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Departement Leefmilieu en Infrastructuur
Afdeling Waterwegen en Zeewezen
Afdeling Waterbouwkundig Laboratorium en Hydrologisch Onderzoek

STUDIE DENSITEITSSTROMINGEN IN HET KADER VAN LTV

STROOM- EN SALINITEITSMETING TE KALLO

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1 INTRODUCTION

1.1 The assignment

On March 1, 2002 the study "Densiteitsstromingen Schelde in het kader van LTV" (16EB/01/01) assigned by WLHO (Departement Leefmilieu en Infrastructuur, Afdeling Waterwegen en Zeewezen, Afdeling Waterbouwkundig Laboratorium en Hydrologisch Onderzoek) to WL | Delft Hydraulics in association with IMDC has started.
The study consists of the following parts:

- The set up and execution of an extensive measurement campaign
- The building of a physical model, including the access channel to a sluice
- The building of a 3D numerical model
- The writing of a report on future possible actions that can be taken in order to obtain a better understanding of the functioning of sedimentation and silt transport in the Lower Scheldt
- The transfer of the numerical models to the WLHO, including the necessary training sessions.

This report is written as part of sub-assignment 1: the set up and execution of an extensive measurement campaign.

1.2 Purpose of the measurement campaign

The through tide measurement campaign conducted at Kallo is part of the extensive measurement campaign in the study on density currents in the river Scheldt, in the framework of the Scheldt Long Term Vision (LTV). In addition to long term measurement campaigns at certain designated posts along the river Scheldt, the measurement plan also covered two series of through tide measurements at different locations on June 5th and 12th 2002.

The purpose of the measurement campaign was to supply a coherent set of data which will not only be applied in the calibration and validation of the numerical models that are being developed in the framework of the study on density currents on the one hand, but which could also contribute to the knowledge of the behaviour of density currens in the river Scheldt, and more specifically around the areas of the Kallo Lock and the future Deurganckdock.

Table 1 gives a survey of the measurement campaign and the resulting factual data reports. Appendix 1 is a survey of the entire measurement plan, with the locations of the through tide measurement campaigns and the long term measurement locations.

This report is the factual data report of the through tide current and salinity measurements at Kallosluis on June 5th 2002 . An interpretation and analysis of the measurement data will be made in the data analysis report (I/RA/11216/02.045/CMA), which is in preparation.

Measurement Location	Measurement Period	Type of Measurement	Report number
Waarde	5/06/2002	Through tide current and salinity measurement	I/RA/11216/02.037/CMA
Waarde	12/06/2002	Through tide current and salinity measurement	I/RA/11216/02.038/CMA
Oosterweel	5/06/2002	Through tide current and salinity measurement	I/RA/11216/02.039/CMA

Oosterweel	12/06/2002	Through tide current and salinity measurement	I/RA/11216/02.040/CMA
Deurganckdok	5/06/2002	Through tide current and salinity measurement	I/RA/11216/02.041/CMA
Deurganckdok	12/06/2002	Through tide current and salinity measurement	I/RA/11216/02.042/CMA
Kallo	5/06/2002	Through tide current and salinity measurement	I/RA/11216/02.043/CMA
Kallo	12/06/2002	Through tide current and salinity measurement	I/RA/11216/02.044/CMA
Zandvliet	June 2002	Long term current and salinity measurement	I/RA/11216/02.046/FDK
Lillo-Ponton			
Deurganckdok			
Schelle			
Oosterweel			
Petroleumsteiger			
Kallo	June 2002	Long term current and salinity measurement	I/RA/11216/02.047/CMA
Merelbeke	June 2002	Discharge measurement	I/RA/11216/02.029/CMA
Analyses of the data			I/RA/11216/02.045/CMA

Table 1 : survey of the measurement campaigns that have been conducted for the study on density currents in the river Scheldt.

1.3 The report

The first chapter forms the introduction, with a short description of the measurement campaign. Chapter 2 describes the measuring equipment used. Chapter 3 includes the proceedings of the measurement campaign. In chapter 4 the processing of the data set and the measurement results are presented.
This report is based partly on Medida reports n° v0007med-2002 , v0008med-2002, v0009med-2002 (Medida,2002).

