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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

M E S II
MEGHNA ESTUARY STUDY

TECHNICAL NOTE MES-043

Acceleration of Accretion
Evaluation of Cross Dam Pilot Schemes

December 2000

DHV CONSULTANTS BV

in association with

DEVCONSULTANTS LTD

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SUMMARY

So far a number of cross dams has been constructed within the Meghna Estuary, the most recent example is a dam connecting the two islands of Urir Char located in the northeastern part of the estuary. This earth dam was built in January/February 1998 by LGED using local technology. After the closure the channel on both sides of the dam has been very rapidly filled up with sediment, indicating tremendous potential for accelerating accretion in this area.

During MES another cross dam has been installed in a channel connecting Char Montaz with Char Rustam, this channel is located in the southwestern part of the estuary. Instead of a closed earth dam, a permeable dam consisting of a geotextile bed protection, an under water dam of concrete blocks, A-frames made of GI pipe and geotextile screens, has been design and implemented.

Both the design and implementation procedures of this permeable cross dam are based on an innovative approach and therefore the project has been considered as a pilot scheme. The experience gained during installation and subsequent monitoring of this scheme provided very valuable information regarding the functionality, performance and durability of the structure.

Since the installation of the dam in March 1999 two monsoon seasons and on cyclone passed and although some damage occurred only minor repairs were required. It has been measured that 2,200,000 m^3 has been deposited in the closed channel. Taking into account an allowance for natural accretion about 2,000,000 m^3 net may have settled as a result of cross dam construction.

The overall conclusion is that the Char Montaz cross dam pilot scheme has been quite successful in demonstrating the viability of this innovative design. The lessons learnt during implementation and monitoring have been described in this report. These lessons have also been incorporated in a review of the design and implementation of the Nijhum Dwip permeable cross dams as well as in areas with potential for acceleration of accretion to the West of Sandwip and Urir Char.

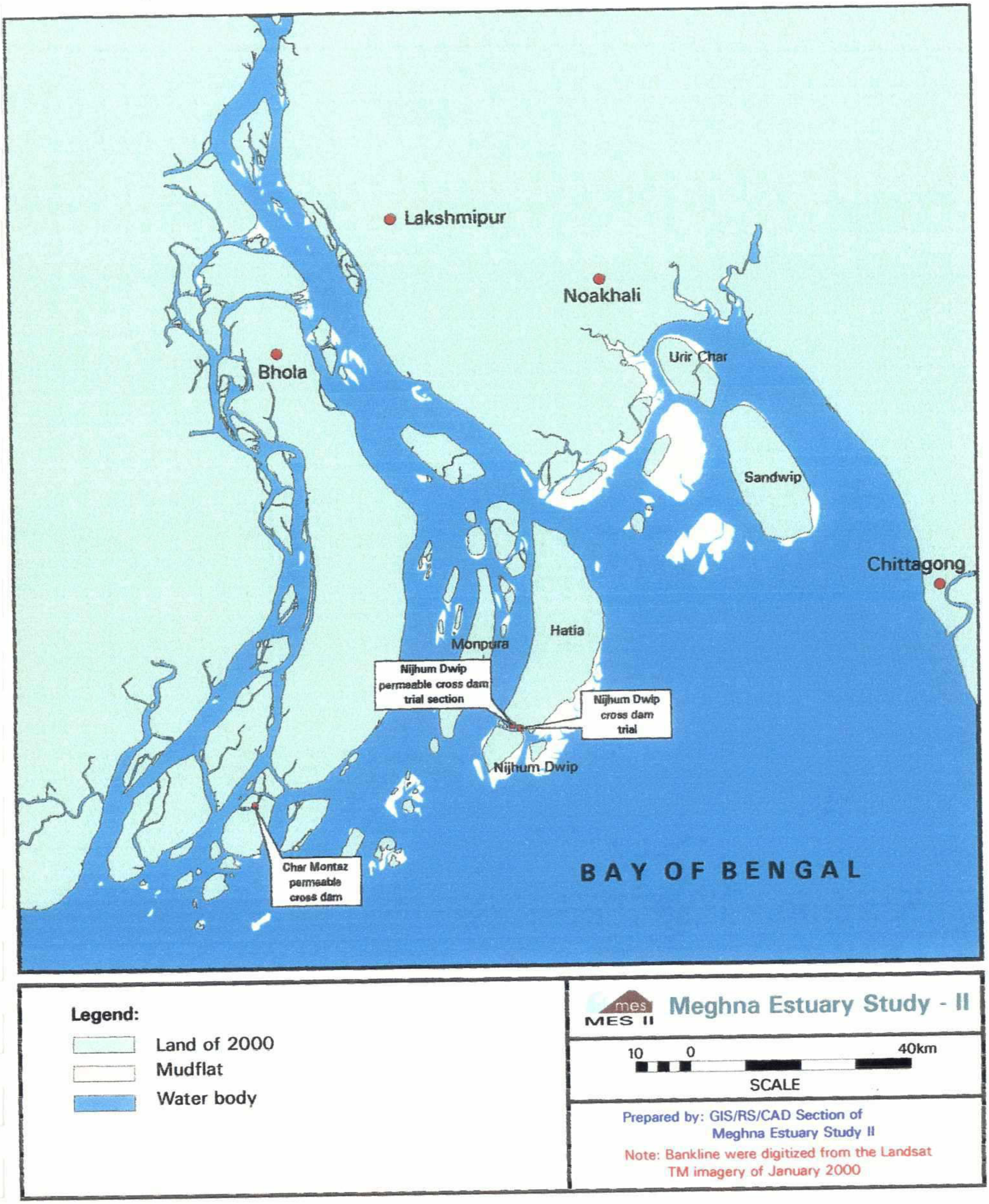
In anticipation of the implementation of the Nijhum Dwip cross dam in the not-too-far-away future, two small trial sections of cross dams have been implemented in 1997 and 2000. Again some valuable lessons were learned both for design and implementation methodology of future cross dams in this area and elsewhere.

In Chapter 2, the design considerations as well as implementation procedures of the three pilot schemes related to acceleration of accretion that were implemented during MES are described in some detail.
After implementation the schemes have been monitored until date by visual inspection, under water inspections and bathymetric surveys. The observations and findings are presented in Chapter 3.

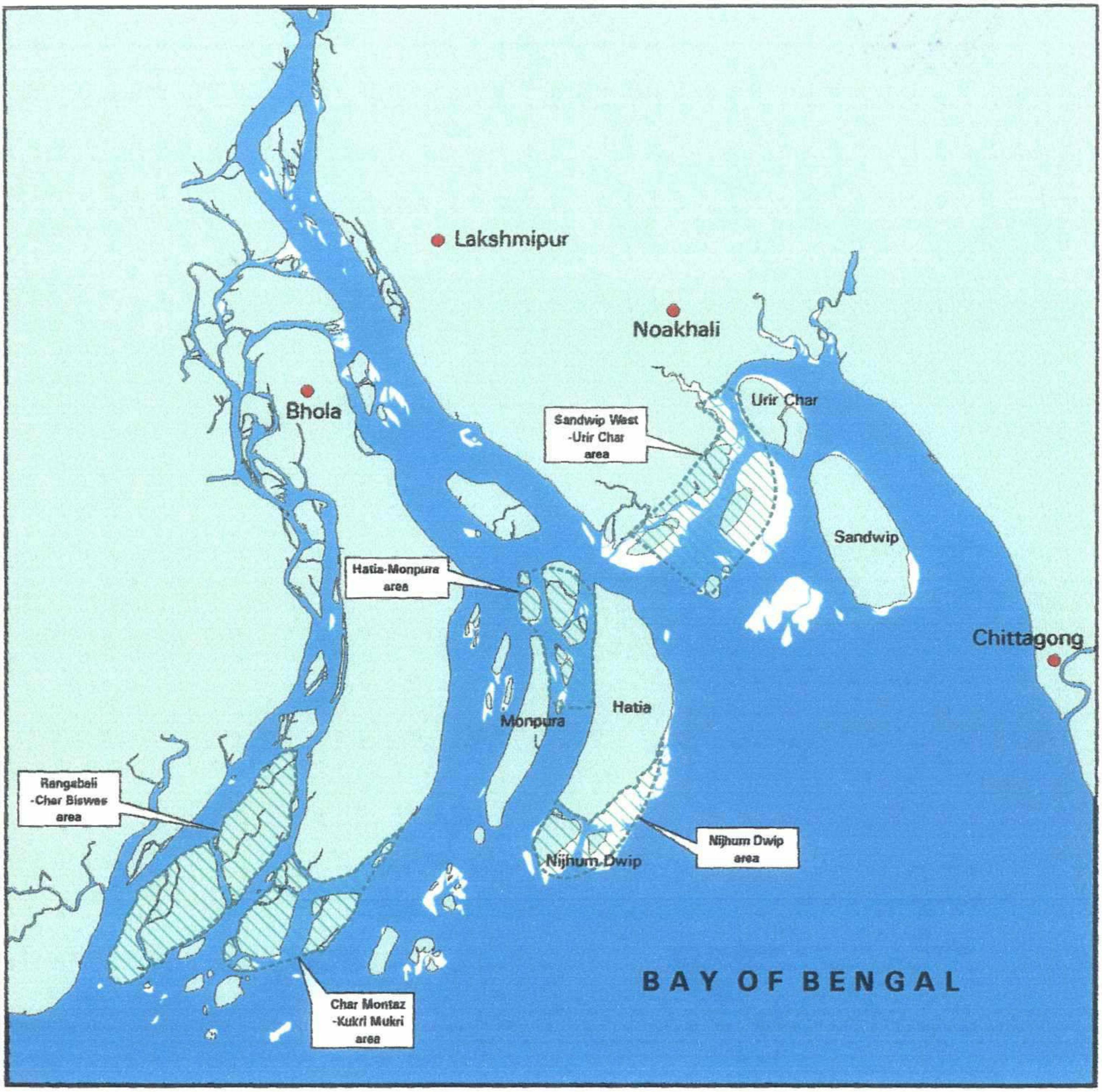
An evaluation of the performance and durability as well as installation methodology of the pilot schemes is given in Chapter 4. Recommendations on improvement of the design, installation facilities, etc have also been included.
The potential for acceleration of accretion throughout the Meghna Estuary has been outlined in Chapter 6. The area with most potential, West of Sandwip and Urir Char, has been given particular attention.

The impact of (permeable) cross dams on water levels and velocities has been simulated with the updated and detailed two-dimensional model of these areas. The main results of these simulations are presented in ANNEX C and a preliminary design and cost estimate for two cross dams are given in ANNEX D.

Location of pilot schemes for acceleration of accretion in the Meghna Estuary Study



Location of potential areas for acceleration of accretion in the Meghna Estuary Study



Legend:

- Land of 2000
- Mudflat
- Water body

Meghna Estuary Study - II

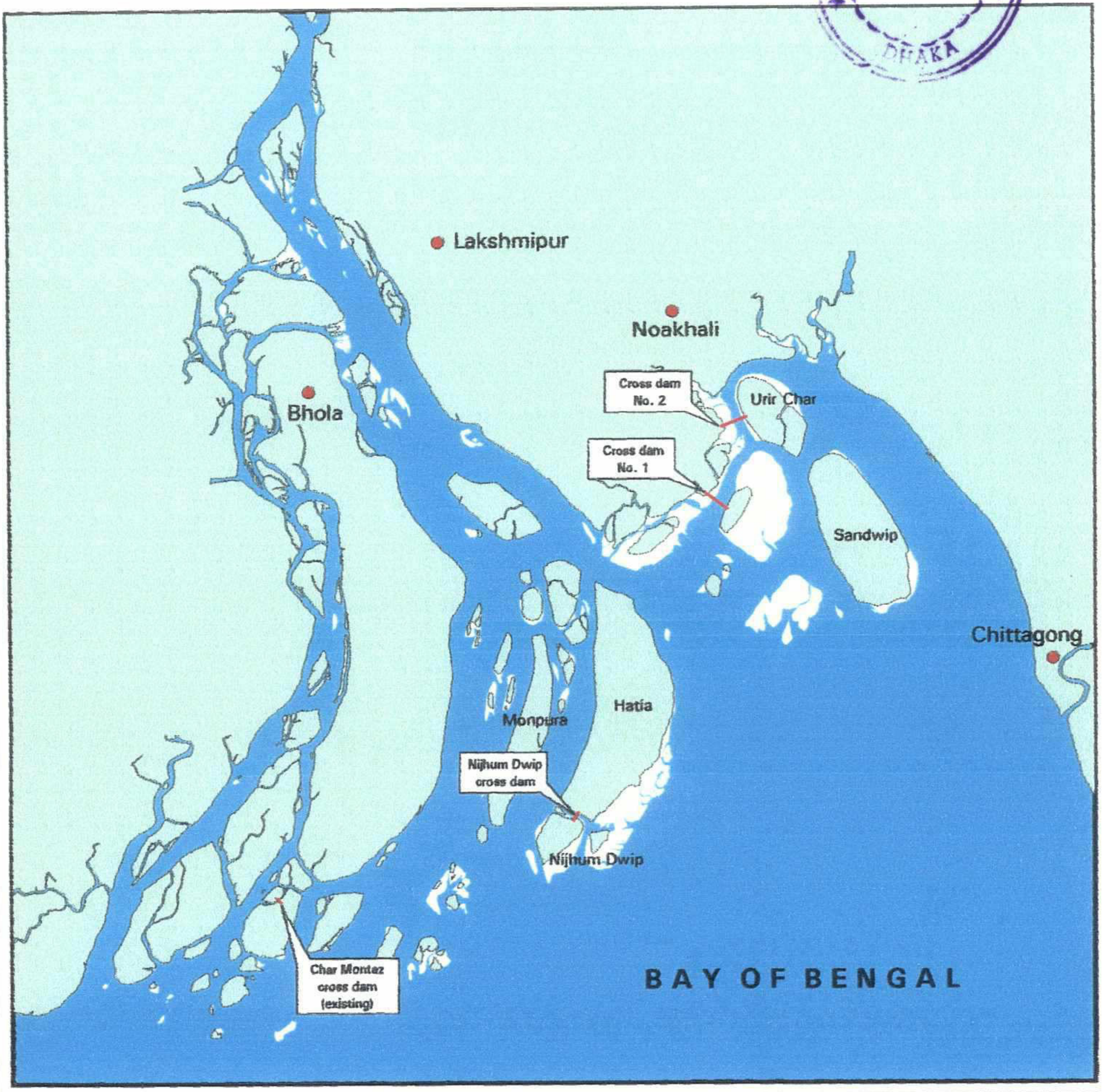
10 0 40km

SCALE

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

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

Location of existing and potential permeable cross dam



Legend:

- Land of 2000
- Mudflat
- Water body

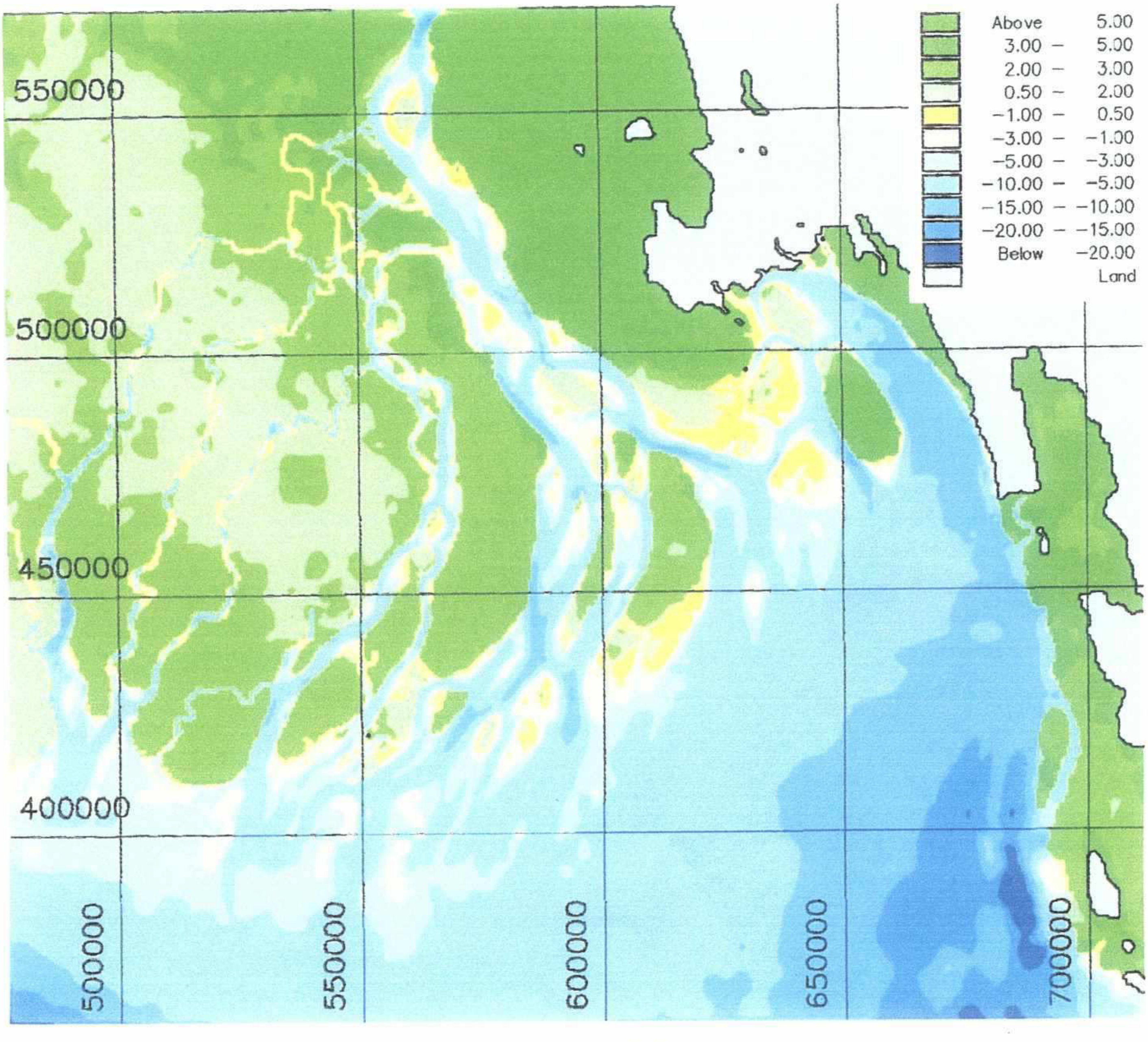
MES II **Meghna Estuary Study - II**

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



Bathymetric map of Meghna Estuary

(based on 1999/2000 surveys)

1. INTRODUCTION

At the upstream entrance to the Meghna Estuary (as defined by MES) at Chandpur the Ganges, Brahmaputra and Meghna rivers annually supply a huge volume of sediment to the delta. The quantity of sediment varies from year mainly depending on the characteristics of the monsoon in a particular year; the actual volume is the balance of the supply of sediment from the catchment areas of the rivers as well as the balance of erosion and accretion within the river systems. The actual annual quantity is very variable and is estimated at 1.0 billion m^3 to more than 3.0 billion m^3. However long term measurements of the sediment quantities passing at Chandpur are not available.

