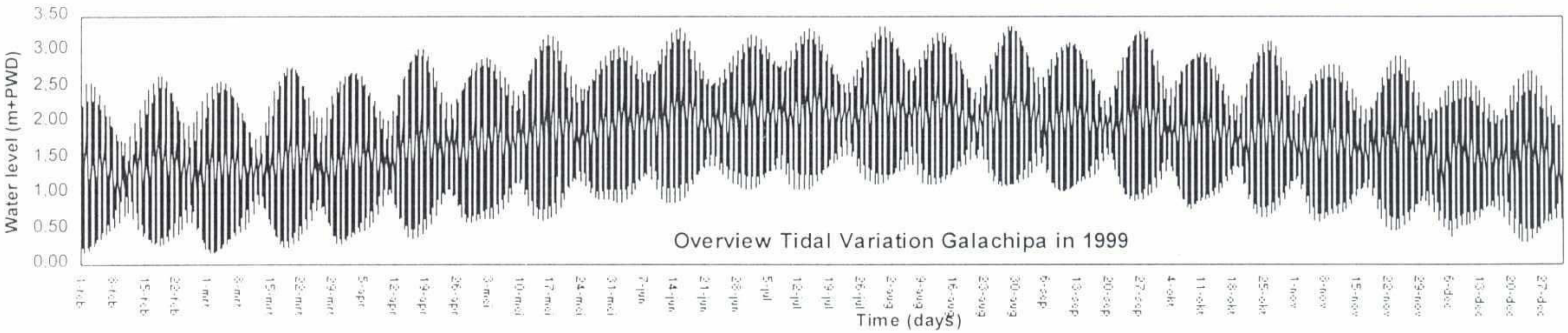




8f


Tidal Variation Galachipa (Lohalia River) in August and September 1999
Water level (m+PWD)
Time (days)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00


Tidal Variation Galachipa (Lohalia River) in Oktober and November 1999
Water level (m+PWD)
Time (days)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00


Overview Tidal Variation Galachipa in 1999
Water level (m+PWD)
Time (days)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00

Appendix – 6

Char Montaz Permeable Cross Dam
Accretion Volume Computations

CHAR MANTAZ X-DAM

VOLUME COMPUTATIONS

CRUISE 4
Date of survey : 09 - 11 May 1999

UPPER SURFACE
Level Surface defined by Z = 5 m.PWD

LOWER SURFACE
Grid File: D:/XDAM/CR04B25M.GRD
Grid size as read: 193 cols by 121 rows
Delta X: 25 m
Delta Y: 25 m
X-Range: 556100 m to 560900 m
Y-Range: 428000 m to 431000 m
Z-Range: -5.00 to 1.06 m.PWD

VOLUMES

Approximated Volume by
Trapezoidal Rule:-11.92 million m^3
Simpson's Rule: -11.68 million m^3

CUT & FILL VOLUMES
Positive Volume [Cut]: 0
Negative Volume [Fill]: 11.92 million m^3

CRUISE 6
Date of survey : 03 - 04 July 1999

UPPER SURFACE
Level Surface defined by Z = 5 m.PWD

LOWER SURFACE
Grid File: D:/XDAM/CR06B25M.GRD
Grid size as read: 193 cols by 121 rows
Delta X: 25 m
Delta Y: 25 m
X-Range: 556100 m to 560900 m
Y-Range: 428000 m to 431000 m
Z-Range: -5.00 to 0.94 m.PWD

VOLUMES

Approximated Volume by
Trapezoidal Rule:-11.84 million m^3
Simpson's Rule: -11.58 million m^3

CUT & FILL VOLUMES
Positive Volume [Cut]: 0
Negative Volume [Fill]: 11.84 million m^3

d2

CRUISE 10
Date of survey: 16 September 1999

UPPER SURFACE
Level Surface defined by Z = 5 m.PWD

LOWER SURFACE
Grid File: D:/XDAM/CR10B25M.GRD
Grid size as read: 193 cols by 121 rows
Delta X: 25 m
Delta Y: 25 m
X-Range: 556100 m to 560900 m
Y-Range: 428000 m to 431000 m
Z-Range: -4.59 to 1.18 m.PWD