2 THE MEASUREMENT CAMPAIGN

2.1 Description of the measurement campaign

The current and salinity measurement took place at Kallosluis on June 5th 2002 from 5:00 MET until 19:00 MET and was conducted by Medida.

The purpose of the measurements in the vicinity of Kallo was:

- to characterize the flow pattern and the salinity distribution both in the river and access channel to the lock
- to determine the presence of eddy currents and density currents
- to collect a set of data for the calibration of the numerical 3D hydrodynamic model.

Three survey vessels were deployed at Kallo. A first (K1), the vessel Meerkoet for current profiling on the river, a second (K2), the vessel Zwaan for CTD profiling on the river an in the entrance to the Kallo Lock, and a third (K3), the vessel Oostende XI for current profiling and ondulating CTD measurements in the entrance to the Kallo Lock (see appendix 4 and 8).

From the survey vessel Meerkoet the area outside the entrance channel to the Kallo Lock was surveyed with a downward looking ADCP, mounted at the nose of the vessel.

From the survey vessel Zwaan CTD profiling measurements and point velocity measurements (with Anderaa 3500) were executed outside and inside the access channel to the Kallo Lock.

From the survey vessel Oostende XI ADCP and ondulating CTD measurements were conducted mostly inside the access channel.

Appendix 4 is a survey of the entire measurement plan, with the locations of the through tide measurement campaigns and the long term measurement locations.
Appendix 9 offers a survey of the measurement location with sailed ADCP & ondulating CTD measurement tracks, whereas Appendix 10 gives a survey of the location where CTD profiles and point velocity measurements were carried out .
Table 2 displays the averaged start and end point of the ADCP measurement tracks and the averaged length. whereby K1-prefix indicates a measurement conducted from vessel 1 (Meerkoet), K2-prefix indicates a measurement conducted from vessel 2 (Zwaan) and K3-prefix indicates a measurement conducted from vessel 3 (Oostende XI). Table 3 does the same for the undulating CTD measurements.

Table 4 and Table 5 give the average positions of the CTD measurement points and the point velocity measurement points respectively, with the bottom depth at those locations. K2 stands for vessel 2.

Name	Start easting	Start northing	End easting	End northing	Average length	Average course
K1ad	591391.8	5680666.8	591004.6	5680912.3	460.2	122.1
K1ae	590952.8	5680856.8	590487.1	5680234.1	787.9	217.1
K1au	590534.5	5680158.6	590949.4	5680160.5	416.3	151.9
K1Aeb	590534.5	5680158.6	590949.4	5680160.5	325.5	311.6
K3a2	590365.3	5680437	589975.9	5680101	575.7	220.5

K3a3	589921.9	5680264	590288.6	5680169	381.6	284.5
K3a4	589875.1	5680096	589890.6	5680229	152.7	15.9
K3ac	590770	5680520	590227	5680243	615.7	242.8
K3ae	590376.9	5680207	590422.3	5680437	236.9	11.0
K3ak	590478.7	5680497	590794.1	5680596	332.0	72.5
K3al	590204.5	5680263	589897.2	5680220	404.8	234.1
K3am	590204.5	5680263	589897.2	5680220	335.1	52.4
K3az	590293	5680125	589951.1	5680033	354.9	254.9

Table 2 Average start and endpoint of ADCP measurement tracks

Name	Start easting	Start northing	End easting	End northing	Average length	Average course
K3co2	590377.4	5680441	589971.3	5680096	594.95	220.705
K3co3	589910.2	5680273	590277.1	5680173	391.68	285.18
K3co4	589874.4	5680092	589888.6	5680233	163.12	15.108
K3coc	590777.3	5680522	590219.2	5680237	634.18	242.82
K3coe	590358.3	5680181	590422.2	5680445	276.81	13.54
K3cok	590462.1	5680491	590791.4	5680599	348.44	71.84
K3col	590462.1	5680491	590791.4	5680599	426.72	261.11
K3com	590352.5	5680179	590615.1	5680386	345.86	51.84
K3coz	590306	5680129	589949.8	5680030	371.09	254.54

