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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

M E S II
MEGHNA ESTUARY STUDY

TECHNICAL NOTE MES-030

FLOAT TRACKING AND ADCP MEASUREMENTS
MONSOON 2000

June 2001

DHV CONSULTANTS BV

in association with

DEVCONSULTANTS LTD
SURFACE WATER MODELLING CENTRE

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1. INTRODUCTION

One of the goals of MES is the collective gathering of hydrological data in order to improve the knowledge of the physical environment of the Meghna estuary (ref.1). Within this framework, float track measurements and ADCP measurements were taken during the monsoon period of 2000 to.

Float tracking consist of a GPS that is mounted on a float, see figure 1. This float is released in the water and will travel at the same speed as the water. The GPS records its position every 30 seconds during the time it is in the water. By using a number of floats, a good idea is obtained of the spatial distribution of the velocity in an area.

ADCP stand for Acoustic Doppler Current Profiler (ref.2). This system uses sound to estimate current speeds. The ADCP sends a burst of sound into the water, see figure 2. From the Doppler change of the reflected sound from floating particles the current speed can be determined. This method gives an instantaneous current velocity profile of the whole water column. By sailing a transect across a river and compensating for the vessel speed, velocity profiles can be taken at many places. This gives the opportunity to calculate the discharge when the cross sectional area is known.

Figure 1. Float

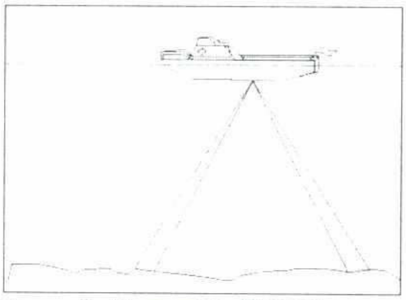

Figure 2. Boat with ADCP instrument

Float tracking has been done during the whole 2000-monsoon period, see figure A1. The water level at Chandpur has been added to give a reference to the hydrological circumstances. Four different locations were sampled, see figure A2 for general location of the measuring locations

1. Spur heads at Hanar Char South II
2. Meghna branches around Char Bhairabi
3. Spur heads at Haim Char
4. Nijhum Dwip tidal channel.

ADCP measurements were done on 12, 13 September in the east and west branch along Char Bhairabi and on 2, 3 September near the spurs of Hanar Char South II, see figure A2.

The Hanar Char location was chosen, because the spurs at Hanar Char South II would be tested for the first time during the monsoon 2000. At the Haim Char location, spurs were already built two years earlier, but still a good idea could be obtained from current velocities in the area. The measurements in the east and the west branch of the Meghna at the northing of Hanar Char can be used to get an idea of the discharge.
At Nijhum Dwip, a dam might be built in the future. To get an idea of the current velocities during the construction period, float tracking was done in November and December 2000.
The ADCP measurements were also part of the monitoring surveys at Hanar Char South II and were used to calculate the discharge in the east and the west branch.

The goal of this report is: *Description of the theory behind float tracking and ADCP measurements and interpretation of the results.*

The first two goal will be met in the chapter on theory. The second goal will be is split up in several sub goals:

- Investigation of flow velocities during the whole monsoon period
- Investigation of maximum velocities and their relation to bathymetry.
- Analyses of morphological change an flow velocities
- Analyses of detailed float track measurements for a tidal cycle.
- Calculation of discharges from float tracking.
- Comparison of float track and ADCP data.

2. THEORY

2.1 Float tracking

2.1.1 Introduction

Float tracking is a long-used way of measuring flow velocities in rivers, (ref. 3). Different types of floats have been used over the years see figure 3. The main idea is to time the period for a float to travel a certain distance. This gives a general idea of the velocity in a large stretch of river. In MES measurementshas, a GPS was attached to a floating device in order to record the floats positions over time, see figure A3. From this displacement, the current velocities were calculated for a much higher spatial resolution.

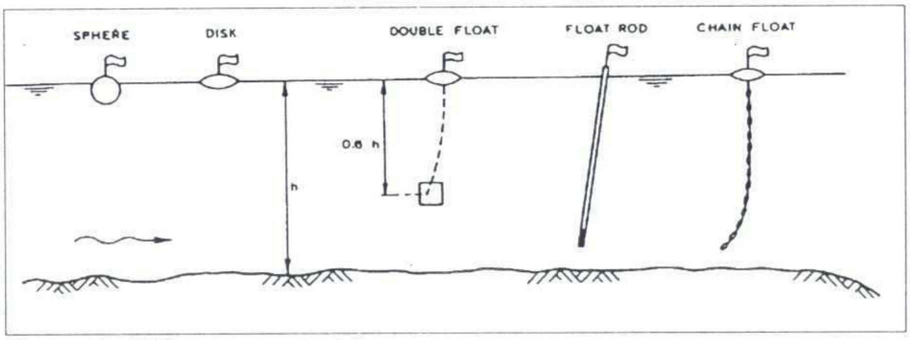

Figure 3. Different types of floats

The procedure for float tracking used by MES, is to use a country boat or speedboat to drop the GPS, attached to the float, at a predefined location. The GPS was been programmed to record its position every 30 seconds. The float is retrieved from the water after a predefined time or at a certain position.

The data stored in the GPS is downloaded to a computer for post processing. Post processing involves:

- Calculation of current speed
- Calculation of current angle
- Generation of plots of the paths of the floats, labeled by the speed in m/s

2.1.2 Surface velocity versus depth averaged velocity

The main disadvantage of FT is the location of the float in the water column. The floats used by MES have their main surface at a depth of 1m below the water surface, effectively recording the current speed at that depth.

A normal turbulent velocity profile will have higher current speeds in the upper layers of the water column. Depending on the shape of the float, a correction must be made to transform the float velocity to depth-averaged velocity. Depending on the type of float a correction factor of 0.85 to 0.95 is used, (ref. 3). This correction factor can be defined by:

$$K = \frac{u}{u_h} \quad (1)$$

where
K correction factor

u depth-averaged velocity
u_h surface velocity

To define the correction factor needed for the Meghna river data an empirical approach has been used. ADCP velocity profiles are used to determine the difference in current velocity between the top layer and the depth-averaged velocity. Two methods have been used:

- Power function method
- Top bin method

<u>Power function method</u>
The velocity profiles of ADCP are used to fit a power function through the data. The power function is than used to define the correction factor for the calculation of the depth averaged velocity from the float velocity.

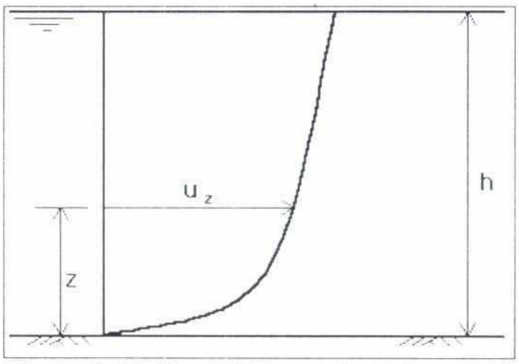

Figure 4: Outline of power function symbols

A power function of flow verticals is given by Van Rijn (ref. 4), see figure 4:

$$u(z) = u_h \left(\frac{z}{h} \right)^{1/C} \quad (2)$$

where
u(z) velocity at z (m) above the bottom (m/s)
u_h velocity at water surface (m/s)
z height above the bottom(m)
h water depth (m)
C constant, normally in the range from 6 to 10

This relation is fitted to the ADCP velocity profiles. From this fit, a value for C and u_h is obtained.
The depth-averaged velocity then follows from:

$$u = \frac{1}{h} \int_0^z u(z) dz \quad (3)$$

Top bin method
An other approach is to compare the velocity recordings from the top bin from the ADCP with the average of all the bins. This will give directly the values needed for the calculation of K. The assumption being made that the velocity at the top bin at 1.65 m below the water properly represents the float track velocity at approximately 1 m below the water.

2.1.3 Discharge calculation from float tracking

Midsection method
Discharge calculation of float track measurements is based on the mid section method. For this method, the current velocity is representative for an area extending to both sides of the location of the float. Either the boundaries of the area are given by the start point of the bathymetric cross section, or the midpoints between the floats, see figure 5. This figure displays the West branch of the Meghna River.

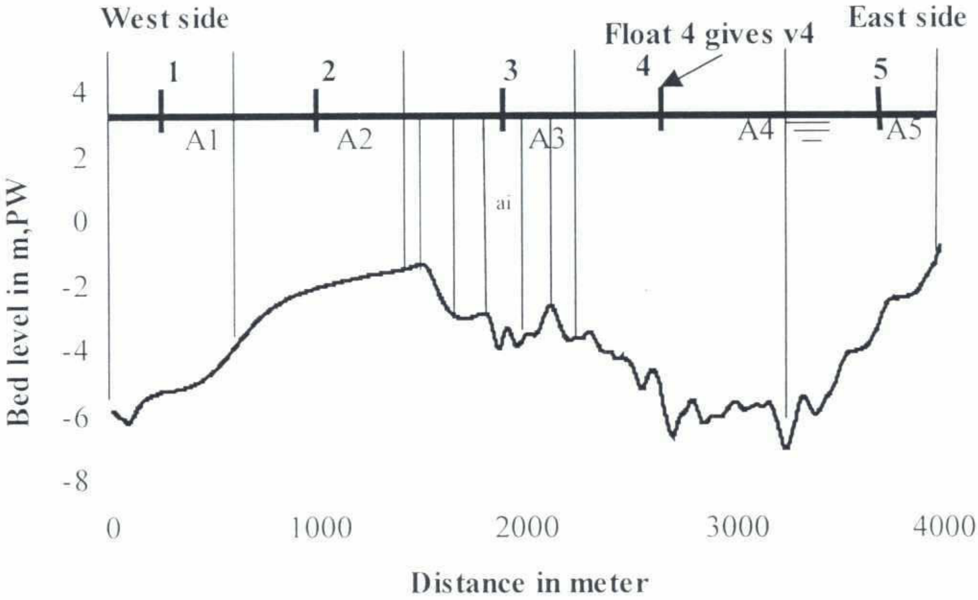

Figure 5. Principles of discharge calculation from float track data

Five floats were used for the estimation of the discharge. This gives five separate areas to calculate the discharge. The following equation is used to calculate the discharge:

$$Q = \sum A_i * v_i \qquad (4)$$

where

$$A_i = \sum a_i \qquad (5)$$

v_i velocity of float i (m/s)
A_i cross sectional area of sub area i (m^2)
a_i sub area of A_i (m^2)

The floats are not always released at exactly the same locations, so the midpoints between the floats vary for each run. This means that also the areas, allocated to the different floats, vary.

Cross sections
The cross section is defined by the bathymetry and the water level. The bathymetry is taken from the ADCP echo sounding, close to the float track location. The location of the ADCP cross-section and the float tracking can be seen on figure A4.

The water level is based on the recordings at Chandpur, twelve kilometer north of the place of the measurements. The water levels between these two places will be different due to the tide. This is corrected by shifting the waterlevel curve in time and compensating for surface slope of the water.

The time shift of the water level has been calculated by the formula for the propagation of surface waves, (ref. 3):

$$c = \sqrt{g * h} \qquad (6)$$

where

c propagation speed (m/s)
g gravitation constant (m/s^2)
h averaged water depth between Chandpur and float track location (m)

The average water depth is based on the average bottomlevel in 2000 and the average water level in Chandpur during the float track measurements. This gives a value of 9 m water depth and a wave propagation speed of 9.4 m/s. The time shift is than 20 min. The surface slope of the water is $0.39\ 10^{-4}$ according to a 2D model simulation for the same period. The vertical shift in water level between Chandpur and Hanar Char is 0.47 m.

2.2 ADCP

The ADCP is an instrument that determines velocity using the Doppler shift by measuring reflectied acoustic signals from sediment particles in the water. The instrument is capable of measuring velocity magnitude and direction throughout a water column (which it divides in equally sized areas, called bins). It is also capable of bottom tracking and can, therefore, keep track of its own relative position as it is moved across a channel (ref. 2).

2.2.1 Factors influencing accuracy of ADCP measurements

The ADCP emits an acoustic pulse called ping. Sediment particles that float ambiently with the water currents reflect some of the energy from the ping back to the ADCP. The ADCP uses the return signal to calculate a velocity.

The velocity calculated from each ping has a statistical uncertainty. However, each ping is an independent sample. The ADCP reduces this statistical uncertainty by averaging a collection of pings. A collection of pings averaged together is an ensemble (ref. 2).

Next to this random error in single pings, there are biases. The biases can become significant as the statistical uncertainty after averaging of a collection of pings reduces towards zero. This bias is called the long-term accuracy of the ADCP, as opposed to the short-term accuracy, which depends on the random error and the amount of averaging used.

2.2.2 Data at the surface and near the bottom

The ADCP measurement profile misses data at the surface of the river and near the bottom. Data are lost at the surface because the ADCP must be deployed at the approximate keel depth of the boat to prevent the acoustic beams from interfering with the hull. Data are lost near the bottom as a result of contamination by echoes from the riverbed directly below the ADCP. While most of the energy in the beam is directed through the main lobes (see figure A5) some energy leaks into side lobes. Some of this side-lobe energy will travel downward, directly to the bottom. Even though the side lobe energy is weak, the bottom is a much stronger reflector of sound than are the scatterers in the water. Thus, the direct bottom echo can be comparable in strength to the main lobe echo at the same range. Missed data near the surface and bottom can be corrected by assuming model profiles.

2.2 .3 Pitch and roll

Pitch and roll of the boat can cause the depth cells to move up or down and can affect the trigonometry used to compute the horizontal velocity (ref. 2). Random errors increase because of pitch and roll, but bias increases by only about one centimeter per second. Given a riverine environment, the pitch and roll will normally be small compared to an ocean-going boat and thus negligible in its effect on the data.

2.2.4 ADCP calibration

ADCP calibration depends primarily on the stability of the transducer beam geometry and of the frequency generation and processing circuitry. By constructing the transducers to be mechanically rigid and by designing the circuitry to minimize drift and temperature effects, the need for calibration is reduced or eliminated. In fact, users cannot adjust or otherwise affect measurement calibration other than in post-calibration for sound speed variations.

2.2.5 Accuracy compass

To be able to calculate the (ADCP)velocity vectors a compass is needed. When surveys are executed with one of the smaller survey boats (also called tender boat) a fluxgate compass is used. The accuracy of this compass is ± *1*- 2 degrees.

2.2.6 Discharge calculation from ADCP

The flow velocity of the water is determined after making vector calculations of the ADCP velocity relative to the water and the ship velocity relative to the bottom. The compensation for the vessel speed can be done using two sources of data.

The first is by bottom tracking by the ADCP instrument itself. This is a very high precision method to calculate the vessel speed. However, some environmental conditions make it difficult for the ADCP to make unbiased bottom track measurements. Biases can occur when (ref. 5)

- The bottom is non-stationary and moves with the flow
- There is a very heavy layer of suspended sediment moving along with the flow, and the ADCP falsely detects the bottom in the moving suspended sediment layer
- The bottom is out of range

In each of these cases, it is necessary to use an external means for estimating the boat's velocity. This is provided by the second potential source, dGPS. The dGPS calculates the boat's position to an accuracy of 1-3 m (ref. 5) and supplies it about every second. These waypoints can be used to calculate the boats speed.

Once the proper choice has been made for the boats speed, a transect across the river can be sailed, recording the current speed in many verticals and in bins of 50 cm. This leaves the bottom part, the top part of the vertical unsampled and the current speed in the area between the bank line and the first vertical is unknown. This means that the existing data has to be extrapolated.

The top part is extrapolated by assuming that the velocity recorded in the top bin is representative for the whole top layer. This can be justified, as the velocity profile is more or less a power function giving a very straight profile in the top layer of water.

The bottom part is calculated by the following power function, see also 2.1.2:

$$u(z) = u_h\left(\frac{z}{h}\right)^{1/C}$$

where

u(z)	velocity at z (m) above the bottom (m/s)
u_h	velocity at lowest bin (m/s)
z	height above the bottom(m)
h	distance to lowest bin (m)
C	constant, equals 6.

This takes the influence of the bottom roughness into account.

The area between the ends of the transect line and the bank line is taken into account by assuming the same velocity profile as recorded for the ends of the transects. This does not take the influence of the side roughness into account. The error is very small, provided the transect ends close to the bankline.

MES has developed software for processing the data in the office, called off-line processing. This is based on dGPS vessel tracking.

3. STUDY AREA AND TIME PERIOD

Four different areas have been sampled by float tracking, see Figure A2:

1. Meghna branches (West and East)
2. Hanar Char South II
3. Haim Char
4. Nijhum Dwip

ADCP measurements were done at Hanar Char South II and the Meghna branches. Float track measurements were done from June until October 2000. Sampling frequency and number of floats varied. ADCP measurements were done only on 2,3 and 12,13 September. A full table with the dates, locations and times of float tracking and ADCP measurements is given in appendix A.

3.1 Meghna Branches

South of Chandpur the Meghna is divided into two branches by Char Bhairabi, see figure A4. This char first emerged in the early nineties. It started from the east side of the river, gradually building towards the West. At this moment, the east branch has higher velocities and discharges than the west branch. The flow velocity measurements are part of the hydrological monitoring of this area.

Five floats have been released over the full width of the branch. The space between the float lines was about 180 to 240 meters for the east branch and 500 to 800 m for the west branch. The travel distance of the floats was around 2000 m for the east branch and 800 m, for the west branch.

3.2 Hanarchar

The Hanar Char South II bank protection works are located in the upper part of the Meghna Estuary on the left hand bank of the Meghna River in the Chandpur district 12 km south of Chandpur. The coordinates are 565850 m east and 553980 north (BTM). The location is shown on figure A2 and in more detail in A4.

This location is part of the follow-up of the Haim Char erosion control pilot. The float tracking was done in the first monsoon after the installation in May 2000

Five to eight floats were released close to the spur heads, at a regular spatial intervals, 40 m. In this way the current speed close the spurs has been measured. The length of the float path was 1500 m.

3.3 Haimchar

The Haimchar bank protection works are located in the upper part of the Meghna Estuary on the left bank of the Meghna River in the Chandpur district 20 km south of Chandpur. The central coordinates are 565550 m east and 549700 North (BTM). The location is shown on figure A2 and in more detail in A4. The area has suffered severe erosion for a long time. MES has tested a low cost bank protection method at this location.

As part of the monitoring, float track measurements were carried out in the third monsoon after installation in 1998. Five to eight floats were released close to the bank, at a regular spatial interval of 35 m. In this way, the current speed close the bank has been measured. The length of the float path was 1500 m.

3.4 Nijhum Dwip

Nijhum Dwip is located in the southern part of the Meghna Estuary in the mouth of the Meghna River. The coordinates of the location are 606275 m East and 443502 m North. The location is shown in figure A2 and in more detail in A6. The reason for the choice of this location is that the Nijhum Dwip channel has been favorite location for acceleration of accretion by cross dam building for two decades (ref. 6)

Satellite imagery shows that Nijhum Dwip is a relatively young island, which started to emerge in the 1950s. In 1996 the total area of Nijhum Dwip was 3,272 ha recent satellite image of 2000 indicates that the rate of formation of intertidal areas is high. Between 1997 and 2000 an island appeared in the channel, this island is now part of the proposed location of the cross dam. To get an idea of the hydrological circumstances during the construction, float tracking was carried out in November and December 2000. Six floats were released at the old proposed dam location, see figure A6. The spacing between the floats was around 200 m. The traveled distance was variable as the current velocities were very low at slack water.

4 DATA DESCRIPTION

4.1 Temporal Resolution of Measurements

A graphical representation of the dates of float tracking and ADCP is given in figure A1. A full table with all the days and start and end times of measurements is given in appendix A

In July and August, measurements were done in three to four day periods related to spring tide and neap tide. On measurement days, float tracking was done three times with a time lag of 4 hours in between

In September there was an overall higher float tracking frequency in two ways. On more days wereregarding the number of days and the time interval between the sampling times normally six or seven times per day. In September, half the number of day has been sampled.

Two periods of very intense measurements were conducted.

- September 2 and 3, the spurs at Hanar Char were intensively monitored in together with ADCP sampling of the same area. Sampling was done on an hourly basis during a full tidal cycle.
- September 12 and 13 the east and west branch of the Meghna river were monitored on a two hourly basis. This was also done together with ADCP sampling.

The reason for this higher frequency was the water level in the Meghna. This reached its peak at September 1. Figure A2 shows the 24 hour averaged water level reaching at Chandpur 12 km to the north of Hanar Char. This maximum water level at Chandpur relates to maximum current speeds at Hanar Char South II. The intense float tracking at September 12 and 13 was not done on exactly the highest water levels possible, but still a very high water level was observed, see figure A2. October has again been sampled at a lower frequency. On eight days, float tracking has been done, with 3 to 4 measurements per day.

From November 22 to December 5, float tracking has been done in the Nijhum Dwip tidal Channel. In total 117 numbers of measurements have been done during 15 days in the Nijhum Dwip channel

4.2 Description of datasets

From the standard processing of data the following types of files are generated.

- Float tracking: Every time a float track run is performed, the individual paths of the floats are processed into a column file containing the easting, northing, speed and traveled distance. These files are presented in a graphical form using a software package called "Grapher". An example is presented in figure A14.

- ADCP: Off-line processing results in plots of all the transects sailed. This is a graphical presentation of the data. The velocity for all the bins is plotted as a scaled arrow. The direction of the current is linked to the direction of the arrow. in addition, ASCII text files are generated for every transect containg the depth averaged velocities for all the ensembles and ASCII text files containing all the velocities measurements for all the bins in a transect.

This enables easy access to the data for further use.

5. RESULTS

5.1 Float Tracking

5.1.1 Correction factor

The results of the power function method for calculation of depth-averaged velocity from float tracking are presented in figure A7. Four different values for C have been determined, based on the ADCP velocity profiles. Values ranged from 9 to 30. A value of 15 was assumed representative as an average. The correction factor resulting from equation 1 is then 0.93.

The results of the "top bin" method are shown in table 1. From 48 verticals of four different transects the top bin and depth averaged velocity have been calculated to get the correction factor. The average correction factor was 0.9. Table A1 in the appendix gives all the data.

5.1.2 Velocities during the monsoon

<u>Meghna branches along Char Bhairabi</u>
The velocities in the west branch are generally lower than in the east branch, see figure A8. During the measuring period, the minimum velocities didn't change much. For the West branch the minimum velocities ranged from 1.4 m/s in July to 1.8 in September. The maximum velocities range from 1.7 in July to 2.4 m/s in September, in October the maximum speed drops to 1.3 m/s.

For the East branch, the minimum current velocities range from 2.1 to 2.7 m/s and the maximum velocities range from 2.7 to 3.6 m/s. Both minimum and maximum velocities are highest in September and drop sharply in October.

Overall, the current velocities don't vary a lot between July and September, although a maximum occurs in September. In October a large decrease in velocities are found. The same pattern can be seen from 24 hour averaged water levels in Chandpur in figure A1. The water level remains relatively stable until the start of October.

<u>Hanar Char South II</u>
For the three spurs of the Hanar South II pilot location, flow velocities have been plotted separately. The results are presented in figure A9 to A11. The lowest velocities are found at spur HS7, the highest at spur HS9. In July, the velocities are significantly lower than in the other months.

The minimum velocities range from 0.5 to 1.8 m/s during the monsoon. This value can be seen as representative for the velocities near the spurs, because the velocity increases away from the bank. One exception is the period at the end of September when very high velocities were measures. This is presented in section 5.1.4.

<u>Haim Char</u>
Much less data was gathered for the Haim Char location. The lowest values were 1.5 m/s, the highest as much as 3.2 m/s, see figure A12. It must be noted that at the time of the measurements, no spurs were present, but some remnants of the spurs still remained.

5.1.3 Dry period

<u>Nijhum Dwip</u>
All the data of the full measurement period is plotted in figure A13a to A13d. The data is separated in the northern tracks 1-3 and the southern tracks 4 to 6, see figure A14. The positive

direction of the current is the incoming tide, the negative direction is the outgoing tide. A plot of the tracks and the direction of the tides are shown in figure A14 and A15.
From the plots of water level and current velocities it can be seen that track 4 to 6 display higher velocities for the negative direction. Tracks 1 to 3 have generally higher velocities for the positive direction. This means that the northern part is flood-dominated and the southern part of the channel is ebb-dominated. The maximum velocities found during a tidal are 0.8 m/s for neap tide and 1.5 m/s for spring tide.

5.1.4 Maximum velocities and bathymetry

Meghna branches along Char Bhairabi
Maximum velocity in the West branch of the Meghna is as high as 2.1 m/s on 12 September, see figure A16. In the four western tracks, the velocity mostly varies between 1.8 and 2.2 m/s. No clear relation with the bathymetry can be established. The eastern track shows significantly lower values as it is close to Char Bhairabi. This is probably due to extra friction because of lower water depth.

The background of this figure is the bathymetry of May 2000. This is the survey closest in time to the float track day. However, a time lag of 4 months lies between the bathymetric survey and the float track survey. In the mean time, bars can be displaced, obscuring the relation between the velocity and bathymetry.

The east branch has much higher maximum velocities, see figure A17. The maximum velocity found during the whole monsoon is 3.7 m/s on 12 September. The bathymetry is from May 2000. Again, relation with bathymetry can not be found.

Hanar Char South II
The maximum velocities are measured at 26 September. The maximum velocities at the spur heads are 1.9 m/s for HS7, 2.1 for HS8 m/s and 2.4 m/s for HS9. Further away from the bank line the velocity is maximum 2.8 m/s, see figure A18.

In front of spur HS8 a large scour hole has developed. This is caused by the bottom screens placed in front of this spur by MES. The location of the screens is indicated by the yellow rectangle. This scour hole, created by the screens, attracts the water flow as can be see from graphs A19a to A19d. These graphs demonstrate the effect most clearly. This effect though, was not continuous during the whole monsoon.

Haim Char
The maximum velocities were measured at 27 September, see figure A20. The values range from 2.4 m/s close to the shore and 3.4 m/s 200 m away from the bank line. No clear relation can be found with the bathymetry as the bathymetric data was gathered in May 2000 with 600 m between the survey lines. Not enough detail is available for further analyses. However, it can be concluded that an increase in flow velocity coincides with an increase in water depth.

Nijhum Dwip
The maximum velocities in the Nijhum Dwip tidal channel are 1.75 m/s for the flood-dominated channel in the northern part, see figure A21. This has been measured at spring tide as can be seen from figure A13. The tidal range was 2.8 m. The maximum velocities in the ebb-dominated channel are lower at 1.4 m/s during peak ebb current, this is not depicted in a figure.
The proposed cross dam location is also shown in this figure. The current velocities in this figure give an indication what can be expected during the construction.

5.1.5 Detailed tidal monitoring of Hanar Char and Meghna branches

Meghna branches

At 10, 11, 12 September intensive float tracking was done in the east and the west branch of the Meghna. The results are presented as a graph showing time and speed, see figure A22. This means that the detailed spatial information of the current speed is lost. Every cluster of data represents one float track run starting north and going in a southwest direction. This means that still some spatial information is preserved as the earliest points of one cluster in figure A22 are related to the first part of the tracks as seen in A16.