Downstream of Chandpur erosion and accretion continuously reshape the river channel system and the islands and chars in the coastal zone. The major forces driving these processes are the annual monsoon flooding and the tidal currents. The dominant force shaping the channel system in the upper part of the estuary are the strong currents during the monsoon, while the tidal currents are the driving forces shaping the islands and chars.
In a transition zone, the southern part of the lower Meghna, the Shabazpur channel and the Hatia channel both forces have a strong effect on erosion and accretion.

In the river system downstream of Chandpur migration of the channels, shallows and chars is a continuous process. At the outer bends of the channels erosion takes place while at the same time accretion will be found in the inner bends of the channels and at the lee side of shoals and islands. As a result of these processes valuable existing land and infrastructure is lost while new land emerges that after the land levels have been raised sufficiently requires a huge investment to provide and protect new infrastructure.

The chars emerging between Chandpur and Ramgati may be eroded again within a short period of time. An example is the chars between Haimchar and Damudya that have been continuously reworked in the past 25 years. Char Gazaria, between Ramgati and Burhanuddin, is another example that emerged about 20 years ago and under the present conditions is being eroded quite rapidly from the North. At the same time South of Gazaria the channel has become quite shallow. Because of this unstable situation measures to accelerate accretion in and along the main river system are not attractive.

The major areas in the estuary where accretion is predominant are located Southwest of Bhola, South of Hatia, West of Hatia and in between Sandwip and Hatia. The feasibility of measures to accelerate accretion in these areas will be discussed in Chapter 5.

Within the framework of MES three pilot schemes have been implemented.
These schemes are described in Chapter 2, in Chapter 3 the results of monitoring are provided and in Chapter 4 the performance of the pilot schemes is evaluated.

2 PILOT SCHEMES ACCELERATION OF ACCRETION

2.1 Small scale interventions

In the Terms of Reference for the Meghna Estuary Study the implementation of so-called "small-scale interventions" was included. As an example a small cross dam constructed by the local population in a tidal channel separating islands of Manpura was given.

However after study of the available reports, including the feasibility reports for the Sandwip and South Hatia cross dams, it was proposed to reallocate the available funds.

Instead of a small dam as per Terms of Reference, implemented in accordance with standard practice, low-cost innovative measures to accelerate accretion as well as to control erosion of the riverbanks were proposed and accepted by BWDB.

2.2 Nijhum Dwip cross dam trial

Due to time constraints, related to availability of funds and procurement of geotextile, the first measures could only be implemented at the end of the 1996/1997 winter season.

The main purpose of this trial was to investigate the feasibility of reducing the cross-section of a cross dam. According to the cost estimate presented in the Feasibility Study on South Hatia cross dams (1990), the cost of the dam body, consisting of clay filled bags, was 83% of the construction of the works.

A substantial reduction of the number of bags would not only reduce the overall cost of the dam but also would increase the EIRR of the project. In addition the volume of earthworks would be reduced drastically which would reduce the efforts to complete the dam within the relatively short time slot available at the site.

2.2 Char Montaz permeable cross dam

The Char Montaz permeable cross dam is based on a completely new concept. Instead of a massive dam of earth filled bags with a crest level above the highest water level, a low under water dam on a composite geotextile bed protection with ballast blocks forms the core of the cross dam. The under water dam provides stability to steel A-frames and woven geotextile screens that are fixed to the A-frames. See Figure 2.1.

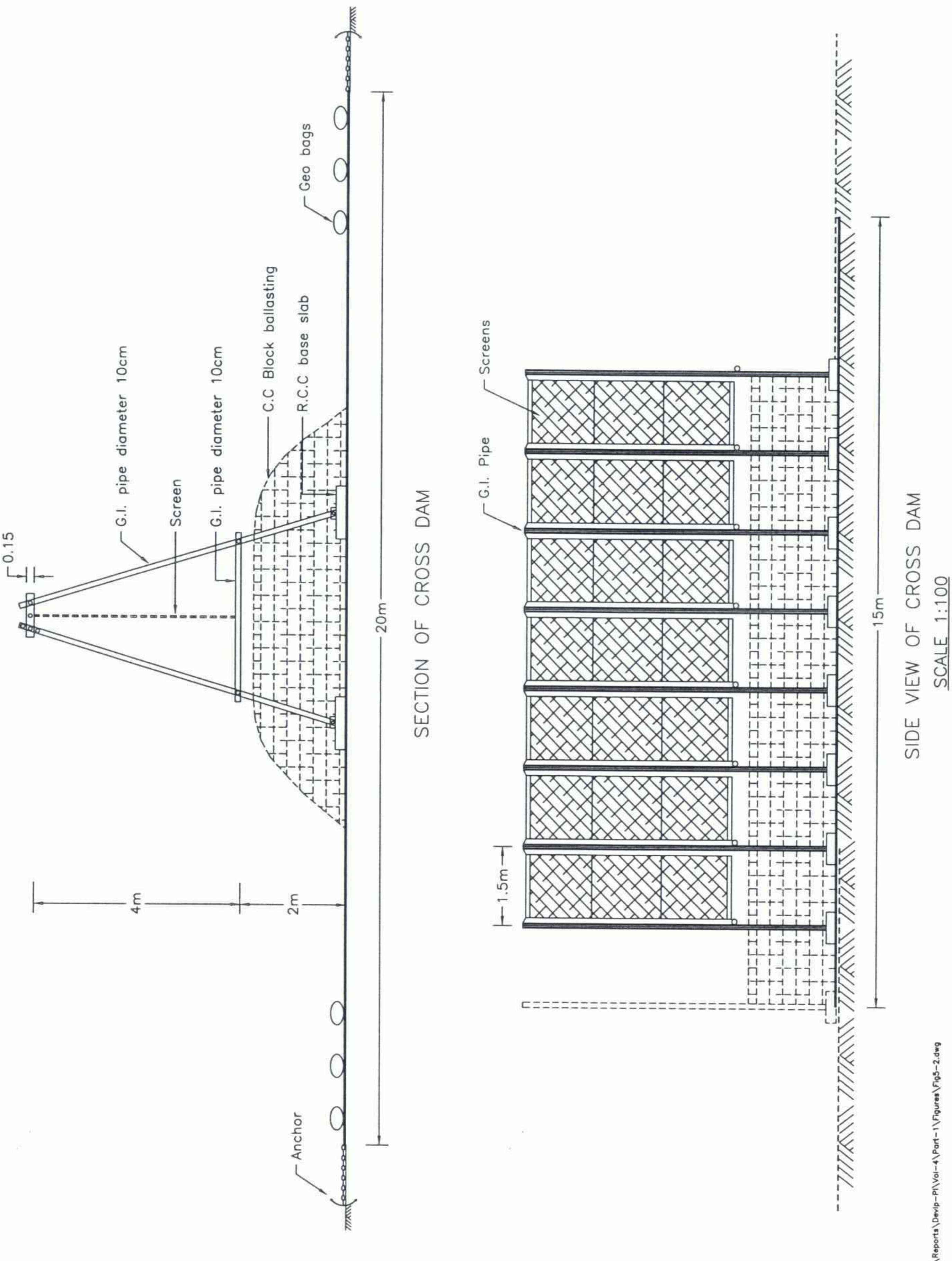
Initial cost estimates indicated that the cost of a permeable cross dam would be much lower than the cost of a cross dam constructed with earth-filled bags. It was also thought that the time required for the most crucial part of the construction could be completed in a relatively short time. The final closure of the dam would also be simpler and less risky than the traditional closure of the remaining gap in the cross dam.

The site selected for the first implementation of the new concept for obvious reasons should have relatively easy conditions as far as width, depth, tidal currents, maximum head differences, bed characteristics, sediment concentration in the water, accessibility during execution as well as for monitoring etc. The site at Char Montaz fulfilled most of these requirements though the site is in a relatively far away area of the estuary.

It was possible to install the dam in a relatively short time although the actual start of the works should have been much earlier, handling of the THP had still to be learned, lowering and ballasting of a 50 m x 25 m bed protection mattress was for the first time.

The final closure of the dam was as easy as expected, lowering and fastening of the screens was done as planned during slack water around neap tide without problem. Detailed information about the design and implementation of the Char Montaz cross dam is provided in the report: Installation of Char Montaz cross dam pilot scheme, MES II, July 1999.

Figure 2.1: Section and side view of the cross dam at Char Montaz



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2.3 Nijhum Dwip permeable cross dam trial section

As mentioned the site for implementation of the first cross dam based on an innovative design concept was selected to ensure relatively easy conditions as for as the execution and loading of the structure was concerned.

At Nijhum Dwip the site conditions would be much more severe. In particular exposure to wave induced forces on the geotextile screens was an unknown factor in relation to the overall durability of the permeable cross dam concept.

Therefore it was deemed necessary to install a trial section approximately in the alignment of the future cross dam. The initial site selected was at a distance of about 500m from the North bank of the channel in the selected alignment of the dam. Since the means to install the trial section were limited the best conditions were selected as far as tide and weather was concerned. On 29 February 2000 very favorable neap tide conditions were expected with an amplitude of only 1m and slack water at a very convenient time during the day.

Unfortunately the preparations in Dhaka were delayed due to unavoidable circumstances and a nightly attack by pirates on the THP and load carrying vessels further delayed the arrival at site.

When everything was finally ready to start the installation of the bed mattress the tidal currents had already become much stronger and strong winds prevailed much earlier than expected. In particular the anchoring system of the THP was not adequate under these conditions and several attempts to install the trial section of the cross dam failed.

For that reasons the attempts to install the works were halted and try again during the next neap tide period. To facilitate the installation works it was decided to move the site for installation much closer to about 150 m from the shore.

However, the weather conditions remained very windy and it appeared impossible to strengthen the anchoring system of the THP sufficiently so that it remained stable in the currents, waves and winds. In the end the only way that remained to install the trial section was to move very close to the shore so that 2 shore anchors could be established.

The bed level at this location is about 1.5m higher than at the original location so the maximum loading on the screens by waves will be less than designed. However the dynamic nature of the loading is expected to be fully tested on the screens.

It also appeared difficult to install the supports of the A-frames in the current since slack water at the site was very short. Another problem was posed by the fact that the trial section was partly installed on recent silt deposit so that substantial (unequal) subsidence of the footings of the A-frames occurred.

Although installation was far from smooth, still a lot of lessons have been learned by all involved in the exercise, lessons that should be remember when the Nijhum Dwip cross dam is finally going to be built.

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3. MONITORING OF PILOT SCHEMES

3.1 Nijhum Dwip cross dam trial

Monitoring of this first trial was limited because of lack of transport facilities and time constraints. However it was observed that the earth filled bags that were used for the dam body were gradually emptied by the flowing water as well as suction by waves. A few months after installation the bags started to deteriorate and after the monsoon all the bags had been removed and the bed protection mattress had been covered by silt deposits.

3.2 Char Montaz permeable cross dam

After installation of the Char Montaz cross dam the behavior of the structure as well as the accretion in the closed of 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.

- The foot, a concrete slab connected to the A-frame with a hinge construction, of a number of A-frames has subsided. 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 too weak and was further weakened by corrosion of the metal parts in the saline water during the winter season.

- The maximum head 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 holes 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 very well noticeable at both end 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 Figure 3.1

3.3 Nijhum Dwip permeable cross dam trial section

The performance of the structure has been closely monitored in the period between installation and December 2000. After installation it was found that the A-frames had not been fixed properly on the footings while ballast blocks had not been dumped evenly on top of these footings. Additional strengthening has been carried out in May 2000.

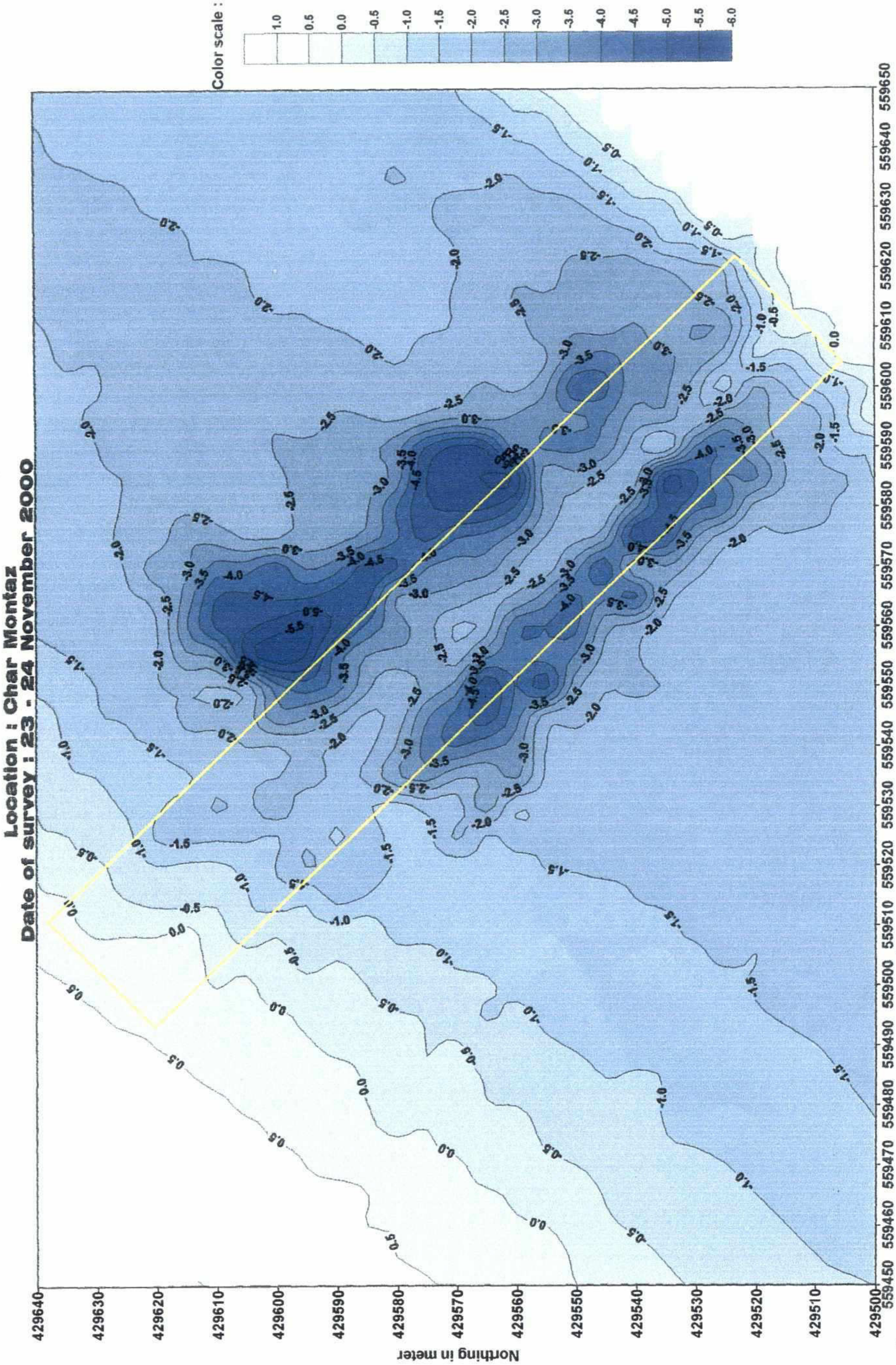
The main purpose of installing a trial section was to determine the durability of the geotextile screens under the attack of waves. Unfortunately the trial section has been installed near the shallow shore so the dynamic loading by waves was less than it would have been in the deeper parts of the channel. On the other hand the fetch length for the predominant waves direction was the longest.

Anyway the screens apparently were not seriously damaged although some stitches got loose. It has to be mentioned that serious wave attack occurred when a cyclone passed the southwestern part of Bangladesh in October 2000.

One or two cuts were found in the screens, the watchman explained that this had been done by fishermen while he was absent for a while and at night.

The water levels at the test site have been recorded while the currents were measured by float tracking in November/December 2000. For details see the Review Design and Implementation of Nijhum Dwip Cross Dam.

Figure 3.1 Present situation depth contours at Char Montaz permeable cross dam



4. EVALUATION OF ACCRETION PILOT SCHEMES

The design and installation of the initial trial section at Nijhum Dwip has provided valuable information for further development of the innovative design concept as well as the implementation methodology. Earth filled bags should not be used if exposed to waves and/or currents. The installation of bed protection mattresses should not be allowed during periods that inclement weather is likely to occur. The installation of bed mattresses requires specialized equipment

As far as acceleration of accretion is concerned, the permeable cross dam at Char Montaz has been quite successful. 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. Figure 4.1 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 2,200,000 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.

As far as the functionality and durability of the cross dam is concerned it may be concluded that:

- The cross dam has functioned as anticipated, the flow through the dam was relatively small even after a number of screens got loose
- 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 footing of the A-frame may have been too small or unequally ballasted with concrete blocks.
- 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.
- Based on these observations it is deemed advisable to redesign the A-frames and in the future use solid concrete frames with enlarged footings to transfer the loads (head differences and waves) acting on the geotextile screens to the foundation.
- 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
- Ripping of the geotextile by sharp edges of concrete blocks or slaps should be prevented as much as possible by rounding of sharp edges or by locally doubling the geotextile.
- During execution of the works much more attention has to be paid to dumping as per design and not in heaps as happened at Char Montaz. 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 tht the works are carried out according to the design.
- All bamboo's used to straighten the bed mattresses during installation have to be removed after initial ballasting.
- 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

The trial section of the permeable cross dam in the Nijhum Dwip channel has not been installed in the proper location, as a result the screens have not been tested under the full dynamic forces of waves.