VOLUMES

Approximated Volume by
Trapezoidal Rule:-11.54 million m^3
Simpson's Rule: -11.28 million m^3

CUT & FILL VOLUMES
Positive Volume [Cut]: 0
Negative Volume [Fill]: 11.54 million m^3

CRUISE 13
Date of survey : 28 – 29 November 1999

UPPER SURFACE
Level Surface defined by Z = 5 m.PWD

LOWER SURFACE
Grid File: D:/XDAM/CR10B25M.GRD
Grid size as read: 193 cols by 121 rows
Delta X: 25 m
Delta Y: 25 m
X-Range: 556100 m to 560900 m
Y-Range: 428000 m to 431000 m
Z-Range: -5.00 to 0.62 m.PWD

VOLUMES

Approximated Volume by
Trapezoidal Rule:-11.31 million m^3
Simpson's Rule: -11.07 million m^3

CUT & FILL VOLUMES
Positive Volume [Cut]: 0
Negative Volume [Fill]: 11.31 million m^3

CRUISE 2000/07
Date of survey : 13 June 2000

UPPER SURFACE

Level Surface defined by Z = 5 m.PWD

LOWER SURFACE

Grid File: C:/MONXDAM.C07/MONBCR07.GRD
Grid size as read: 193 cols by 121 rows
Delta X: 25 m
Delta Y: 25 m
X-Range: 556100 to 560900
Y-Range: 428000 to 431000
Z-Range: -5.23 to 1.51 m.PWD

VOLUMES

Approximated Volume by
Trapezoidal Rule:-10.99 million m3
Simpson's Rule: -10.68 million m3

CUT & FILL VOLUMES

Positive Volume [Cut]: 0
Negative Volume [Fill]: 10.99 million m^3

CRUISE 2000/13
Date of survey : 23 - 24 November 2000

UPPER SURFACE

Level Surface defined by Z = 5 m.PWD

LOWER SURFACE

Grid File: C:/MONXDAM.C13/MONBCR13.GRD
Grid size as read: 193 cols by 121 rows
Delta X: 25
Delta Y: 25
X-Range: 556100 to 560900
Y-Range: 428000 to 431000
Z-Range: -7.48 to 0.86 m.PWD

VOLUMES

Approximated Volume by
Trapezoidal Rule:-9.70 million m3
Simpson's Rule: -9.69 million m3