On 10 September, the West branch was measured, during ebb, recording the highest velocities of that day. The average velocities range from 1.8 m/s to 2 m/s, see figure A22. The lowest velocities are generally recorded in the eastern part of the channel, close to the bank.
The East branch was float tracked at 11 September. Velocities range on average from 2.4 to 3.5 m/s. Highest velocities occur at the end of the falling stage. Lowest velocities occur halfway between low and high water and Chandpur. It must be noted that high and low water levels occur 20 minutes earlier at Hanar Char

At 12 September, both branches were float tracked one by one. The graph, figure A22, shows the differences in current velocities for both branches. The maximum velocities for the East branch are about 1.8 times higher than in the West branch.

Hanar Char

Very intensive float track surveys have been done during 2,3 September at the spur heads in Hanar Char. In addition, the water level at Chandpur is plotted to give an idea of the general hydrological circumstances,see figure A23. The results are displayed in the same was as for the Meghna branches.

The average velocity at 2 September is 2 m/s, with a maximum at 15:30 hours, see figure A22. No clear variation during a tidal cycle can be seen from this day as the time span of measuring is too short.. At 3 September, this is possible however. The velocity ranges from 1 m/s during flood and 2 m/s on average during ebb. Maximum velocities are recorded around 16:00 hours. The scattered points for the lower velocities are caused by the changing paths of the floats. During some runs, floats are closer to the shore, registering lower velocities.

5.1.6 Bathymetric change and float tracking

The relation between morphological change and current velocities has been investigated from two bathymetric surveys and float track measurements. The bathymetric surveys were done at 2, 3 and 12, 13 September 2000. The bottom levels from the first survey are subtracted from the second. In this way erosion over this time period gives a negative value and accretion a positive value. The float tracking was done at 3 September 2000. The results are presented in figure A24. The bathymetry at 13 September can be seen from an earlier figure, see figure A18. The screen area is shown in yellow.

In the center of this figure, an area with erosion can be seen, bounded in the North and the South by accretion. Both erosion and accretion are locally more than 2 meters and in most of the area more than 1 m change occurs. These are very large bathymetric changes for a time span of 10 days. Interpolation errors are not the cause of this difference as also the original survey lines were checked. The area near the bank shows complex pattern of erosion and accretion, but this is probably due to interpolation errors as not always, the same survey lines were sailed and the slope angle of the bank is high. Flow velocities increase over the accretion areas and decrease in the erosion area. This is not as expected. Measuring errors during one or both of the surveys cannot be excluded.

5.1.7 Discharge calculations

The results of the discharge calculations are shown in figure A25. The discharge in the West branch varies between 40,000 m^3/s and 51,000m^3/s. The East Channel has a range between 50,000 and 68,000 m^3/s. As float tracking was not done simultaneously in the two branches, there is a certain amount of uncertainty to the discharges, so no precise information is known of the division of discharges over the branches. However, the east branch clearly has a higher discharge. The cross section used for calculation of discharges is shown in figure A26.

5.2 ADCP

5.2.1 Velocity measurents near spurs

At 2 and 3 September ADCP velocity measurements were done near the spurs at Hanar Char South II. This was done during the maximum ebb flow. The table with the start times is in appendix A. Figure A27 and A28 show the plan view of the area for the depth-averaged velocities. The velocities on 3 September are higher than on 2 September. For both days, the velocities are increasing towards the South.

Figure A27 shows very different picture for the southern reach. High and low velocities alternate. The same can be concluded from the table, where high and low discharges alternate for the same length of survey lines. This indicates a malfunctioning of the system during a part of the measurements.

5.2.2 Discharges in the Meghna branches

The discharges in the Meghna branches also show a lot of scatter. They vary between 30,000 and 50,000 m^3/s for the West branch and between 45,000 and 77,000 m^3/s for the East branch, see figure A29. The West branch also shows alternating high and low discharges, indicating malfunctioning of the system. Possibly an average of the two consecutive transects gives a reliable value
Another problem is the change in length of the survey lines. They varied between 1300 and 2200 meter for the East branch and 3900 and 4400 m for the West branch. For the East branch, 2200 m is wider than the channel, which is only 1800 m.

5.3 Comparison between float tracking and ADCP measurements

5.3.1 Velocities in the Meghna branches

Figure A30 shows the velocities in the East and the West branches as vector plots labeled by the current velocities. There is a large similarity between the two types of measurements that were taken close together in time. The ADCP shows a large variability at short distances, indicating turbulence.

Average velocities in the two branches are listed below in table 1. Difference in speed is within 15 percent.

date	time	branch	ADCP	Float track
120900	13:00	east	2.9	3.4
120900	16:00	east	2.3	2.4
120900	14:13	west	1.95	1.9
120900	16:40	west	1.5	1.5
130900	6:30	east	2.3	2.7
130900	12:50	east	2.7	3.3
130900	9:10	west	1.6	1.95
130900	16:40	west	1.25	1.4

Table 1. Comparison between ADCP an float track velocities

5.3.2 Discharges in the Meghna branches

For both methods, ADCP and float tracking the discharges in the West branch are lower than in the East branch. The ADCP however shows a much larger scatter in the data. The discharges are listed in the table below and are shown in figure A31.

Discharges calculated from float tracking				Discharges calculated from ADCP					
West Channel		East Channel		East Channel			West Channel		
Date and time	Dis-charge m^3/s	Date and time	Dis-charge m^3/s	Date and time	length of tran-sect	Dis-charge m^3/s	Date and time	length of tran-sect	Dis-charge m^3/s
10/9/00 8:44	45085	11/9/00 9:00	65891	9/12/00 12:36	1314	**45,578**	9/12/00 14:13	4080	**48,779**
10/9/00 9:34	44952	11/9/00 10:00	64974	9/12/00 13:01	1692	**61,980**	9/12/00 14:52	4073	**37,304**
10/9/00 10:30	44346	11/9/00 11:00	66617	9/12/00 15:29	1801	**46,645**	9/12/00 16:40	4288	**42,446**
10/9/00 11:30	47464	11/9/00 12:00	66249	9/12/00 15:50	1995	**48,954**	9/12/00 17:09	4122	**30,880**
10/9/00 12:20	46921	11/9/00 13:00	64962	9/13/00 6:32	1663	**48,656**	9/13/00 8:39	4006	**43,432**
10/9/00 13:20	43565	11/9/00 15:00	55540	9/13/00 10:10	1842	**58,457**	9/13/00 9:12	4052	**34,556**
10/9/00 14:30	43688	11/9/00 16:00	49867	9/13/00 10:25	2241	**75,894**	9/13/00 11:27	4400	**47,618**
10/9/00 15:15	42425	11/9/00 17:00	50932	9/13/00 12:37	1738	**56,155**	9/13/00 11:57	3973	**35,599**
12/9/00 9:04	47853	12/9/00 6:14	55342	9/13/00 12:51	1708	**58,421**	9/13/00 13:58	4016	**46,335**
12/9/00 10:45	48522	12/9/00 8:30	67122	9/13/00 15:06	1885	**48,303**	9/13/00 14:30	4076	**36,393**
12/9/00 12:35	47669	12/9/00 10:20	63954						
12/9/00 14:30	51196	12/9/00 12:08	68452						
12/9/00 15:03	45801	12/9/00 13:00	68433						
12/9/00 17:02	40411	12/9/00 15:30	54373						
12/9/00 17:22	41511	12/9/00 16:00	51884						

Table 2 Comparison of ADCP and float track discharges

6. DISCUSSION

The correction factor using the "top bin method" gives more reliable results than the power function method. Top bin method gives 0.9 as a value for the correction. The power function gives 0.93

The top bin method is based on many more samples (48) than the power function method. In addition, the found value for C, 15, is higher than normally used: 6 to 10. If a lower value would be used for C than the correction factor from the power function method would also be lower, lowering the difference between the two methods.

The flow velocities during the monsoon show lower values in July for the Hanar Char South II location. The Meghna branches do not show much lower values for July in relation to August and September, see figure A9 to A11. The reason for this may be a morphological change in the area. No clear idea can be obtained from this change, based on the bathymetric surveys as the survey area is not large enough.

The maximum velocities in this report are not necessarily the highest velocities that occurred during the monsoon as sampling is not continuous. Still, a good idea can be obtained from the data.

The measurements of flow velocities also have an error. The error for an individual position reading from GPS is as much as 20 m. The position is read every 30 seconds. This means that for a current velocity of 1m/s the readings of the position are only 30 m apart. The influence of the error of the GPS is relatively large than. This is a random error in the speed calculation, so for every reading the displacement can be in any direction increasing or decreasing the speed at that point. As a longer area is covered by the float, a longer recording should eliminate part of this random error.
The newest type of GPS (Garmin e-trex) give a value for the uncertainty. If this would be recorded a better idea would be obtained of the error.

The link between the morphological change and the float tracking has not been successful. The cause is the temporal resolution of the float tracking and the bathymetric surveys. The bathymetric surveys were 10 days apart. No float track measurements were done during these 10 days, only at the start of the period. The flow pattern is just an instantaneous phenomenon. This is not necessarily linked to the morphological change during a whole period. For a good idea of the cause of the morphological changes, a shorter period should be used for the time span between the bathymetric surveys and velocities should be measured more frequently.

The discharge calculations from the float tracking have a low spatial resolution of the flow velocity as only five floats per cross section were used. Based on ADCP data, the standard deviation of the flow velocity over a certain length has been determined. The length of the transects is 250 m for the East branch and 800 m for the West branch. This is the same as the average distance between the floats for these channels. Standard deviations have been calculated for every 800 or 250 m transect possible between the banks. The average standard deviation for the West branch is 0.38 m/s for an average flow velocity of 1.11 m/s. For the East branch the average standard deviation is 0.14 for an average flow velocity of 3.21 m/s. This shows that the current velocities in the West branch are more variable than in the East branch. For shorter distances, the standard deviation decreases, but not much. The ADCP data have their own scatter as can be seen from figure A27 and A28, so it would be better to do this test with floats.

The float lines don't cross the lines of the bathymetry. Therefore, the distance from the bank line of the bathymetry to the first midpoint between float 1 and 2 is too large. This gives an overestimation of the discharge. As the difference was not very large the effect is small, but it would be better to do a bathymetric cross section crossing the float lines. The float lines don't have to very long, as only one reliable flow velocity is needed for the discharge calculation. Depending on the flow velocity, a period of 2 minutes between start and end of the float track line would be enough. In this way floats could be used more than once during one transect as time required between dropping and collecting the floats are limited.
A check on the error of the discharge calculation can be performed by using two bathymetric cross sections some distance apart. The floats should cross both lines and the discharge should be equal at both cross sections.

ADCP Discharges show alternating high and low values for the West branch, but not for the East branch. The same effect can be seen from the current velocities in the south of the Hanar Char area, figure A27. Discharge calculations from ADCP data involve many steps and different instruments. The chance of failure of one of these instruments due to human or material failure is large. In order to get more used to this instrument, several tests should be performed to check the consistancy of the instrument. Logging should be kept of the configuration file used, use of compass and alignment of the ADCP in order to improve the data collection and the possibilities of compensation of mistakes in the off line processing stage.

7. CONCLUSIONS

The following conclusions can be drawn from the data:

1. Correction factor is 0.9 for the calculation of depth-averaged velocities from float tracking.
2. The maximum flow velocities as measured during the monsoon 2000 period are:
   - West branch: 2.1 m/s on 12 September
   - East branch: 3.7 m/s on 12 September
   - Hanar Char South II at spur heads: 1.9 m/s for HS7, 2.1 for HS8 m/s and 2.4 m/s for HS9 on 26 September
   - Hanar Char South II 100 m away from the bank: 2.8 m/s on 26 September
   - Haim Char: from 2.4 m/s close to the shore and 3.4 m/s on 27 September

   No clear relation is apparent between flow velocity and bathymetry as the float tracking was not done simultaneously with a bathymetric survey.

3. The Northern part of the Nijhum Dwip channel is flood dominated, the southern part is ebb-dominated. Maximum flow velocities are 1.7 m/s for the northern part and 1.4 m/s for the southern part during spring tide. Neap tide condition gives flow velocities of maximum 0.8 m/s.
4. Discharges for the West branch vary between 42,000 and 51,000 m^3/s based on float track measurements. The ADCP gives values between 36,000 and 49,000 m^3/s, but these data have not been collected properly. The East branch' discharges vary between 50,000 and 68,000 m^3/s according to the float tracking and 48,000 and 76,000 calculated from ADCP. Float tracking gives consistant results
5. Current velocities from ADCP and float track data compare within 15 %.
6. No relation between bathymetric change and flow velocities is apparent from the available data.

8. RECOMMENDATIONS

General

- Calculate discharge and average velocity for all the float tracking over the full width of a channel
- Record the error in the position reading from the GPS at the start and end of the float line. The newest version of Garmin GPS has this option.
- Keep one GPS stationary. The apparent movement of the GPS is the error of the signal. This error registration can be used to correct the floats position. This is the same principle as used for the height registration of RTK positioning.
- Test the error in GPS positioning by holding all the GPS instruments next to eachother. They should all give the same position.

Discharge calculations from float tracking

- Several bathymetry transects for the calculations of discharge should be sailed during the float track measurements, and the float lines should cross the transect. The ends of the bathymetry should be at the bank lines.
- The float track should be done simultaneously at as many locations as possible to increase the resolution of the velocity measurements.
- Floats only need to cross the transect line, so the float lines can be very short.. The velocities can be averaged for every float line, as not the spatial distribution of velocities is needed, but only a reliable average across the bathymetric transect.
- Discharge should be determined for several transects and the averaged.

Morphological changes and float tracking

- Float tracking should be done over a larger area and repeated during the time span between the bathymetric surveys.
- Bathymetric surveys should be done on the same survey lines and with local water level recording to increase precision.

ADCP

- Sort out all the details of the ADCP data collection and processing
- Standardize the metadata of an ADCP flow velocities collection including the configuration file, use of compass and alignment of the ADCP.
- Check all the processing software

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6. MES. 2000 Review design and implementation of Nijhum Dwip cross dam
Submitted to Ministry of Water Resources, Bangladesh Water Development Board, by DHV consultants BV and associates, December 2000

Figures

Figure A1 Float tracking and ADCP 2000

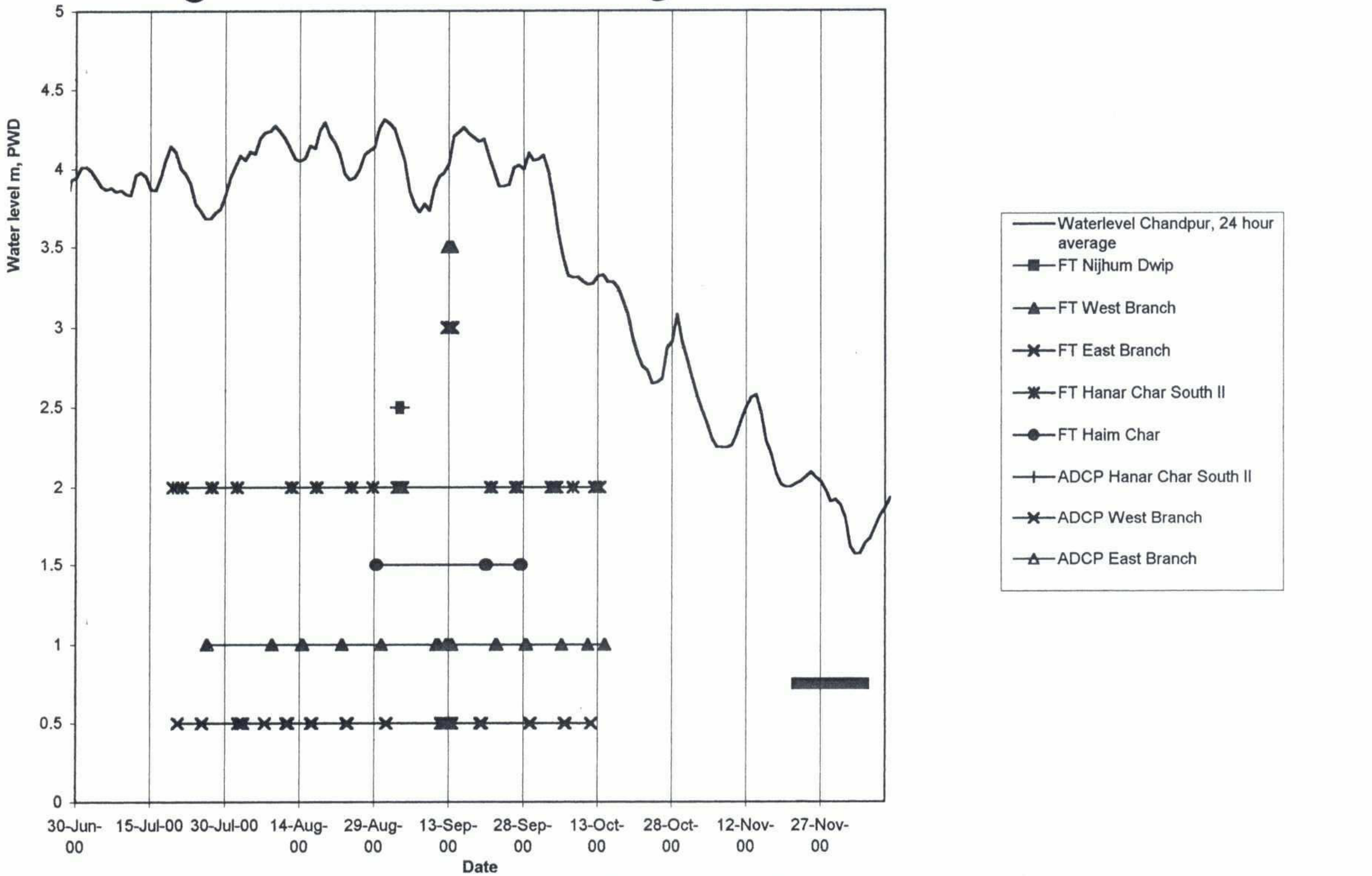

Figure A 2: Locations of ADCP and Float Track measurements

Legend:

- Land of 2000
- Mudflat
- Water body
- Location of ADCP & Float Track measurement