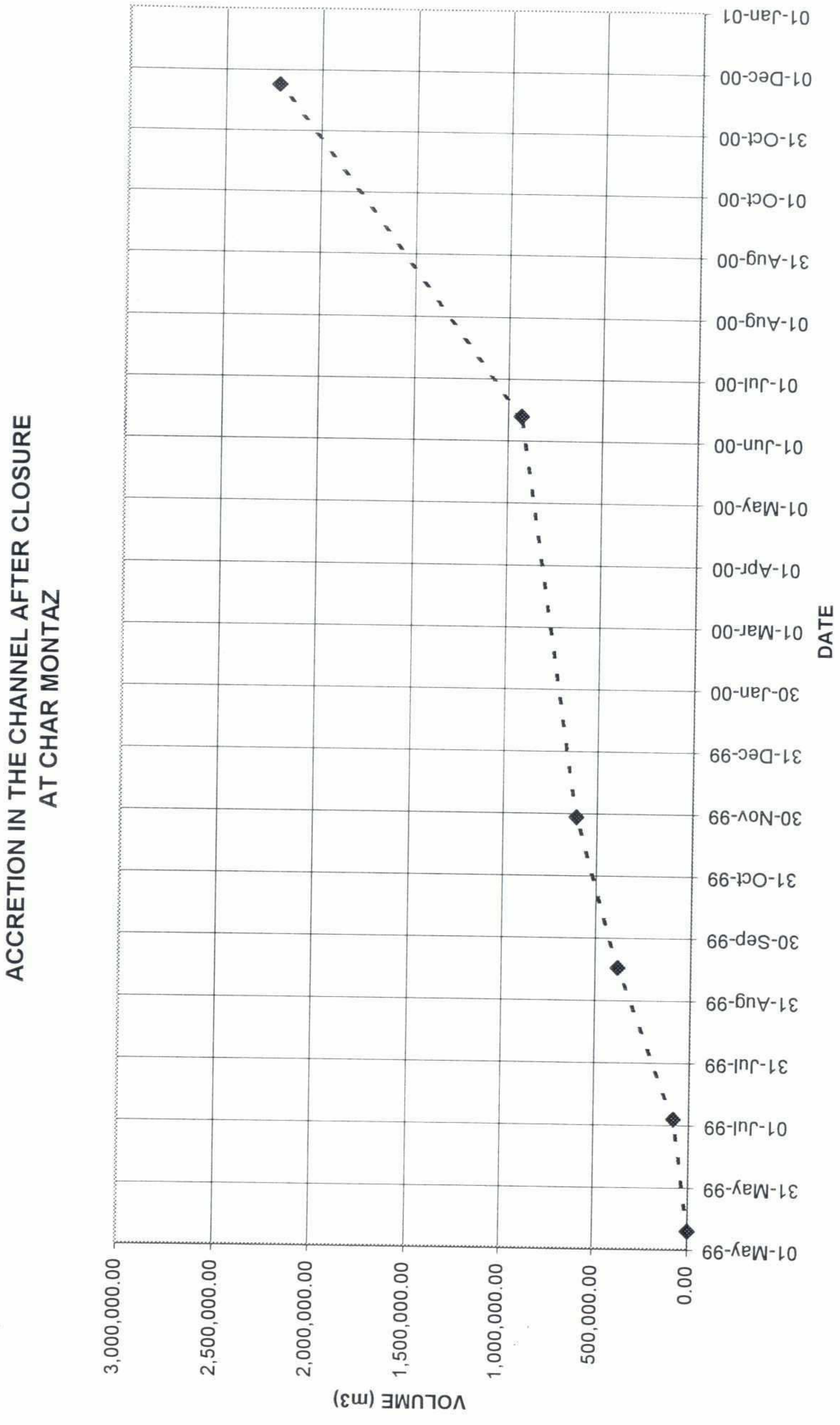
The design of the screens and the way it is attached to the concrete frames should be improved as indicated in ANNEX D. It is also proposed to test the strength of the stitches of the screens in a laboratory and further improve the design and stitching pattern.

Very important lessons were learned with regard to proper timing of the installation works; the under water works and installation of frames has to be competed by the first of March to avoid the risk of inclement weather conditions.

Much attention will have to be given to the anchoring system of the THP under the prevailing strong currents.

The proper installation of A-frames with angle shaped footings as designed for this trial section was not possible under the prevailing weather conditions and lack of slack water. This design should be abandoned.

Figure 4.1 Accretion in the tidal channel at Char Montaz after closure



5. POTENTIAL FOR ACCELERATION OF ACCRETION IN THE MEGHNA ESTUARY

In the Master Plan and the Development Plan prepared during MES five areas have been earmarked as having potential for acceleration of accretion:

1. Rangabali - Char Biswas
2. Char Montaz - Kukri Mukri
3. Nijhum Dwip
4. Hatia - Monpura
5. Sandwip West - Urir Char

Rangabali - Char Biswas and Char Montaz - Kukri Mukri

The potential for acceleration of accretion in Rangabali - Char Biswas and Char Montaz - Kukri Mukri has been studied at pre-feasibility and feasibility level respectively. The Char Montaz cross dam pilot scheme is located within the second area. This cross dam has been evaluated in Chapter 4, the performance of the dam clearly demonstrates the positive effect of closing a tidal channel on the rate of accretion in the channel.

As long as no measures are taken to influence the currents in this area, the processes of erosion and accretion will continue. Riverbank erosion appears at a limited number of locations and the rate of erosion is small because of moderate currents even during the monsoon period. Accretion will prevail in the future however the formation of new land will to a certain extent occurs at random. The available satellite imagery acquired in past years shows that in the course of the coming 25 years time substantial areas may be accreted and either be covered with forest or used for agricultural activities.

If at some future point of time the Government of Bangladesh wishes to accelerate accretion in this area and join individual islands, the installation of permeable cross dams will be an effective method to achieve this goal. The design of the dam will have to be improved as described in this note while detailed studies on the impact will have to be carried out to ascertain that the individual measures have no unacceptable consequences for the environment.

Nijhum Dwip

The potential for acceleration of accretion in the area between South Hatia and Nijhum Dwip has been described in a separate technical note on the design and implementation of Nijhum Dwip cross dam. Although a definite decision has not yet been taken, this cross dam may be constructed in the not too far away future.

Hatia - Monpura

Simultaneously with rapid erosion of Hatia North accretion is continuing in an inter-tidal area to the West of Hatia and North of Monpura island. In recent years the channel between Gazaria and Moulvir Char has become quite shallow and may eventually completely silt up depending on the development of the main channel system along the Ramgati and Bhola coasts. The construction of cross dams at strategic locations in the inter-tidal zone between these islands may not only accelerate accretion but might would also reduce the ongoing erosion of the West coast of Hatia island.

Sandwip West - Urir Char

The most dynamic area from a morphological point of view in the Meghna Estuary is the area West of Sandwip and Urir Char. Very severe erosion is continuing along the South coast of Urir Char and Char Pir Baksh. The latter char will have disappeared completely in the near future while in the coming 10 years the Southern half of Urir Char will be removed by the strong tidal current in the outer bend of the curved channel to the South of Urir Char.

At the same time in the inner bend of the same channel accretion is ongoing and will continue. This will result in an extension of the accreted areas West of Sandwip in a northeasterly direction. Other future natural developments are difficult to predict, it is likely that the ongoing accretion to the West of Sandwip will continue in the foreseeable future though the tidal channels in the area may change course.

The channel between Urir Char and the Noakhali mainland is already quite shallow in places. The inter-tidal zone in this area may shift to the North as the deep channel South of Urir Char shifts to the North.

The installation of cross dams at suitable locations in the tidal channels would change the situation drastically as is demonstrated by the results of simulations with the detailed hydrodynamic model of the area between Sandwip and Hatia. In large areas the flow velocities would be reduced substantially and as a result rapid accretion will fill these areas within a very short time.

The results of the simulations are presented in the Second Update Report of the Two-Dimensional General Model of the Meghna Estuary, prepared by SWMC, December 2000. Since the draft report became available during preparation of this technical note a thorough analysis of this report is not possible.

However a detailed analysis and subsequent adjustment of the possible options for cross dam construction should be carried out at a later stage to ascertain the feasibility of acceleration of accretion in this area with a high potential for land reclamation.

Based on a first impression of the contents of the Update Report the following remarks are made:

- As indicated in the Second Update Report the maximum flow speed will change after installation of one or more cross dams. Although a high maximum velocity may indicate erosion, the changes in the flow pattern during a complete tidal cycle should be taken into account when analyzing the effect of a cross dam on local erosion

- The simulations indicate that a cross dam between Urir Char and the Noakhali main land will increase the maximum flow velocities in the channel between Sandwip and Urir Char. Before conclusions are drawn with regard to a possible acceleration of erosion in this channel a more detailed analysis of the changes in the flow pattern during the tidal cycle should be carried out. In addition the duration of increased velocities should be estimated taking into account that rapid accretion as a result of cross dam construction will change the flow pattern in a relatively short time.

- A cross dam connecting the Noakhali mainland with a recently emerged char appears to reduce velocities in a large area. The areas with increased velocities according to the simulations are not in the neighborhood of existing land. See Figure 5.1.Therefore installation of this cross dam may be the most promising with the least impact on existing land.

- The combined effect of the two cross dams will result in accelerated accretion in a very large area. See Figure 5.2. The first cross dam to be installed should connect the Noakhali mainland with the new char. The dam connecting Urir Char to the mainland would be second to avoid increases in maximum velocities in the channel between Sandwip and Urir Char as much as possible.

- Other cross dams could be considered after completion of the two dams mentioned above.

In ANNEX C the results of preliminary simulations with the MIKE21 two-dimensional model are shown.

For a completely closed cross dam no 1, head differences of 2 m have been calculated. This will require a rather strong structure with heavy ballast for stability. Therefore it may be an advantage to start with a relatively permeable cross dam no1, that will reduce the head difference substantially. In addition the acceleration of accretion is expected to be higher for a permeable cross dam than for a completely closed cross dam. However this has to be confirmed by further detailed analysis.

The head differences simulated for cross dam no 2 (in combination with dam no 1 appear to be much less and therefore the stability of the structure will be less problematic.

At selected locations the difference in water levels before and after implementation of cross dams have calculated using the results of the MIKE21 simulations.
At Hatia north the differences will be less than 10 cm and at high tide lower water levels have been calculated.

Large differences, in the order of 40 – 55 cm have been calculated at Urir Char North in the case of combined implementation of cross dams no 1 and no 2. However at highest high water the difference found was 40 cm. The effect on water levels of dam no 1 in this area is much lees, 10 – 20 cm.

The changes in maximum water levels northeast of Sandwip are less than 30 cm while water level differences at Sandwip west are less than 5 cm.

In ANNEX D a preliminary design and cost estimate has been given. For this preliminary design it has been assumed that the maximum head will be about 1.5 m, taking into account reduced head as a result of permeability. The most favorable sections, as far as bed level is concerned, have been selected from the surveys in 1999/2000.

In order to reduce the forces on individual screens, three geotextile screens installed in series have been included in the design. The quantity of ballast required for stability has been roughly estimated. At a later stage the stability of the structure should be analyzed in detail and the hydraulic behavior of the three screen as well as the design of the geotextile screens should be evaluated carefully.

A rough cost estimate has been prepared per km cross dam based on the preliminary design as well as earth dams connecting the permeable cross dam to the mainland of Noakhali and the char. The cost of cross dam no 1 is estimated at 800 million Taka (about 15,000,000 US$); the cost of cross dam no 2 is estimated at 900 million Taka (about 17,000,000 US$)

Figure 5.1: Effect of cross dam no 1 on velocities in the adjacent tidal channels

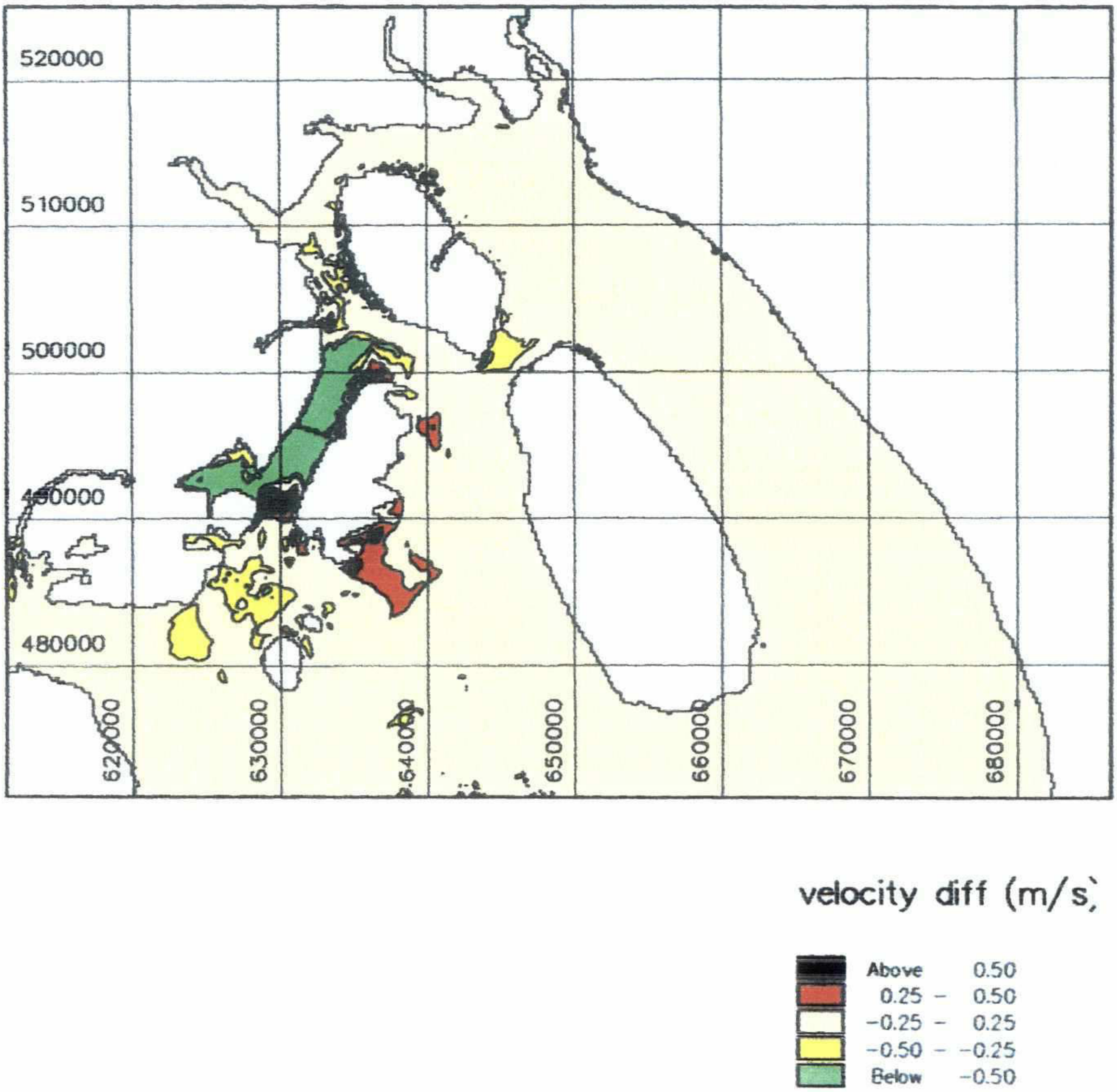
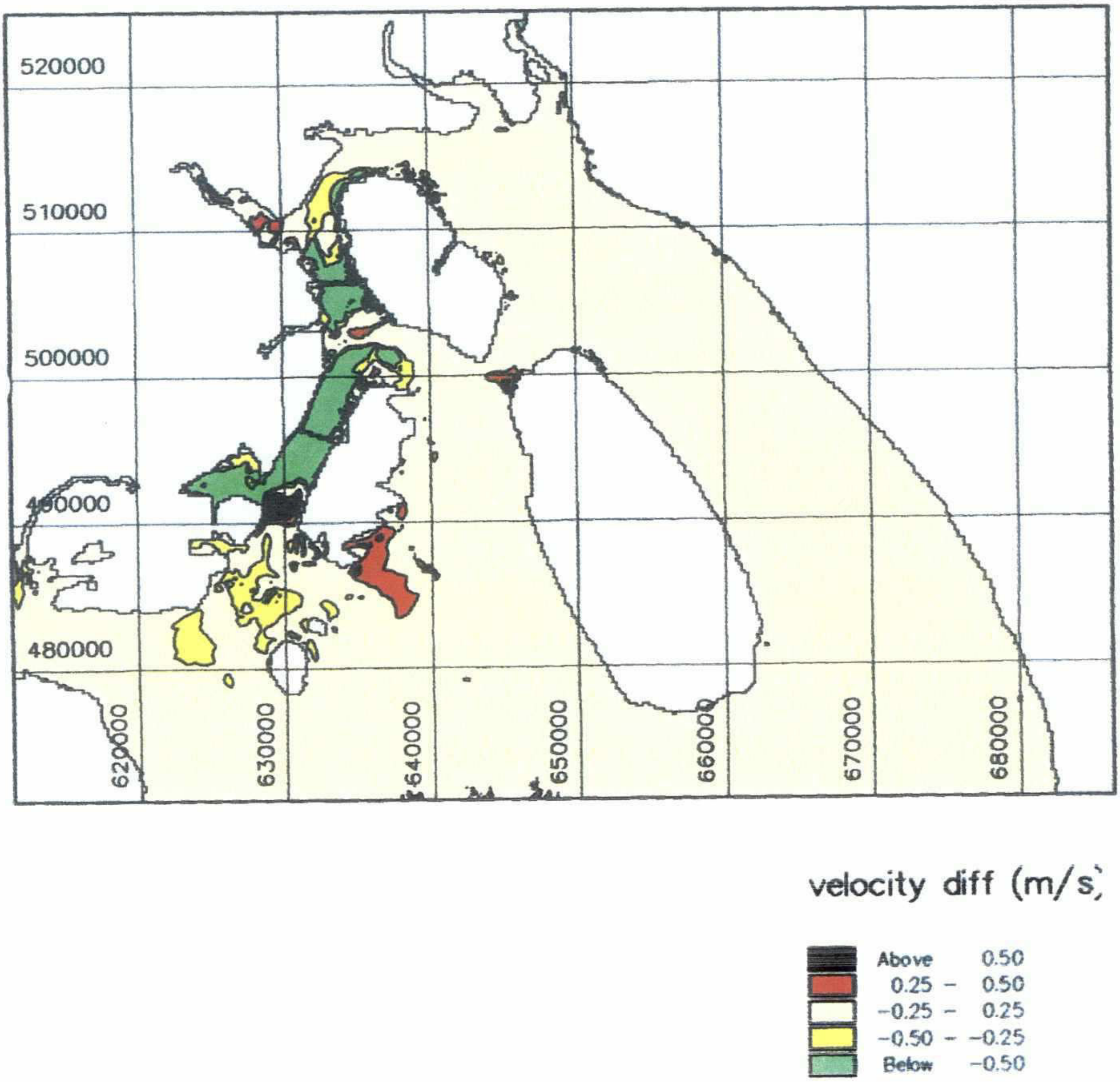