Table 3 : Average start and endpoint of undulating CTD measurement tracks

Name	Easting	Northing	Bottom depth (mTAW)
K2c00	590479.25	5679870.09	-3.90
K2cd1	591023.83	5680902.08	-12.37
K2cd2	591232.09	5680747.66	-9.50
K2cd3	591454.44	5680617.60	-4.19
K2ce1	590417.43	5680460.24	-10.98
K2ce2	590401.56	5680366.81	-10.97
K2ce3	590392.71	5680262.90	-11.36
K2cu1	590534.88	5680164.83	-11.44
K2cu2	590710.11	5680166.13	-15.67
K2cu3	590884.88	5680168.86	-2.91

Table 4 average positions of the CTD measurement points

Name	Easting	Northing	Bottom depth (mTAW)
K2ve1	590415.2	5680449	-10.91
K2ve2	590402.7	5680369	-11
K2ve3	590395.2	5680260	-11.4

Table 5 : average positions of the point velocity measurement locations

2.2 The equipment

Appendix 2 gives an overview of the equipment used during the measurements.

2.2.1 Vessel 1 (Meerkoet)

The Acoustic Profiling System used is a 1.5 Mhz VM Nortek NDP .The NDP is mounted on a steel pole on the starboard nose section of the vessel, with the transducers looking vertically downwards to the bottom. A sampling rate of max. 0,5 Hz was set. The bin size of the instrument was set to 0.5 meters.The computer system is connected to the dGPS receiver, the heave compensator and the gyrocompass. Before the start of the measurements, the NDP was calibrated.

2.2.2 Vessel 2 (Zwaan)

The CTD used is a YSI type 600-R. The point velocity meter was an Anderaa 3500. Both the CTD and the Anderaa were mounted onto a ballast fish of appr. 60kgs. The fish was attached onto the steel wire of a hydraulic sea crane onboard the survey vessel.The ctd is mounted approximately 54 cm upwards the bottom side, the Anderaa 39 cm upwards the bottom side of the fish. The CTD output was logged once per second. The Anderaa 3500 logs every 4 seconds, alternating between current speed and current direction.

2.2.3 Vessel 3 (Oostende XI)

The CTD sensor (type YSI 600-R) was attached to a streamlined towfish and operated from a survey computer with an automatical electrical winchsystem; the fish is automatically ondulated up and down between preselcetable top- and bottom levels by the Navitracker. The depth of the Navitracker is calibrated at a known depth with the pressure sensor.The Navitracker system forms the controlling part of this survey, whereby the CTD data was collected together with the singlebeam and GPS data on the Navitracker computer. The singlebeam used is a Atlas Deso 15 singlebeam.

Bathymetric data from the echosounder, the heave compensator and the differential GPS system are gathered through the Atlas Hydromap system.

A downward looking 1.5 Mhz NDP Doppler profiler system, mounted at the side of the vessel has been collecting data from the verical beam below its transducer, allowing correlation processing together with the CTD sensor. The bin size of the instrument was set to 0.5 meters.Before the start of the measurements, the NDP was calibrated.

3 THE MEASUREMENTS

3.1 Measurement periods

Appendix 9 gives a graphic survey of the sailed ADCP tracks, Appendix 5 gives the start and end points of the tracks, the sailed length and the course. Table 2 gives the average start and endpoints for the measurement tracks, as wel as their length and course.
Appendix 9 gives a graphic survey of the sailed undulating CTD tracks, Appendix 6 gives the start and end points of the tracks, the sailed length and the course. Table 3 gives the average start and endpoints for the measurement tracks, as wel as their length and course.
Appendix 7 gives the X and Y coordinates (UTM-ED50) of every ctd profiling point , the bottom depth in mTAW, the maximum and minimum depth on which measurements took place and the depth averaged temperature and salinity. Appendix 8 does the same for the point velocity measurement points.
Appendix 10 is a graphic overview of the locations of the CTD and point velocity measurements.