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

Figure A 3: Design of Float

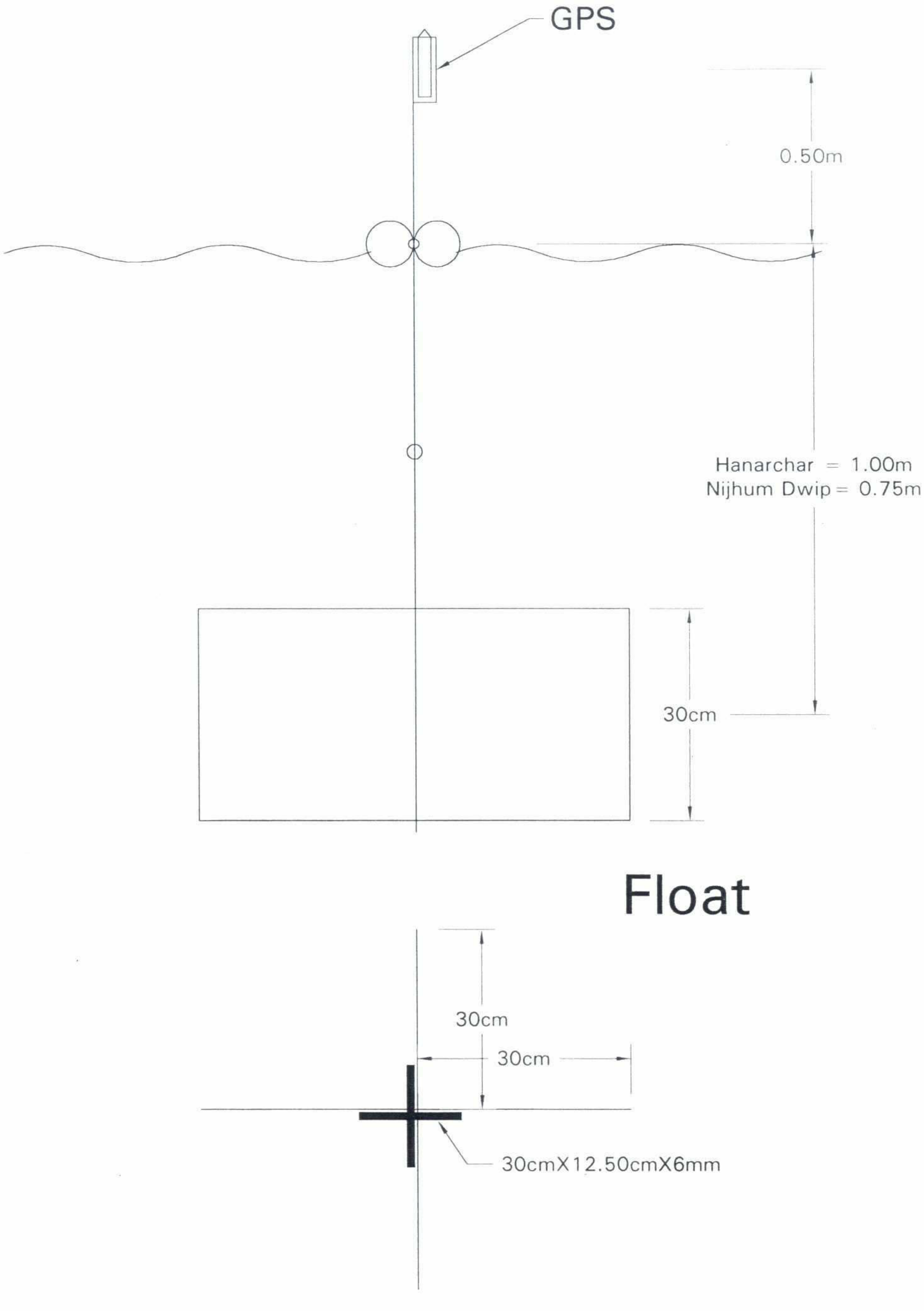

Figure A4 Location of ADCP and float track measurements Monsoon 2000

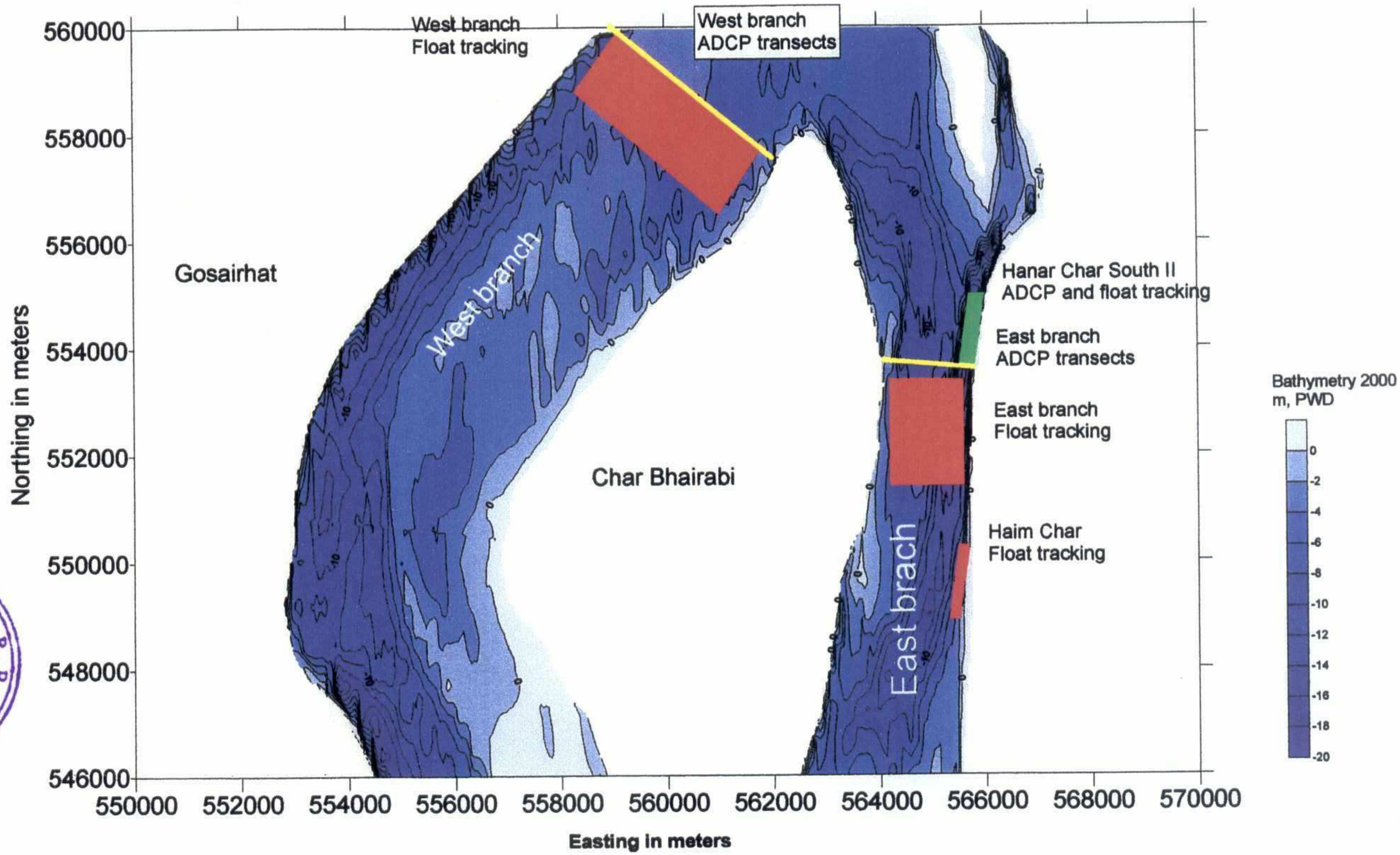

Figure A5 Lack of data for top and bottom from ADCP

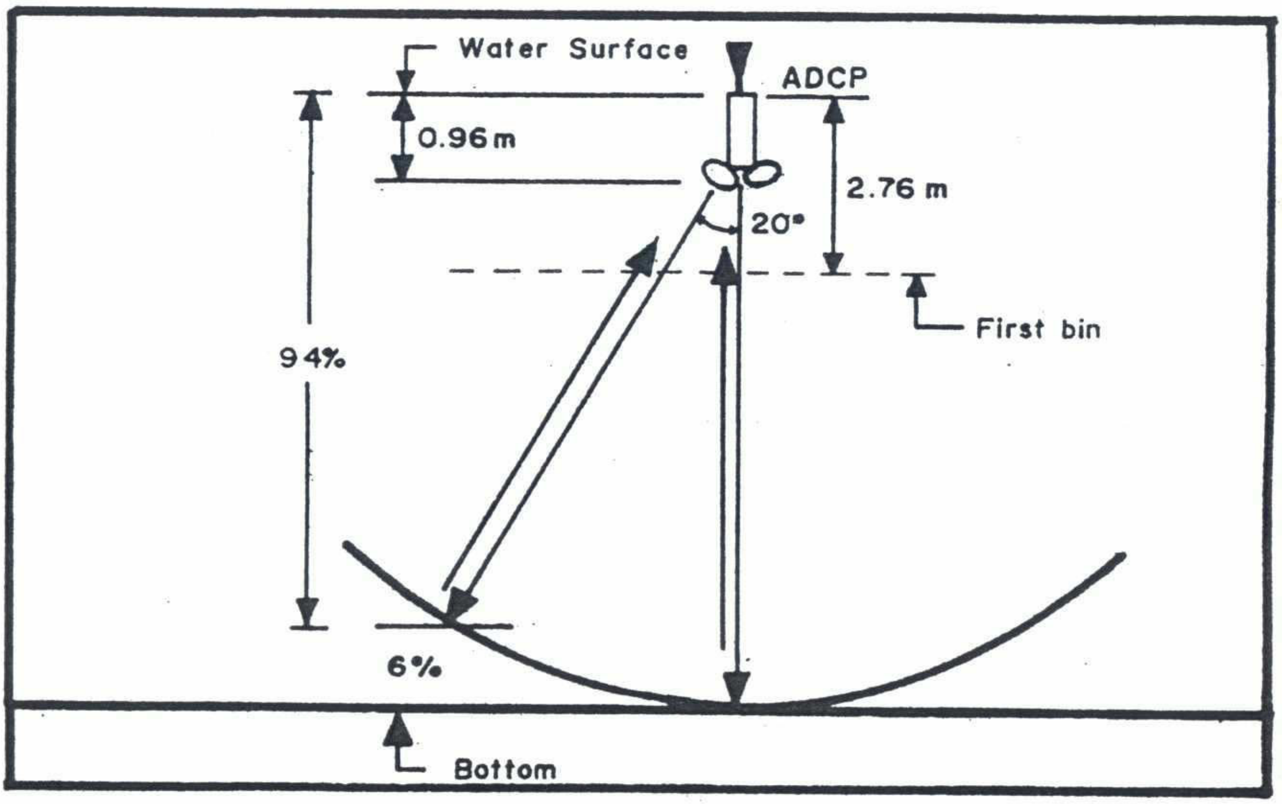

Figure A6 Location of float tracking
Nijhum Dwip 2000

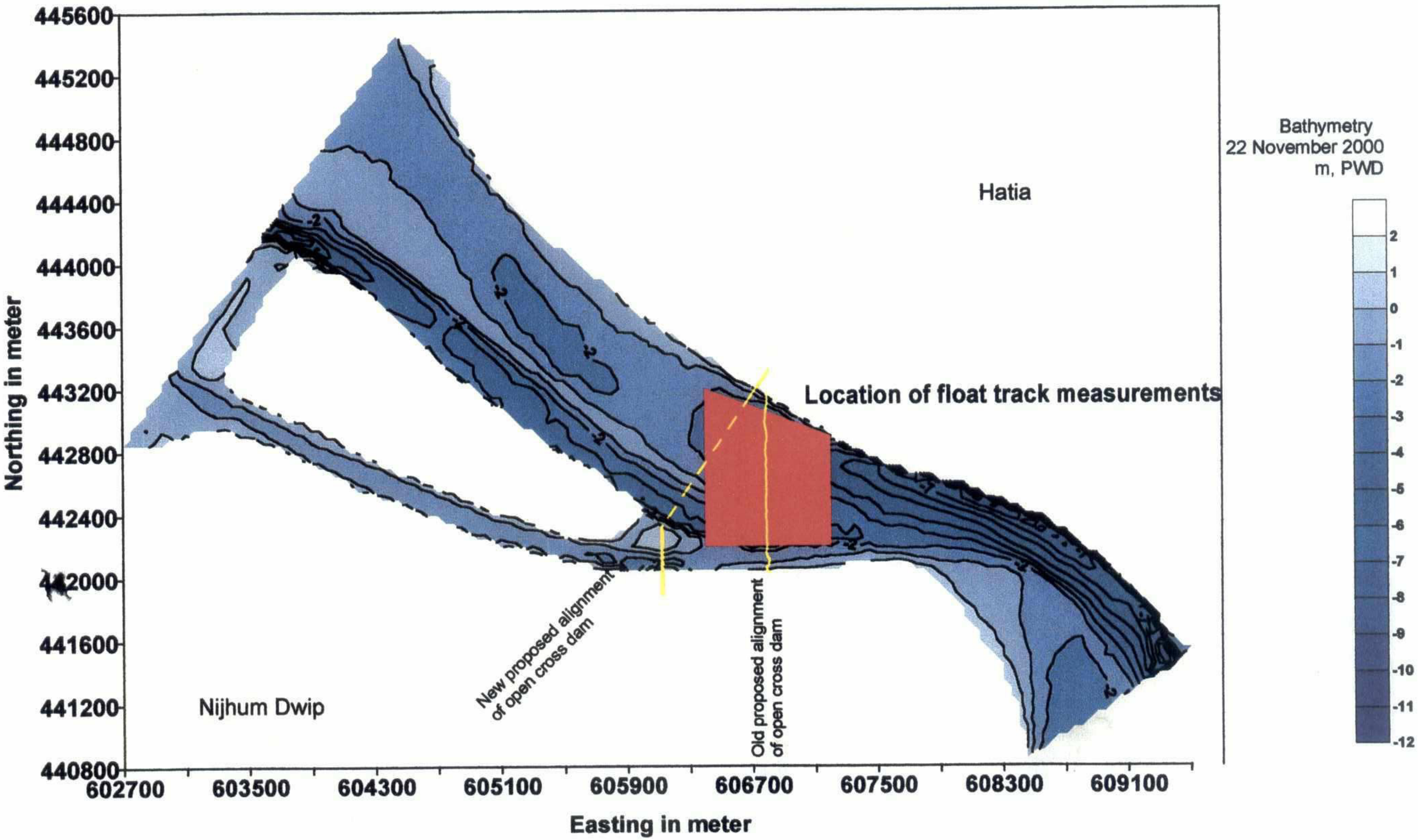

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Figure A7 Fits of power functions to ADCP data

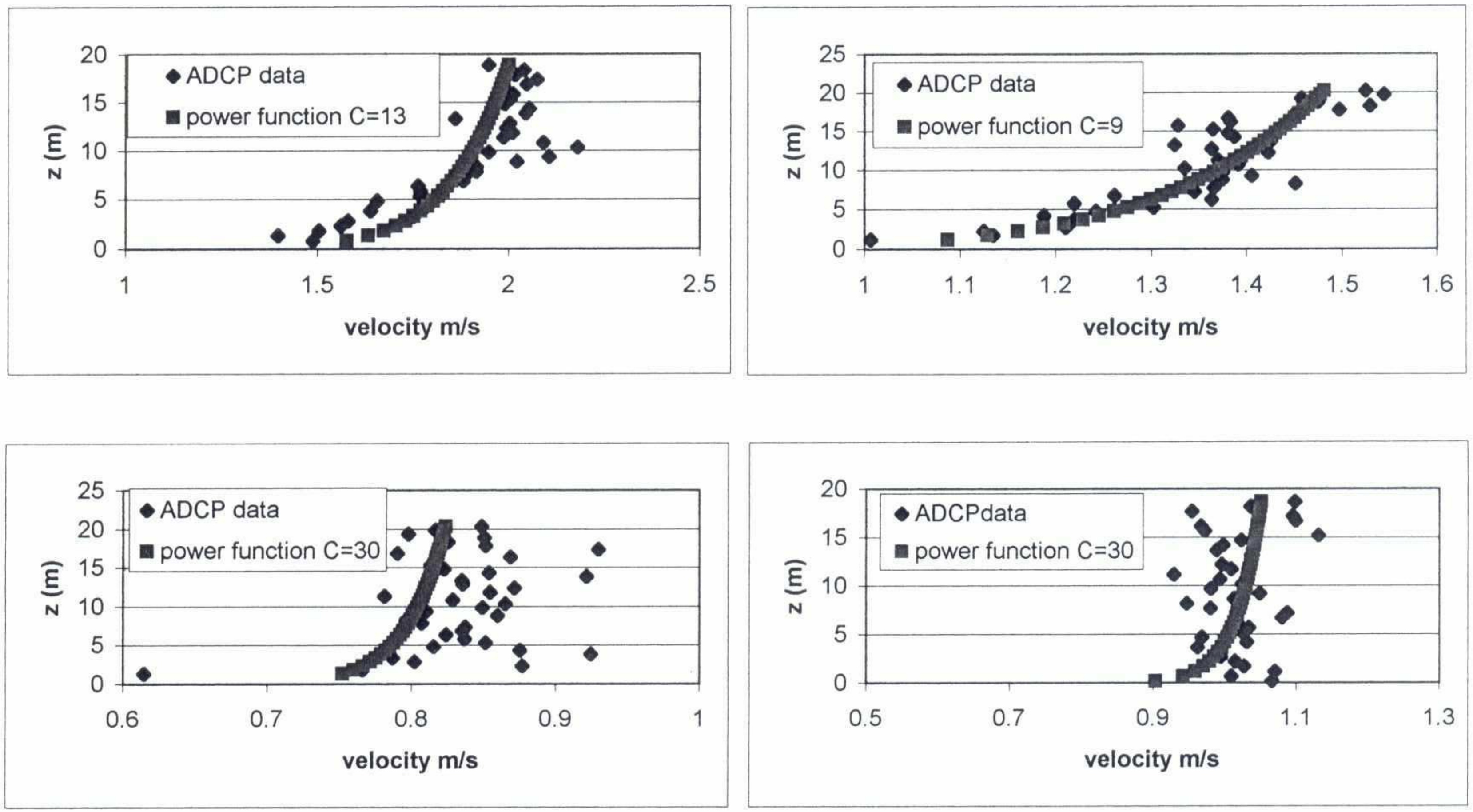


Figure A8 RESULTS FLOAT TRACKING

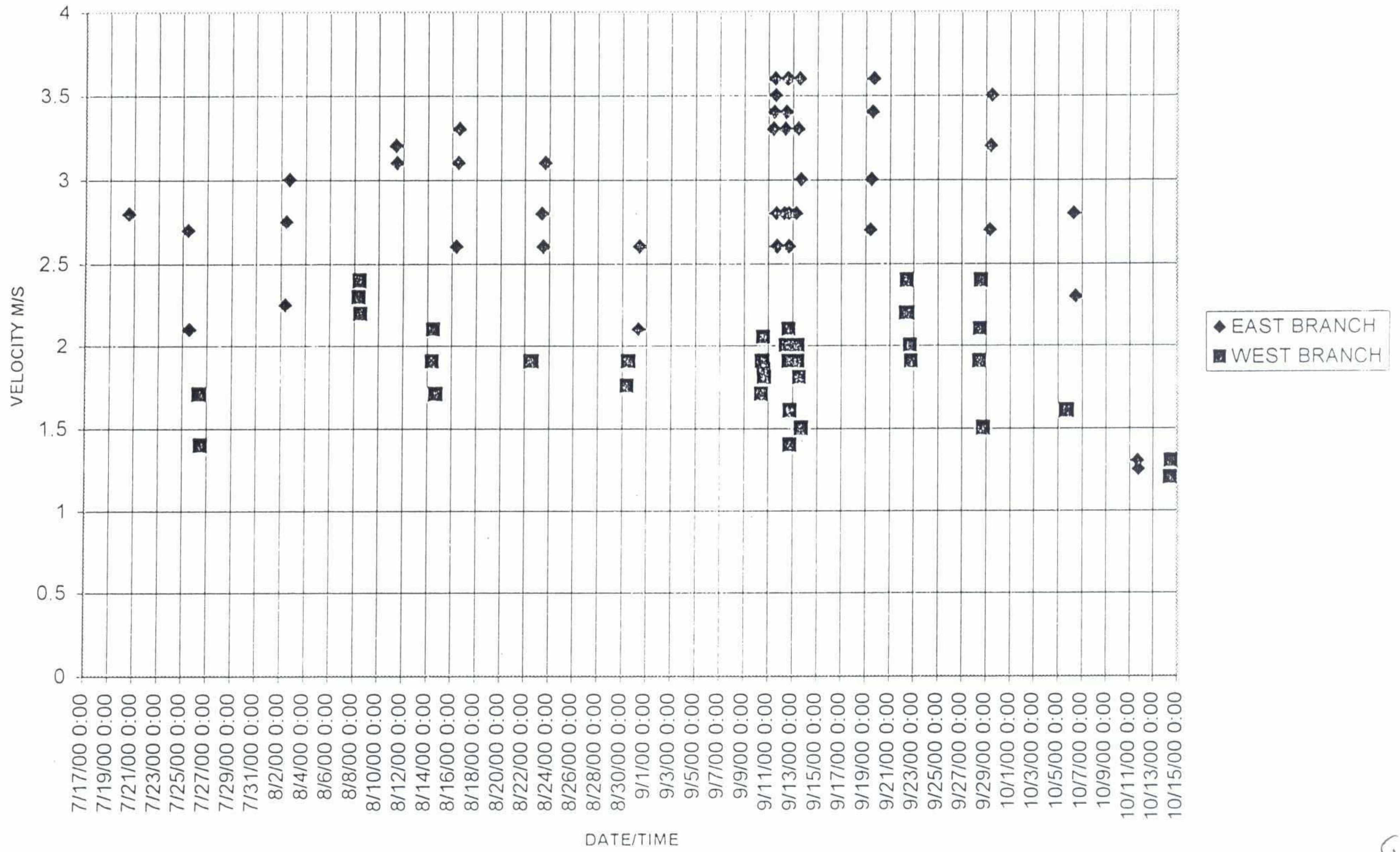


Figure A9 RESULTS FLOAT TRACKING

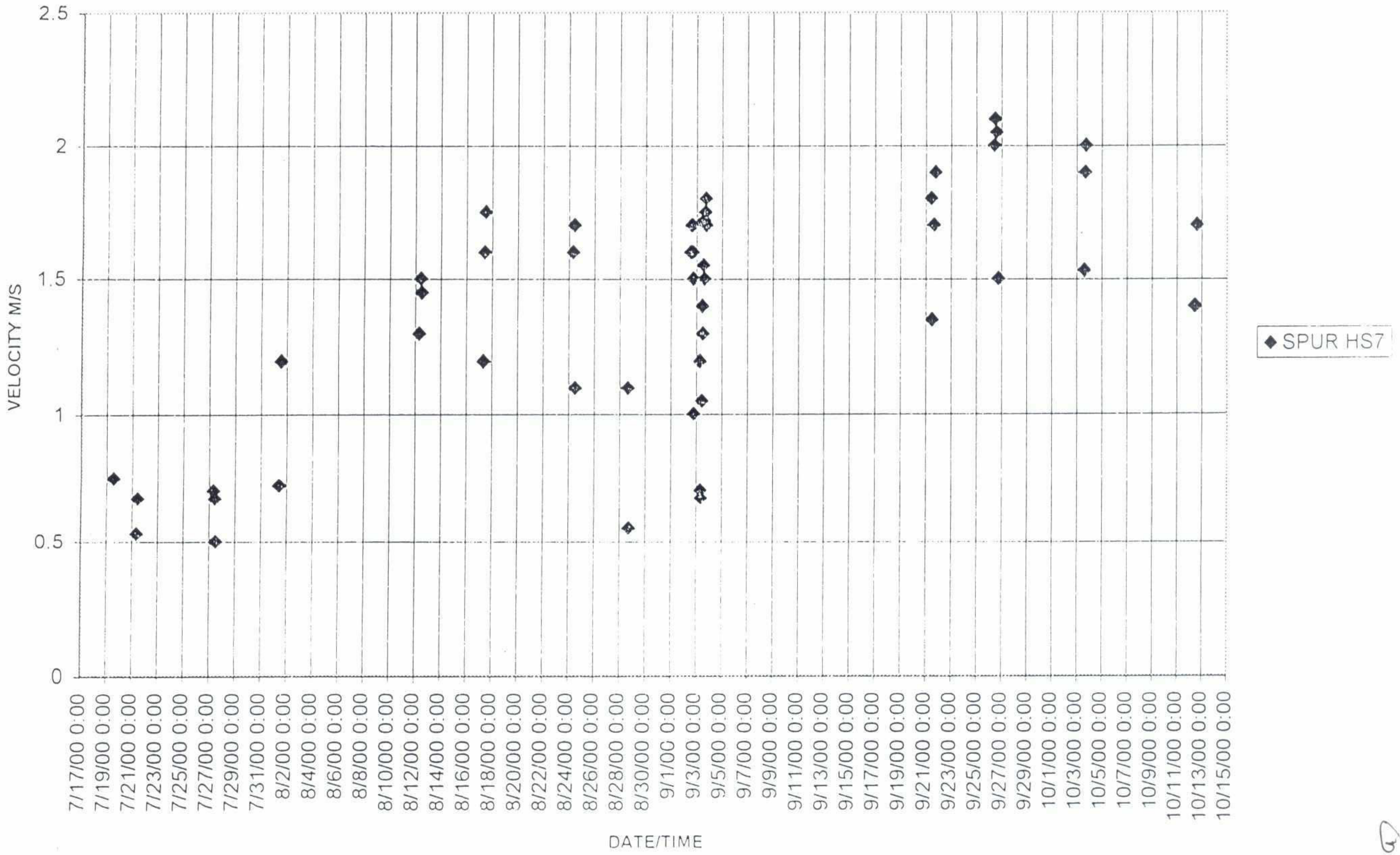


Figure A10 RESULTS FLOAT TRACKING

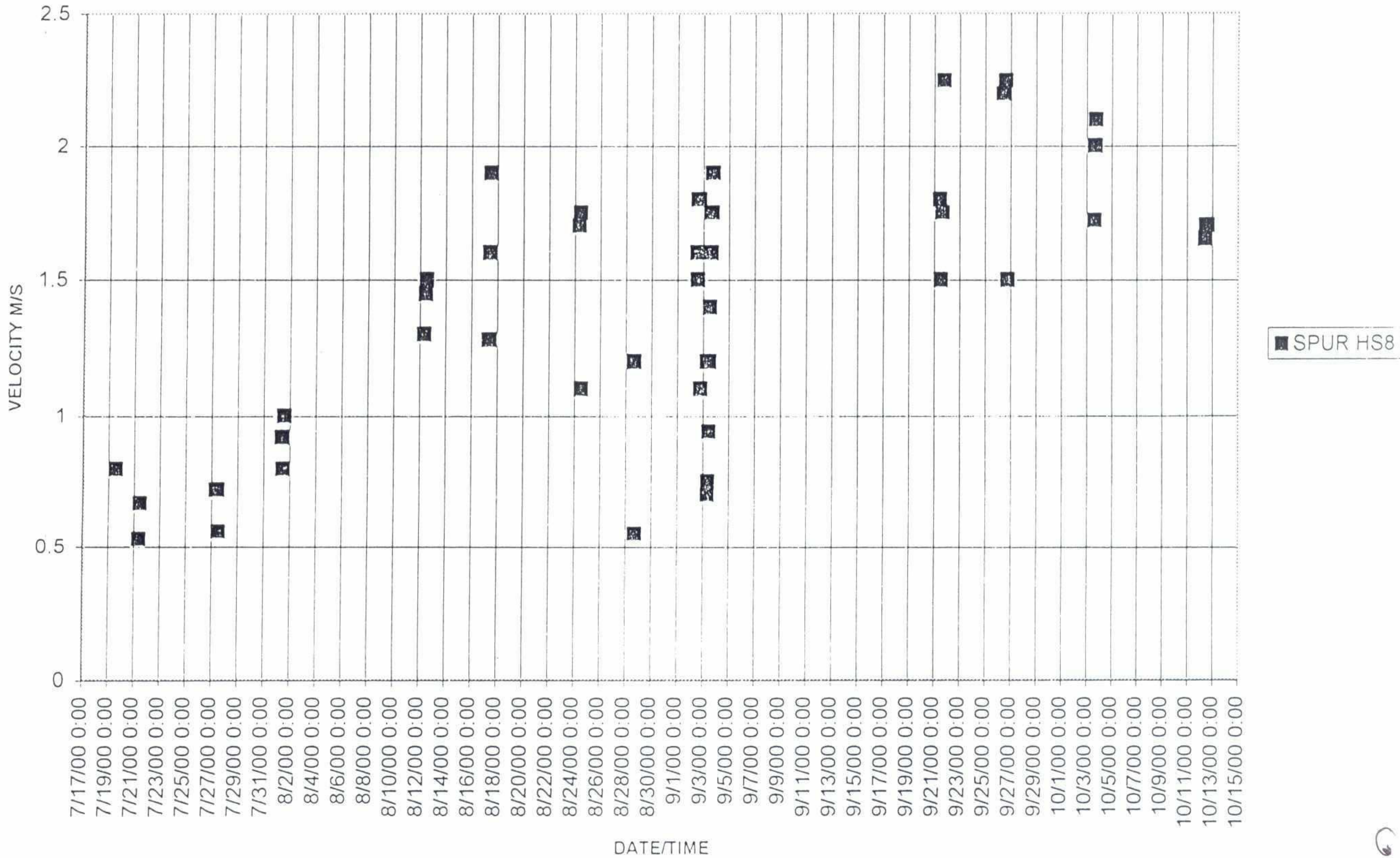
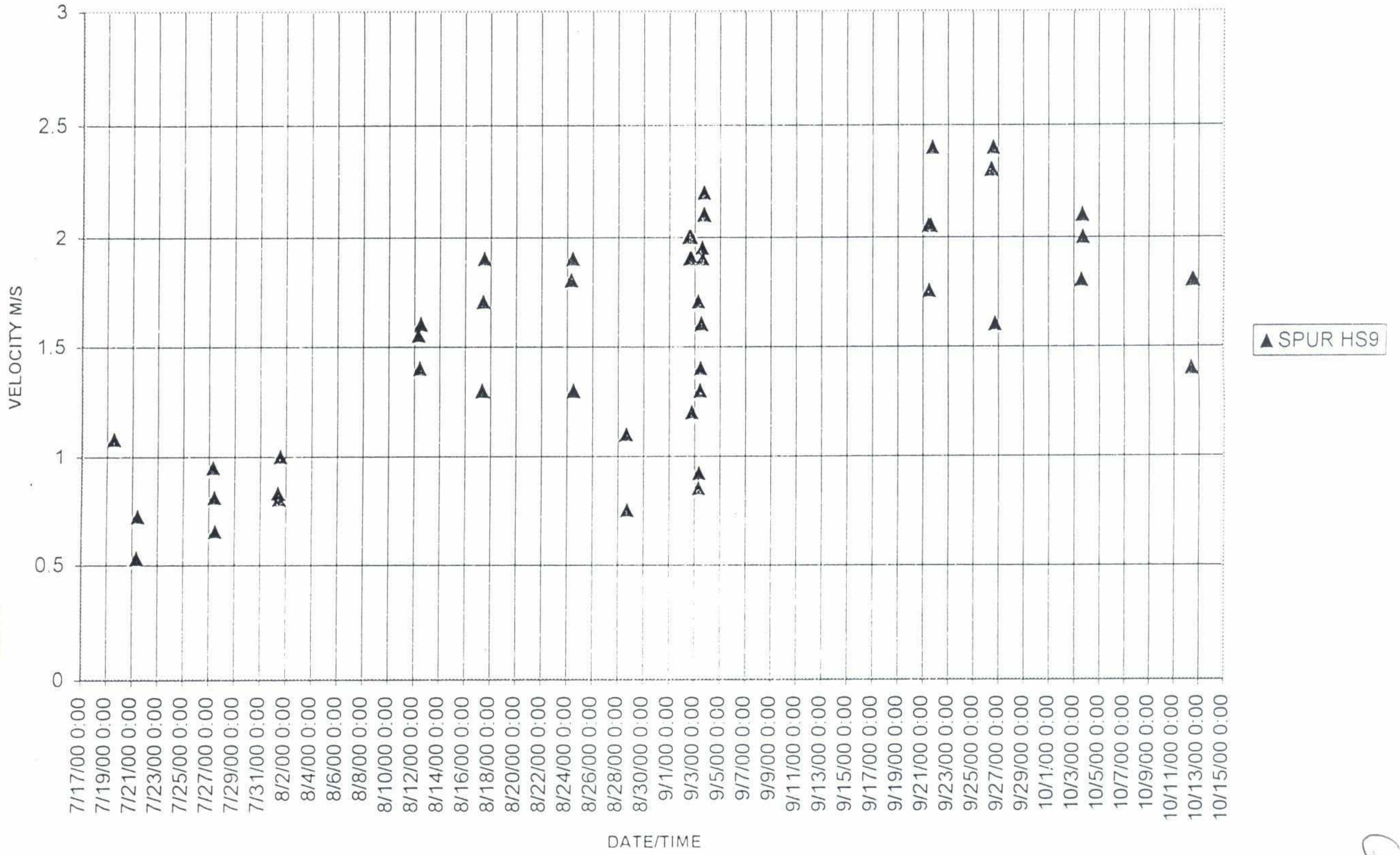