Figure 5.2: Effect of cross dam no 1 and 2 on velocities in the adjacent tidal channels



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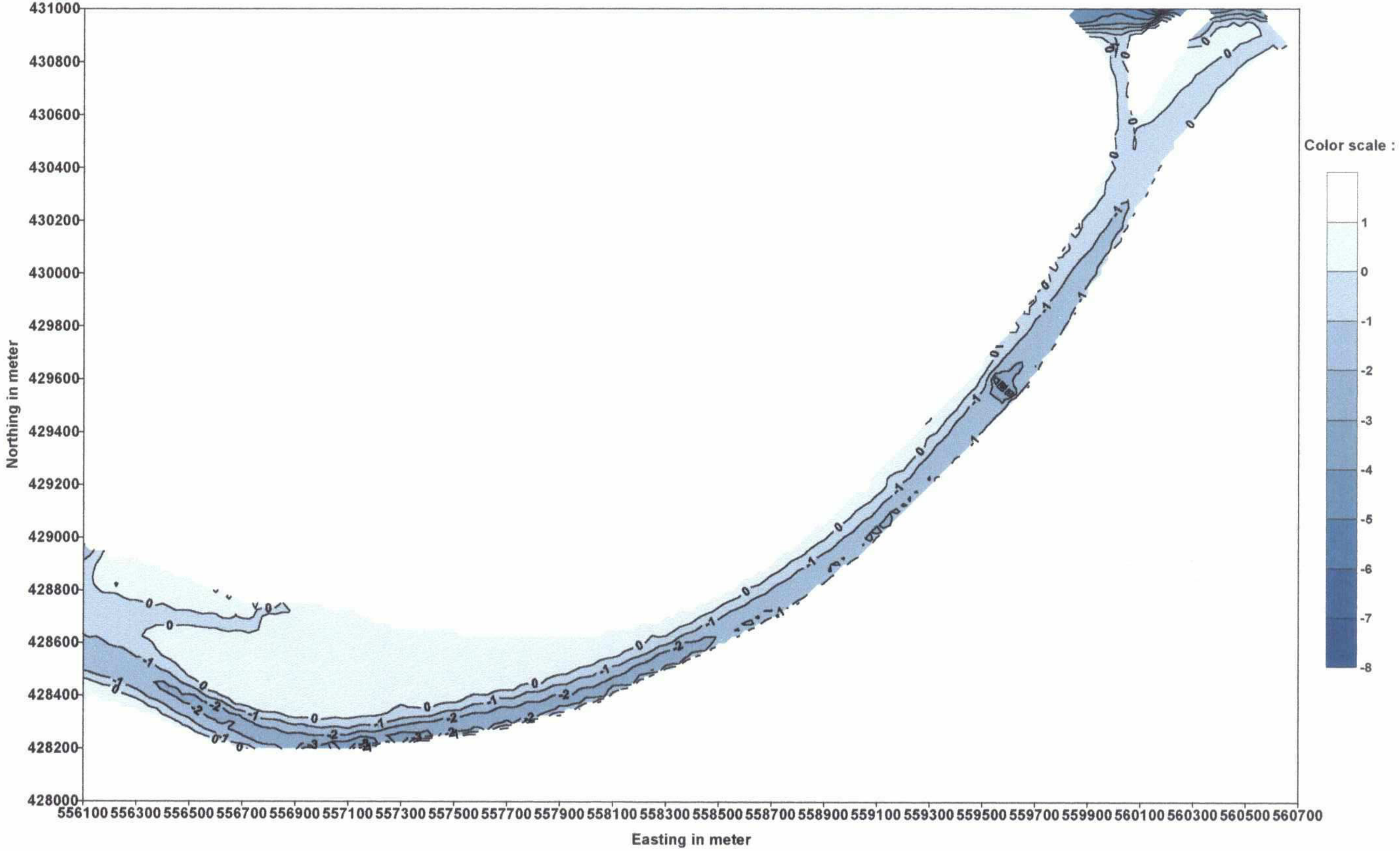
ANNEX A

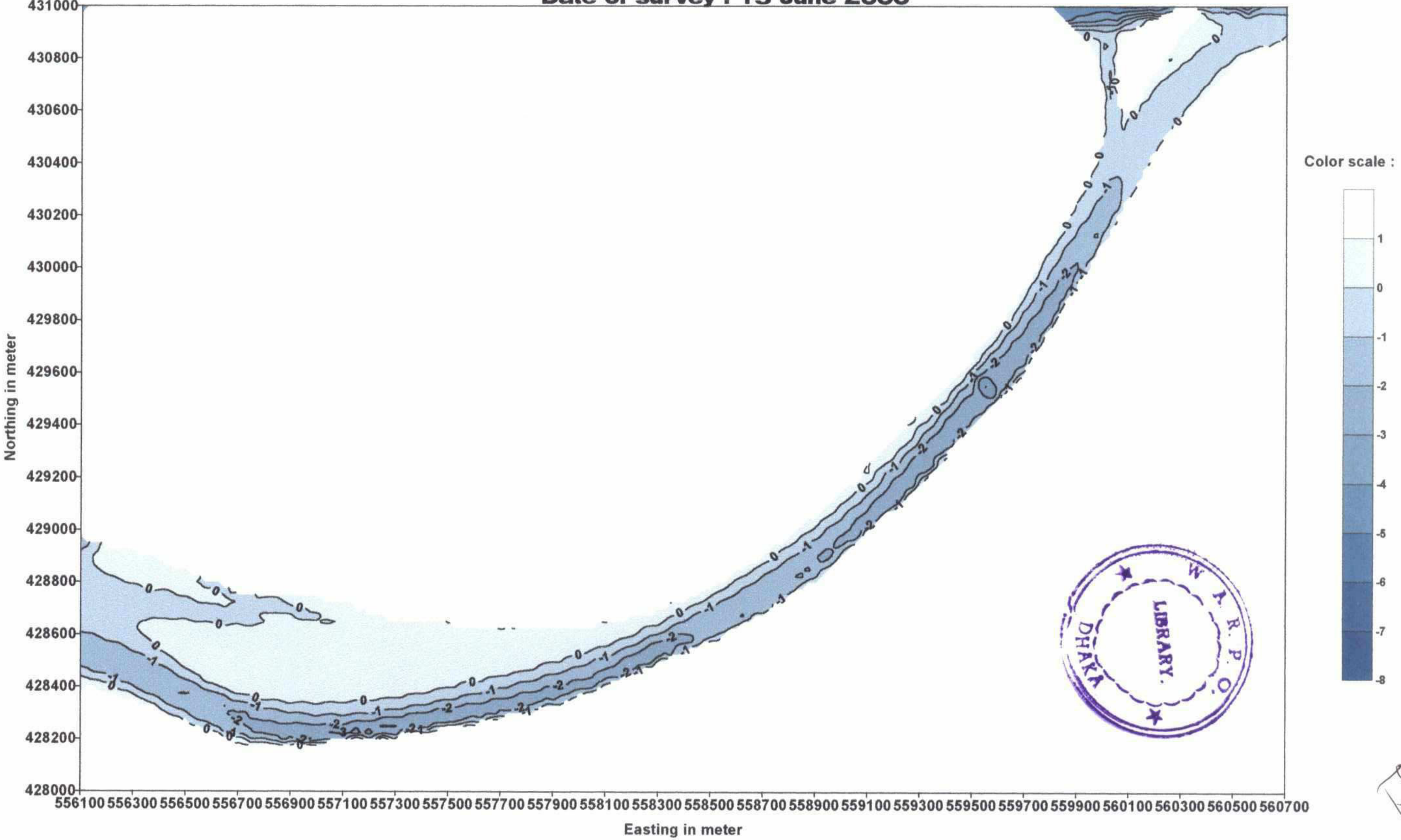
ACCELERATION OF ACCRETION
EVALUATION OF CROSS DAM PILOT SCHEMES

CHAR MONTAZ PERMEABLE CROSS DAM
BATHYMETRIC MAPS

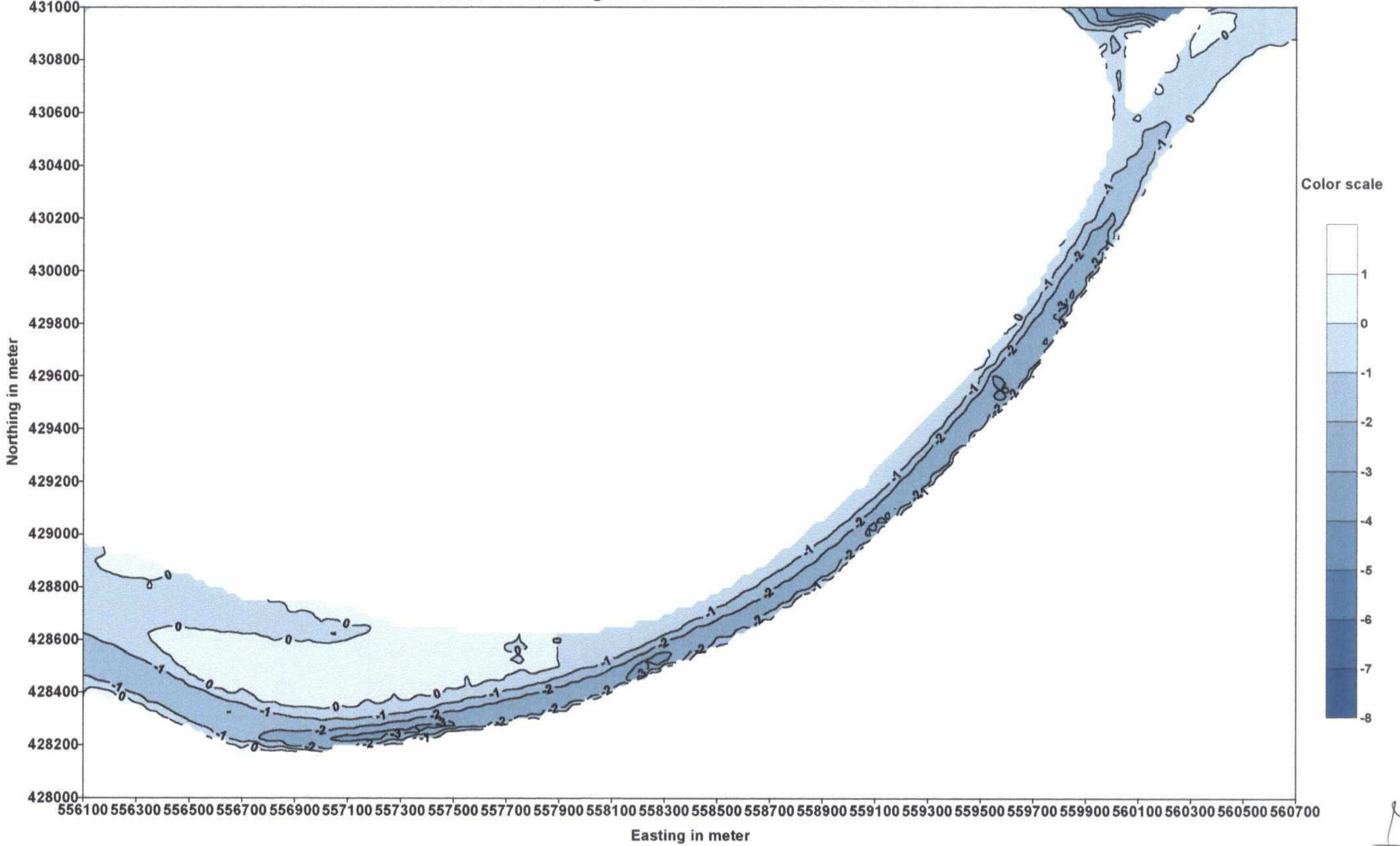
CRUISE 2000/13
Location : Char Montaz
Date of survey : 23 - 24 November 2000



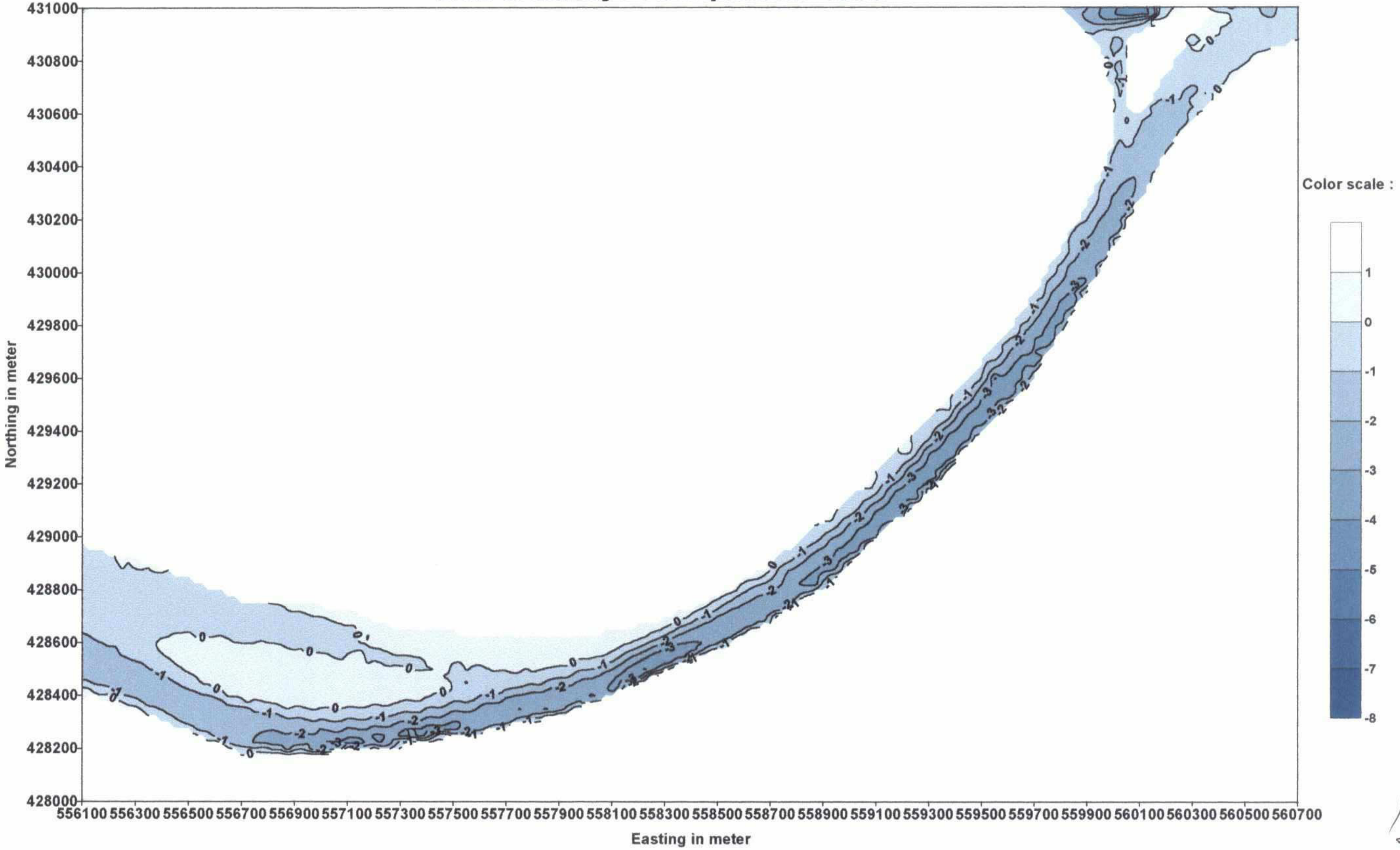
CRUISE 2000/07
Location : Char Montaz
Date of survey : 13 June 2000