3.1.1 NDP measurements

NDP measurements occurred on two vessels, the Meerkoet (vessel 1), which was sailing a regular pattern on the river outside the access channel; and the Oostende XI, which was sailing the K3ae track every half hour. Further ADCP tracks for the Oostende XI were following a dynamical pattern which was determined on board by M. Sas (IMDC) and A.C. Bijlsma (WL | Delft Hydraulics).
The following transects have been marked (see appendix 8):

- K3AE : entrance of the access channel (to visualize the exchange of water between access channel and river)
- K3A2: diagonal in access channel
- K3A3: diagonal in access channel
- K3A4: transect at the entrance to the lock
- K3AZ: transect along the southern part of the access channel
- K3AN: transect along the northern part of the access channel
- K3AK: transect along the northern quay wall of the access channel (from K3AE towards the river Scheldt)
- K3AC: Centreline of the access channel
- K3AL: prolongation of the centreline towards the lock
- K3AM: transect along the southern quay wall of the access channel
- K3AX: transect to measure the flow patterns at the southern edge of the access channel

3.1.1.1 Vessel 1 (Meerkoet)

A total of 94 measurement tracks was sailed.

The Meerkoet sailed a regular pattern consisting of three ADCP measurement tracks : downstream (K1ad), entrance(K1ae) and upstream (k1au). This cycle was repeated every half hour. An additional measurement track (K1aeb) was sailed several times, in order to monitor the outfall from the power station (north of the entrance channel) in the river from. The NDP is set at a measuring frequency of one measurement every 3s.
Together with the NDP, bathymetric singlebeam tracks were recorded with the Odom echosounder.

3.1.1.2 Vessel 3 (Oostende XI)

The Oostende XI sailed 118 measurement tracks, divided into 9 categories. The K3ae track was a fixed track that was sailed every half hour. All other tracks followed a dynamic pattern that was developed while sailing.

3.1.2 CTD measurements

3.1.2.1 Vessel 2 (Zwaan)

Vessel 2 (K2) took CTD profilings inside and outside the entrance channel, along a regular pattern of measurement points. The measurement series, which was ran with a frequency of 1 measurement cycle/ hour, consisted of 9 fixed measurement points, and one optional point (cfr. §3.1.1.1) around the outfall near the Kallo Lock. A measurement cycle consisted in 3 measurements on the upstream measurement track (cfr.§ 3.1.1.1), 3 measurements on the entrance track and 3 measurements on the downstream measurement track.

3.1.2.2 Vessel 3 (Oostende XI)

As the CTD onboard of the Oostende XI vessel was attached to the automated electronical winchsystem (cfr.§ 2.2.3), it was possible to measure the conductivity and temperature (and thus salinity) along measurement tracks, rather than in profiling mode. The NaviTracker system was setup to undulate from just below the water surface to just above the bottom surface. The K3coe track was a fixed track that was sailed every half hour. All other tracks followed a dynamic pattern that was developed while sailing. The CTD logs output to Trackersoft 1 time every second.

3.1.3 Point velocity measurements

An Anderaa 3500 velocity meter was used to measure the velocities in the near bottom zone of the Kallo Lock entrance. The Anderaa was mounted together with the CTD on a ballast towfish, of which the cable had been previously marked in order to be able to determine the depth. Measurements were taken approximately every 0.5 m for about 4 meters. The Anderaa 3500 logged a measurement value every 4 seconds onto the laptop acquisition system. The measure value was alternating between velocity and direction (i.e. every 8 seconds a new velocity value was logged).

3.2 Hydro-meteorological conditions during the measurement campaign.

3.2.1 Vertical tide during the measurement

The vertical tide was measured at the Kallosluis tidal measurement station.
gives the most important characteristics (high and low tide) of the tide at Kallosluis on the day of the measurements.

	Time (hh:mm MET)	Water level (mTAW)
LW (1)	5:30	0.24
HW (2)	11:30	4.85
LW (3)	18:00	0.42
HW (4)	23:50	4.75

Table 6: high tide and low tide at Kallosluis on 05/06/2002

In Table 7 the tidal characteristics of the measurement day are compared to the average tide over the decade 1981-1990 (Claessens and Meyvis, 1994) for the location Kallosluis. The tidal coefficients of 0.84 to 0.9 indicate a slightly higher neap tide than average.