Figure A11 RESULTS FLOAT TRACKING



G8

Figure A12 RESULTS FLOAT TRACKING

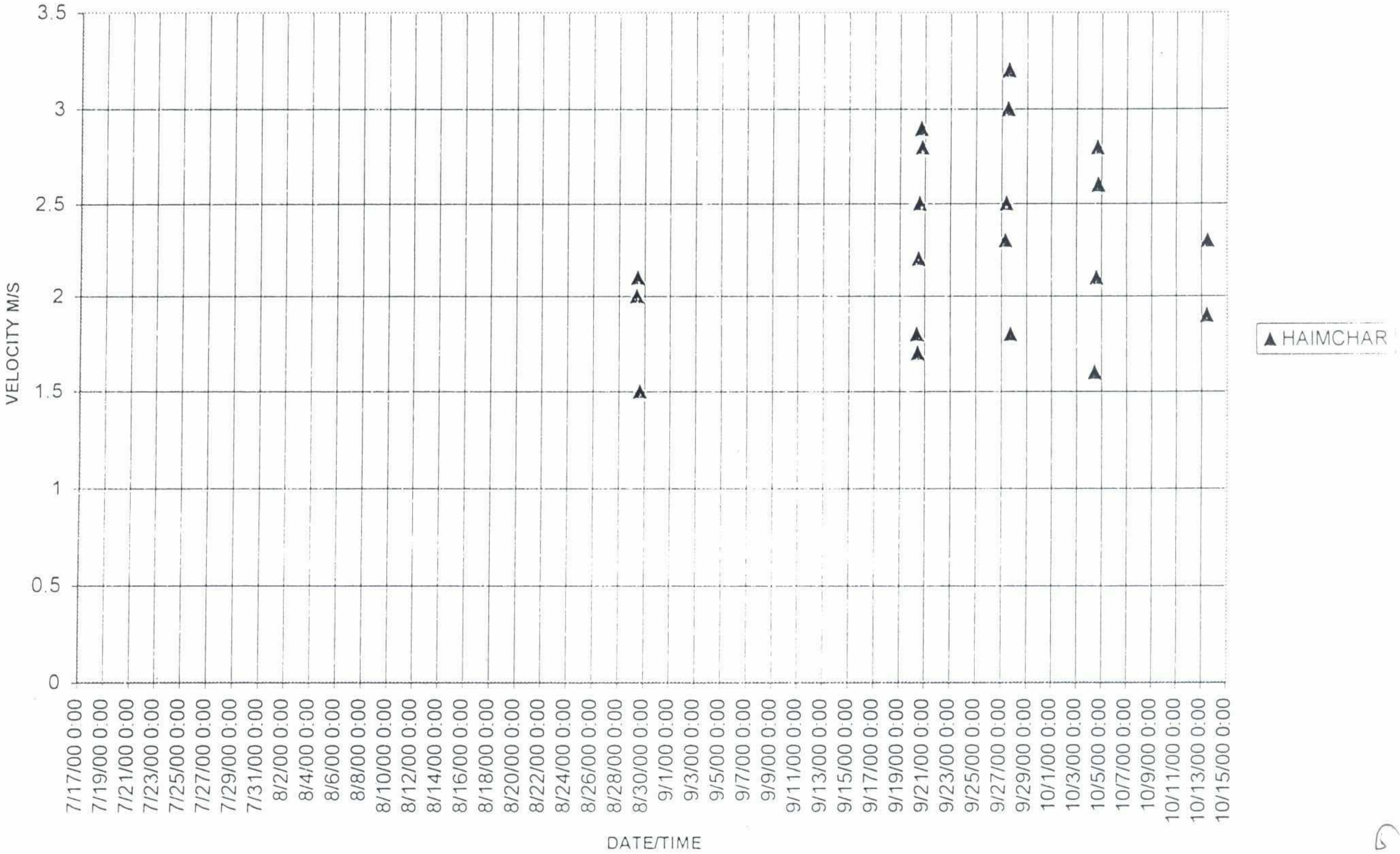


Figure A13a RESULTS OF FLOAT TRACKING AT NIJHUM DWIP

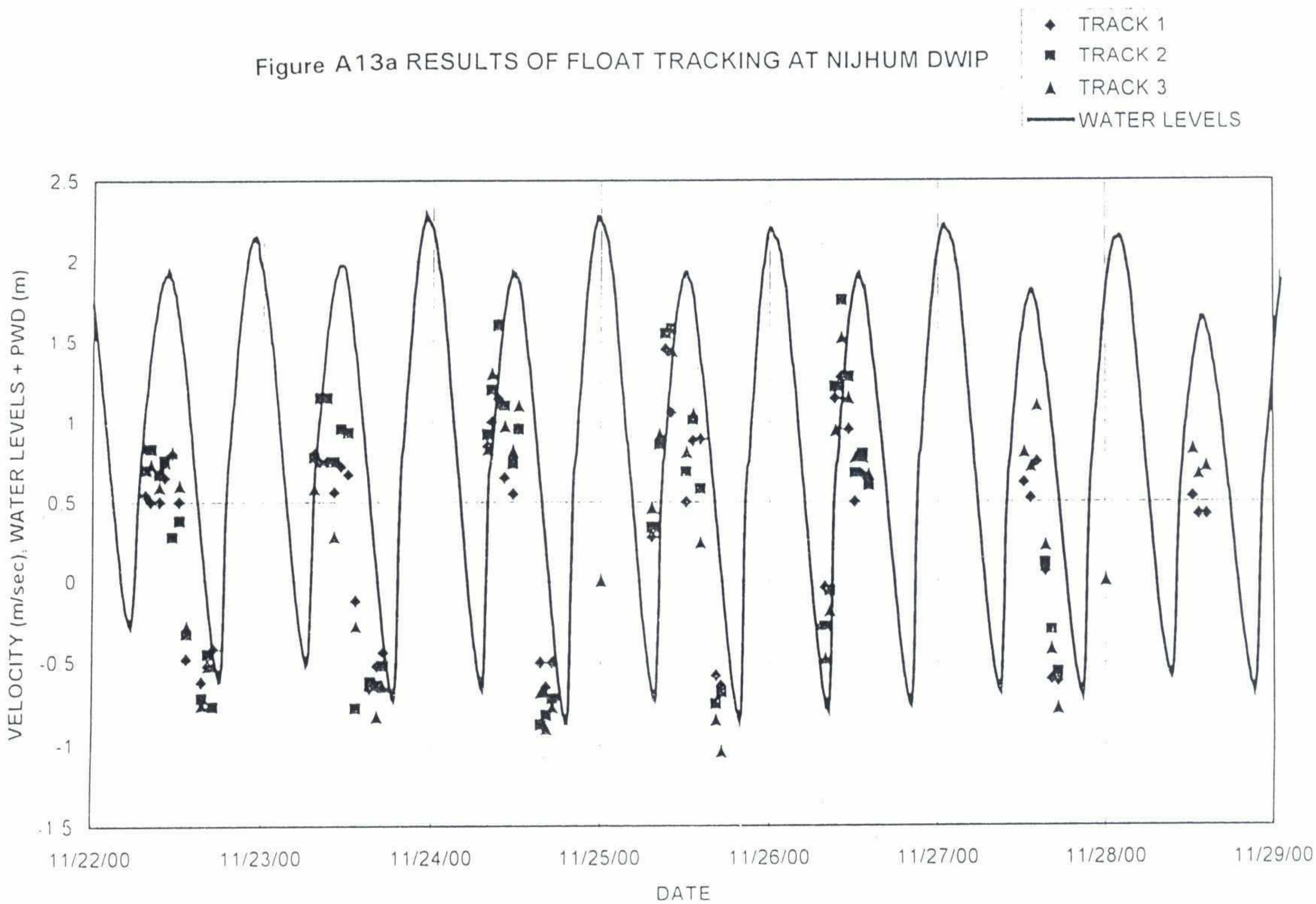


Figure A13b RESULTS OF FLOAT TRACKING AT NIJHUM DWIP

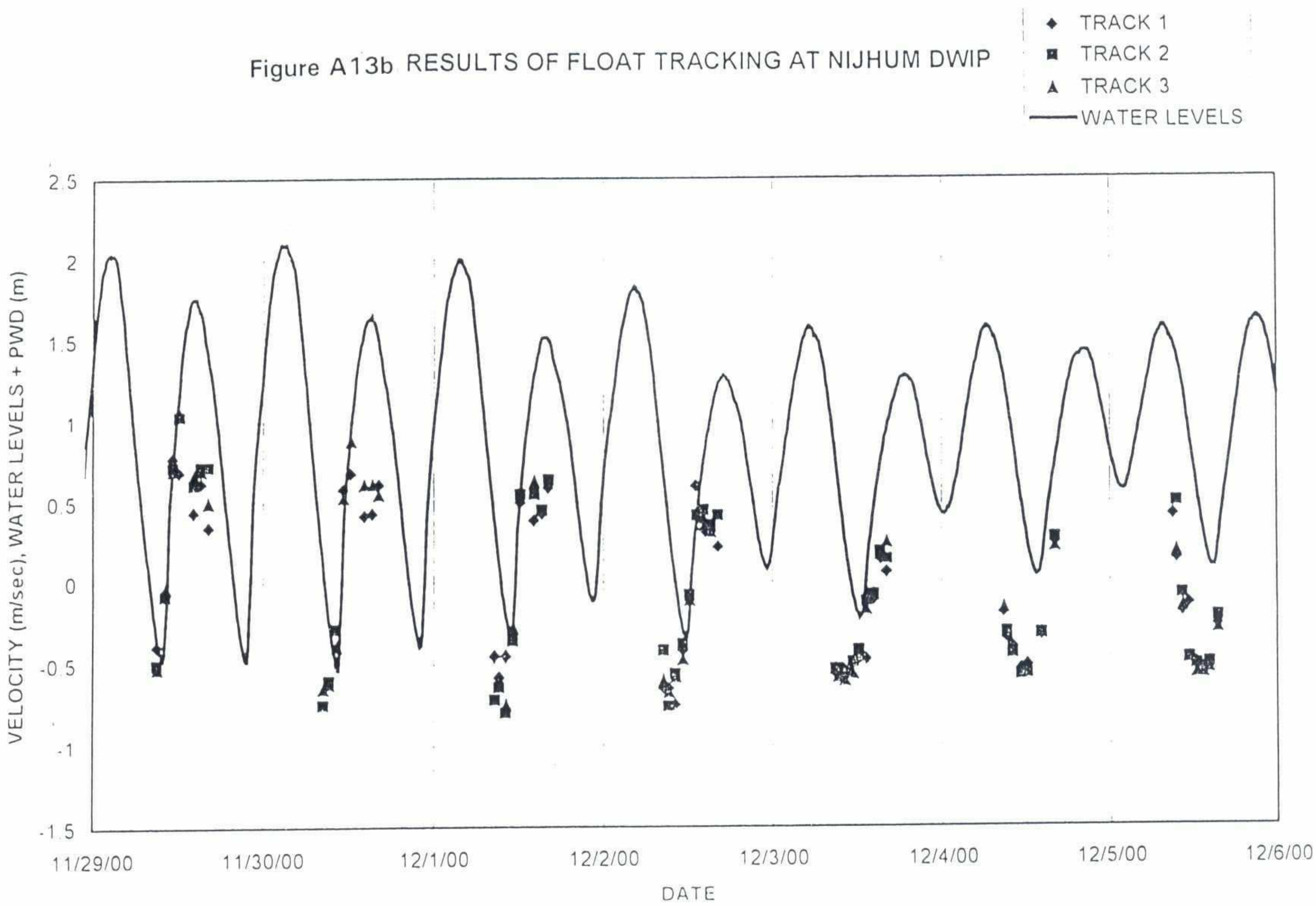


Figure A13c RESULTS OF FLOAT TRACKING AT NIJHUM DWIP

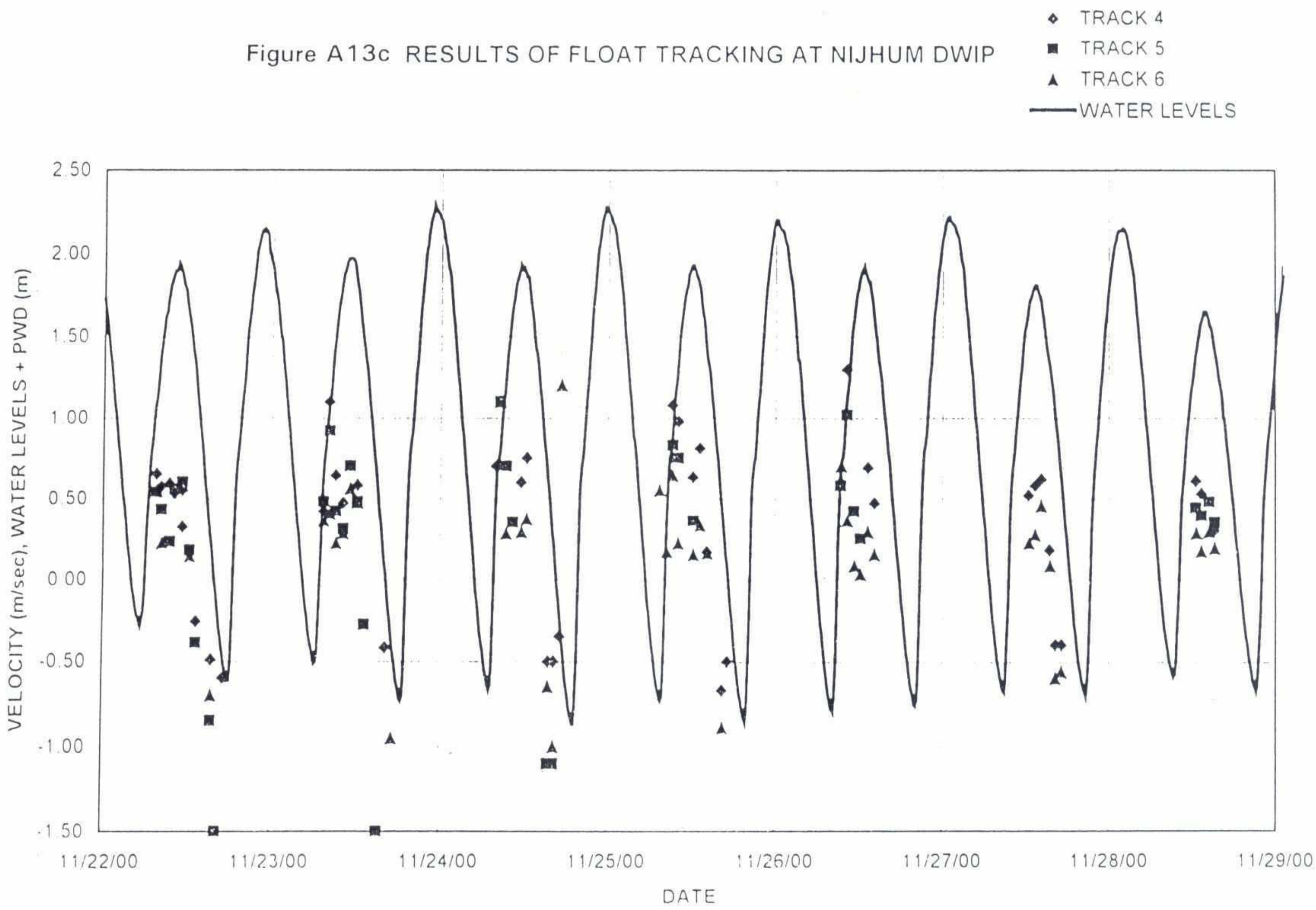


Figure A13d RESULTS OF FLOAT TRACKING AT NIJHUM DWIP

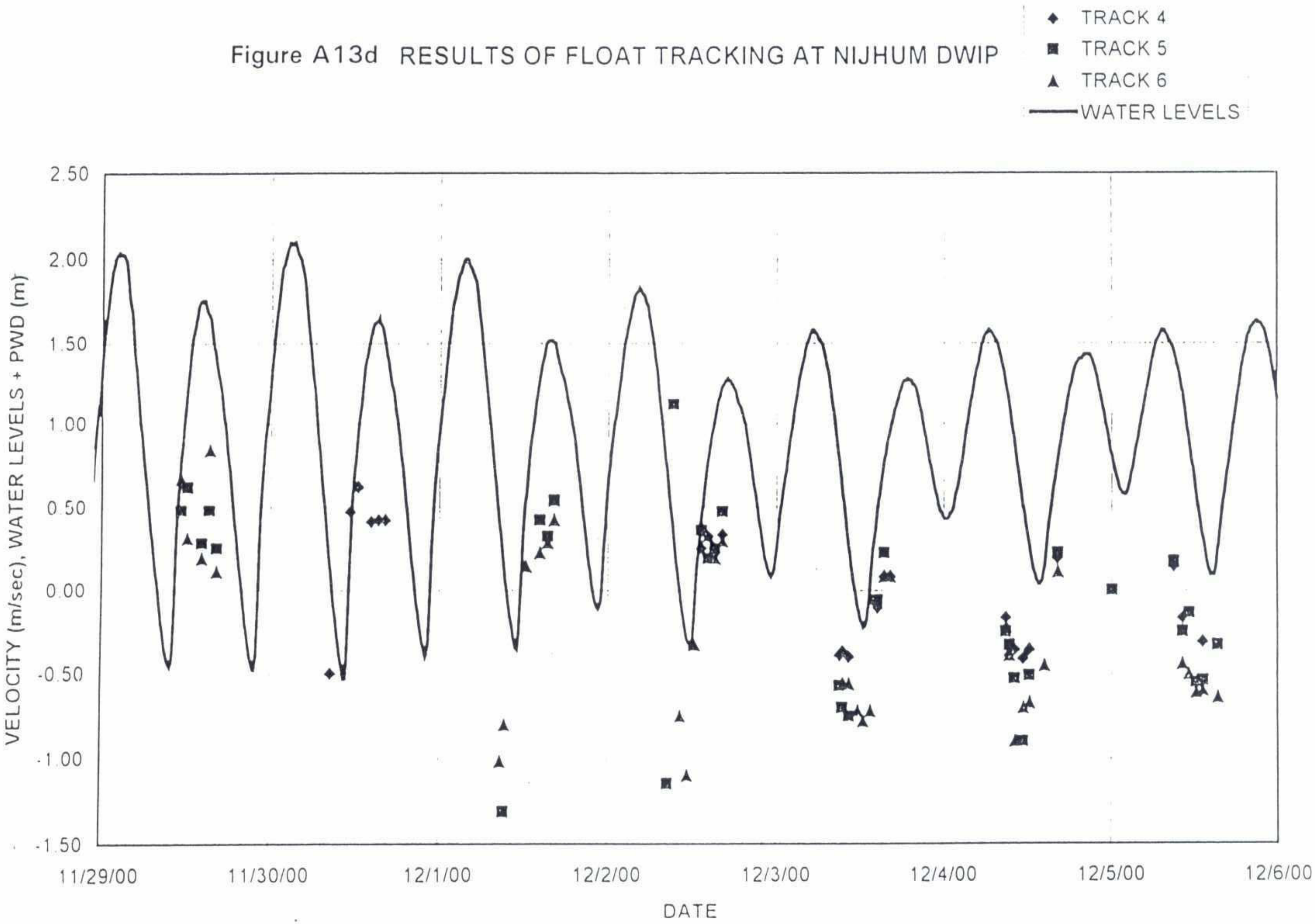


Figure A14

Float Tracking at Nijhum Dwip
22 November 2000
Velocity in m/sec

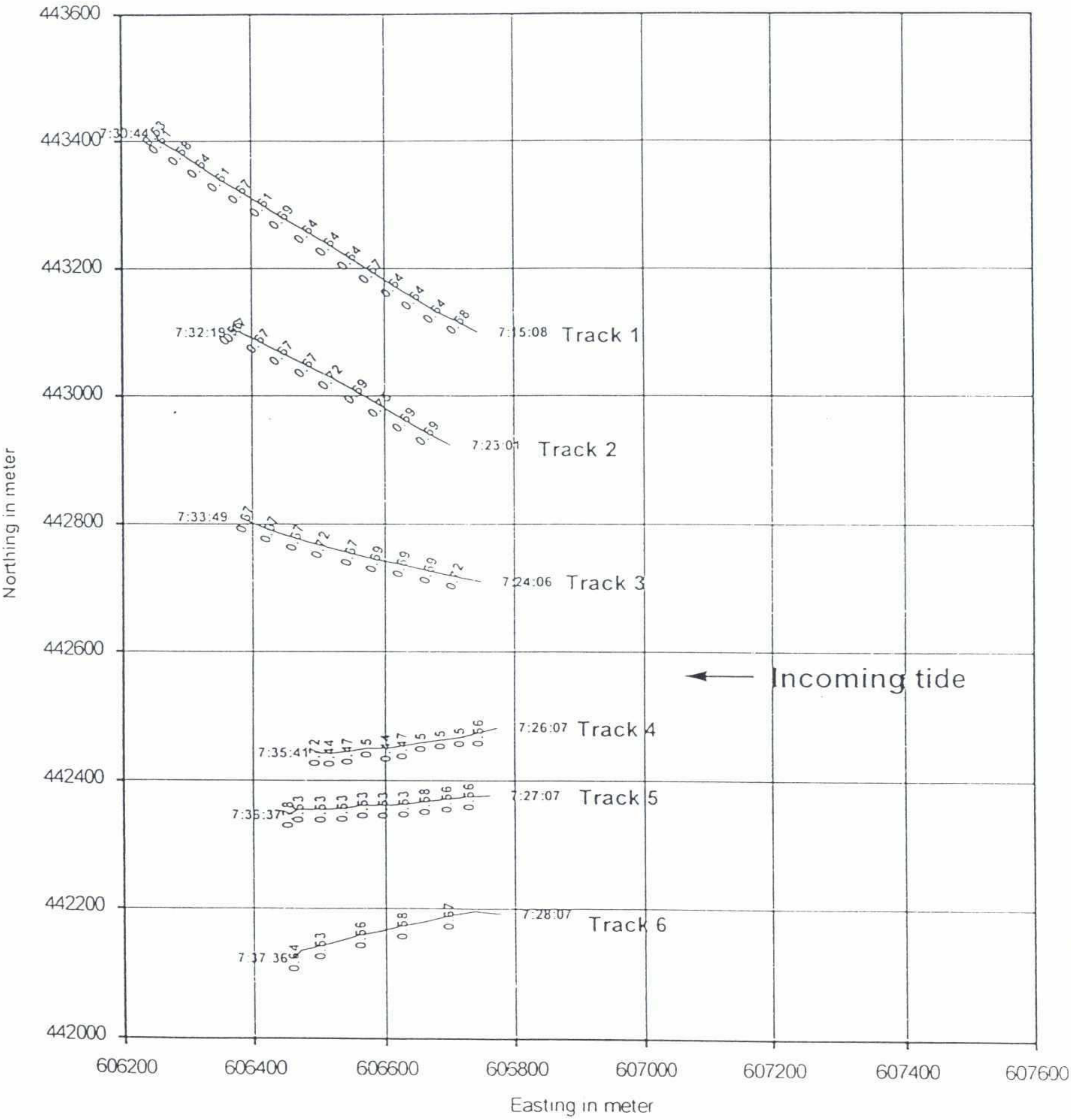


Figure A15

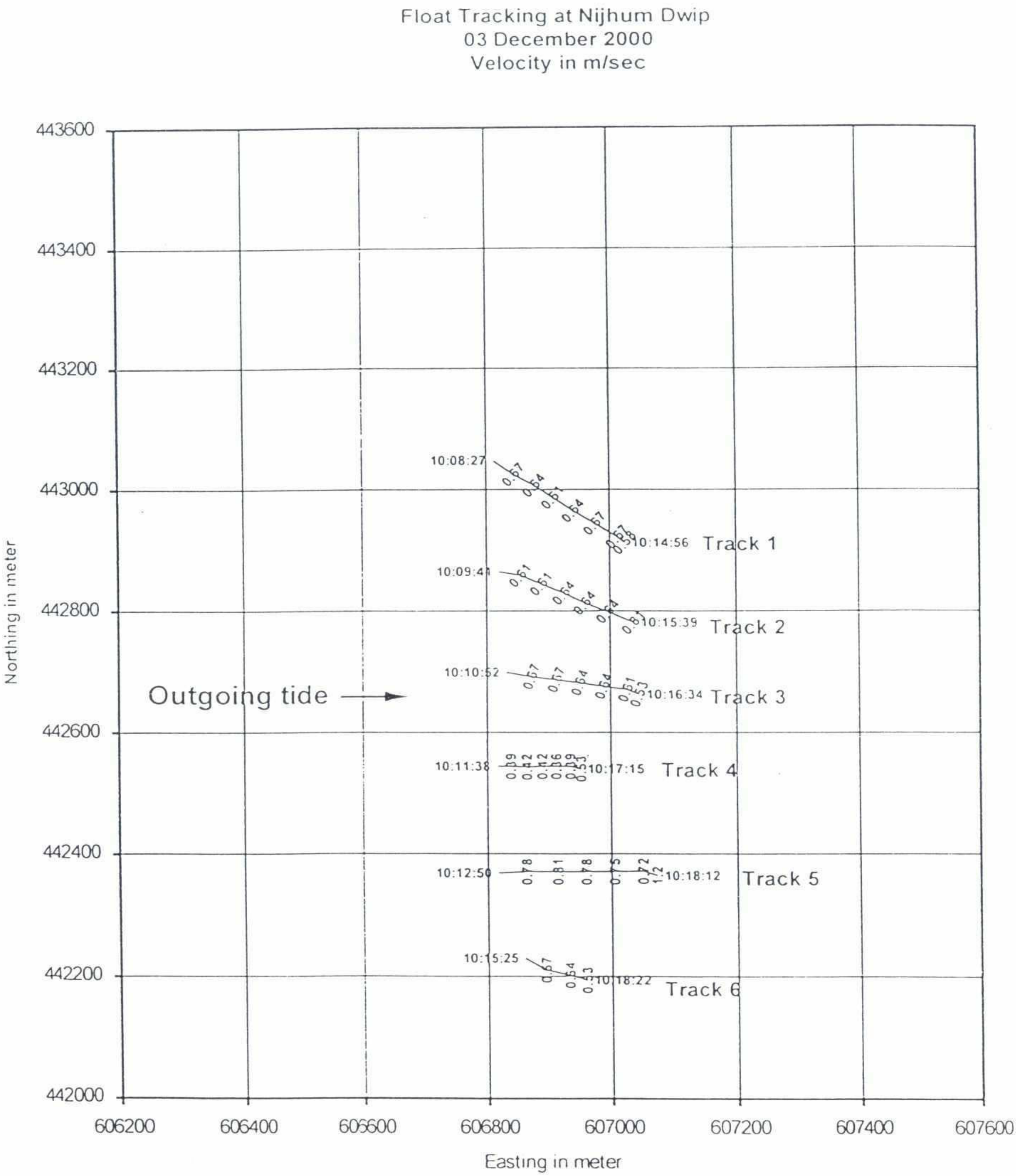
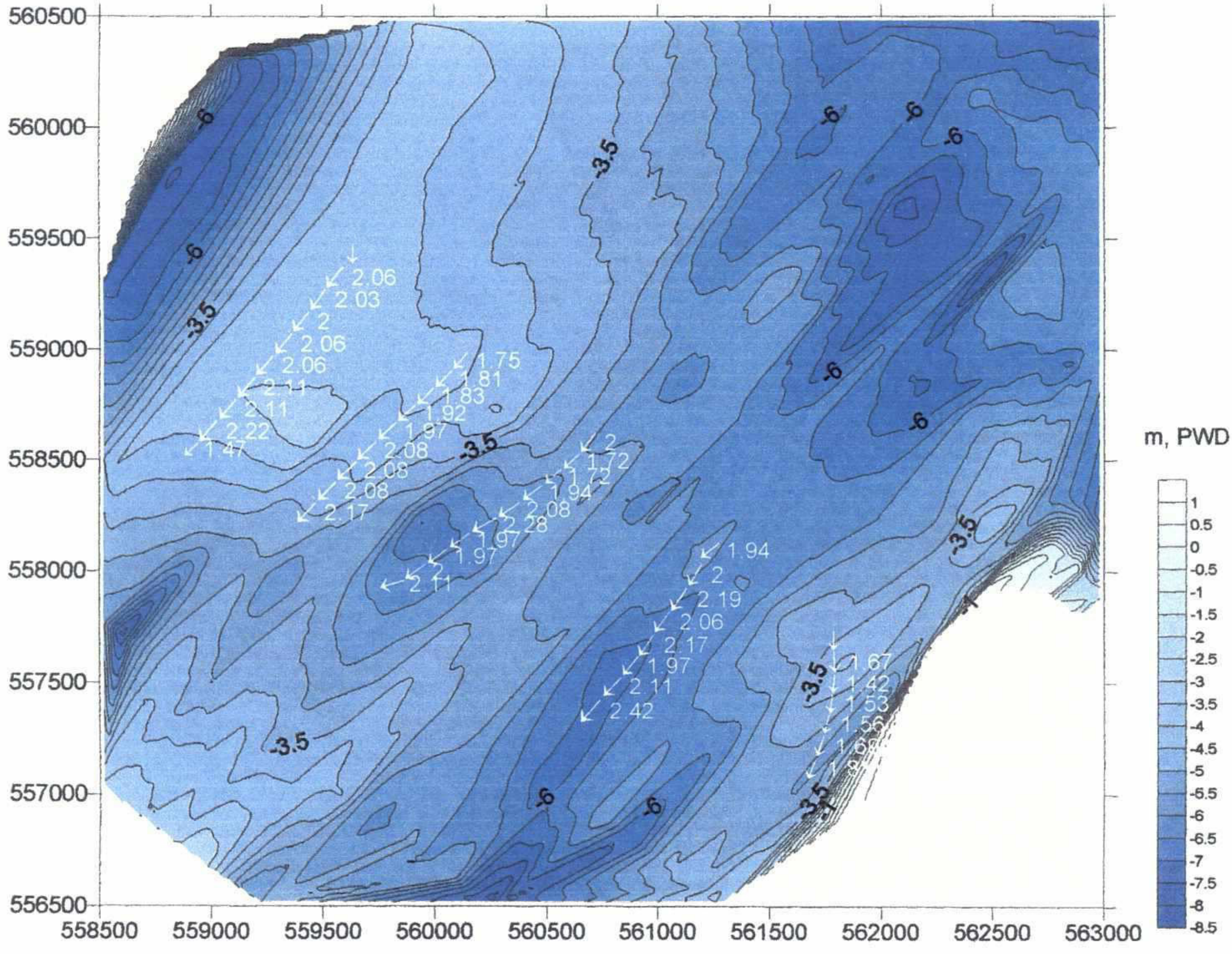
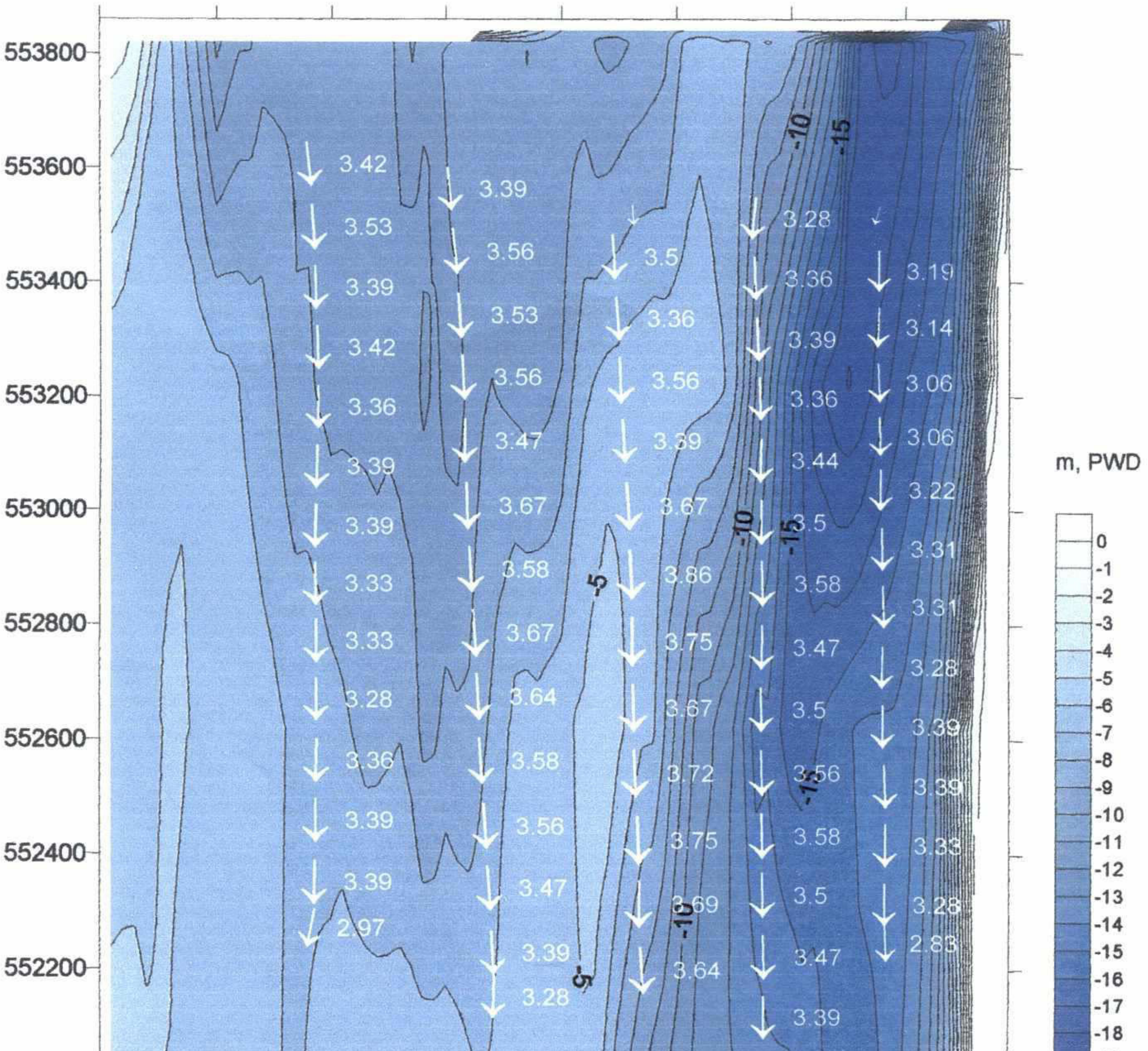