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



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



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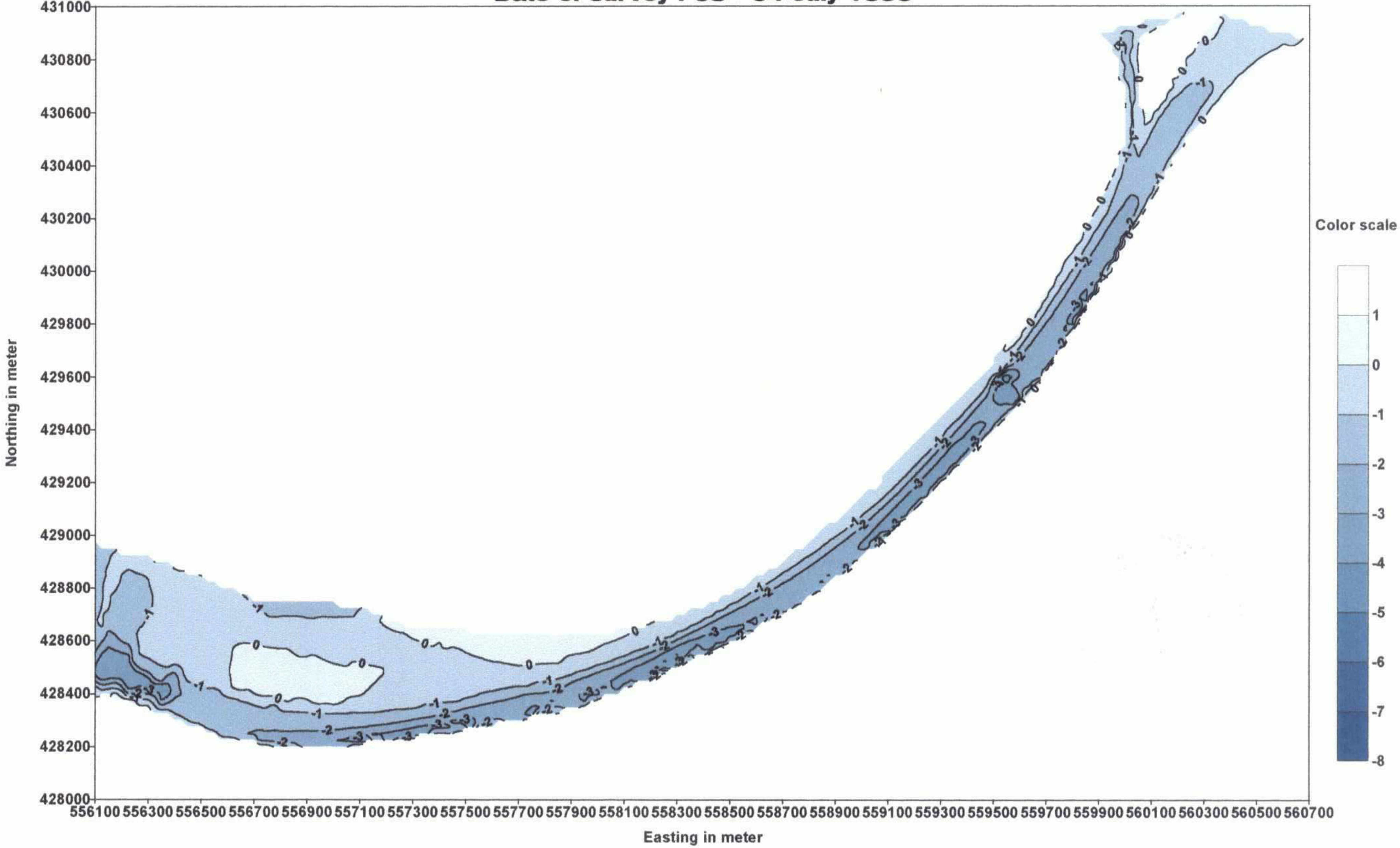
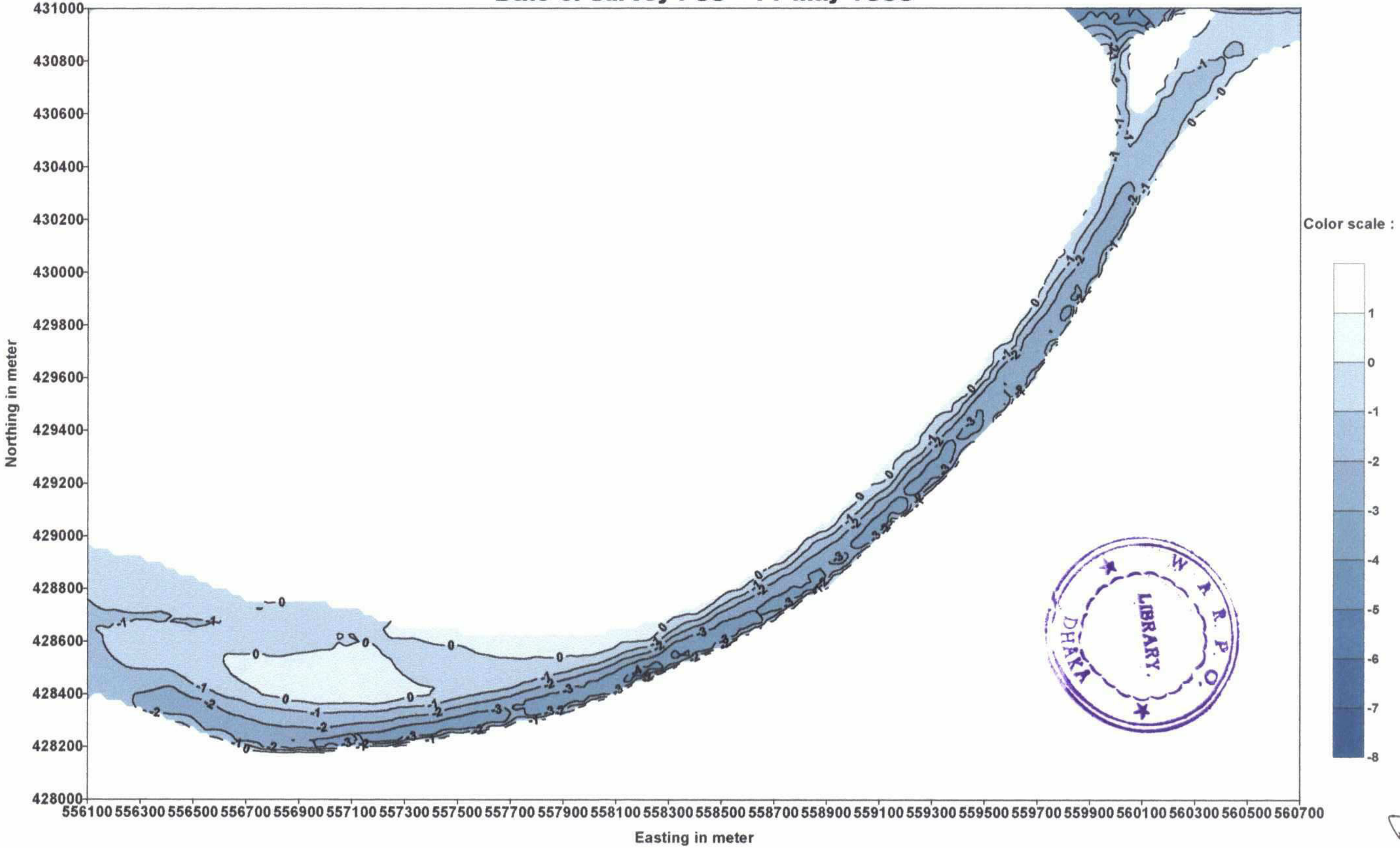
CRUISE 6
Location : Char Montaz
Date of survey : 03 - 04 July 1999