Kallo	Neap tide ('81-'90)	Average Tide ('81-'90)	Spring Tide ('81-'90)	Tide 05/06/2002
Water level (mTAW)				
LW (1)	0.39	0.05	-0.16	0.24
HW (2)	4.55	5.19	5.68	4.85
LW (3)	-	-	-	0.42
HW (4)	-	-	-	4.75
Tidal difference (m)				
Rising(1→2)	4.20	5.14	5.84	4.61
Falling (2→3)	4.20	5.14	5.84	4.43
Rising (3→4)	-	-	-	4.31
Duration (hh:mm)				
Rising (1→2)	5:56	5:26	05:07	06:00
Falling (2→3)	6:46	6:53	07:13	06:30
Rising (3→4)	-	-	-	05:50
Tide (1→3)	12:42	12:19	12:20	12:30
Tide (2→4)	-	-		12:20
Tidal coefficient				
Rising (1→2)	0.81	1	1.14	0.90
Falling (2→3)	0.81	1	1.14	0.86
Rising (3→4)	-	-	-	0.84

Table 7: comparison of the tidal characteristics of 5/06/2002 with the average tide, the average neap tide and the average spring tide over the decade 1981-1990.

3.2.2 Meteorological data

The wind velocity and direction was measured at Deurne meteorological station. On the 5th of June, the wind was blowing in an SSW-SSE direction, with velocities from daily average 11 to maximum 40 km/h.
The average air temperature was 18.9°.(KMI maandbericht, 2002)

3.3 Naval traffic

A survey of the naval traffic is given in Appendix 3.

4 PROCESSING OF THE DATASETS

4.1 Methodology of processing

In the following chapter the results of the ADCP and CTD measurements will be discussed, as wel as the processing of the data.

4.1.1 Processing of the ADCP dataset

A survey of the ADCP measurements has already been given in Table 2.
The results of the ADCP measurements can be found in Appendix 11. The acquisition as well as a part of the processing of the ADCP data was conducted by Medida.

Processing of the data included the combination of the ADCP data with bathymetrical data , resulting from the Multibeam or Odom echosounder data (for Oostende XI resp. Meerkoet) measuring campaign in order to eliminate the lowermost cells, as the information they contain is not reliable.
The bottom depth was deduced from the Multibeam or Echosounder Surveys.

Further processing of the ADCP data included:
for the K1ad, K1au, K3ae, K3a4 measurement tracks :

- The drawing of a contouring map over the section of the perpendicular velocity
- The drawing of a contouring map over the section of the parallel velocity
- The drawing of the variation in depth averaged velocity and the discharge along the measurement line
- The drawing of the velocity magnitude and direction along the measurement line
- Calculation of the total discharge over the sailed section
- Calculation of the area of the sailed cross-section
- Calculation of the cross-sectoinal averaged velocity over the sailed cross-section

For the K3ak, K3a3, K3az, K3am, K3an,K3ax, K3al, K3ac and K3a2 measurement tracks :

- Drawing a contouring map over the section of the perpendicular velocity
- Drawing a contouring map over the section of the parallel velocity
- Drawing the variation in depth averaged perpendicular and parallel velocity along the measurement line
- Drawing the velocity magnitude and direction along the measurement line
- Calculation of the cross-sectional averaged velocity over the sailed cross-section

For the K1ae, K1aeb measurement tracks :

- Drawing a contouring map over the section of the u velocity
- Drawing a contouring map over the section of the v velocity
- Drawing the variation in depth averaged u and v velocity along the measurement line
- Drawing the velocity magnitude and direction along the measurement line

For the processing of the ADCP data, the data measured along the K3ak, K3a3, K3az, K3am, K3an,K3ax, K3al, K3ac, K3a2, K1ad, K1au, K3ae and K3a4 tracks were projected on a "theoretical measurement track", in order to make comparisons between the different measurement cycles more straightforward. This "theoretical measurement track" was calculated from the average measurement tracks coordinates and runs (when possible) from the left bank top of the dike to the right bank top of the dike (coordinates marked in bold). When the orientation of the measurement track makes this impossible, the "theoretical measurement track" is defined as the track between the two outermost measurement points. Table 8 gives the start and end points of the theoretical measurement tracks.

The data collected along the K1ae and K1aeb tracks were not projected on an average track. The shape of the track was such that projection would have affected the presentation and understanding of the data in a negative way. Therefore no projection has been applied on the dataset.