Float Tracking at Nijhum Dwip
03 December 2000
Velocity in m/sec
Northing in meter
Easting in meter
Outgoing tide
Track 1
Track 2
Track 3
Track 4
Track 5
Track 6
10:08:27
10:14:56
10:09:41
10:15:39
10:10:52
10:16:34
10:11:38
10:17:15
10:12:50
10:18:12
10:15:25
10:18:22

Figure A16 Maximum flow velocity from float tracking at West branch Monsoon 2000



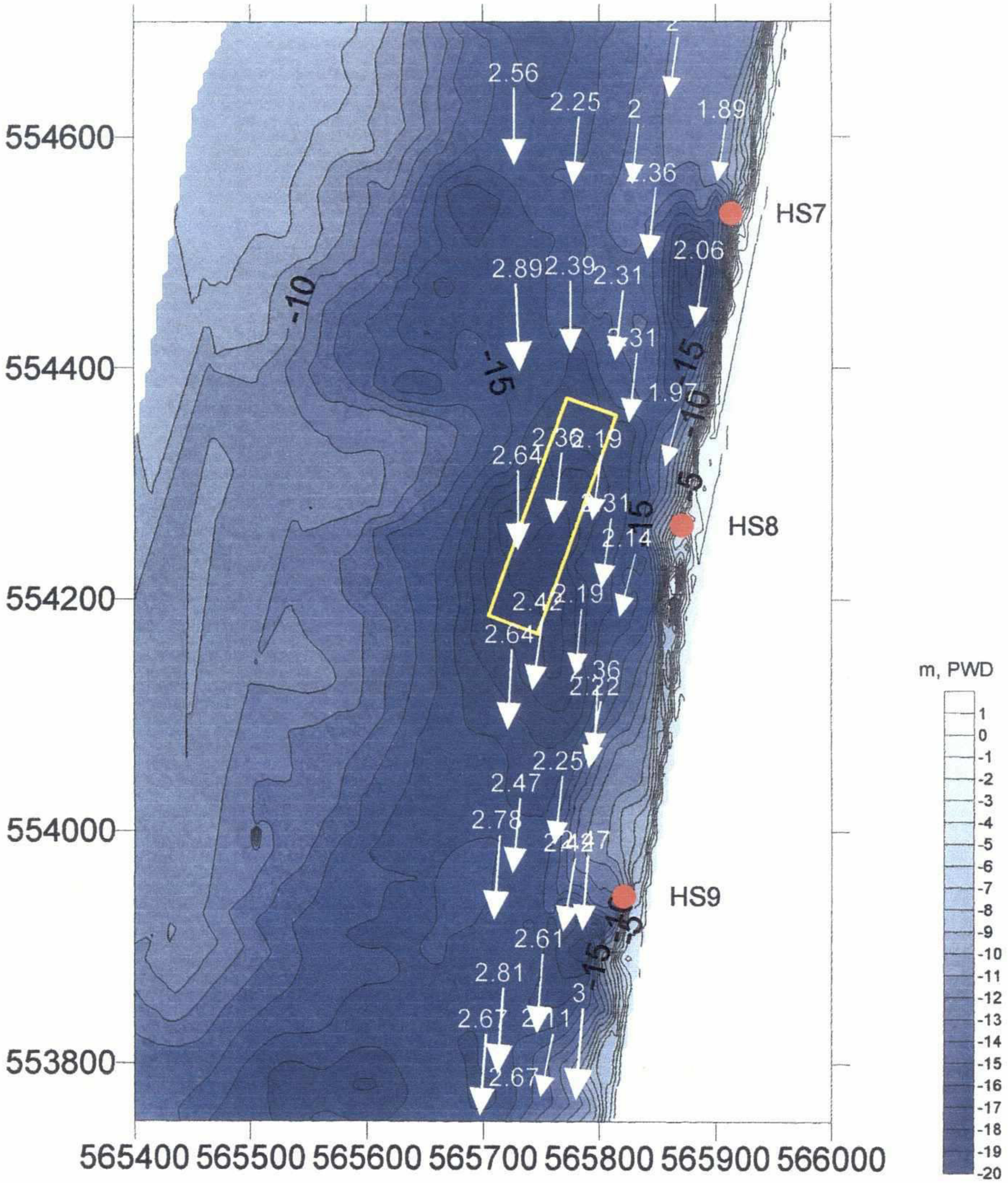
Flow velocity measured at 12-09-2000, in m/s
Background: bathymetry at May - 2000

Figure A17 Maximum flow velocity from float tracking at East branch Monsoon 2000



Flow velocity measured at 12-09-2000, in m/s
Background: bathymetry at May - 2000

Figure A18 Maximum flow velocity from float tracking at Hanar Char South II Monsoon 2000



Flow velocity measured at 26-09-2000, in m/s
Background: bathymetry at 10-09-2000

Figure A19a FLOAT TRACKING (HANARCHAR)
03 September 2000
Velocity in m/s

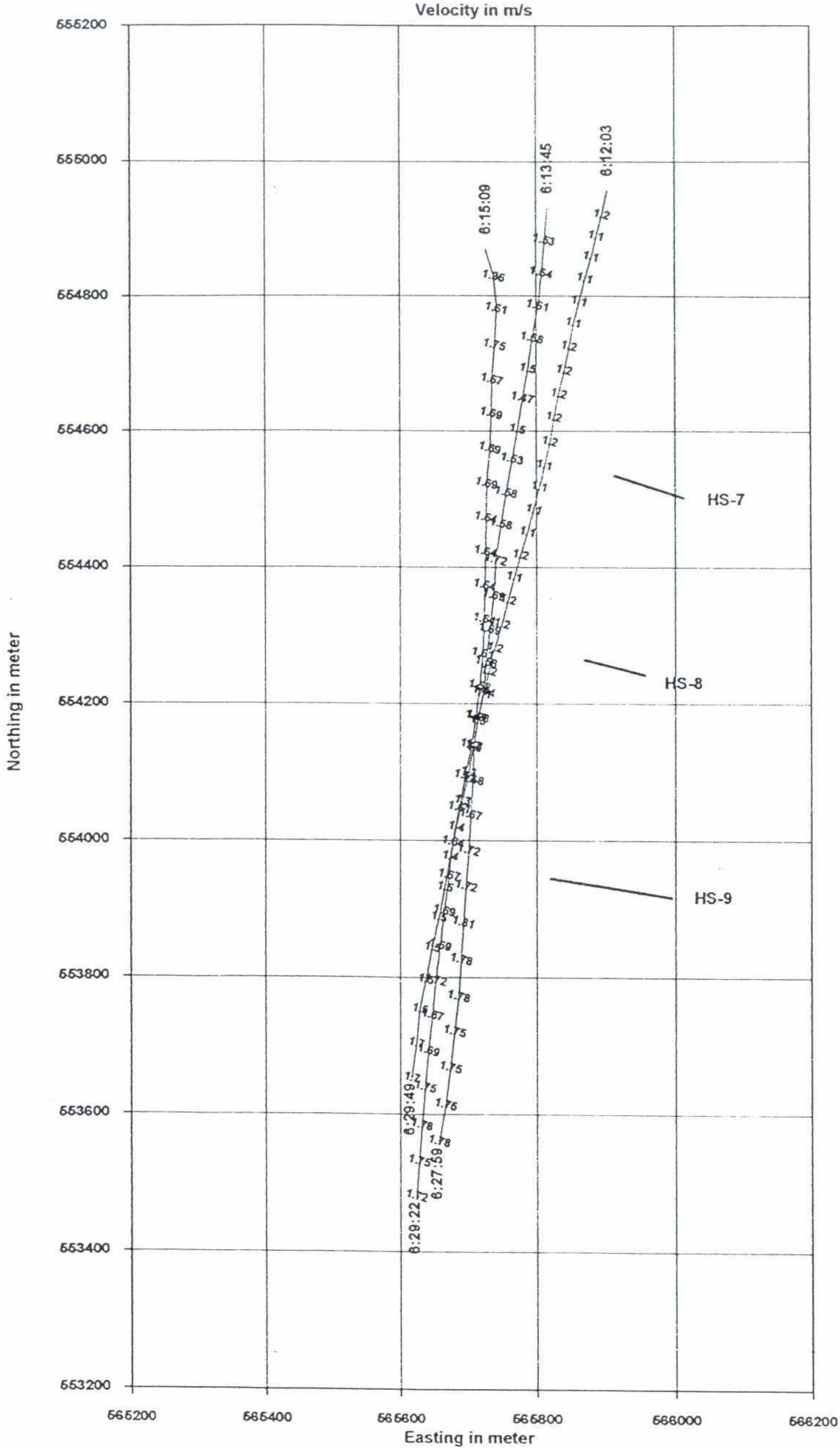


Figure A19b FLOAT TRACKING (HANARCHAR)
03 September 2000
Velocity in m/s

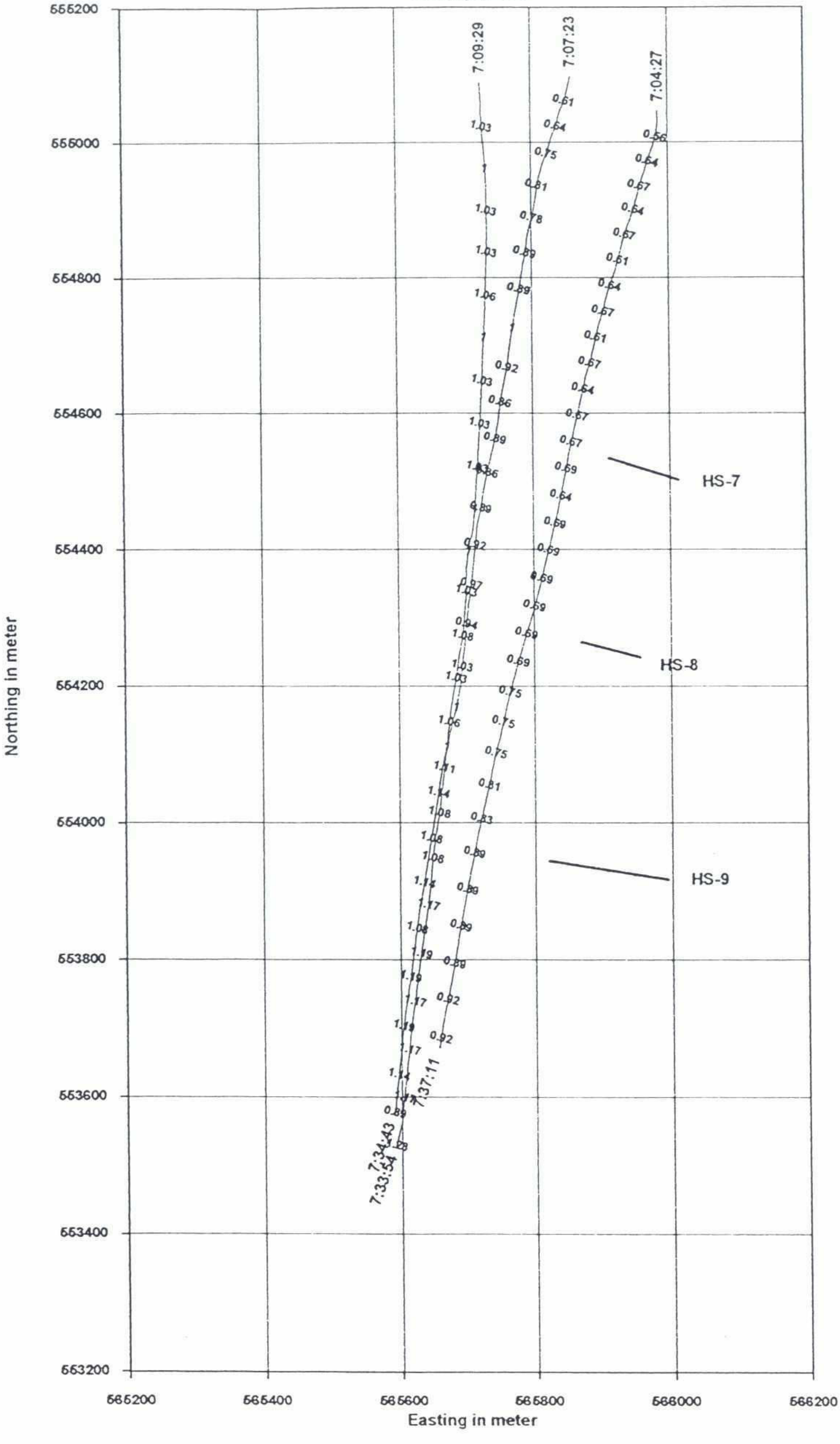


Figure A19c FLOAT TRACKING (HANARCHAR)

03 September 2000

Velocity in m/s

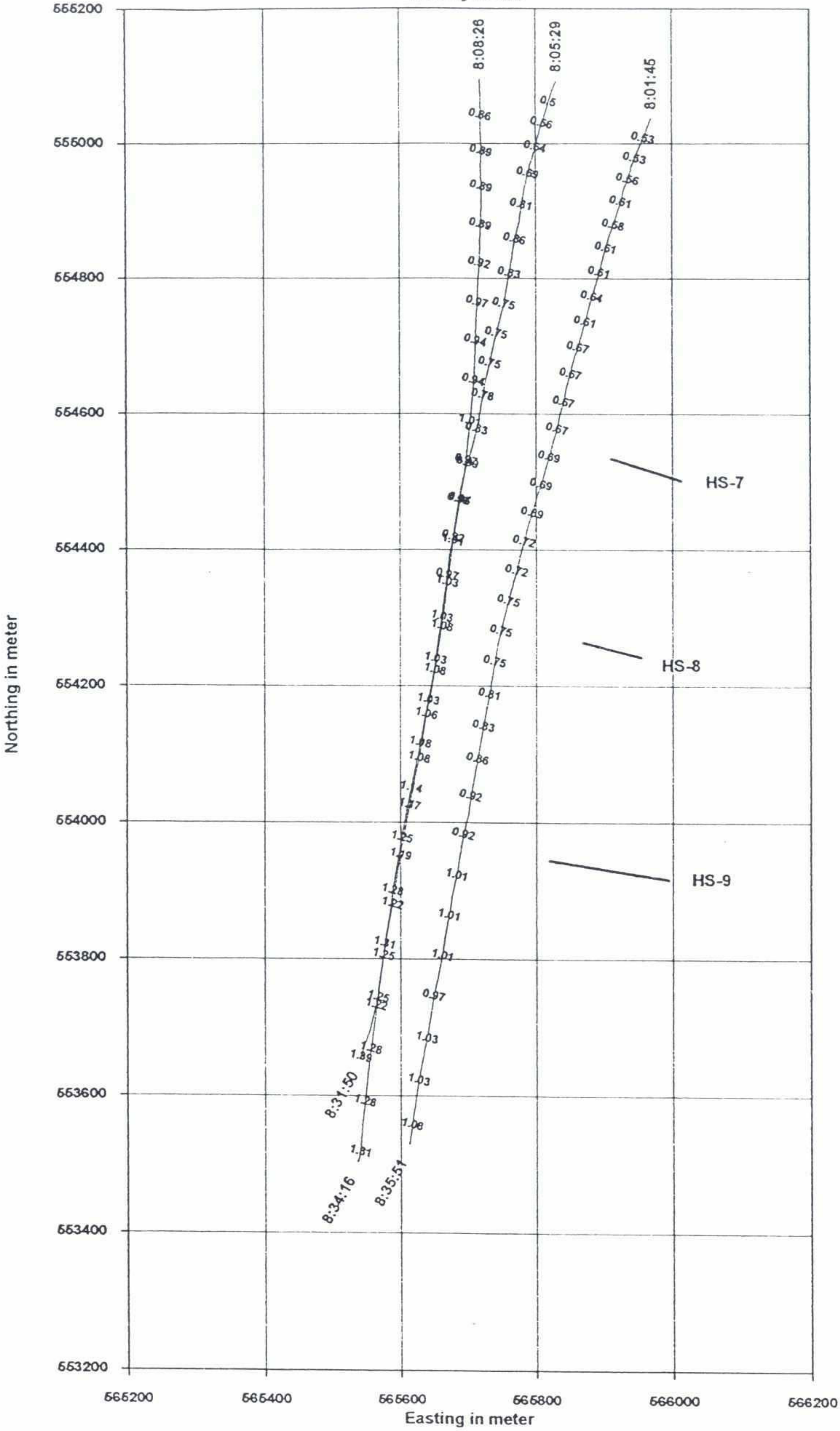


Figure A19d FLOAT TRACKING (HANARCHAR)
03 September 2000
Velocity in m/s

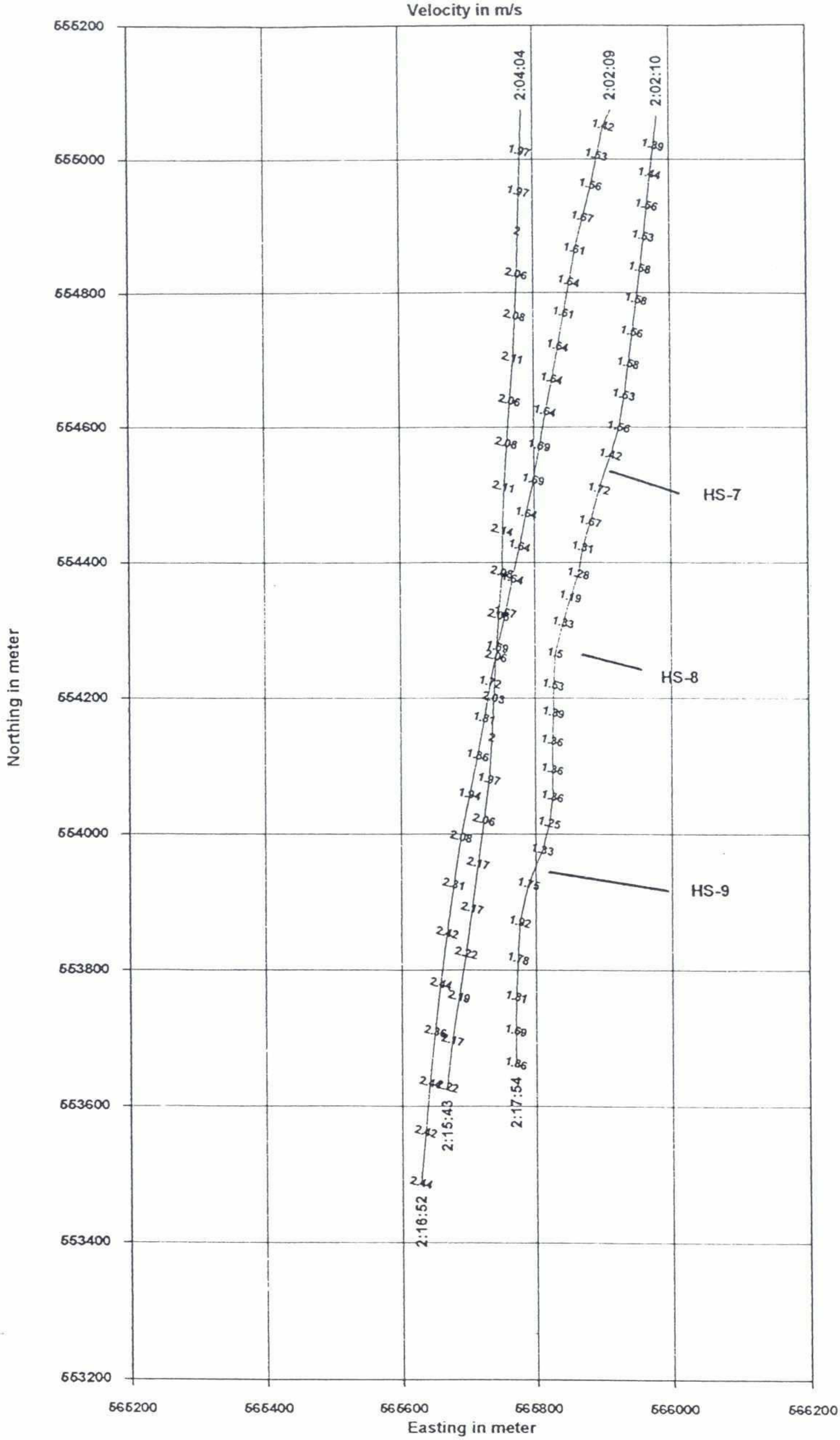
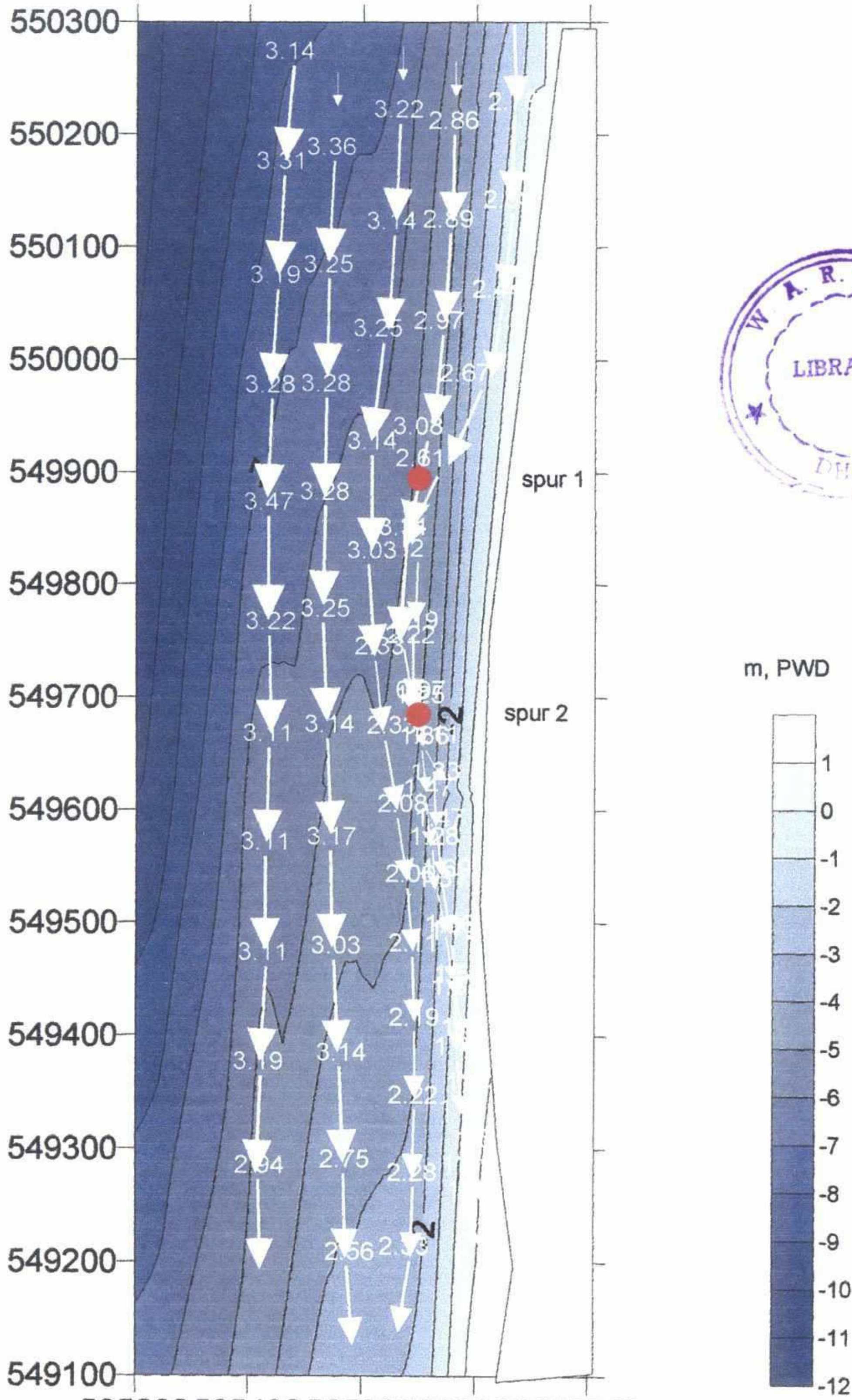
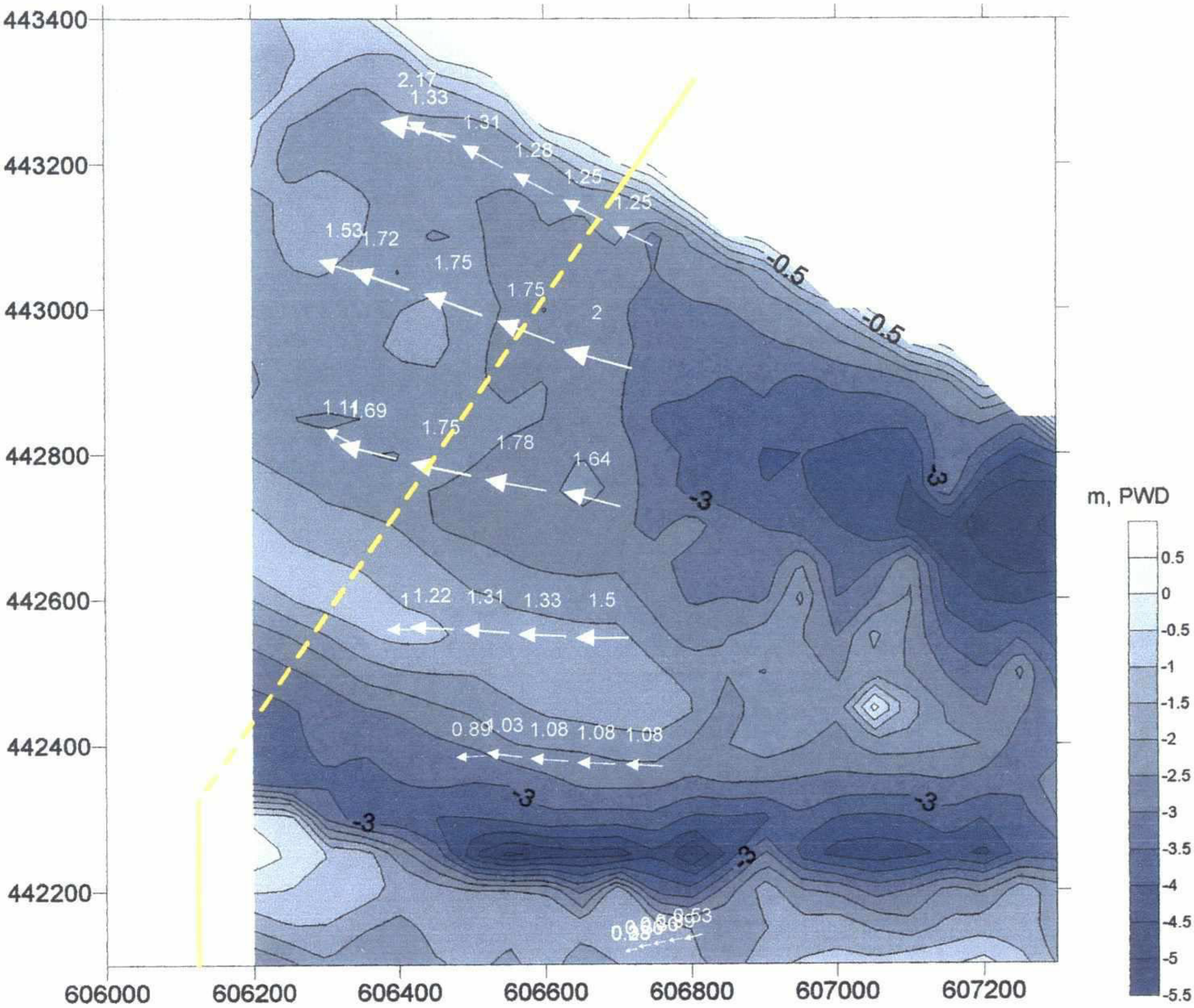