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



ANNEX B

ACCELERATION OF ACCRETION
EVALUATION OF CROSS DAM PILOT SCHEMES

CHAR MONTAZ PERMEABLE CROSS DAM
VOLUME COMPUTATIONS

02

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

56

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

098

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

OR

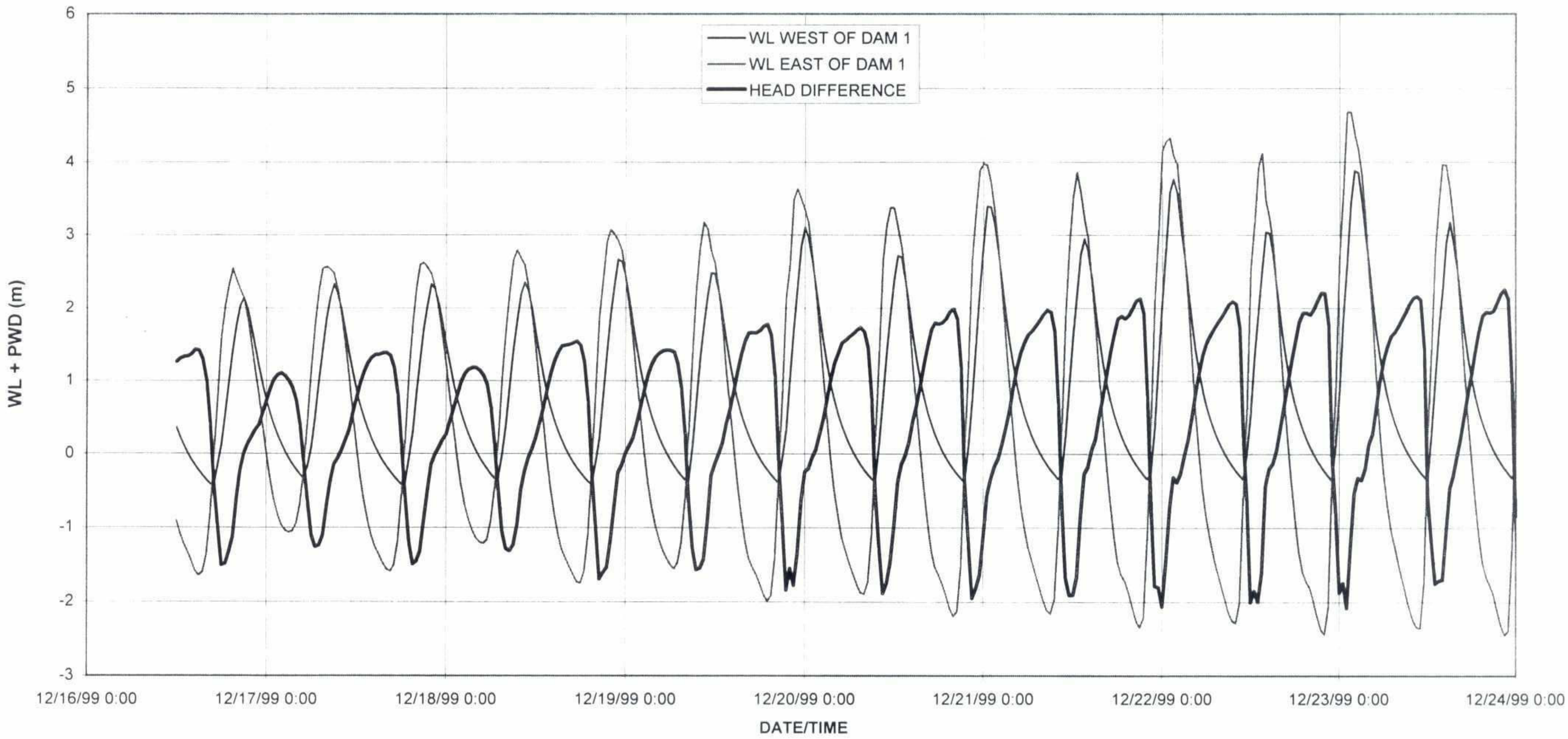
ANNEX C

ACCELERATION OF ACCRETION
EVALUATION OF CROSS DAM PILOT SCHEMES

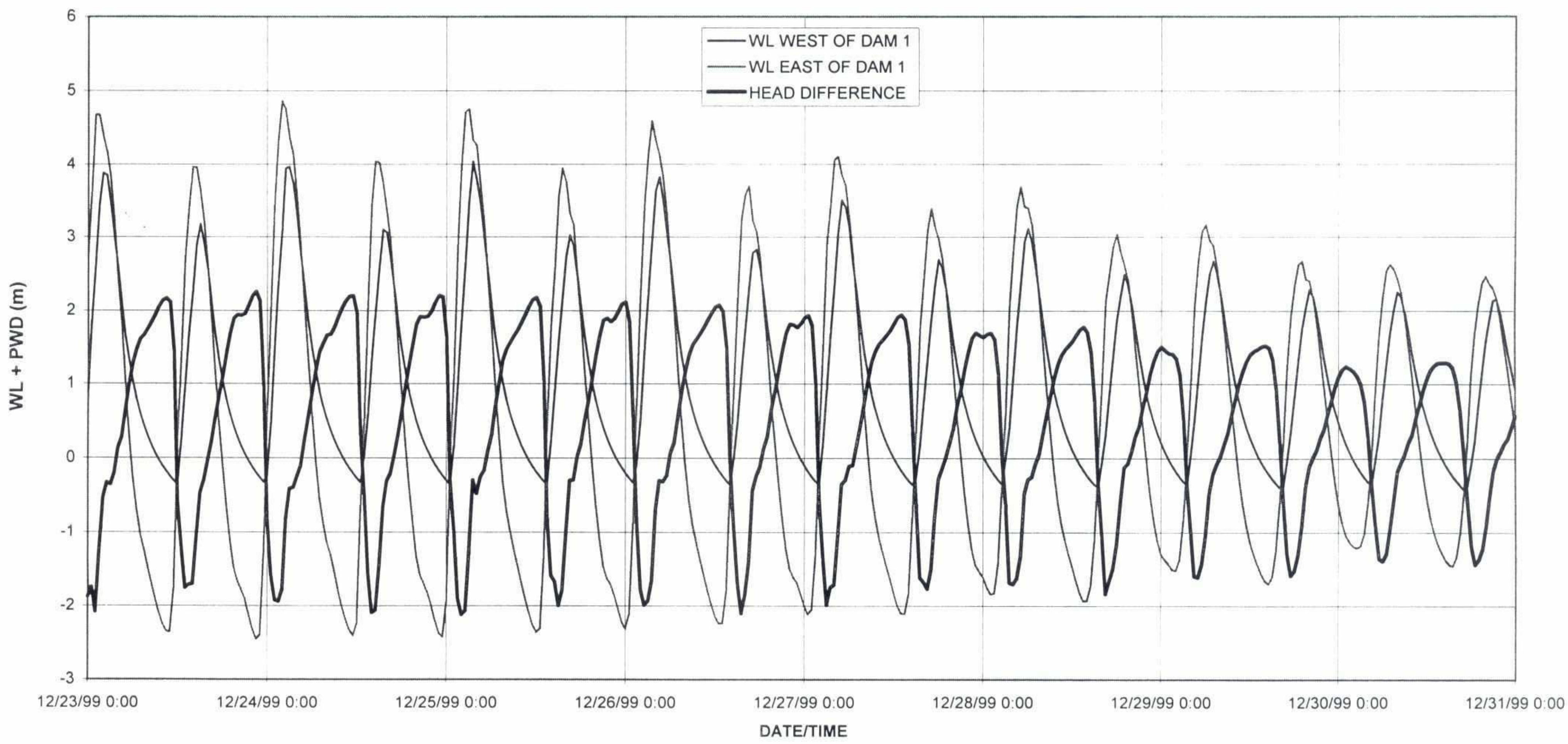
SANDWIP WEST - URIR CHAR
PERMEABLE CROSS DAM 1
PERMEABLE CROSS DAMS 1 AND 2

SIMULATED WATER LEVELS
HEAD DIFFERENCES AT CROSS DAMS
CHANGES IN WATER LEVELS AT SELECTED LOCATIONS

OPTION CROSS DAM 1

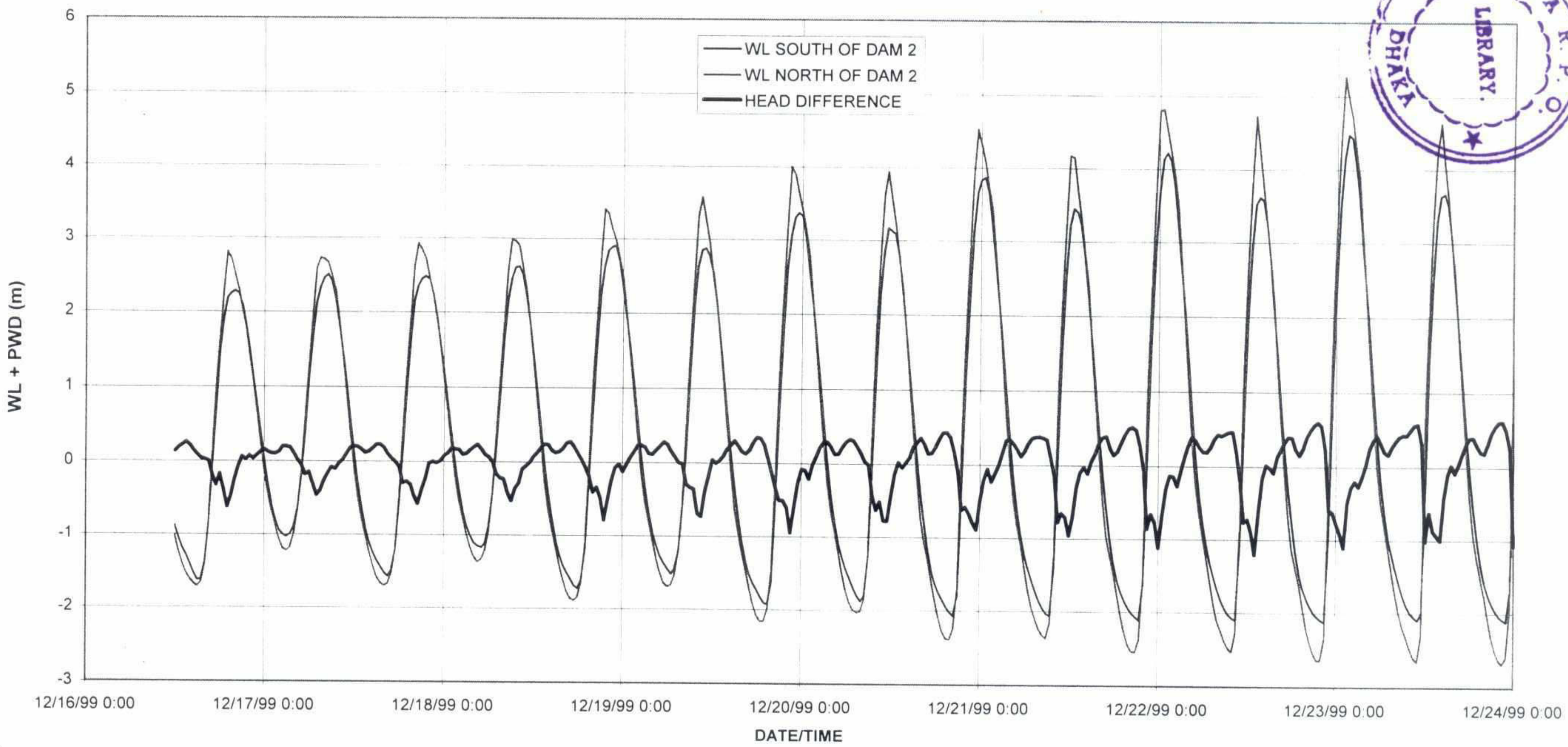


OPTION CROSS DAM 1

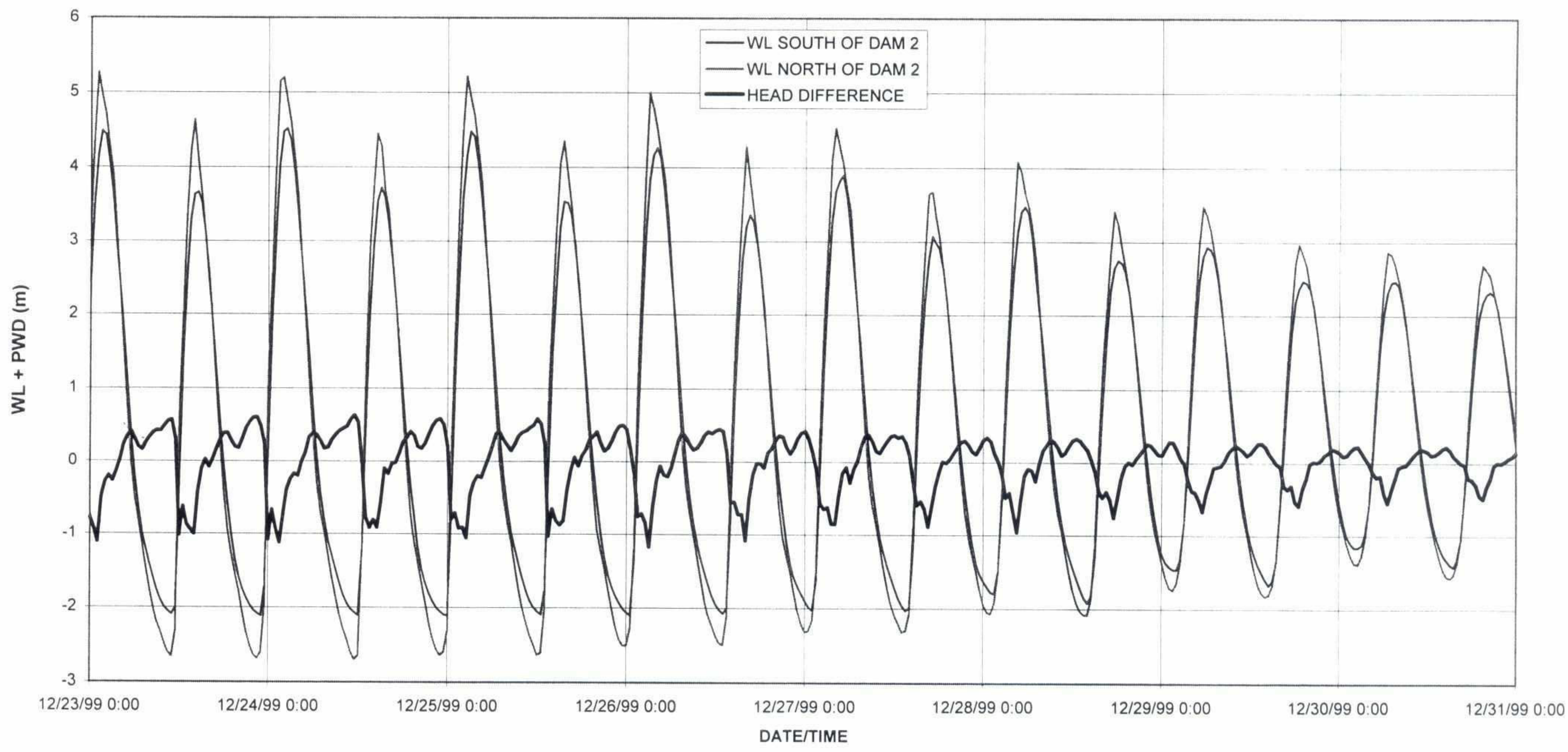


G9

OPTION CROSS DAMS 1 AND 2

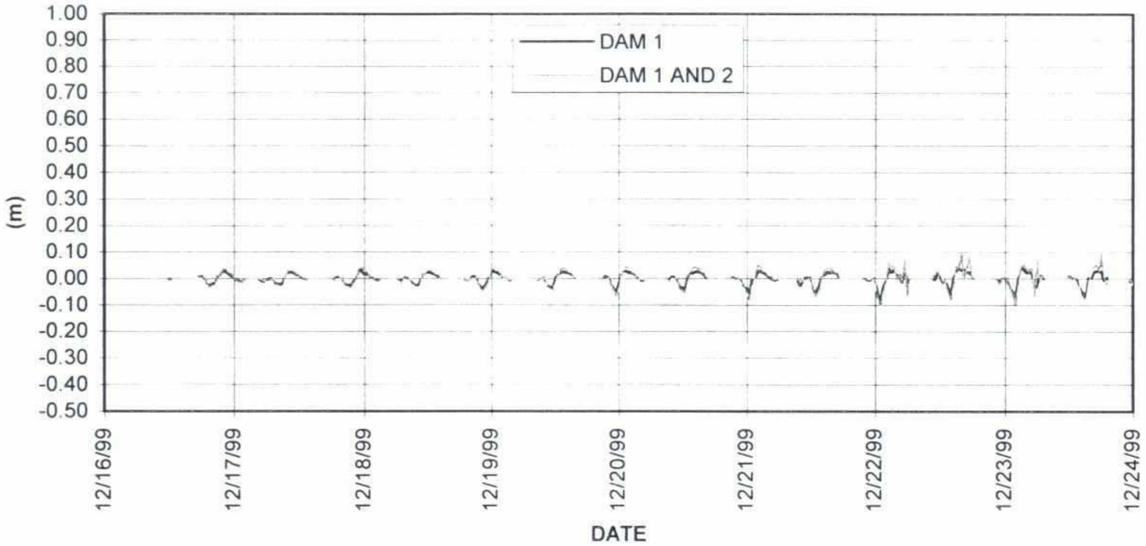


OPTION CROSS DAMS 1 AND 2

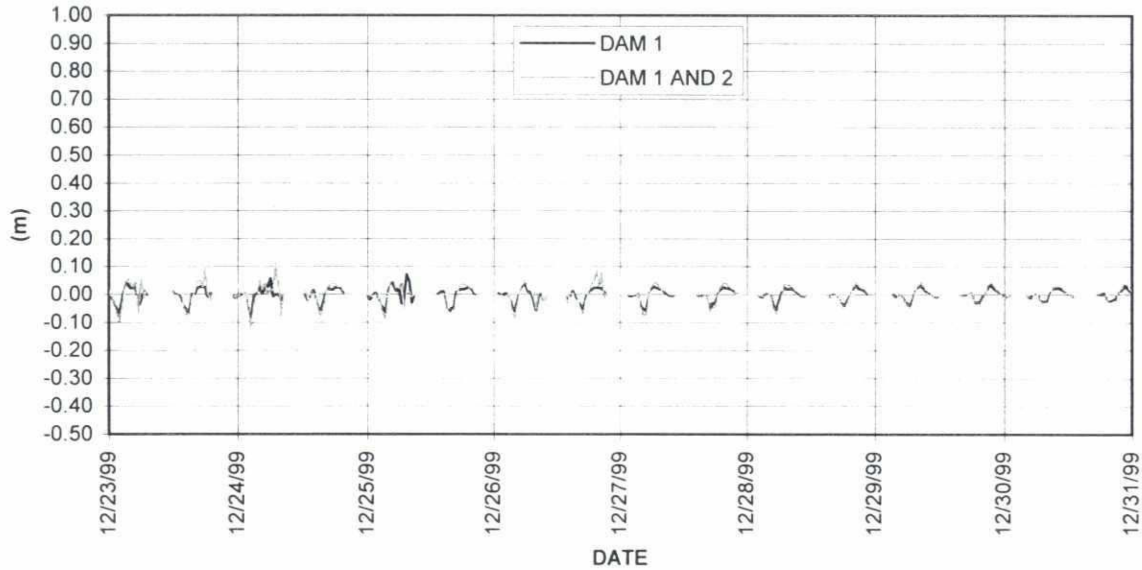


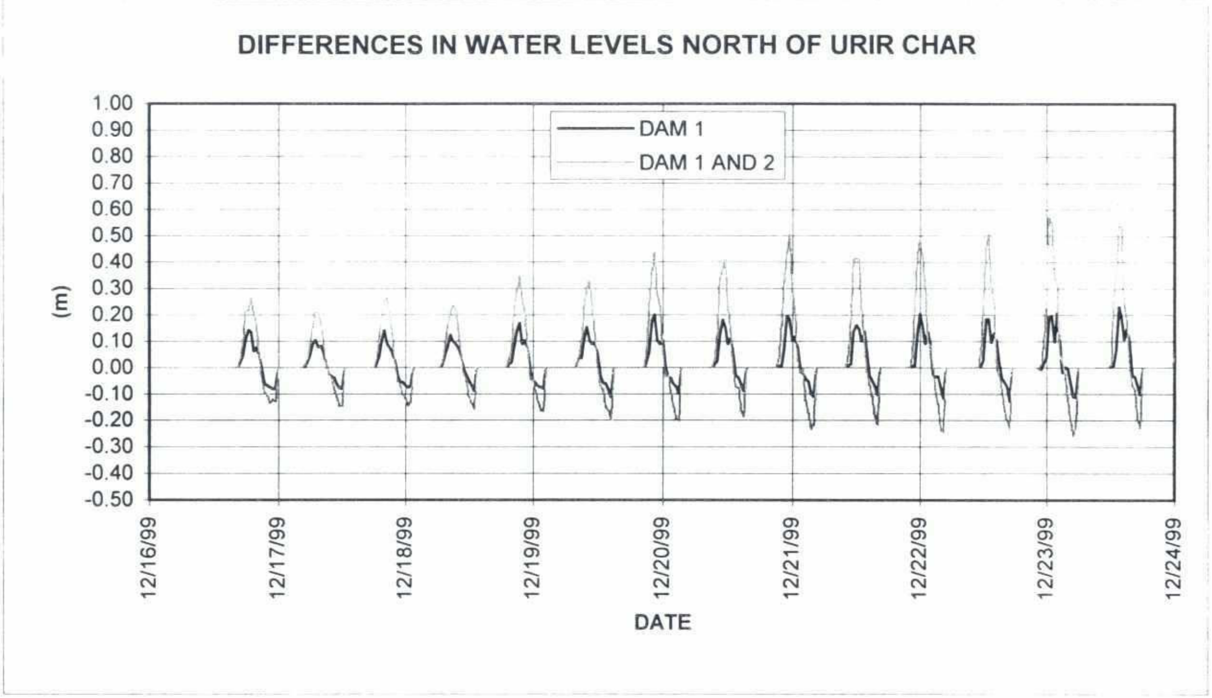
80

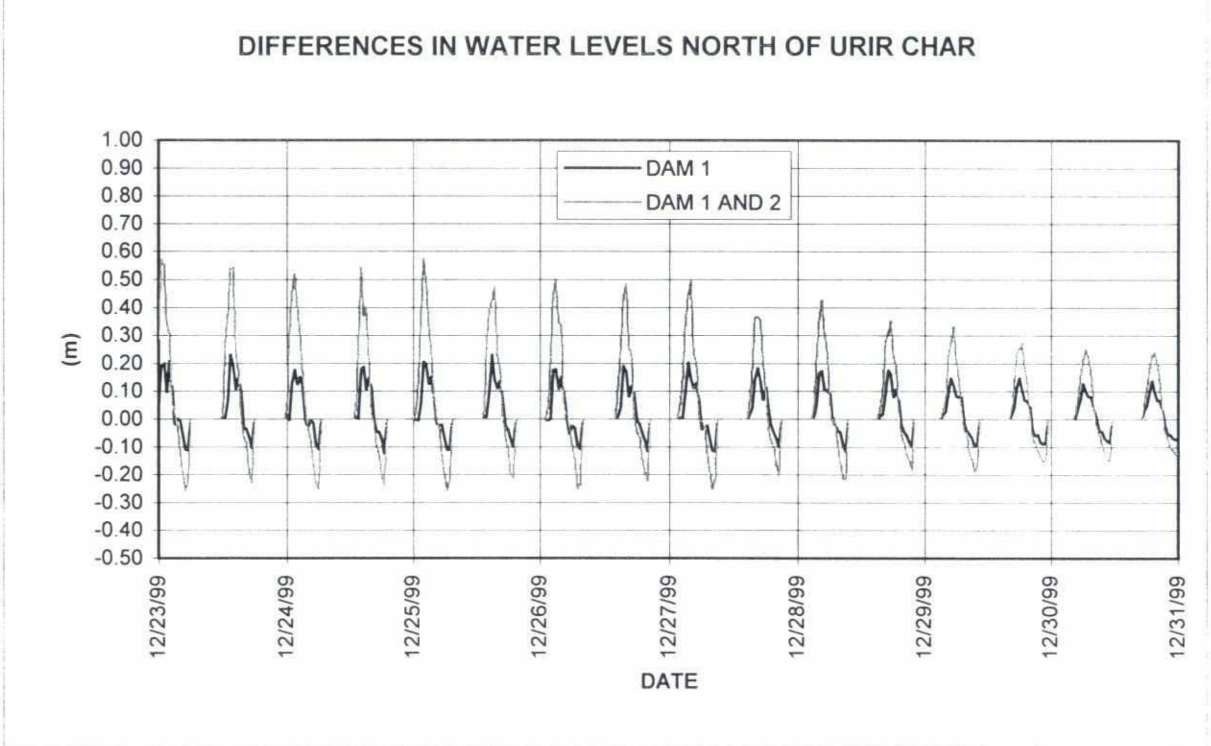
DIFFERENCES IN WATER LEVELS NORTH OF HATIA



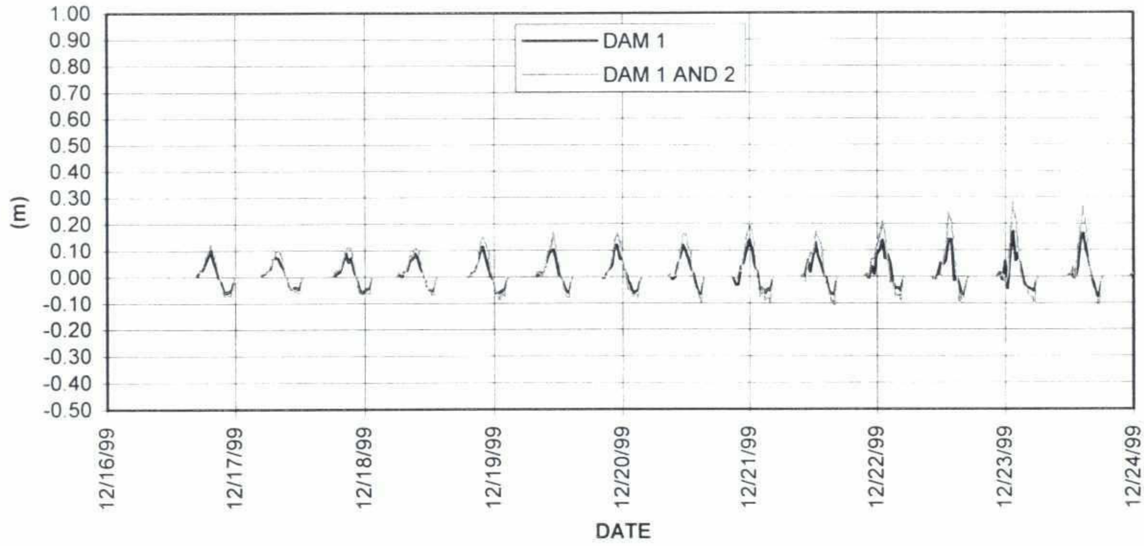
DIFFERENCES IN WATER LEVELS NORTH HATIA



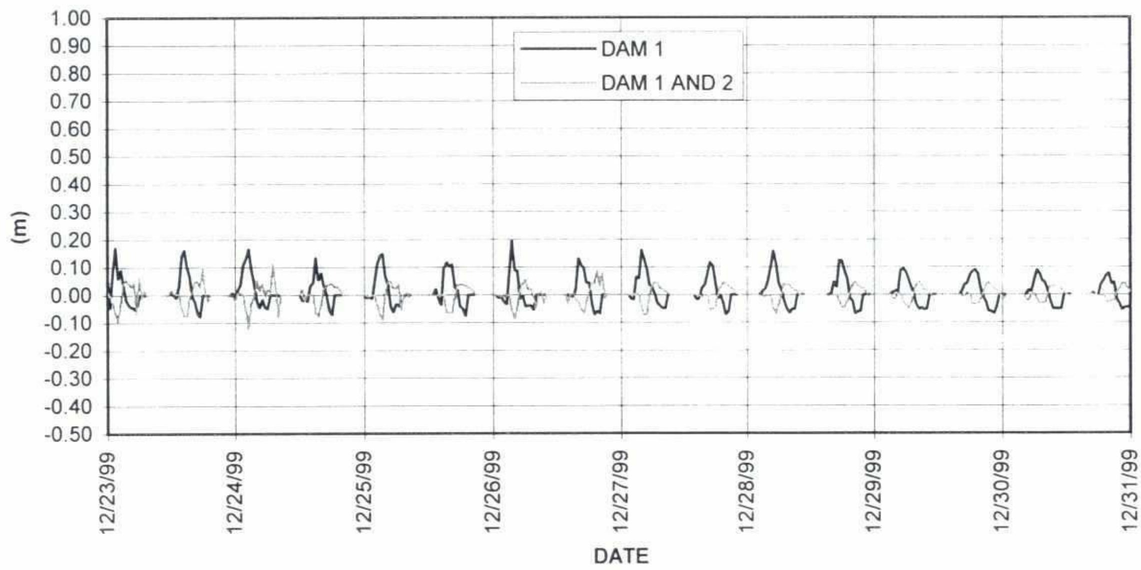

DIFFERENCES IN WATER LEVELS NORTH OF URIR CHAR
DAM 1
DAM 1 AND 2
(m)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
12/16/99
12/17/99
12/18/99
12/19/99
12/20/99
12/21/99
12/22/99
12/23/99
12/24/99
DATE


DIFFERENCES IN WATER LEVELS NORTH OF URIR CHAR
DAM 1
DAM 1 AND 2
(m)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
12/23/99
12/24/99
12/25/99
12/26/99
12/27/99
12/28/99
12/29/99
12/30/99
12/31/99
DATE