	Start Easting	Start Northing	End Easting	End Northing
K1au	**590374.3**	**5680161**	**591589.1**	**5680162**
K1ad	**590988.9**	**5680935**	**591435.4**	**5680623**
K1ae	-			
K1aeb	-			
K3az	589949.4	5680029	590296	5680124
K3am	590372.9	5680194	590629.4	5680391
K3al K3ak	589662.3 590423.3	5680141 5680463	590237.2 590864	5680278 5680616
K3ae	590354.6	5680188	590432.6	5680472
K3ac	589964.6	5680092	590889.6	5680600
K3a4	589879.5	5680074	589901.1	5680236
K3a3	**590428.9**	**5680128**	**589771.5**	**5680315**
K3a2	**589831.8**	**5679974**	**590589.4**	**5680636**

Table 8 coordinates (UTM-ED50) of the "theoretical measurement track". Bold coordinates indicate the track runs from the left bank dike to the right bank dike. If no coordinates are provided, the tracks were not projected.

The velocity measurements have been extrapolated upwards and downwards. In the downward direction, a region of approximately 0.5 meters was extrapolated, in the upward direction, around 1.5 –2 m for the measurements done on board of vessel 1 (Meerkoet), for the measurements done on board of vessel the extrapolation amounted to 0.5 m in the downward direction, and around 2.5 m in the upward direction.
The upward extrapolation was done using a constant value. The downward extrapolation was conducted using equation 4.1 (Van Rijn, 1993).

$$v = v_1 \left(\frac{z}{z_1} \right)^{0.25} \qquad (4.1)$$

in which v_1= current velocity in the first measurement point above the bottom
z_1=height above the bottom of the first measurement point

For the drawing of the contouring maps, the data was interpolated on a regular 40*15 points grid. For the drawing of the contouring plots of the non-projected tracks (K1ae and K1aeb, the data was interpolated at 25 m intervals (horizontally) over 15 points (vertically). For the presentaion of the K1au, K1ad, K3a3 and K3a2 tracks, the bathymetry used in the presentation was derived from bathymetric surveys, carried out by AMT.

The current velocities are negative in the flood direction and positive in the ebb direction. Or for the tracks with a N-S orientation, positive to the West, negative to the East. The discharge was calculated by multiplying the depth-average velocity per ensemble with the distance to the following ensemble, multiplied by the height of the ensemble.

4.1.2 Processing of the ondulating CTD results

The processing of the ondulating CTD results was conducted partly by Medida. Analogous to the NDP processing (cfr. § 4.1.1) the bathymetrical data resultant from the multibeam survey was employed to section the CTD survey tracks into the bathymetric Multibeam data. The salinity was calculated from the measured temperature and conductivity using the pps-78 formula (UNESCO,1991). Appendix 15 gives the calculation procedure.

Further processing of the ondulating CTD data included for every measured section the drawing of a contour map of the salinity over the sailed cross-section, together with contouring maps for the perpendicular and parallel velocities over the cross-section. The results of the processing can be found in Appendix 11.

For the processing of the undulating CTD data, the data measured along the K3cok, K3co3, K3coz, K3com, K3con, K3cox, K3col, K3coc, K3co2, K1cod, K1cou, K3coe and K3co4 tracks were projected on a "theoretical measurement track", in order to make comparisons between the different measurement cycles more straightforward. This "theoretical measurement track" was calculated from the average measurement tracks coordinates and runs (when possible) from the left bank top of the dike to the right bank top of the dike (coordinates marked in bold). When the orientation of the measurement track makes this impossible, the "theoretical measurement track" is defined as the track between the two outermost measurement points. Table 9 gives the start and end points of the theoretical measurement tracks.

The data collected along the K1coe and K1coeb tracks were not projected on an average track. The shape of the track was such that projection would have affected the presentation and understanding of the data in a negative way. Therefore no projection has been applied on the dataset.

	Start Easting	Start Northing	End Easting	End Northing
K3coz	589935.4	5680016	590310.4	5680133
K3com	590352.5	5680179	590615.1	5680386
K3col	589662.9	5680139	590264.1	5680258
K3cok	590403.6	5680456	590850.1	5680618
K3coe	590333.9	5680172	590439	5680469
K3coc	589965.1	5680090	590893.6	5680598
K3co4	589865.6	5680073	589899.3	5680239
K3co3	590314.9	5680165	589874.9	5680268
K3co2	589908.4	5680060	590440.2	5680475

Table 9 : coordinates (UTM-ED50) of the "theoretical measurement track".