Figure A20 Maximum flow velocity from float tracking at Haim Char
Monsoon 2000

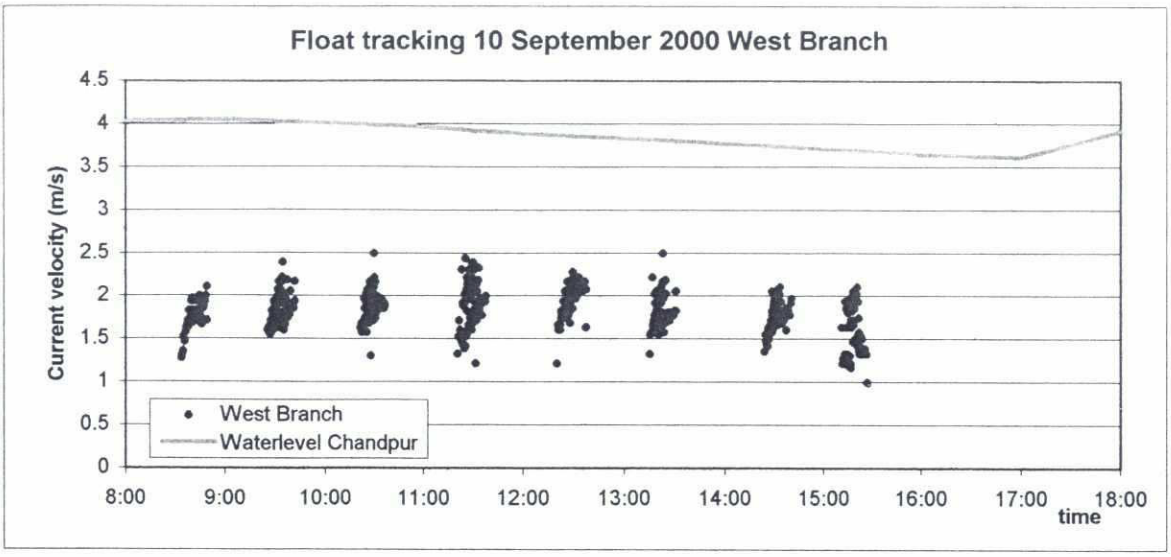


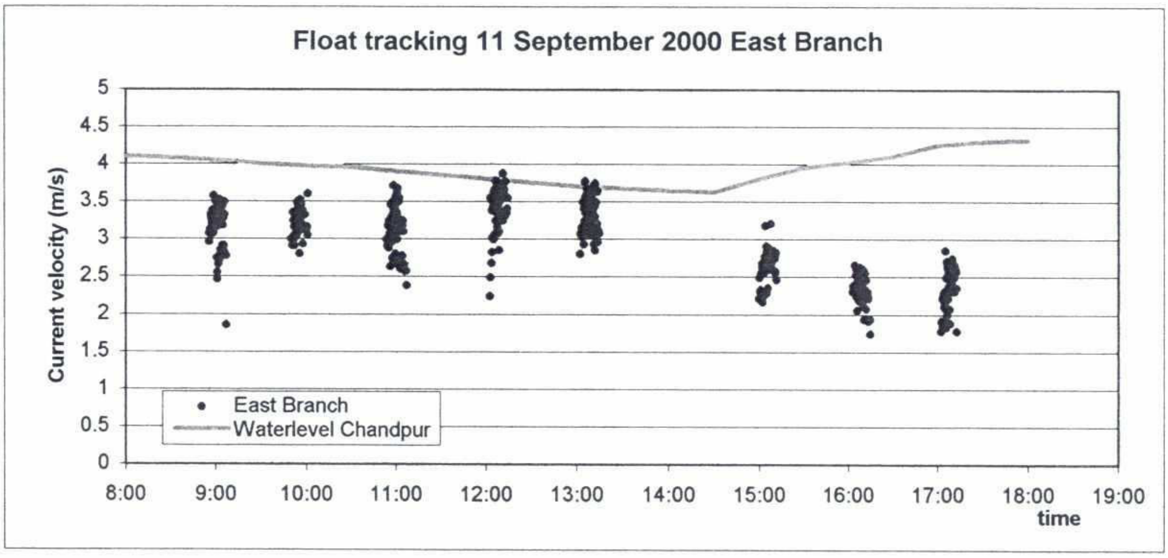
Flow velocity measured at 27-09-2000, in m/s
Background: bathymetry at May - 2000

Figure A21 Maximum flow velocity from float tracking at Nijhum Dwip November / December 2000



Flow velocity measured at 26-11-2000, in m/s
Background: bathymetry at 22-11-2000





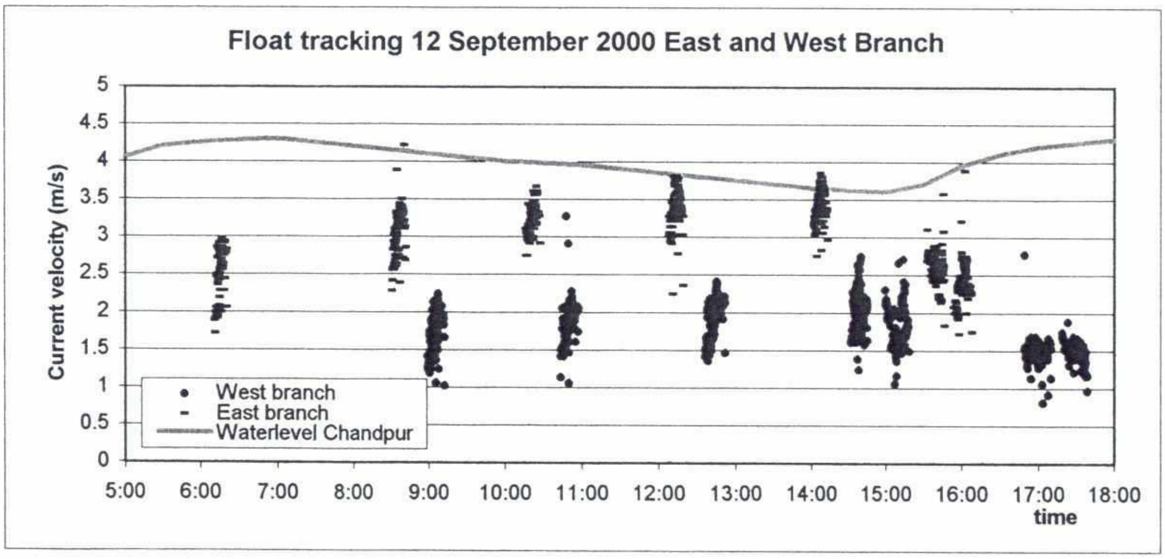
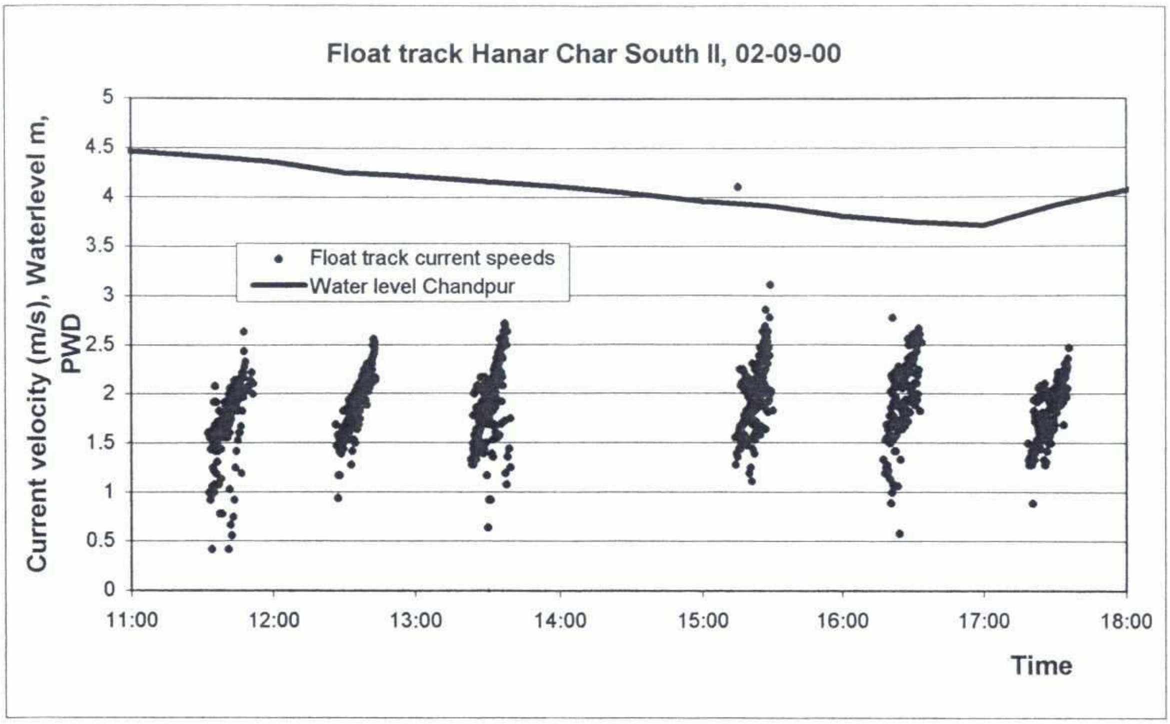


Figure A22 Float track results intensive monitoring Meghna branches



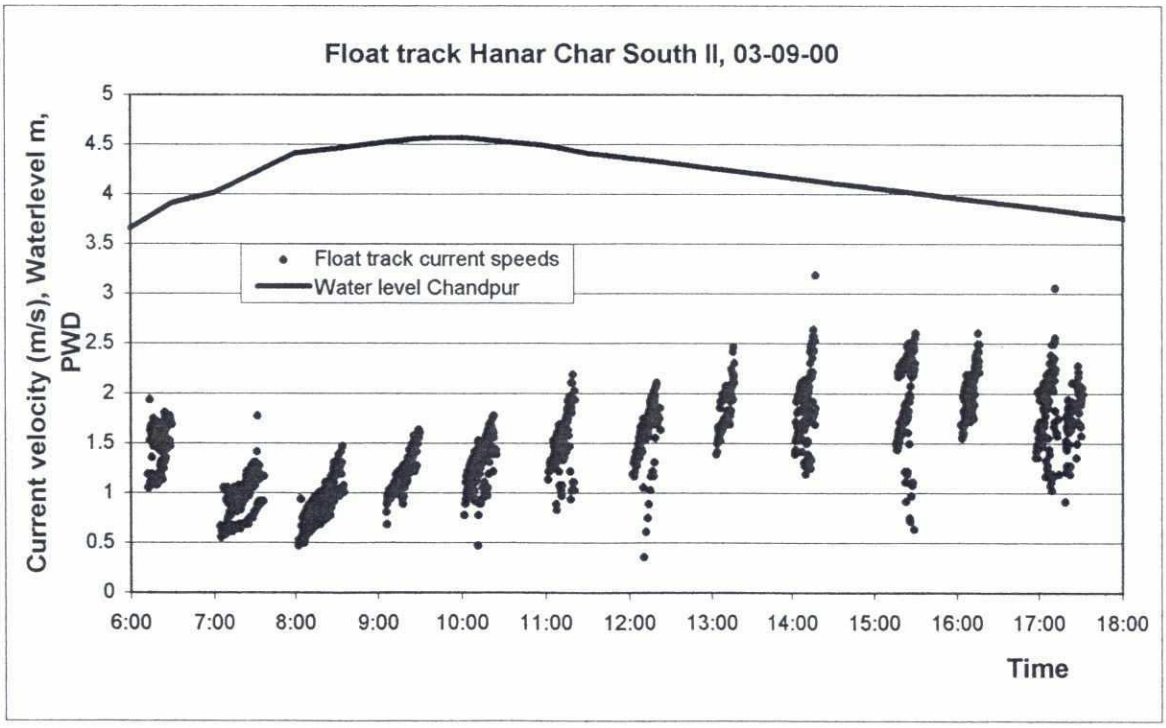
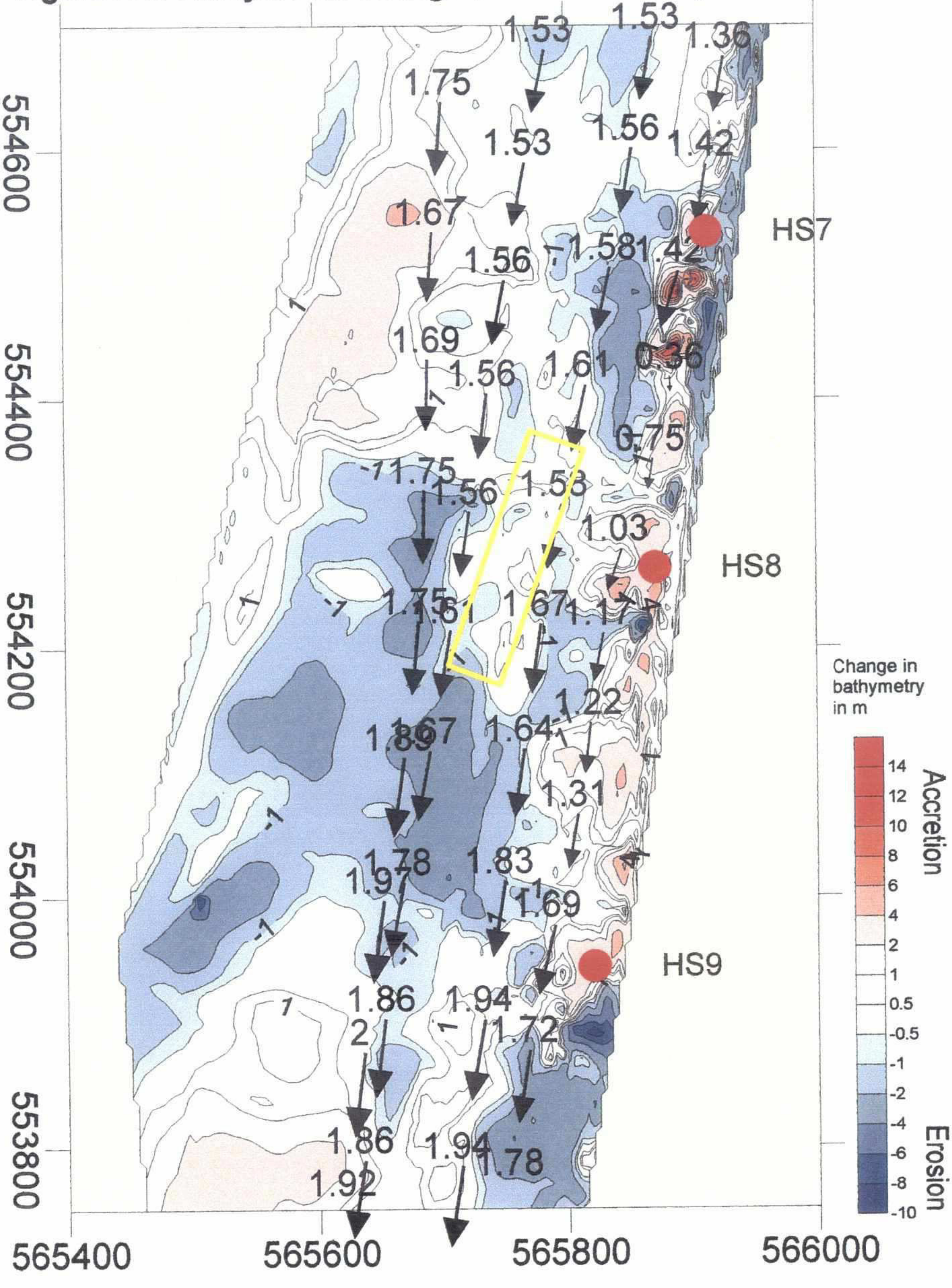


Figure A23 Float track results intensive monitoring Hanar Char

Figure A24 Bathymetric change and flow velocity from float tracking



Change between 13 and 3 September 2000
Flow velocity on 3 September 12.15 hours in m/s