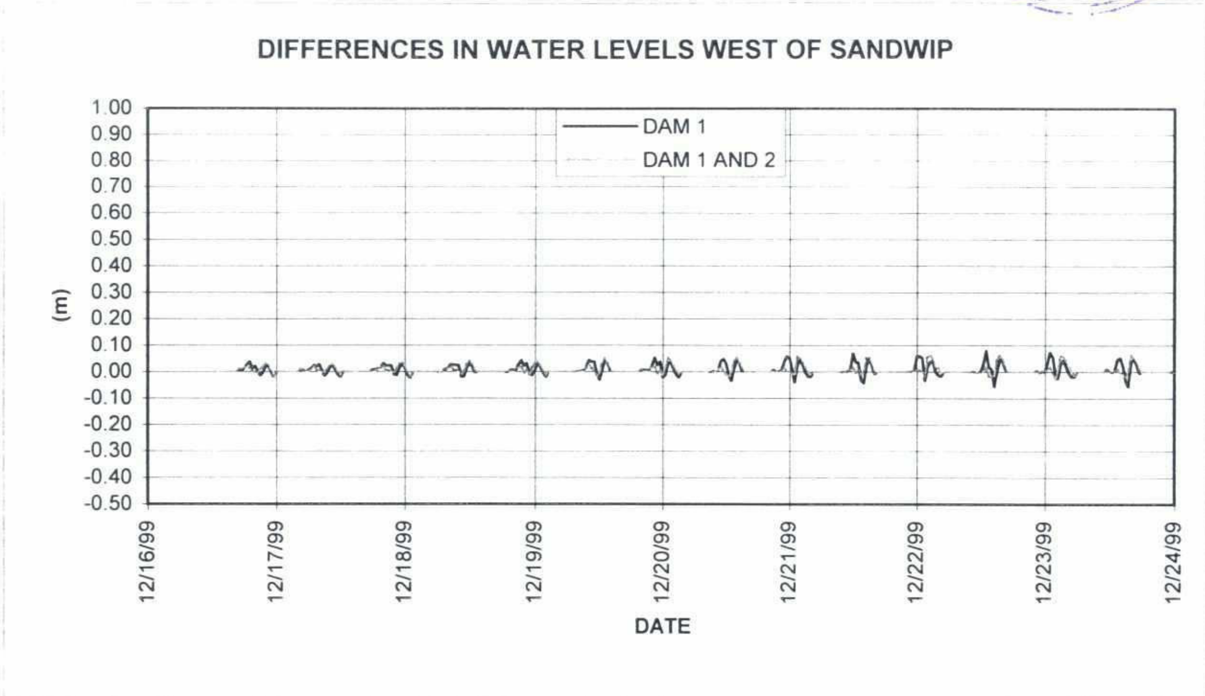
DIFFERENCES IN WATER LEVELS NORTHEAST OF SANDWIP

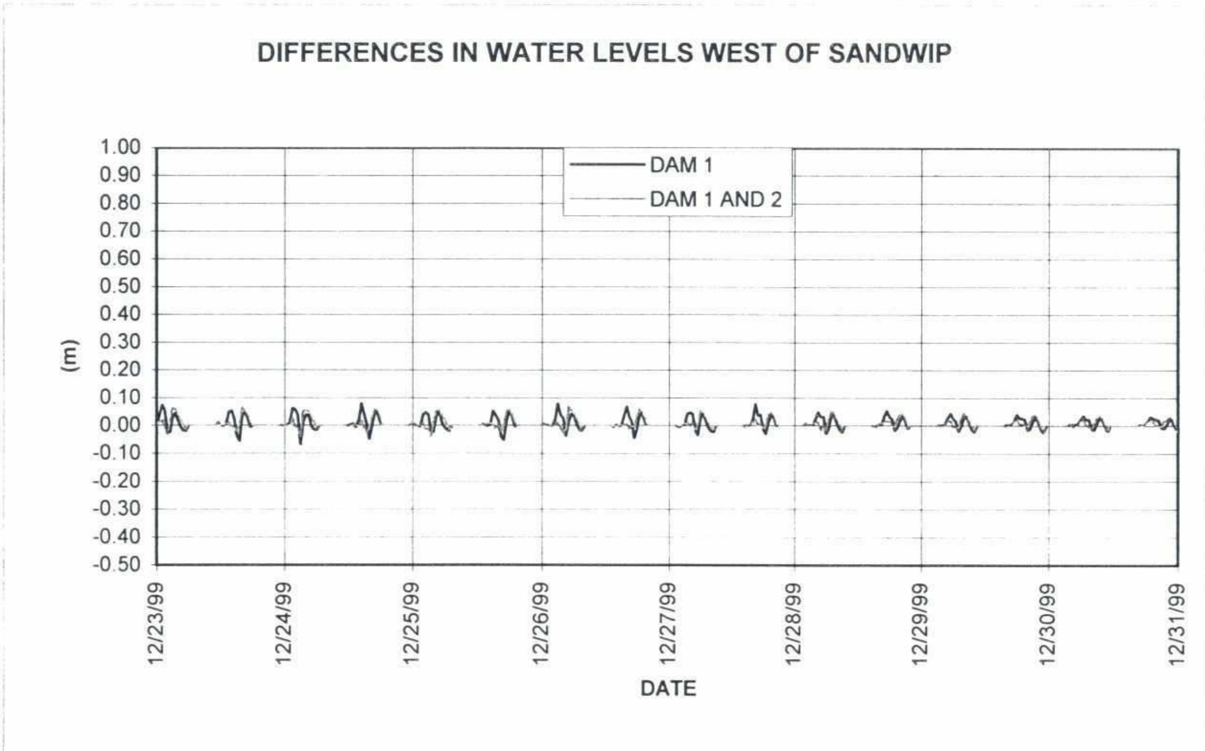


DIFFERENCES IN WATER LEVELS NORTHEAST OF SANDWIP



86


DIFFERENCES IN WATER LEVELS WEST OF SANDWIP
DAM 1
DAM 1 AND 2
(m)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
12/16/99
12/17/99
12/18/99
12/19/99
12/20/99
12/21/99
12/22/99
12/23/99
12/24/99
DATE


DIFFERENCES IN WATER LEVELS WEST OF SANDWIP
DAM 1
DAM 1 AND 2
(m)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
12/23/99
12/24/99
12/25/99
12/26/99
12/27/99
12/28/99
12/29/99
12/30/99
12/31/99
DATE

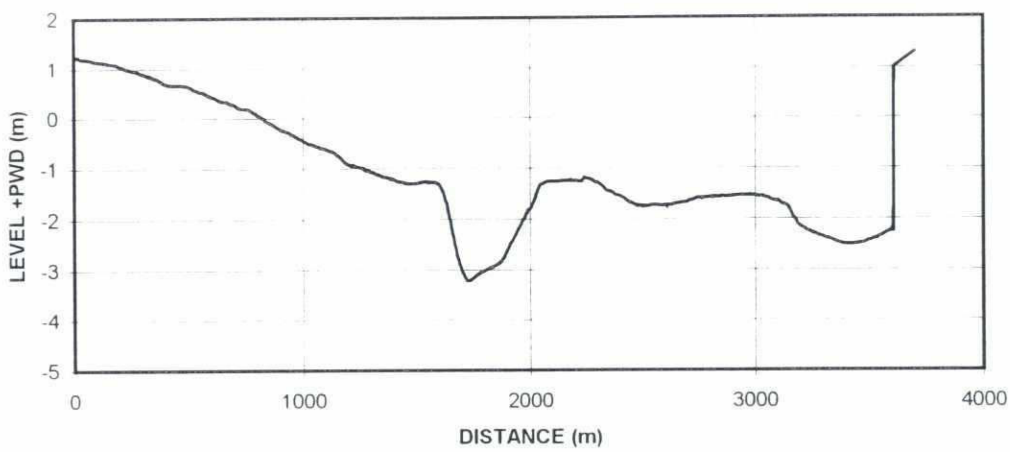
ANNEX D

ACCELERATION OF ACCRETION
EVALUATION OF CROSS DAM PILOT SCHEMES

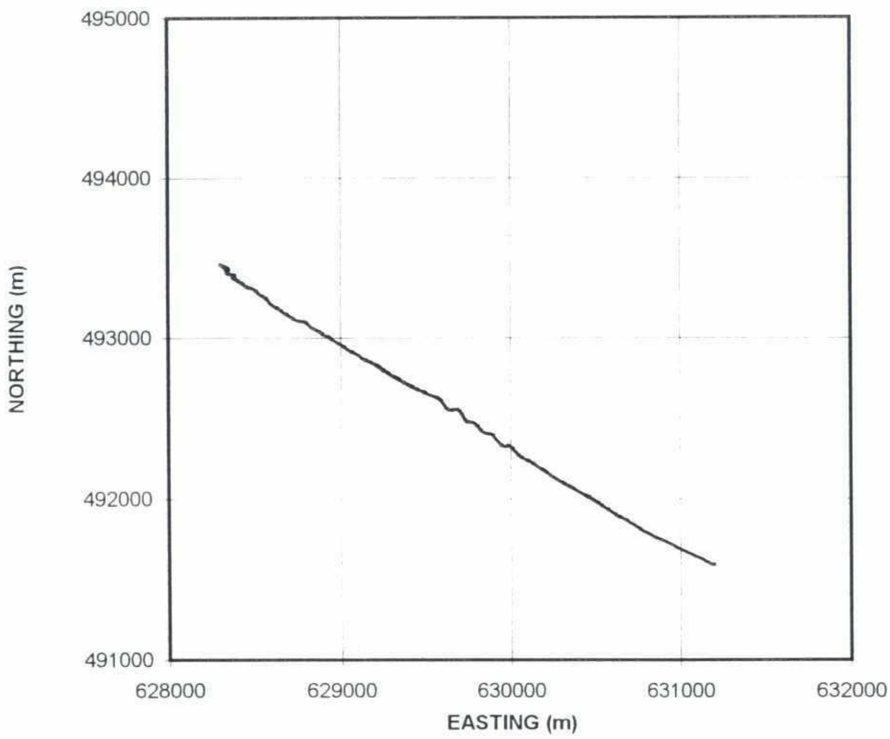
SANDWIP WEST - URIR CHAR
PERMEABLE CROSS DAM 1
PERMEABLE CROSS DAMS 1 AND 2

PRELIMINARY DESIGN AND COST ESTIMATE

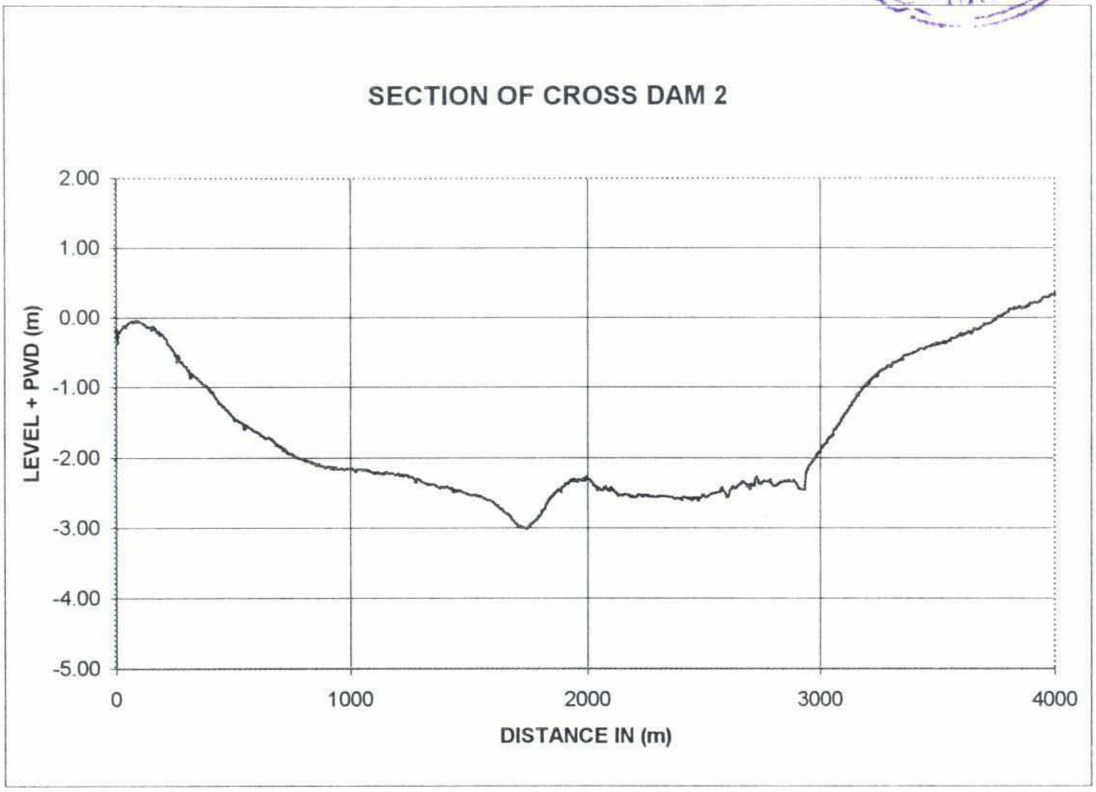
SECTION OF CROSS DAM 1

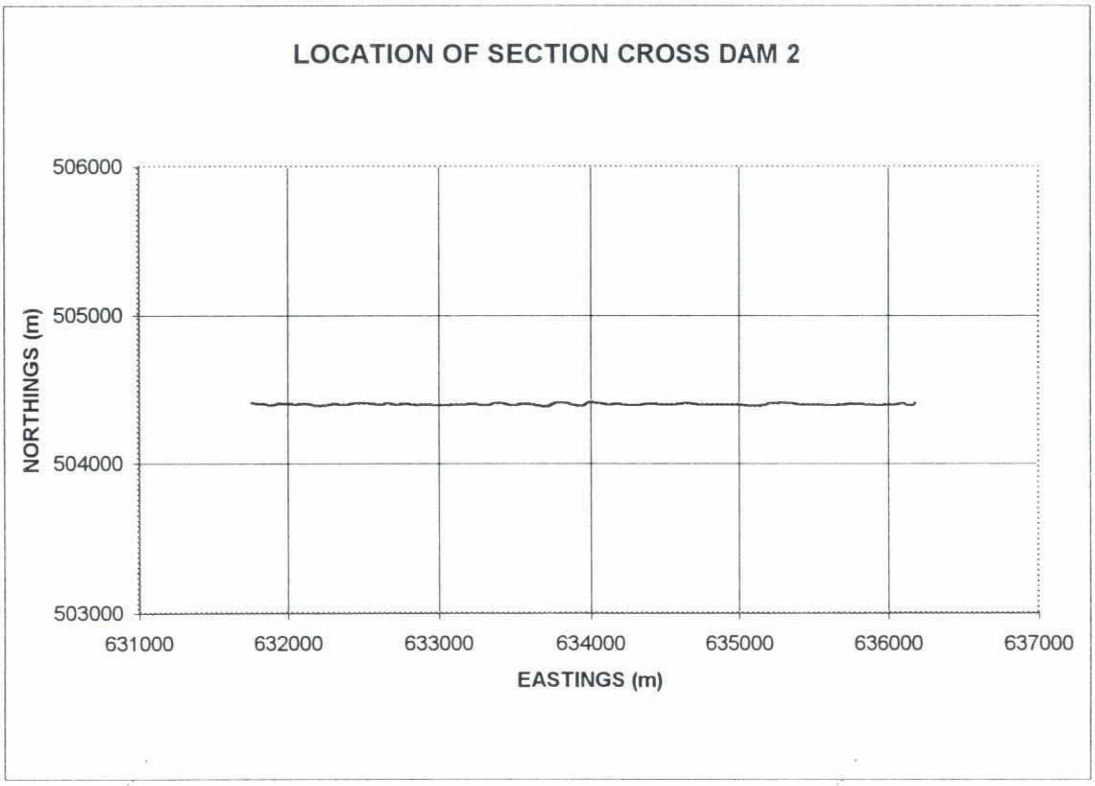


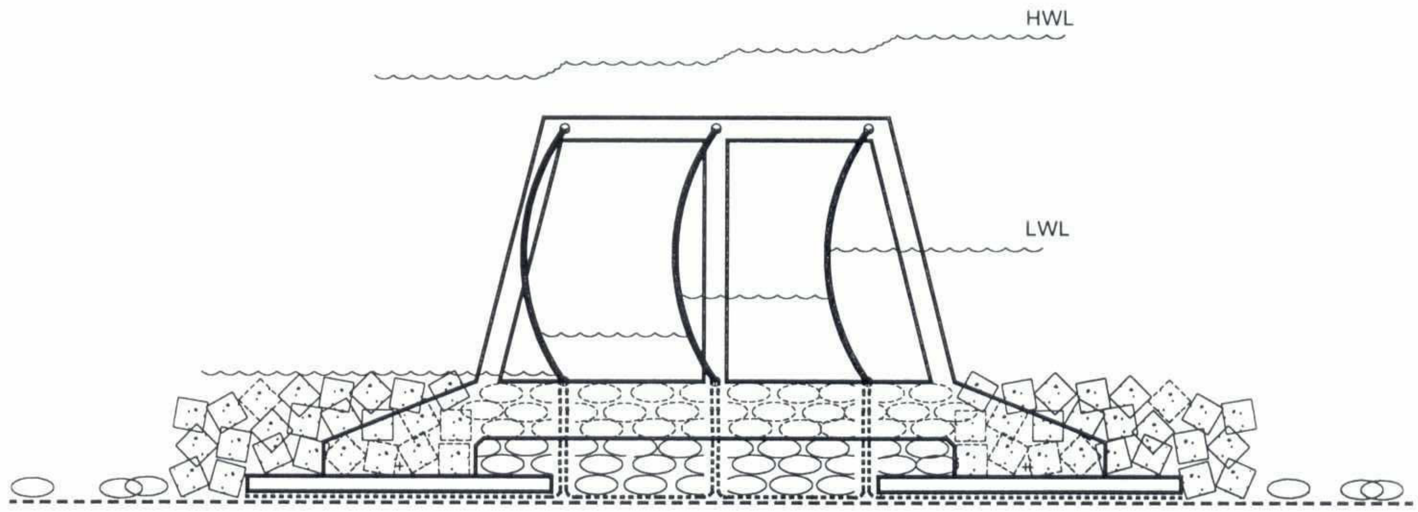
LOCATION OF SECTION CROSS DAM 1



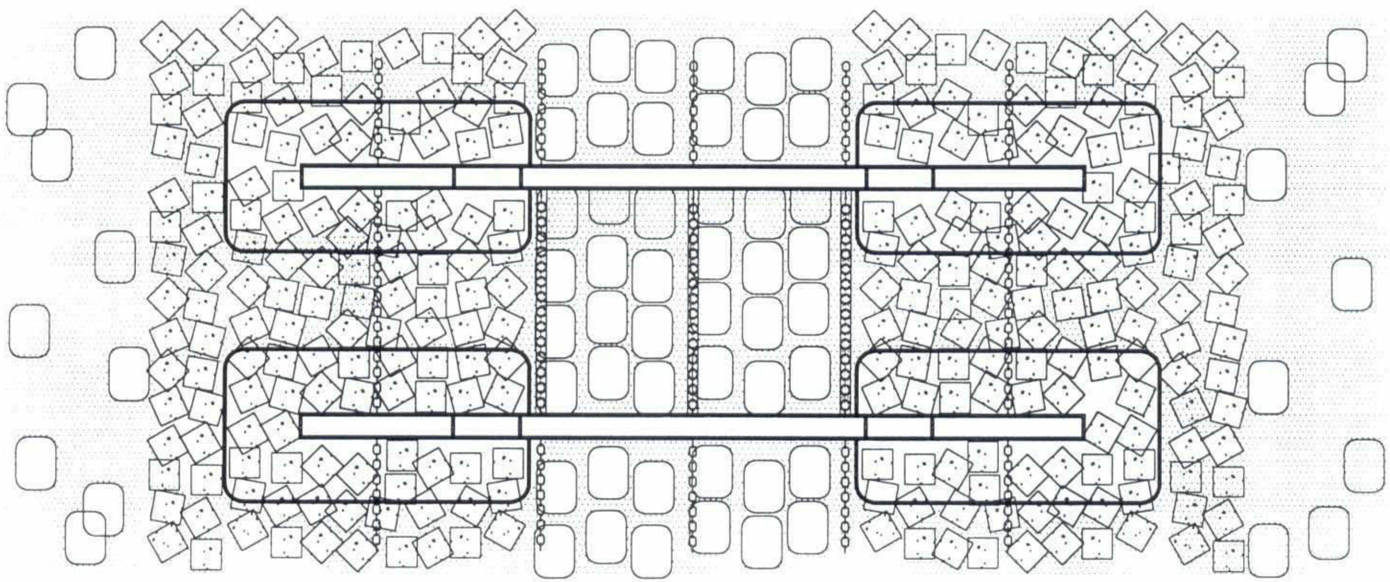
83


SECTION OF CROSS DAM 2
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
LEVEL + PWD (m)
0
1000
2000
3000
4000
DISTANCE IN (m)


LOCATION OF SECTION CROSS DAM 2
506000
505000
504000
503000
NORTHINGS (m)
631000
632000
633000
634000
635000
636000
637000
EASTINGS (m)