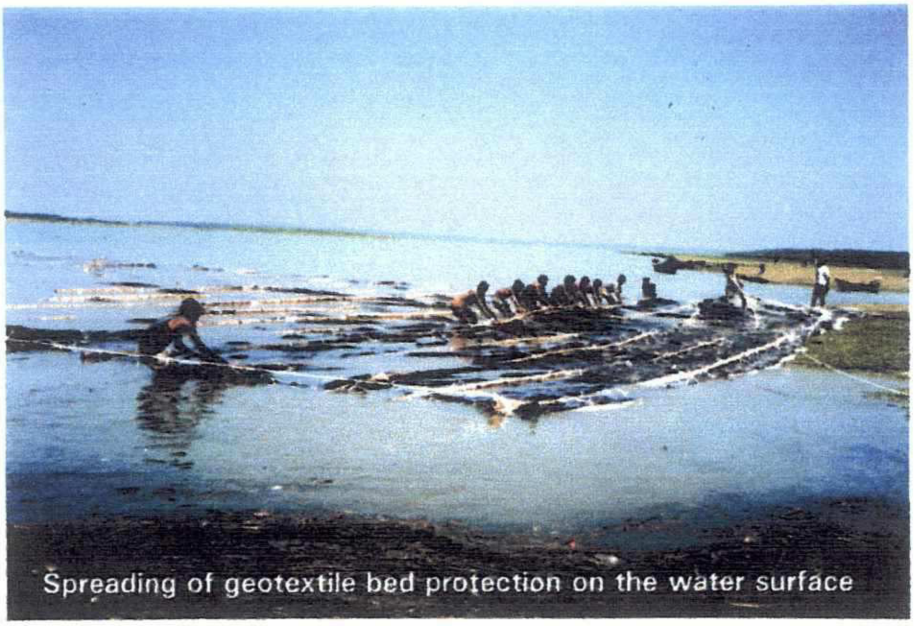
CUT & FILL VOLUMES

Positive Volume [Cut]: 0
Negative Volume [Fill]: 9.70 million m^3

Appendix – 7

Char Montaz Permeable Cross Dam
Pictures

Picture 1

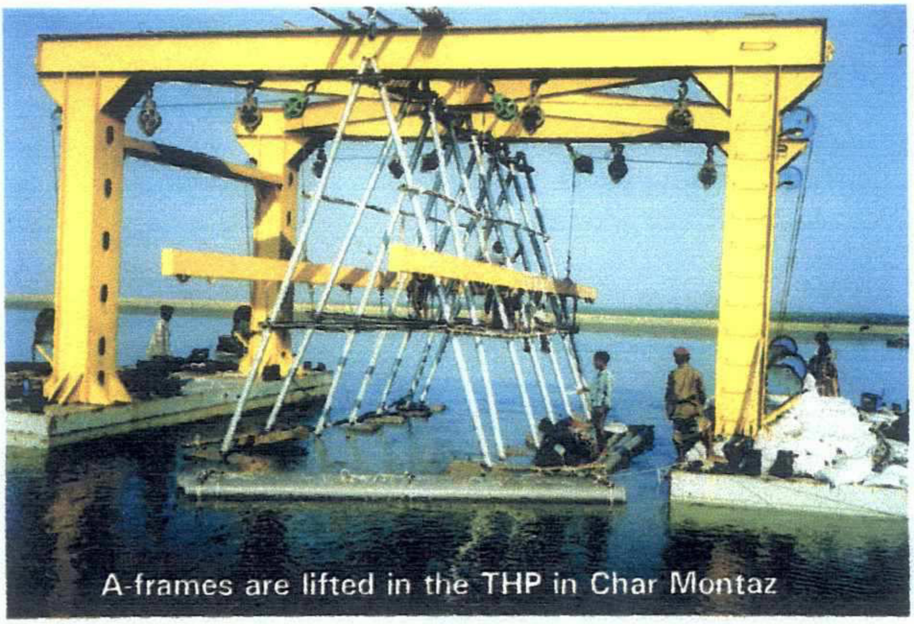


Picture 2

Picture 3 Natural growth on a bamboo which was tied to the bed protection mattress

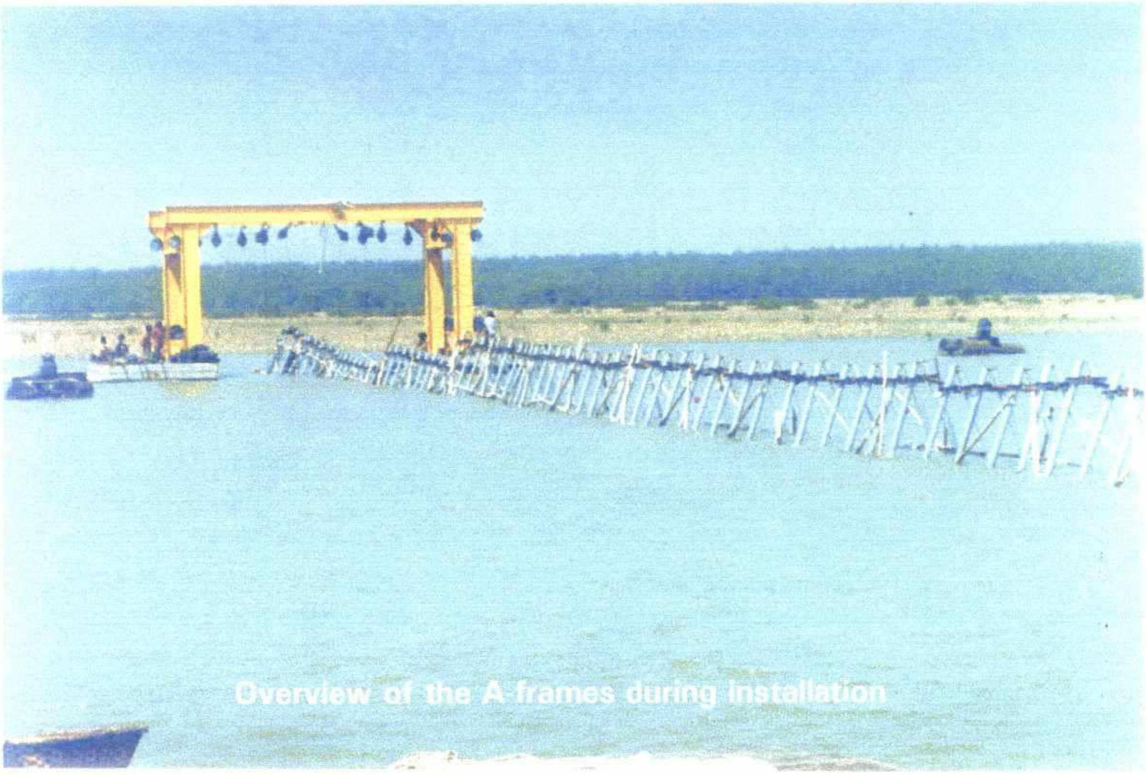
Picture 4 Transport of foundation slabs and A-frames to the THP