The results of the processing can be found in Appendix 12.

4.1.3 Processing of the profiling CTD results

In Appendix 7 a survey has been given of the CTD measurement points and the average coordinate of these points. The results of the CTD processing can be found in Appendix 13.

The salinity was calculated from the measured temperature and conductivity using the pps-78 formula (UNESCO,1991). Appendix 15 gives the calculation procedure.

The validation of the CTD data was done visually : data that showed strong deviations were deleted from the profiles.
The coordinates as well as the values for the bottom depth were deducted from the singlebeam echosounder data.
Comparing the depth given by the echosounder and the depth measured with the pressure-sensor of the CTD, the impression can sometimes be given that the CTD-sensor is located under the bottom . Two possible explanations can be given : the CTD could penetrate into the sludge, and second, in the vicinity of slopes, the depths registered by the CTD sensor and the echosounder are not measured on the same vertical profile, which could explain the difference.

For every CTD profile a measurement report was made. Besides general information, this report contains a graphical representation of the conductivity, the temperature and the salinity in function of the depth. The measurement values are represented in a table (in the case of measurements at relatively deep points not all measurement values are notated) and when possible, the depth averaged values for salinity, temperature and conductivity are given.

4.1.4 Processing of the point velocity measurements

CTD measurements conducted together with the point velocity measurements were used to determine the bottom depth and depth of measurement of every point velocity measurement series. The velocity components (perpendicular and parallel) were calculated. To eliminate deviations in the velocity caused by the oscillating movements of the fish, the depth data were averaged. Strongly deviant velocity data were removed.

Per measurement cycle (one measurement cycle comprises three measurement points), a measurement report was made. Besides general information, this report contains a plot of the velocity against the depth for the 3 measurement points.

4.2 Storage of the data

The contents of the folder “Kallosluis 0506” in the CDROM 11216-1 are the following directories :
-RA02043-Kallo05062002 : de electronic version of this report
-“processed adcp data”
K1a*n.txt : validated data, in the agreed format
K3a*n.txt : validated data, in the agreed format
-“processed ctd data” :
K3c*n.txt : validated data
K1c*n.txt : validated data
-“processed vel data”:
K2v*n.txt : validated data

5 REFERENCES

N.P.Fotonoff and R.C.Millard Jr (1983) Algorithms for computation of fundamental properties of seawater, Unesco technical papers in marine science, Unesco 1983.

KMI maandbericht (2002) Klimatologische waarnemingen juni

Medida (2002) Report of the current and ctd measurements on board m/v Oostende XI at Kallo (v0007med-2002)

Medida (2002) Report of the current measurements on on board m/v Meerkoet at Kallo (v0008med-2002)

Medida(2002) Report of th e current and ctd measurements on board m/v Zwaan at Kallo (v0009med-2002).

Meyvis en Claessens (1991) Overzicht van de tijwaarnemingen in het Zeescheldebekken gedurende het decennium 1981-1990

Unesco (1991) Processing of Oceanographic Station Data

Errata :
In appendix 11, for the series K1ae and K1aeb, the values on the left y-axis are –1.5 –1 0 1 1.5 instead of –30 –15 0 15 30

APPENDICES

Appendix 1 : Tidal data for all through tide measurement locations on 05/06/2002

Appendix 2 : The Equipment

Appendix 3 : Survey of the naval traffic

Appendix 4 : Plan of the measurements

Appendix 5 : Start and endpoint of the sailed ADCP lines, sailed length and course

Appendix 6:Start and endpoint of the sailed undulating CTD tracks, sailed length and course

Appendix 7 : Coordinates of CTD measurement points, bottom depth,and maximum & minimum measurement depth

Appendix 8 : Coordinates of point velocity measurement locations, bottom depth and maximum and minimum measurement depth

Appendix 9 : Graphic survey of the sailed ADCP measurement tracks

Appendix 10 : Graphic survey of CTD measurement and point velocity measurement locations

Appendix 11 : Processing of the ADCP data set

Appendix 12 : Processing of the undulating CTD data set

Appendix 13 : Processing of the profiling CTD dataset

Appendix 14 : Processing of the point velocity measurement data

Appendix 15 : Calculation of the salinity (pps-78 formula)

Appendix 16 : Organisation of the files