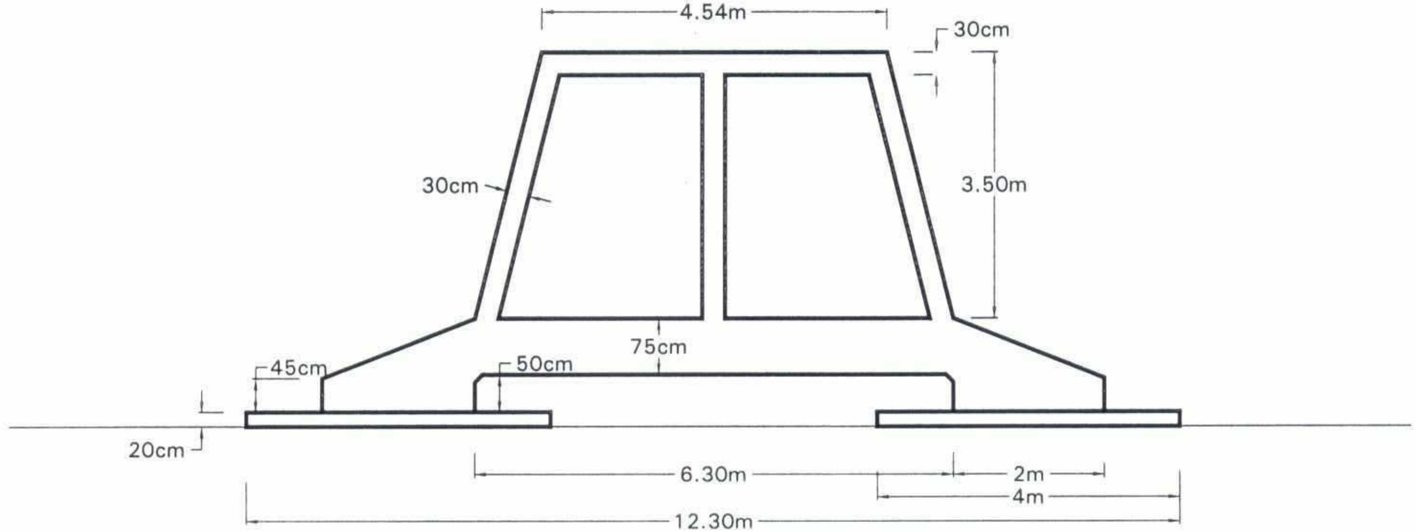


SECTION
SCALE 1:100

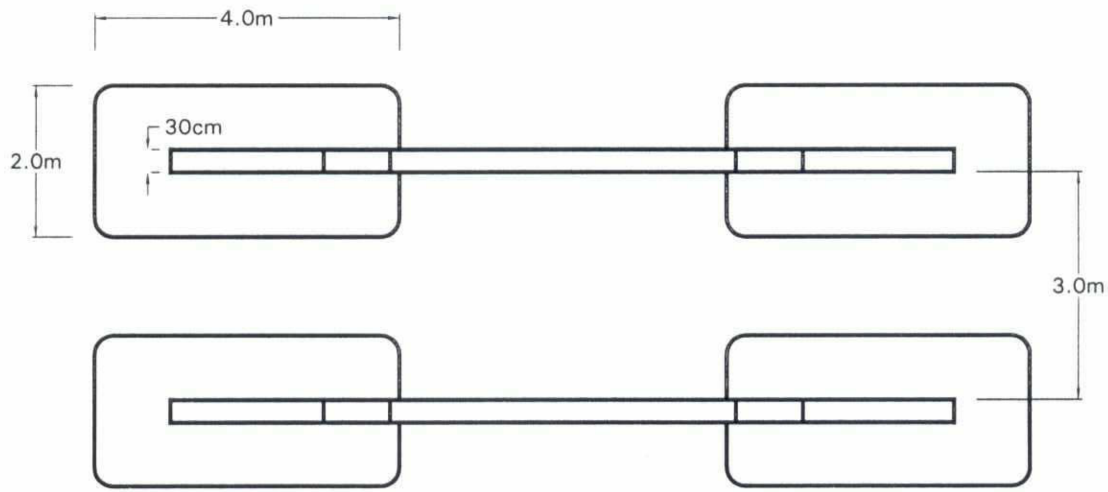


PLAN
SCALE 1:100

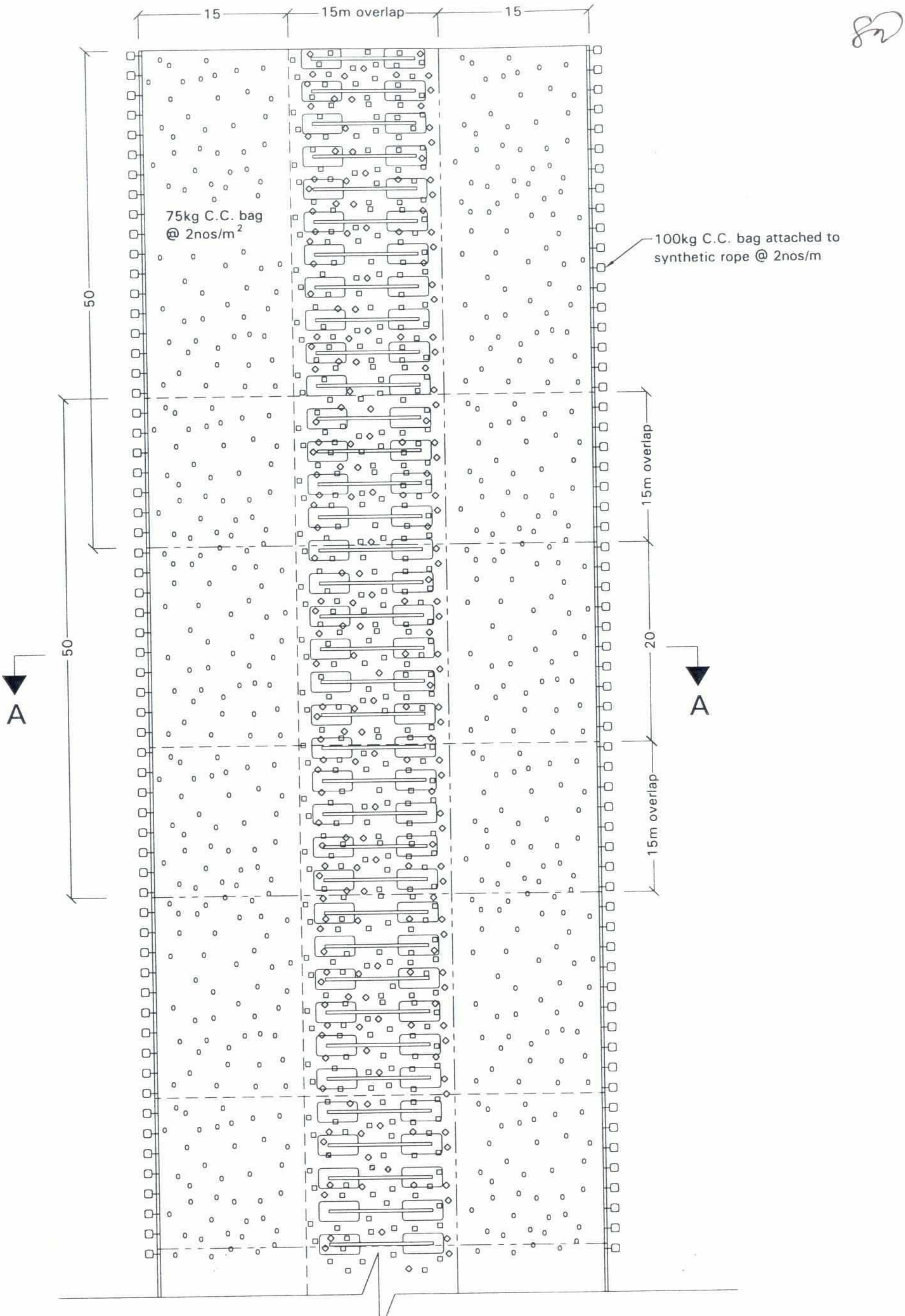
89



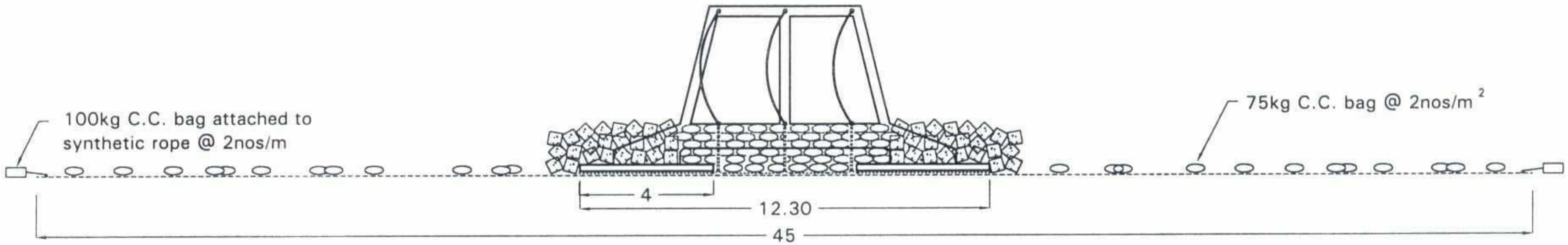
SECTION
SCALE 1:100



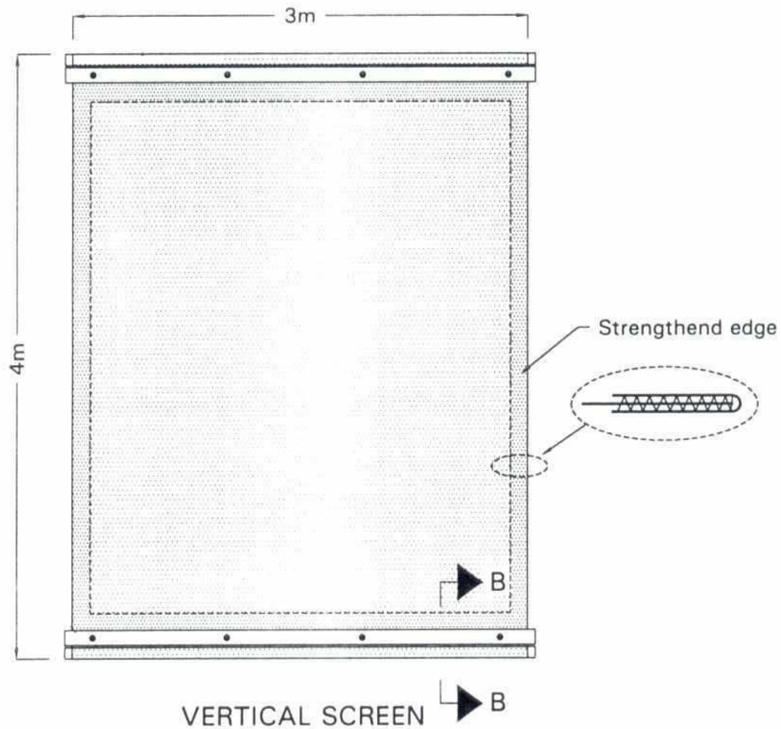
PLAN
SCALE 1:100



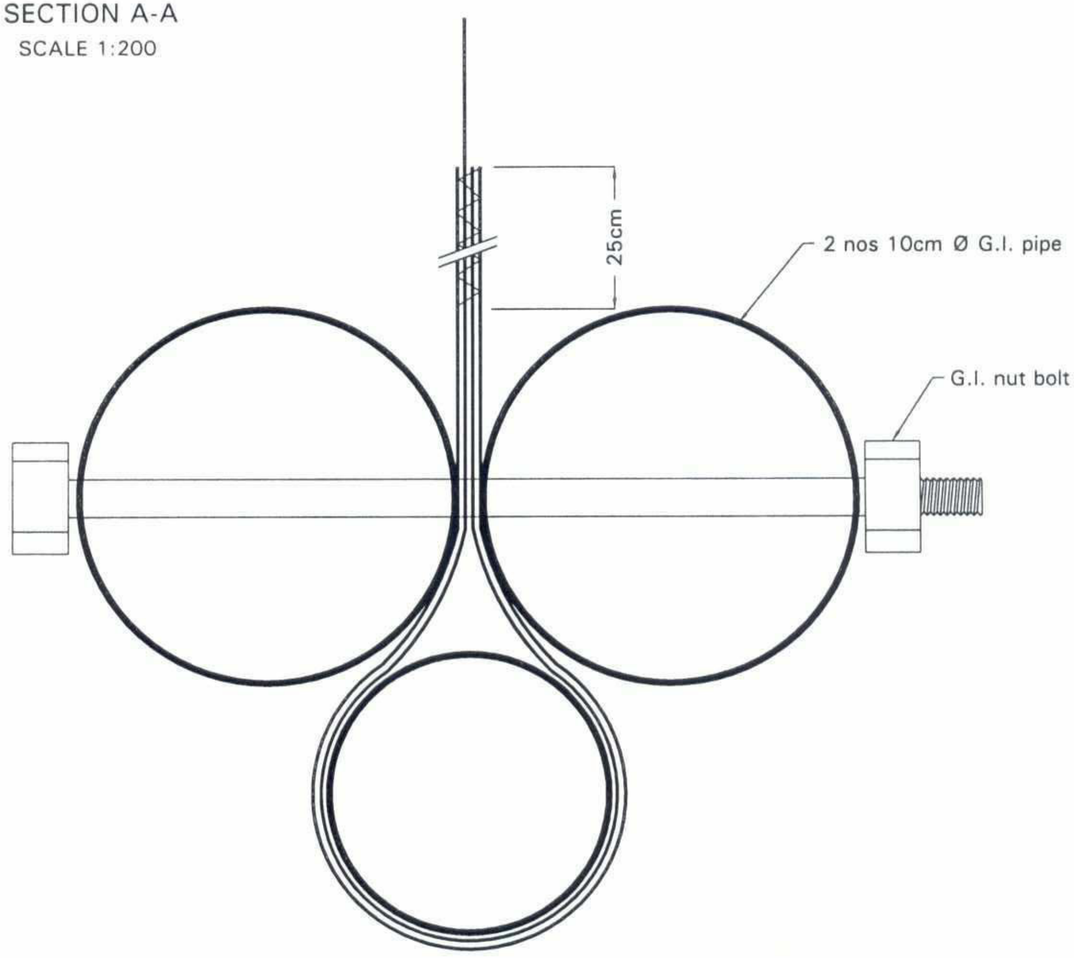
PLAN
SCALE 1:500



SECTION A-A
SCALE 1:200



VERTICAL SCREEN
CROSS DAM
SCALE 1:50



SECTION B-B
SCALE 1:2

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CROSS DAM 1 & 2 WEST OF SANDWIP / URIRCHAR

Cost Estimate

Length of permeable Dam 1000 metre with triple screen

Sl. No.	Description	Unit	Unit rate (Tk.)	Total quantity	Cost (Tk.)
A.	**FOREIGN MATERIALS**				
1.	Propex 6284 + RIG EDY 300.1 Bed Mattress	m^2	91	70,000	6,370,000
2.	Propex 6288 + RIG EDY 300.1 Bed Mattress	m^2	115	47,000	5,405,000
3.	Propex 6288 for screen	m^2	78	18,000	1,404,000
4.	Synthetic rope (5mm, 3mm dia)	Kg	1,120	500	560,000
5.	Sewing yarn	Kg	1,120	850	952,000
6.	Trasport cost of Geotextile	L.S			500,000
	Sub-total*				**15,191,000**
B.	**MOBILISATION / DEMOBILISATION**				
7	Mobilisation / demobilisation	L.S.			2,500,000
	Sub-total				**2,500,000**
C.	**SUPPLY**				
	Manufacturing and Supply				
8.	R.C.C anchor frame	No.	42,120	305	12,846,600
9.	C.C. blocks / slabs (1:3:6)				
	a) 40 x 40 x 40cm	No.	225	135,000	30,375,000
	b) 50 x 50 x 12.5cm	No.	110	24,000	2,640,000
10.	C.C. Blocks inside synthetic bags (75 Kg)	No.	160	280,000	44,800,000
11.	C.C. Blocks inside synthetic bags (100 Kg)	No.	210	4,000	840,000
12.	Steel Chain	m	150	5,000	750,000
	Sub-total				**91,501,600**
	Supply				
13.	Shil Borak bamboo (6.25 - 7.5cm dia)	No.	200	2,400	480,000
14.	PVC pipe (22mm dia, 6mm thick)	m	100	6,000	600,000
15.	Steel anchor (13 -15 kg)	No.	1,000	360	360,000
	Sub-total				**1,440,000**
D.	**LABOUR**				
	Geo-textile works				
16.	Manufacturing bed mattress 50m x 30m	No.	60,000	70	4,200,000
17.	Installation of bed mattress including initial ballasting by 800 nos. C.C. Blocks inside sythetic bag	No.	75,000	60	4,500,000
18.	Manufacturing vertical screen including supply of top and bottom G.I. pipes, hardwares etc.	No.	20,000	910	18,200,000
19.	Installation vertical screen including supply of all hardwares	No.	3,000	910	2,730,000
20.	Placing C.C. blocks (100 kg) under water & tying through divers.	No.	30	4,000	120,000
	Sub-total				**25,550,000**

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Sl. No.	Description	Unit	Unit rate (Tk.)	Total quantity	Cost (Tk.)
	Dumping / Placing C.C. Block / Slab				
21.	Dumping C.C. Block				
	a) 40 x 40 x 40cm	No.	25	135,000	3,375,000
	b) C.C. blocks inside synthetic bags	No.	15	210,000	3,150,000
22.	Dumping C.C. Blocks inside synthetic bags & tying through divers	No.	28	70,000	1,960,000
23.	Placing C.C slab (50 x 50 x 12.5cm) including preparation of slope and placement of bed mattress.	No.	15	24,000	360,000
	Sub-total				**8,845,000**
	Installation				
24.	Anchor profiles under water	No.	25,000	305	7,625,000
	Sub-total				**7,625,000**
E.	**PROVISIONAL ITEMS**				
25.	Provisional items:				
	a) Manpower	P.S.			500,000
	b) Equipment	P.S.			500,000
	Sub-total				**1,000,000**
F.	**MISCELLANEOUS**				
26.	Supply & drive 6" dia bullah upto required depth	No.	2,000	200	400,000
27.	Transportation of geotextile materials from Dhaka to site	L.S.			500,000
	Sub-total				**900,000**
	Total				**154,552,600**
	Add: 10% Contingency				**15,455,260**
	Grand Total				**170,007,860**

** Local Taxes not included.*