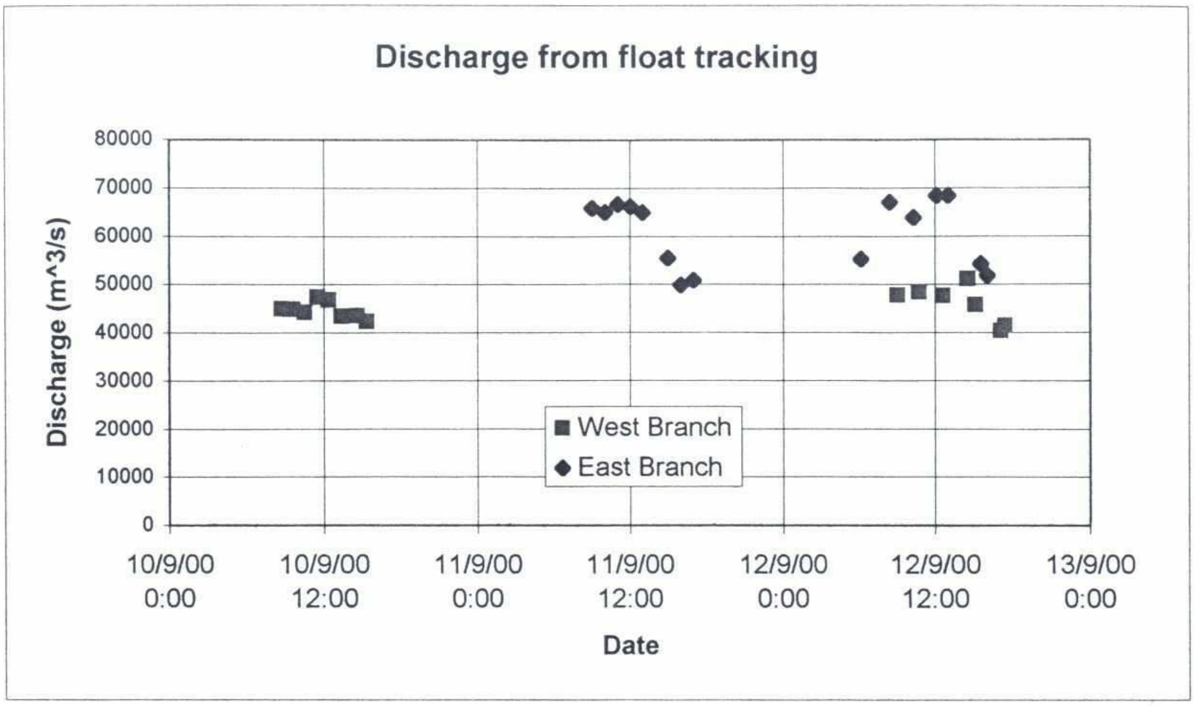


Figure A25

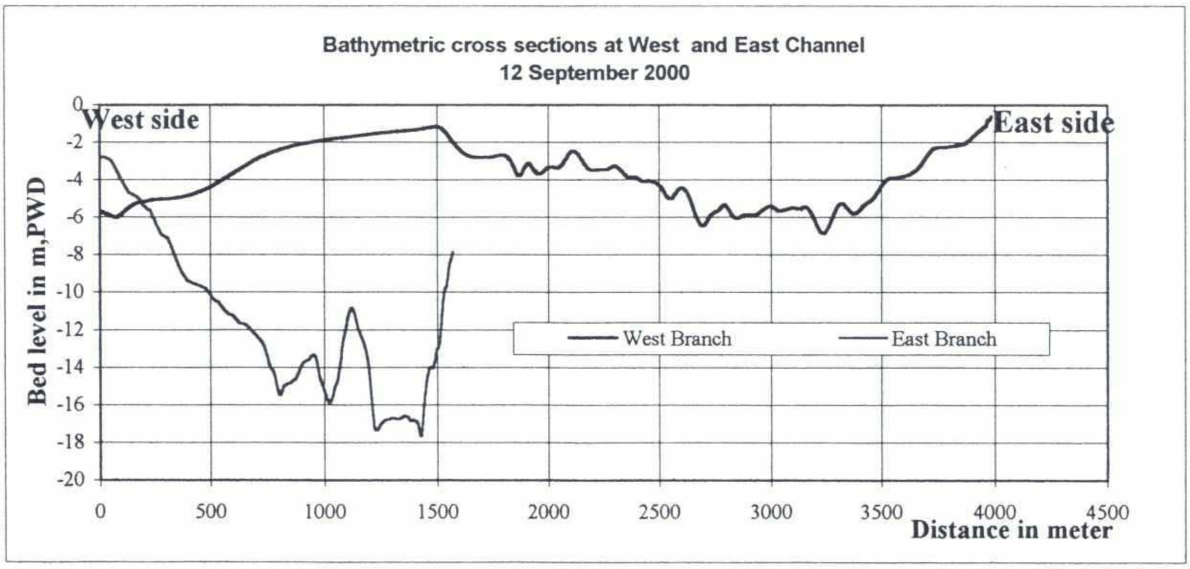


Figure A26

Figure A27 ADCP current velocities Hanar Char South II

2 September 2000

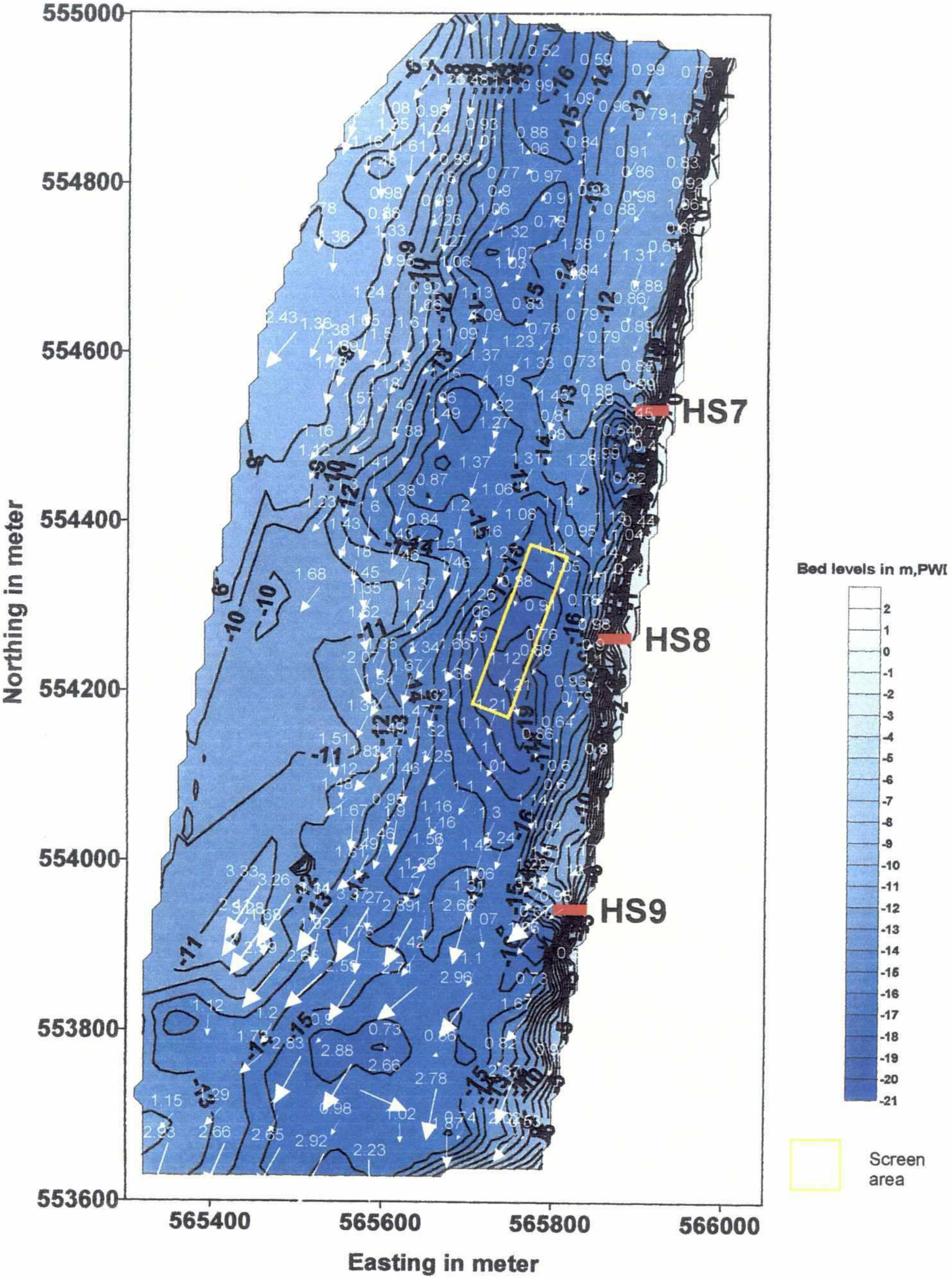
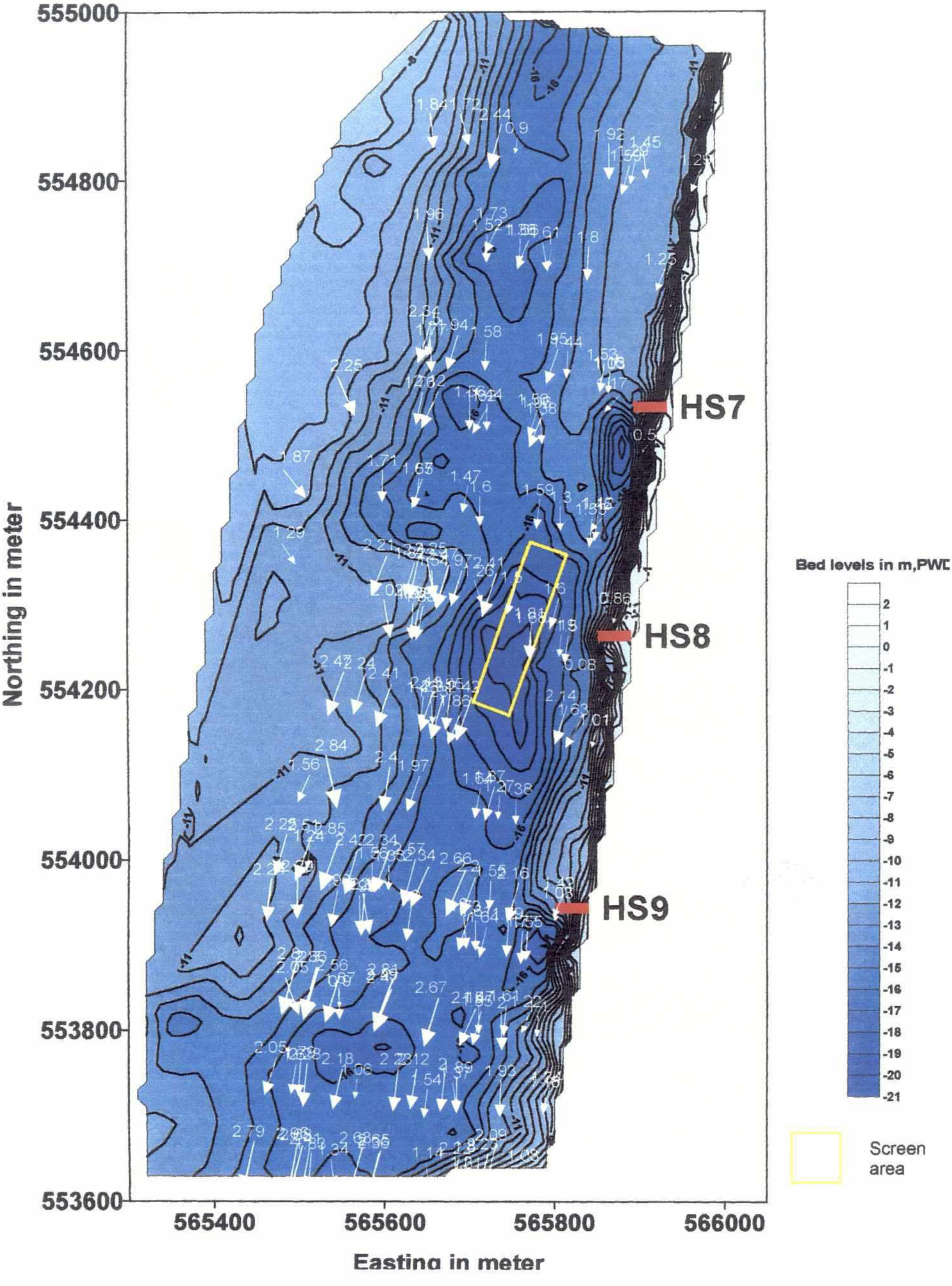


Figure A28 ADCP current velocities Hanar Char South II

3 September 2000



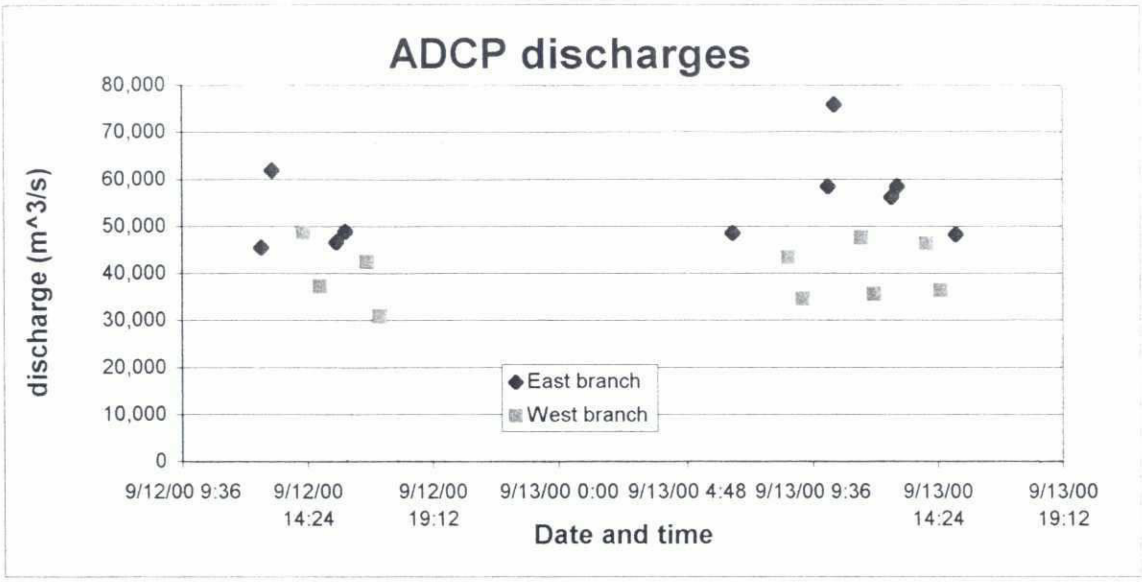
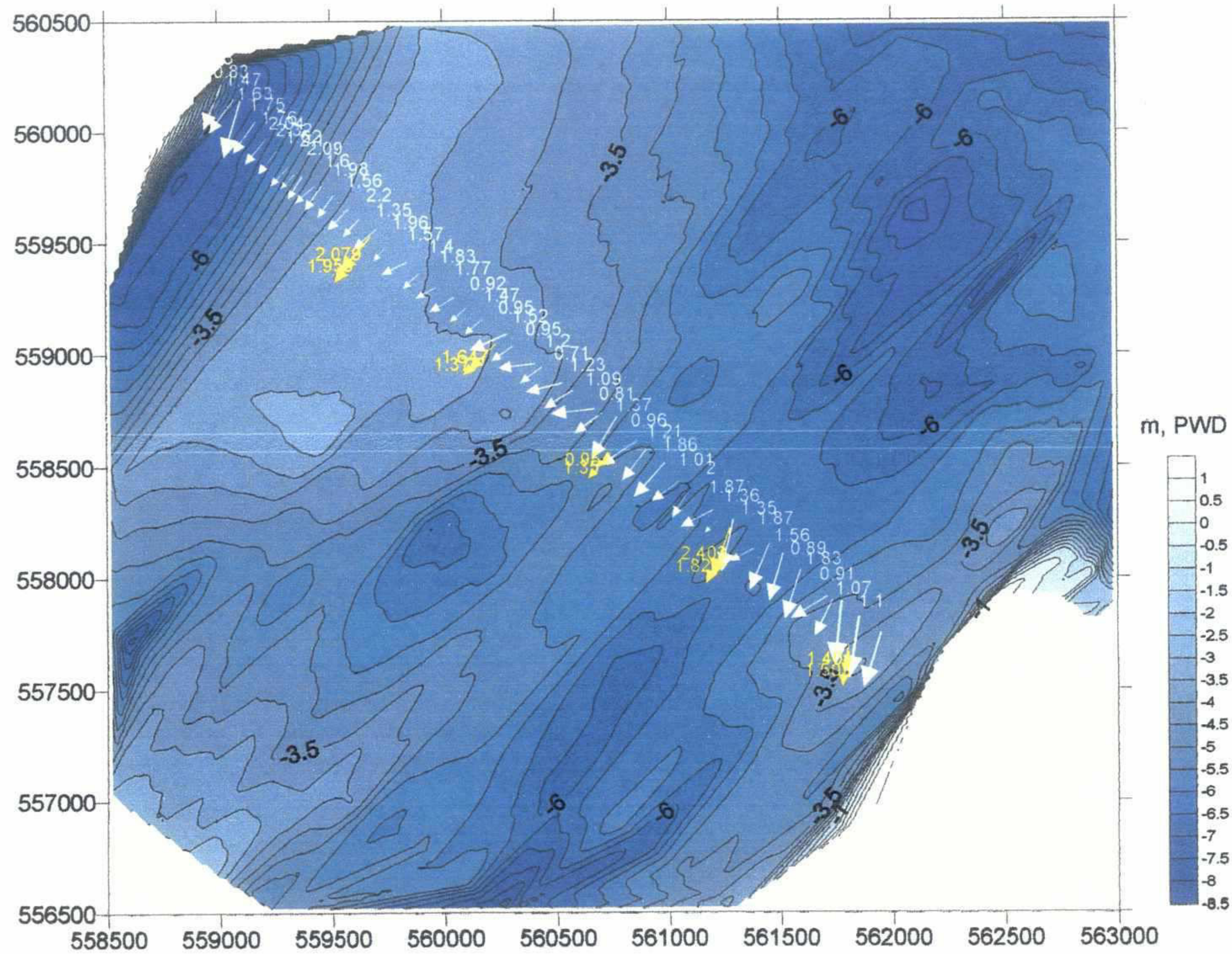


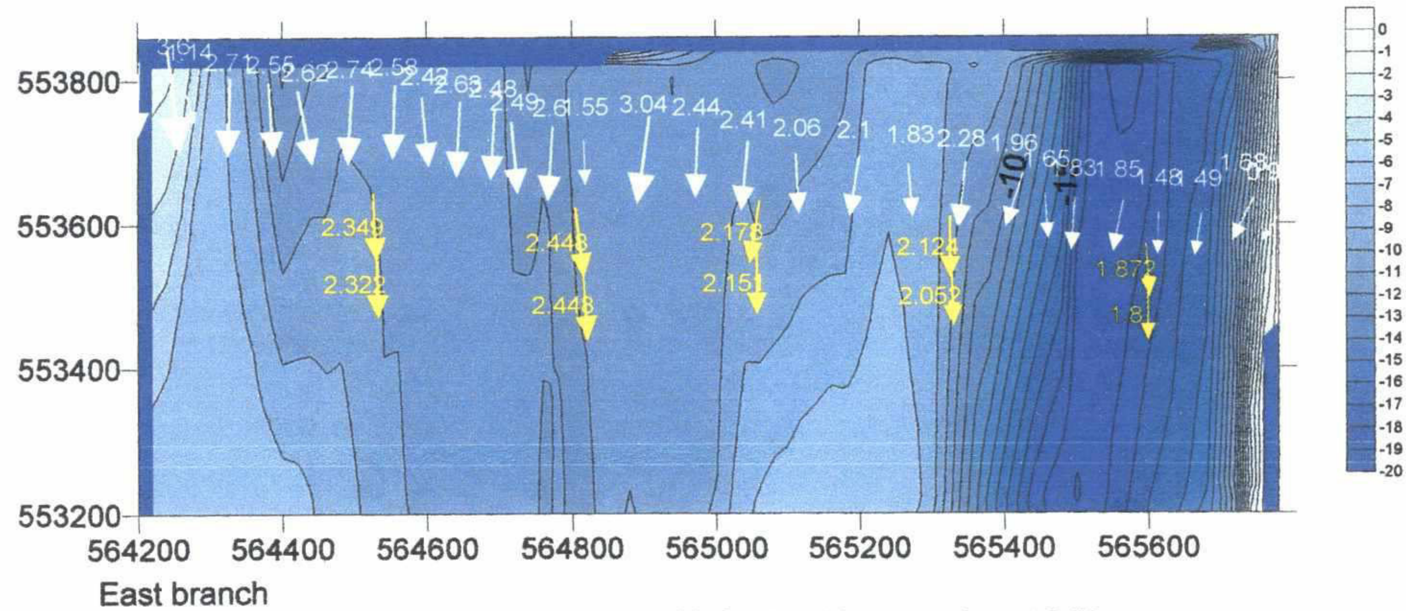
Figure A29 ADCP discharges along Char Bhairabi

Figure 30
Comparison between float tracking and ADCP current velocity measurements

12 September 2000



West Branch
Float tracking in yellow start time 14:59. ADCP in white start time 14:52



East branch
Float tracking in yellow start time 15:59. ADCP in white start time 15:50

Flow velocity measured at 12-09-2000, in m/s

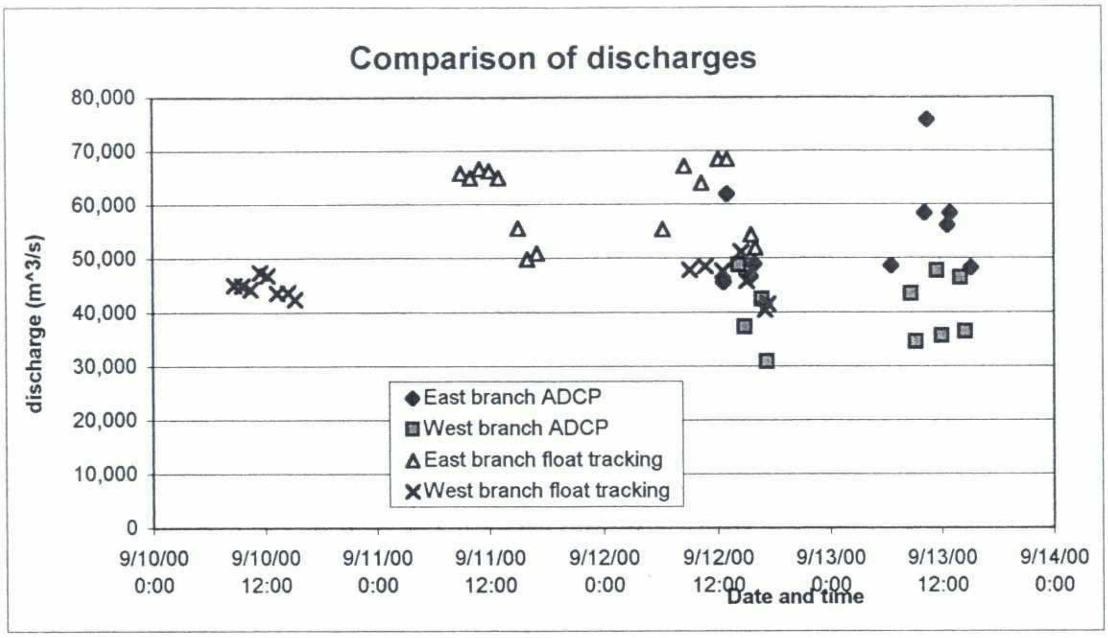


Figure A31 Comparison of ADCP and float track discharges

Appenix A

- Table 1 Determination of float track factors
- Survey dates and times for float tracking 2000
- Survey dates and times for ADCP monsoon 2000

Table 1. Calculation of correction factor for depth averaged flow velocty

H98o4t24				depth av			top bin	Uav/Utop
x	y	westspeed	northspeed	speed	westspeed	northspeed	speed	
566298.7	558890.6	0.21	-0.65	0.683081	0.242	-0.672	0.714246	0.956366
566308.9	558892.6	1	-0.86	1.318939	1.041	-0.957	1.414047	0.93274
566326.5	558896	0.43	-0.44	0.615224	0.5	-0.591	0.774132	0.794726
566348.9	558896.7	0.65	-0.73	0.977446	0.694	-0.949	1.175686	0.831383
566372	558898	0.24	-0.68	0.72111	0.238	-0.961	0.990033	0.72837
566393.5	558896.4	0.07	-1.07	1.072287	0.167	-1.198	1.209584	0.886493
566412	558897.2	-0.21	-0.88	0.90471	-0.261	-1.044	1.076131	0.840706
566429.3	558898.5	-0.12	-0.71	0.720069	-0.041	-1.067	1.067787	0.674357
566447.7	558902.9	0.02	-0.85	0.850235	0.029	-1.052	1.0524	0.807902
566466.2	558904.2	0.01	-0.91	0.910055	0.108	-1.068	1.073447	0.847788
566486.6	558905.6	-0.14	-0.95	0.96026	-0.177	-1.064	1.078622	0.890266
566508	558902.6	0.56	-1.06	1.198833	0.545	-0.991	1.130976	1.059999

H98o4t01				Uav			Atop	Uav/Utop
566174.2	559934.2	0.25	-0.48	0.541202	0.277	-0.57	0.633742	0.853979
566173.4	559935.3	0.31	-0.31	0.438406	0.365	-0.351	0.506385	0.865756
566178.2	559949.3	0.26	0.04	0.263059	0.227	-0.043	0.231037	1.138602
566196.1	559956.7	0.6	-0.69	0.914385	0.843	-0.519	0.989955	0.923664
566220.6	559948.5	0.8	-0.96	1.24964	0.924	-1.065	1.409965	0.886292
566244.1	559952.8	0.29	0.29	0.410122	0.273	0.218	0.349361	1.173921
566265.7	559959.3	0.12	-0.27	0.295466	0.099	-0.304	0.319714	0.924157
566285.1	559954.4	0	-0.55	0.55	0.039	-0.556	0.557366	0.986784
566300.2	559956.5	-0.15	0.21	0.25807	-0.194	0.271	0.333282	0.774328
566311	559958.7	-0.37	-0.07	0.376563	-0.367	-0.087	0.377171	0.998389

H98n4t15				Uav			Atop	Uav/Utop
566265.1	556045	0.18	-0.73	0.751864	0.406	-1.044	1.120166	0.671208
566277.4	556052.1	0.16	-0.58	0.601664	0.233	-0.864	0.894866	0.672351
566297.6	556052.2	0.16	-1.44	1.448862	0.423	-1.629	1.683024	0.860868
566318.7	556046.4	-0.05	-1.49	1.490839	0.143	-1.711	1.716965	0.868299
566342.4	556039.8	-0.31	-1.34	1.375391	-0.163	-1.57	1.578439	0.871362
566365.1	556035.3	-0.38	-1.22	1.277811	-0.298	-1.475	1.504802	0.849155
566387.2	556031.1	-0.4	-1.29	1.350592	-0.291	-1.411	1.440695	0.937459
566408.3	556029.1	-0.45	-1.12	1.207021	-0.438	-1.211	1.287775	0.937292
566428.6	556026.2	-0.37	-1.43	1.477092	-0.345	-1.428	1.469084	1.005451
566446.7	556024.8	-0.41	-1.09	1.16456	-0.455	-1.182	1.26655	0.919474
566466.1	556024.4	-0.45	-1.24	1.319129	-0.381	-1.118	1.181137	1.116829
566486.1	556019.1	-0.44	-1.33	1.400893	-0.447	-1.331	1.404055	0.997748

H98n4t30				Uav			Atop	Uav/Utop
565857.1	555366.8	0.17	-0.99	1.00449	0.349	-1.219	1.267976	0.7922
565875.2	555367	0.31	-0.77	0.83006	0.304	-1.012	1.056674	0.78554
565894.2	555371.5	0.07	-1.14	1.142147	0.021	-1.2	1.200184	0.951644
565914.3	555368.7	-0.11	-1.5	1.504028	-0.269	-1.564	1.586965	0.947739
565935.8	555363.8	-0.1	-1.31	1.313811	-0.177	-1.383	1.39428	0.942286
565955.2	555361	-0.13	-1.17	1.1772	-0.199	-1.292	1.307236	0.900526
565977.3	555357.7	-0.16	-1.28	1.289961	-0.201	-1.389	1.403468	0.919124
565999	555353.5	-0.24	-1.18	1.204159	-0.303	-1.162	1.200855	1.002752
566019.3	555350.2	-0.3	-1.14	1.178813	-0.416	-1.245	1.312662	0.898033
566039.9	555346.5	-0.24	-1.07	1.096586	-0.29	-1.128	1.164682	0.941532
566060.8	555339.9	-0.37	-1.34	1.390144	-0.435	-1.332	1.401231	0.992087
566079.9	555334.3	-0.44	-0.9	1.001798	-0.422	-0.89	0.984979	1.017076

average of 48 factors: **0.9038**

Survey dates for float tracking 2000

Date	Location	Start time	End Time
20-Jul-00	East Branch	11:37	12:05
20-Jul-00	East Branch	12:42	13:05
25-Jul-00	East Branch	9:08	9:33
25-Jul-00	East Branch	11:18	11:43
25-Jul-00	East Branch	0:00	13:24
01-Aug-00	East Branch	16:05	17:06
02-Aug-00	East Branch	8:12	8:29
02-Aug-00	East Branch	9:57	10:18
02-Aug-00	East Branch	15:02	15:19
11-Aug-00	East Branch	8:37	8:56
11-Aug-00	East Branch	10:16	10:41
11-Aug-00	East Branch	16:09	16:19
16-Aug-00	East Branch	7:24	7:41
16-Aug-00	East Branch	11:03	11:29
16-Aug-00	East Branch	13:08	13:29
23-Aug-00	East Branch	8:55	9:15
23-Aug-00	East Branch	11:11	11:32
23-Aug-00	East Branch	15:06	15:25
31-Aug-00	East Branch	7:23	7:42
31-Aug-00	East Branch	9:12	9:31
11-Sep-00	East Branch	8:55	9:07
11-Sep-00	East Branch	9:05	10:01
11-Sep-00	East Branch	10:54	11:07
11-Sep-00	East Branch	12:02	12:14
11-Sep-00	East Branch	13:01	13:14
11-Sep-00	East Branch	14:58	15:12
11-Sep-00	East Branch	16:02	16:15
11-Sep-00	East Branch	17:02	17:13
11-Sep-00	East Branch	18:01	18:02
11-Sep-00	East Branch	20:03	20:41
12-Sep-00	East Branch	10:16	10:27
12-Sep-00	East Branch	12:07	12:19
12-Sep-00	East Branch	14:01	14:13
12-Sep-00	East Branch	15:32	15:46
12-Sep-00	East Branch	15:53	16:08
13-Sep-00	East Branch	6:38	6:52
13-Sep-00	East Branch	10:12	10:27
13-Sep-00	East Branch	12:45	12:55
13-Sep-00	East Branch	15:01	15:02
19-Sep-00	East Branch	8:55	9:06
19-Sep-00	East Branch	10:57	11:08
19-Sep-00	East Branch	12:51	13:01
19-Sep-00	East Branch	15:02	15:13
29-Sep-00	East Branch	7:12	7:21
29-Sep-00	East Branch	9:12	9:24
29-Sep-00	East Branch	11:03	11:14
06-Oct-00	East Branch	7:08	7:02
06-Oct-00	East Branch	9:01	9:02
06-Oct-00	East Branch	11:03	11:15
11-Oct-00	East Branch	15:19	15:29
11-Oct-00	East Branch	17:01	17:15
26-Jul-00	West Branch	7:04	7:42
26-Jul-00	West Branch	9:07	9:43
26-Jul-00	West Branch	10:47	11:27
08-Aug-00	West Branch	7:23	7:45
08-Aug-00	West Branch	9:12	9:05
08-Aug-00	West Branch	11:01	11:24
14-Aug-00	West Branch	8:26	8:51
14-Aug-00	West Branch	10:02	10:28
14-Aug-00	West Branch	16:29	16:51
22-Aug-00	West Branch	10:09	10:32
22-Aug-00	West Branch	13:04	13:27
22-Aug-00	West Branch	13:58	11:41
30-Aug-00	West Branch	8:01	8:26
30-Aug-00	West Branch	10:05	10:28
30-Aug-00	West Branch	0:00	12:23
10-Sep-00	West Branch	8:34	8:49
10-Sep-00	West Branch	9:25	9:42
10-Sep-00	West Branch	10:21	10:37
10-Sep-00	West Branch	11:02	11:38
10-Sep-00	West Branch	12:02	12:38
10-Sep-00	West Branch	13:15	13:31
10-Sep-00	West Branch	14:23	14:04
10-Sep-00	West Branch	15:01	15:27
12-Sep-00	West Branch	8:58	9:12
12-Sep-00	West Branch	10:43	10:57
12-Sep-00	West Branch	12:36	12:51
12-Sep-00	West Branch	14:31	14:45
12-Sep-00	West Branch	14:59	15:18
12-Sep-00	West Branch	16:48	17:01
12-Sep-00	West Branch	17:18	17:39
13-Sep-00	West Branch	8:42	9:06
13-Sep-00	West Branch	9:15	9:37
13-Sep-00	West Branch	11:03	11:52
13-Sep-00	West Branch	12:05	12:27
13-Sep-00	West Branch	16:24	16:44
22-Sep-00	West Branch	7:25	7:04
22-Sep-00	West Branch	9:01	9:24
22-Sep-00	West Branch	11:03	11:26
22-Sep-00	West Branch	15:19	15:34
22-Sep-00	West Branch	17:02	17:22
28-Sep-00	West Branch	9:21	9:35
28-Sep-00	West Branch	11:12	11:29
28-Sep-00	West Branch	17:09	17:24
28-Sep-00	West Branch	0:00	13:17
05-Oct-00	West Branch	15:23	15:37
05-Oct-00	West Branch	17:08	17:22
14-Oct-00	West Branch	9:17	9:32
14-Oct-00	West Branch	11:13	11:29