Picture 5



A-frames are lifted in the THP in Char Montaz

Picture 6



Overview of the A-frames during installation

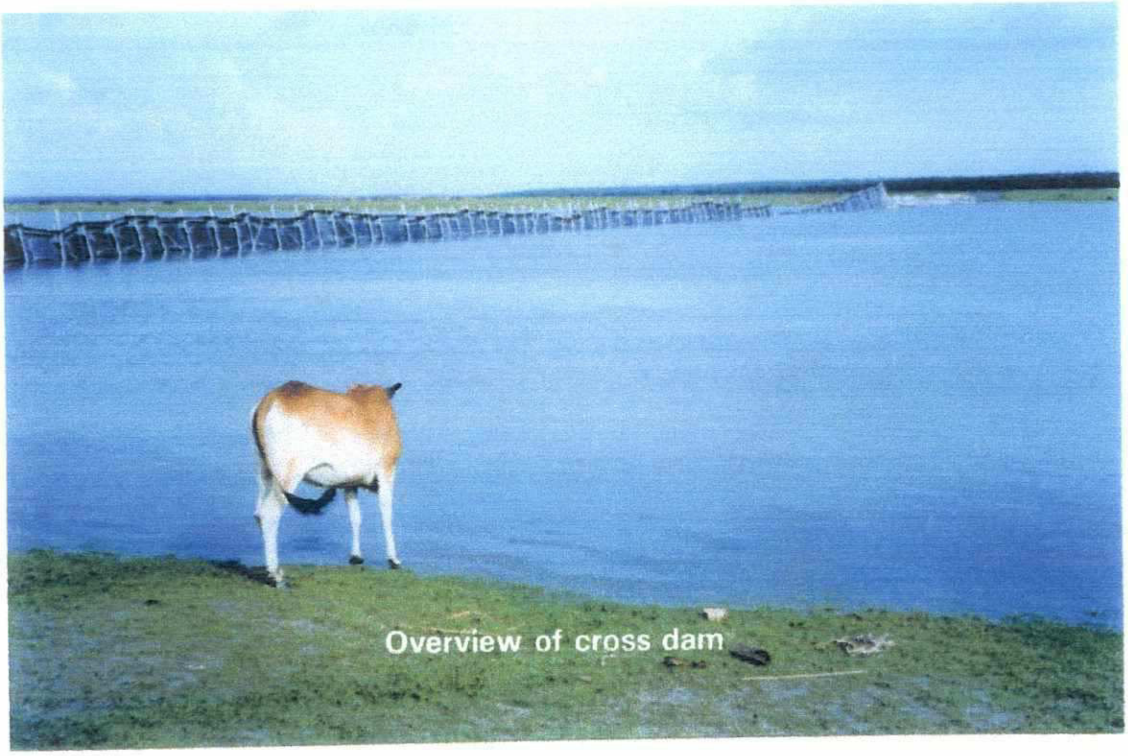
Picture 7

Installation of last set of frames using the THP

Picture 8

The Char Bestin side of the Char Montaz cross dam

Picture 9



Overview of cross dam

Picture 10

Tilted A-frames after spring tide