Date	Location	Start time	End Time
19-Jul-00	Hanar Char South II	11:49	12:12
21-Jul-00	Hanar Char South II	7:27	8:16
21-Jul-00	Hanar Char South II	9:06	9:44
27-Jul-00	Hanar Char South II	6:32	6:58
27-Jul-00	Hanar Char South II	9:11	9:52
27-Jul-00	Hanar Char South II	11:01	11:54
01-Aug-00	Hanar Char South II	8:14	8:52
01-Aug-00	Hanar Char South II	10:09	10:36
01-Aug-00	Hanar Char South II	12:02	12:43
12-Aug-00	Hanar Char South II	7:11	7:24
12-Aug-00	Hanar Char South II	9:09	9:26
12-Aug-00	Hanar Char South II	11:12	11:29
17-Aug-00	Hanar Char South II	7:29	7:46
17-Aug-00	Hanar Char South II	9:17	9:32
17-Aug-00	Hanar Char South II	11:12	11:29
24-Aug-00	Hanar Char South II	7:14	7:24
24-Aug-00	Hanar Char South II	9:06	9:02
24-Aug-00	Hanar Char South II	11:15	11:35
28-Aug-00	Hanar Char South II	15:18	14:41
28-Aug-00	Hanar Char South II	15:52	16:37
02-Sep-00	Hanar Char South II	11:32	11:51
02-Sep-00	Hanar Char South II	12:56	12:43
02-Sep-00	Hanar Char South II	13:23	13:38
02-Sep-00	Hanar Char South II	15:13	15:03
02-Sep-00	Hanar Char South II	16:17	16:32
02-Sep-00	Hanar Char South II	17:18	17:35
02-Sep-00	Hanar Char South II	18:06	18:25
03-Sep-00	Hanar Char South II	6:12	6:03
03-Sep-00	Hanar Char South II	7:04	7:34
03-Sep-00	Hanar Char South II	8:01	8:35
03-Sep-00	Hanar Char South II	9:06	9:03
03-Sep-00	Hanar Char South II	10:02	10:25
03-Sep-00	Hanar Char South II	11:01	11:31
03-Sep-00	Hanar Char South II	12:02	12:23
03-Sep-00	Hanar Char South II	13:03	13:17
03-Sep-00	Hanar Char South II	14:02	14:18
03-Sep-00	Hanar Char South II	15:16	15:03
03-Sep-00	Hanar Char South II	16:03	16:17
03-Sep-00	Hanar Char South II	16:57	17:12
03-Sep-00	Hanar Char South II	17:02	17:24
03-Sep-00	Hanar Char South II	17:27	17:31
21-Sep-00	Hanar Char South II	9:04	9:14
21-Sep-00	Hanar Char South II	11:02	11:14
21-Sep-00	Hanar Char South II	15:02	15:13
21-Sep-00	Hanar Char South II	0:00	17:01
26-Sep-00	Hanar Char South II	9:11	9:22
26-Sep-00	Hanar Char South II	11:02	11:11
26-Sep-00	Hanar Char South II	13:05	13:15
26-Sep-00	Hanar Char South II	17:07	17:02
03-Oct-00	Hanar Char South II	13:54	14:09
03-Oct-00	Hanar Char South II	15:37	15:05
03-Oct-00	Hanar Char South II	16:33	16:45
04-Oct-00	Hanar Char South II	9:32	9:05
04-Oct-00	Hanar Char South II	13:46	13:56
04-Oct-00	Hanar Char South II	15:33	15:44
04-Oct-00	Hanar Char South II	16:33	16:45
12-Oct-00	Hanar Char South II	9:07	9:25
12-Oct-00	Hanar Char South II	11:07	11:45
12-Oct-00	Hanar Char South II	13:05	13:23
13-Oct-00	Hanar Char South II	9:02	9:34
13-Oct-00	Hanar Char South II	11:13	11:34

Date	Location	Start time	End Time
29-Aug-00	Haim Char	8:43	9:01
29-Aug-00	Haim Char	10:18	10:41
29-Aug-00	Haim Char	14:33	15:01
20-Sep-00	Haim Char	7:34	7:05
20-Sep-00	Haim Char	9:06	9:25
20-Sep-00	Haim Char	11:04	11:24
20-Sep-00	Haim Char	13:08	13:24
20-Sep-00	Haim Char	15:02	15:03
20-Sep-00	Haim Char	17:04	17:17
27-Sep-00	Haim Char	7:24	7:36
27-Sep-00	Haim Char	9:06	9:15
27-Sep-00	Haim Char	11:14	11:22
27-Sep-00	Haim Char	13:05	13:14
27-Sep-00	Haim Char	17:01	17:26

Date	Location	Start time	End Time
22-Nov-00	Nijhum Dwip	7:15	7:37
22-Nov-00	Nijhum Dwip	8:06	8:21
22-Nov-00	Nijhum Dwip	9:17	9:27
22-Nov-00	Nijhum Dwip	10:11	10:11
22-Nov-00	Nijhum Dwip	11:05	11:17
22-Nov-00	Nijhum Dwip	12:04	12:17
22-Nov-00	Nijhum Dwip	13:06	13:18
22-Nov-00	Nijhum Dwip	15:17	15:31
22-Nov-00	Nijhum Dwip	16:07	16:02
22-Nov-00	Nijhum Dwip	16:55	17:14
23-Nov-00	Nijhum Dwip	7:16	7:27
23-Nov-00	Nijhum Dwip	8:04	8:21
23-Nov-00	Nijhum Dwip	9:01	9:13
23-Nov-00	Nijhum Dwip	10:05	10:16
23-Nov-00	Nijhum Dwip	11:03	11:13
23-Nov-00	Nijhum Dwip	12:04	12:15
23-Nov-00	Nijhum Dwip	13:06	13:16
23-Nov-00	Nijhum Dwip	15:07	15:19
23-Nov-00	Nijhum Dwip	16:05	16:15
23-Nov-00	Nijhum Dwip	16:59	17:11
24-Nov-00	Nijhum Dwip	7:42	7:51
24-Nov-00	Nijhum Dwip	8:18	8:28
24-Nov-00	Nijhum Dwip	9:13	9:25
24-Nov-00	Nijhum Dwip	10:11	10:02
24-Nov-00	Nijhum Dwip	11:24	11:35
24-Nov-00	Nijhum Dwip	12:01	12:21
24-Nov-00	Nijhum Dwip	15:21	15:31
24-Nov-00	Nijhum Dwip	16:01	16:21
24-Nov-00	Nijhum Dwip	17:01	17:17
25-Nov-00	Nijhum Dwip	7:12	7:29
25-Nov-00	Nijhum Dwip	8:17	8:28
25-Nov-00	Nijhum Dwip	9:05	9:18
25-Nov-00	Nijhum Dwip	9:57	10:08
25-Nov-00	Nijhum Dwip	12:03	12:15
25-Nov-00	Nijhum Dwip	13:01	13:12
25-Nov-00	Nijhum Dwip	14:05	14:15
25-Nov-00	Nijhum Dwip	16:15	16:26
25-Nov-00	Nijhum Dwip	17:02	17:11
26-Nov-00	Nijhum Dwip	2:05	2:15
26-Nov-00	Nijhum Dwip	7:49	7:56
26-Nov-00	Nijhum Dwip	8:29	8:36
26-Nov-00	Nijhum Dwip	9:16	9:25
26-Nov-00	Nijhum Dwip	10:08	10:02
26-Nov-00	Nijhum Dwip	11:11	11:22
26-Nov-00	Nijhum Dwip	12:06	12:16
26-Nov-00	Nijhum Dwip	13:01	13:02
27-Nov-00	Nijhum Dwip	12:15	12:25
27-Nov-00	Nijhum Dwip	13:01	13:02
27-Nov-00	Nijhum Dwip	14:05	14:14
27-Nov-00	Nijhum Dwip	15:16	15:25
27-Nov-00	Nijhum Dwip	16:07	16:17
27-Nov-00	Nijhum Dwip	17:02	17:11
28-Nov-00	Nijhum Dwip	12:25	12:33
28-Nov-00	Nijhum Dwip	13:13	13:21
28-Nov-00	Nijhum Dwip	14:02	14:28
28-Nov-00	Nijhum Dwip	15:08	15:15
29-Nov-00	Nijhum Dwip	8:57	9:04
29-Nov-00	Nijhum Dwip	10:07	10:13
29-Nov-00	Nijhum Dwip	11:01	11:21
29-Nov-00	Nijhum Dwip	12:04	12:16
29-Nov-00	Nijhum Dwip	15:11	15:21

Date	Location	Start time	End Time
29-Nov-00	Nijhum Dwip	16:11	16:02
29-Nov-00	Nijhum Dwip	1/0/1900 2	14:07
30-Nov-00	Nijhum Dwip	8:22	8:28
30-Nov-00	Nijhum Dwip	9:08	9:25
30-Nov-00	Nijhum Dwip	10:12	10:27
30-Nov-00	Nijhum Dwip	11:09	11:18
30-Nov-00	Nijhum Dwip	12:14	12:25
30-Nov-00	Nijhum Dwip	14:06	14:15
30-Nov-00	Nijhum Dwip	14:07	14:16
30-Nov-00	Nijhum Dwip	15:12	15:21
01-Dec-00	Nijhum Dwip	8:37	8:42
01-Dec-00	Nijhum Dwip	9:08	9:15
01-Dec-00	Nijhum Dwip	10:06	10:14
01-Dec-00	Nijhum Dwip	11:06	11:15
01-Dec-00	Nijhum Dwip	12:11	12:02
01-Dec-00	Nijhum Dwip	14:07	14:17
01-Dec-00	Nijhum Dwip	15:14	15:23
01-Dec-00	Nijhum Dwip	16:09	16:19
02-Dec-00	Nijhum Dwip	8:26	8:34
02-Dec-00	Nijhum Dwip	9:09	9:18
02-Dec-00	Nijhum Dwip	10:07	10:22
02-Dec-00	Nijhum Dwip	11:01	11:26
02-Dec-00	Nijhum Dwip	12:56	13:19
02-Dec-00	Nijhum Dwip	14:08	14:19
02-Dec-00	Nijhum Dwip	15:09	15:19
02-Dec-00	Nijhum Dwip	16:11	16:21
03-Dec-00	Nijhum Dwip	8:52	9:00
03-Dec-00	Nijhum Dwip	9:13	9:23
03-Dec-00	Nijhum Dwip	10:08	10:18
03-Dec-00	Nijhum Dwip	11:19	11:38
03-Dec-00	Nijhum Dwip	12:06	12:02
03-Dec-00	Nijhum Dwip	13:01	13:23
03-Dec-00	Nijhum Dwip	14:13	14:22
03-Dec-00	Nijhum Dwip	15:01	15:02
03-Dec-00	Nijhum Dwip	16:05	16:15
04-Dec-00	Nijhum Dwip	8:45	8:55
04-Dec-00	Nijhum Dwip	9:14	9:23
04-Dec-00	Nijhum Dwip	10:03	10:11
04-Dec-00	Nijhum Dwip	11:14	11:23
04-Dec-00	Nijhum Dwip	12:08	12:17
04-Dec-00	Nijhum Dwip	14:09	14:22
04-Dec-00	Nijhum Dwip	15:11	15:21
04-Dec-00	Nijhum Dwip	16:06	16:16
05-Dec-00	Nijhum Dwip	8:55	9:03
05-Dec-00	Nijhum Dwip	9:22	9:31
05-Dec-00	Nijhum Dwip	10:12	10:02
05-Dec-00	Nijhum Dwip	11:09	11:18
05-Dec-00	Nijhum Dwip	12:11	12:02
05-Dec-00	Nijhum Dwip	13:08	13:18
05-Dec-00	Nijhum Dwip	14:05	14:12
05-Dec-00	Nijhum Dwip	15:18	15:28
05-Dec-00	Nijhum Dwip	16:07	16:15

ADCP transects HANAR CHAR PILOT SCHEME
Date of survey : 03 September 2000

File Name	Start Time	End Time	Start Easting (m)	Start Northing (m)	End Easting (m)	End Northing (m)	Width (m)	Area (m^2)	Discharge (m^3/sec)
HA933T01	6:09:16	6:11:47	565611.7	554868.1	565969.9	554801.8	382	5143	7668
HA933T02	6:14:28	6:16:43	565626.7	554753.6	565946.3	554677.9	353	5093	7469
HA933T04	6:24:26	6:26:26	565611.2	554617.8	565920.2	554557.5	641	4982	6543
HA933T05	6:29:04	6:31:14	565600.8	554544.1	565906.9	554484.3	347	5657	7075
HA933T06	6:33:43	6:35:56	565580.8	554458.2	565903.0	554381.4	381	6120	8531
HA933T07	6:38:48	6:41:05	565548.9	554361.9	565881.8	554286.5	384	6246	8503
HA933T08	6:44:03	6:46:05	565551.7	554297.4	565851.2	554240.4	346	5847	7970
HA933T09	6:48:37	6:50:52	565535.3	554208.5	565855.1	554138.8	359	6166	8110
HA933T10	6:53:23	6:55:43	565513.0	554109.9	565848.6	554037.3	391	6104	9090
HA933T11	6:58:18	7:00:34	565496.7	554005.5	565812.6	553935.5	364	5977	8517
HA933T12	7:03:04	7:05:43	565491.3	553962.1	565831.4	553890.0	398	6531	9227
HA933T13	7:08:11	7:10:31	565470.2	553854.4	565806.5	553803.4	383	6201	8678
HA933T14	7:13:43	7:16:10	565453.8	553740.0	565811.5	553712.9	399	6690	8030
HA933T15	7:18:48	7:21:05	565429.6	553661.3	565797.3	553624.7	388	6353	7720
HA933T16	8:02:48	8:05:04	565450.6	553638.2	565795.6	553630.0	390	6451	7456
HA933T17	8:09:43	8:11:57	565449.9	553739.1	565814.4	553712.8	390	6561	7311
HA933T18	8:15:00	8:17:12	565448.4	553866.1	565805.9	553805.3	426	6996	9025
HA933T19	8:21:00	8:23:11	565489.6	553958.3	565829.5	553889.3	397	6699	8608
HA933T20	8:25:43	8:27:48	565502.0	554007.9	565811.0	553937.6	374	6215	8086
HA933T21	8:30:34	8:32:46	565520.2	554121.7	565846.8	554034.6	401	6401	8472
HA933T22	8:35:26	8:37:28	565538.7	554203.7	565852.8	554142.7	366	6423	8101
HA933T28	8:48:24	8:51:08	565448.1	554365.4	565889.4	554286.8	474	7523	9586
HA933T29	8:54:19	8:57:06	565489.8	554456.0	565906.2	554378.3	479	7475	9348
HA933T30	9:00:31	9:02:56	565533.1	554547.1	565903.9	554489.1	422	6647	8614
HA933T31	9:06:08	9:08:41	565553.3	554625.0	565929.4	554553.6	417	6095	6732
HA933T32	9:11:24	9:13:25	565640.2	554743.1	565939.2	554683.2	344	5318	6334
HA933T33	9:16:08	9:18:07	565668.4	554862.8	565968.6	554798.2	347	5197	6156
HA933T34	10:02:57	10:05:00	565671.8	554856.8	565973.7	554802.2	358	5270	6635
HA933T36	10:08:15	10:10:14	565639.5	554725.4	565934.6	554678.0	349	5327	6491
HA933T37	10:11:46	10:14:01	565914.9	554559.8	565615.6	554614.3	344	5393	7255
HA933T38	10:15:22	10:17:45	565508.3	554574.7	565902.4	554491.3	426	6730	8078
HA933T39	10:19:20	10:21:21	565902.7	554393.2	565582.5	554444.8	348	5584	7491
HA933T40	10:22:52	10:25:17	565563.1	554338.0	565857.4	554295.2	392	6457	7587
HA933T42	10:29:49	10:32:09	565496.5	554208.0	565847.2	554142.8	381	6491	8506
HA933T43	10:33:30	10:35:58	565841.4	554049.8	565511.5	554105.4	370	5778	9143
HA933T44	10:36:56	10:39:22	565459.7	554024.6	565806.8	553941.9	393	6372	9077
HA933T45	10:40:21	10:43:04	565826.4	553889.5	565482.8	553963.1	382	6280	10244
HA933T46	10:43:59	10:46:44	565422.4	553864.9	565806.9	553803.0	417	6643	10141
HA933T47	10:47:58	10:50:30	565799.8	553734.8	565436.1	553739.1	406	6692	10525
HA933T48	10:51:22	10:54:48	565383.3	553655.4	565788.4	553632.8	454	7308	11176
HA933T49	12:05:50	12:09:25	565791.2	553638.2	565441.7	553628.2	459	6076	11595
HA933T50	12:15:18	12:18:27	565354.4	553748.0	565807.9	553720.9	472	7692	12067
HA933T51	12:19:35	12:22:10	565804.8	553797.5	565474.8	553846.0	365	5686	10313
HA933T52	12:25:16	12:27:56	565420.4	553962.2	565810.1	553903.6	413	6666	11606
HA933T53	12:28:51	12:31:18	565814.6	553961.3	565492.3	554005.1	350	5562	11193
HA933T55	12:36:48	12:39:06	565838.2	554142.0	565537.1	554200.0	329	5698	9822
HA933T56	12:40:53	12:43:00	565526.1	554303.4	565846.0	554242.0	346	5841	8861
HA933T57	12:43:45	12:45:59	565868.6	554290.1	565561.0	554346.2	345	5634	8739
HA933T59	12:50:36	12:52:42	565896.5	554489.1	565588.1	554539.9	334	5581	9475
HA933T60	12:54:03	12:56:14	565588.1	554617.8	565908.8	554563.4	352	5098	7809

ADCP transects HANAR CHAR PILOT SCHEME
Date of survey : 03 September 2000

File Name	Start Time	End Time	Start Easting (m)	Start Northing (m)	End Easting (m)	End Northing (m)	Width (m)	Area (m^2)	Discharge (m^3/sec)
HA933T01	6:09:16	6:11:47	565611.7	554868.1	565969.9	554801.8	382	5143	7668
HA933T02	6:14:28	6:16:43	565626.7	554753.6	565946.3	554677.9	353	5093	7469
HA933T04	6:24:26	6:26:26	565611.2	554617.8	565920.2	554557.5	641	4982	6543
HA933T05	6:29:04	6:31:14	565600.8	554544.1	565906.9	554484.3	347	5657	7075
HA933T06	6:33:43	6:35:56	565580.8	554458.2	565903.0	554381.4	381	6120	8531
HA933T07	6:38:48	6:41:05	565548.9	554361.9	565881.8	554286.5	384	6246	8503
HA933T08	6:44:03	6:46:05	565551.7	554297.4	565851.2	554240.4	346	5847	7970
HA933T09	6:48:37	6:50:52	565535.3	554208.5	565855.1	554138.8	359	6166	8110
HA933T10	6:53:23	6:55:43	565513.0	554109.9	565848.6	554037.3	391	6104	9090
HA933T11	6:58:18	7:00:34	565496.7	554005.5	565812.6	553935.5	364	5977	8517
HA933T12	7:03:04	7:05:43	565491.3	553962.1	565831.4	553890.0	398	6531	9227
HA933T13	7:08:11	7:10:31	565470.2	553854.4	565806.5	553803.4	383	6201	8678
HA933T14	7:13:43	7:16:10	565453.8	553740.0	565811.5	553712.9	399	6690	8030
HA933T15	7:18:48	7:21:05	565429.6	553661.3	565797.3	553624.7	388	6353	7720
HA933T16	8:02:48	8:05:04	565450.6	553638.2	565795.6	553630.0	390	6451	7456
HA933T17	8:09:43	8:11:57	565449.9	553739.1	565814.4	553712.8	390	6561	7311
HA933T18	8:15:00	8:17:12	565448.4	553866.1	565805.9	553805.3	426	6996	9025
HA933T19	8:21:00	8:23:11	565489.6	553958.3	565829.5	553889.3	397	6699	8608
HA933T20	8:25:43	8:27:48	565502.0	554007.9	565811.0	553937.6	374	6215	8086
HA933T21	8:30:34	8:32:46	565520.2	554121.7	565846.8	554034.6	401	6401	8472
HA933T22	8:35:26	8:37:28	565538.7	554203.7	565852.8	554142.7	366	6423	8101
HA933T28	8:48:24	8:51:08	565448.1	554365.4	565889.4	554286.8	474	7523	9586
HA933T29	8:54:19	8:57:06	565489.8	554456.0	565906.2	554378.3	479	7475	9348
HA933T30	9:00:31	9:02:56	565533.1	554547.1	565903.9	554489.1	422	6647	8614
HA933T31	9:06:08	9:08:41	565553.3	554625.0	565929.4	554553.6	417	6095	6732
HA933T32	9:11:24	9:13:25	565640.2	554743.1	565939.2	554683.2	344	5318	6334
HA933T33	9:16:08	9:18:07	565668.4	554862.8	565968.6	554798.2	347	5197	6156
HA933T34	10:02:57	10:05:00	565671.8	554856.8	565973.7	554802.2	358	5270	6635
HA933T36	10:08:15	10:10:14	565639.5	554725.4	565934.6	554678.0	349	5327	6491
HA933T37	10:11:46	10:14:01	565914.9	554559.8	565615.6	554614.3	344	5393	7255
HA933T38	10:15:22	10:17:45	565508.3	554574.7	565902.4	554491.3	426	6730	8078
HA933T39	10:19:20	10:21:21	565902.7	554393.2	565582.5	554444.8	348	5584	7491
HA933T40	10:22:52	10:25:17	565563.1	554338.0	565857.4	554295.2	392	6457	7587
HA933T42	10:29:49	10:32:09	565496.5	554208.0	565847.2	554142.8	381	6491	8506
HA933T43	10:33:30	10:35:58	565841.4	554049.8	565511.5	554105.4	370	5778	9143
HA933T44	10:36:56	10:39:22	565459.7	554024.6	565806.8	553941.9	393	6372	9077
HA933T45	10:40:21	10:43:04	565826.4	553889.5	565482.8	553963.1	382	6280	10244
HA933T46	10:43:59	10:46:44	565422.4	553864.9	565806.9	553803.0	417	6643	10141
HA933T47	10:47:58	10:50:30	565799.8	553734.8	565436.1	553739.1	406	6692	10525
HA933T48	10:51:22	10:54:48	565383.3	553655.4	565788.4	553632.8	454	7308	11176
HA933T49	12:05:50	12:09:25	565791.2	553638.2	565441.7	553628.2	459	6076	11595
HA933T50	12:15:18	12:18:27	565354.4	553748.0	565807.9	553720.9	472	7692	12067
HA933T51	12:19:35	12:22:10	565804.8	553797.5	565474.8	553846.0	365	5686	10313
HA933T52	12:25:16	12:27:56	565420.4	553962.2	565810.1	553903.6	413	6666	11606
HA933T53	12:28:51	12:31:18	565814.6	553961.3	565492.3	554005.1	350	5562	11193
HA933T55	12:36:48	12:39:06	565838.2	554142.0	565537.1	554200.0	329	5698	9822
HA933T56	12:40:53	12:43:00	565526.1	554303.4	565846.0	554242.0	346	5841	8861
HA933T57	12:43:45	12:45:59	565868.6	554290.1	565561.0	554346.2	345	5634	8739
HA933T59	12:50:36	12:52:42	565896.5	554489.1	565588.1	554539.9	334	5581	9475
HA933T60	12:54:03	12:56:14	565588.1	554617.8	565908.8	554563.4	352	5098	7809

ADCP transects HANAR CHAR PILOT SCHEME
Date of survey : 12 Sep 2000

East branch : Lower Meghna at Hanarchar

File Name	Start Time	End Time	Start Easting (m)	Start Northing (m)	End Easting (m)	End Northing (m)	Width (m)	Area (m^2)	Discharge (m^3/sec)
HA9C1T01	12:36:29	12:57:32	565323.4	553615.0	564151.0	553772.4	1314	15,370	45,578
HA9C1T02	13:01:17	13:13:41	564344.4	553747.9	565770.9	553605.4	1692	23,625	61,980
HA9C1T05	15:29:15	15:40:11	564112.2	553772.9	565764.0	553592.2	1801	24,412	46,645
HA9C1T06	15:50:50	16:05:10	565772.4	553583.9	564092.8	553796.1	1995	23,083	48,954

West branch : Lower Meghna at Hanarchar

File Name	Start Time	End Time	Start Easting (m)	Start Northing (m)	End Easting (m)	End Northing (m)	Width (m)	Area (m^2)	Discharge (m^3/sec)
HA9C1T03	14:13:27	14:38:53	561975.1	557563.1	558981.8	560090.3	4080	26,811	48,779
HA9C1T04	14:52:10	15:13:49	558955.9	560099.7	561964.1	557589.5	4073	27,197	37,304
HA9C1T07	16:40:51	17:08:09	562023.7	557542.4	558927.5	560126.8	4288	31,167	42,446
HA9C1T08	17:09:53	17:35:48	558950.3	560093.7	562017.1	557551.3	4122	29,611	30,880

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ADCP transects HANAR CHAR PILOT SCHEME
Date of survey : 13 Sep 2000

East branch : Lower Meghna at Hanarchar

File Name	Start Time	End Time	Start Easting (m)	Start Northing (m)	End Easting (m)	End Northing (m)	Width (m)	Area (m^2)	Discharge (m^3/sec)
HA9D1T01	6:32:36	6:47:42	565776.5	553588.7	564168.1	553769.8	1663	23,138	48,656
HA9D1T05	10:10:44	10:23:54	564063.0	553748.2	565769.8	553598.2	1842	23,929	58,457
HA9D1T06	10:25:56	10:41:38	565770.2	553579.1	564089.3	553787.2	2241	29,894	75,894
HA9D1T09	12:37:50	12:50:37	564123.4	553747.4	565769.3	553602.5	1738	22,622	56,155
HA9D1T10	12:51:45	13:08:52	565780.8	553600.9	564136.3	553787.7	1708	22,552	58,421
HA9D1T13	15:06:29	15:19:45	564081.9	553775.2	565771.7	553583.5	1885	21,231	48,303
HA9D1T14	15:20:46	15:35:21	565777.4	553593.4	564101.5	553765.0	1756	20,799	47,643

West branch : Lower Meghna at Hanarchar

File Name	Start Time	End Time	Start Easting (m)	Start Northing (m)	End Easting (m)	End Northing (m)	Width (m)	Area (m^2)	Discharge (m^3/sec)
HA9D1T03	8:39:59	9:08:12	561976.8	557599.2	558964.5	560112.3	4006	28,369	43,432
HA9D1T04	9:12:21	9:36:45	558947.4	560137.1	562005.0	557589.9	4052	28,363	34,556
HA9D1T07	11:27:58	11:55:03	562036.2	557556.9	558954.0	560128.4	4400	29,772	47,618
HA9D1T08	11:57:56	12:22:07	558932.3	560120.2	561907.1	557624.9	3973	27,216	35,599
HA9D1T11	13:58:38	14:28:54	561941.7	557612.4	558983.9	560140.2	4016	27,020	46,335
HA9D1T12	14:30:31	14:53:59	558931.6	560123.4	561956.9	557614.3	4076	27,677	36,393
HA9D1T17	16:16:12	16:42:48	562081.3	557557.0	558943.3	560152.0	4293	30,776	38,755
HA9D1T19	16:45:50	17:12:44	558929.4	560168.5	562029.6	557537.7	4189	31,056	27,475