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Study on the field steps necessary for the execution of the hydrographic works related to the navigable canals from Constanta harbour in support of the safety of navigation

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Abstract. This paper presents the steps performed for the execution of hydrographic works on the Danube - Black Sea Canal (CDMN) and the White Gate - Midia Năvodari Canal (CPAMN), next to Constanţa harbour. These landmarks represent the elemental key of navigation on the Danube River. The general condition of the navigable channels has not been affected since they were put into use, there are a number of problems related to the stability and local integrity of the banks that can endanger the safety of navigation. The purpose of hydrographic studies is to collect, through systematic surveys in navigable areas, georeferenced data related to: bathymetry in the area of interest; classification and precise positioning of underwater contacts; the profile and characteristics of the submerged relief; the volume of alluvium deposited in the canal ditch and their nature; currents and water levels or the physical properties of the water column.

1. Introduction

In this paper are presented the steps performed for the execution of hydrographic works on the Danube - Black Sea Canal (CDMN) and the White Gate - Midia Năvodari Canal (CPAMN), next to Constanţa harbour.

By its definition, the navigable canal is a hydrotechnical construction created for the purpose of shortening a waterway and ensuring communication between two seas or oceans.

The Danube-Black Sea Canal connects the Black Sea and the North Sea through the Rhine-Main-Danube Canal, shortening the road by about 400 km.

The Danube - Black Sea Canal [1] has a length of 64,410 km and is located between the Constanţa Sud - Agigea harbour and the confluence with the Danube River near Cernavoda, respectively 299.3 km of the Danube.

The White Gate - Midia Năvodari Canal [2] has a length of 33 km and ensures the connection of the Midia harbour with the Danube River, through the Danube - Black Sea Canal. CPAMN detaches from the Danube - Black Sea Canal near White Gate and is provided with two twin locks (Ovidiu and Năvodari):

- Ovidiu - upstream km 12 + 270;
- Năvodari - upstream km 2 + 023.

2. Purpose of hidrographic research

The purpose of the hydrographic studies is to collect using a systematic surveys in the navigable areas georeferenced data related to:
- bathymetry in the area of interest;
- precise classification and positioning of underwater contacts;
- profile and characteristics of submerged relief;
- the volume of alluvium deposited in the canal and their nature;
- currents and water levels;
  - physical properties of the water column;
  - condition of slopes;
  - complete and permanent updating of the database necessary for:
  - production and updating of navigation maps;
  - navigation and traffic management;
  - dredging works;
  - conservation of the water environment;
  - location of underwater structures (cables / pipes);
  - scientific studies.

3. Execution of field measurements

The field team verifies that the details of the canal bank are presented appropriately and accurately in the source data sets. Aerial or satellite photography is used in areas where access is not possible due to landslides or heavy vegetation (Figure 1).

Figure 1 – Aerial photography of the Cumpăna landslide area

The hydrography team leader will complete an informal pre-survey assessment that will review and validate the survey requirements in the project instructions (eg, procurement method, network resolution, survey limits, feature check, etc.) based on the conditions observed in the survey area. Any concerns regarding the nature of the inspection requirements specified in the project instructions will be brought to the attention of the administration for clarification or adjustment as soon as possible after the completion of this assessment. [3]

The main hydrographer must also ensure that any action which he authorizes or undertakes is not such as to endanger the continued existence of any endangered or threatened species or to lead to the destruction or alteration of the habitat. [4]

As soon as possible, after the discovery, the hydrographer shall report to the competent authority all hazards for navigation. If additional hazards are detected during the investigation process, they will be reported immediately. A danger to navigation is considered to be any natural feature (banks of sand, earth or gravel, boulders, rocks, etc.) as well as other objects discovered during the inspection that may present an imminent danger to navigation. All depth characteristics below the level of operation and maintenance of inland waterway regulations may be considered as potential hazards for navigation and subject to reporting.

If during the field works it is found that the heights of the bridges or of the electrical networks crossing the canal do not correspond or are not specified in the electronic maps, information will be provided in order to update the data. The same information is provided in case of discovery of unreported underpasses (pipes).

For each field trip, the team responsible for obtaining the data has a series of procedures that are followed to carry out a campaign adapted to the requirements and in order to ensure the safety of employees and equipment.

The working procedures that were followed in this case were:

- Equipment installation procedures, depth measurement and recording;
- Data processing and representation procedures;
- Backup procedures for data backups;
- Data structure of records;
- Daily activity registration reports;
- Emergency intervention procedures;
- Action procedures in case of equipment failure.

The daily report will include, in addition to the activities carried out, the weather conditions (Figure 2).

19/04/2021 Agigea Sea Conditions

tide-forecast.com

Lat Long: 44.08° N 28.62° E

Detailed Sea Conditions for Agigea over the next 2 days

Issued (local time): 2 pm Monday 19 Apr 2021

Detailed Sea Conditions for Agigea over the next 2 days
Issued (local time): 2 pm Monday 19 Apr 2021

Change units	Monday 19				Tuesday 20								Wednesday 21					
	12PM	3PM	6PM	9PM	0AM	3AM	6AM	9AM	12PM	3PM	6PM	9PM	0AM	3AM	6AM	9AM	12PM	3PM
Tide State	ebb	low	flow	flow	high	ebb	ebb	low	flow	ebb	low	flow	flow	high	ebb	low	flow	high
High Tide height (m)					10:42PM 0.07				10:01AM 0.05					12:06AM 0.07				12:18PM 0.05
Low Tide height (m)		2:09PM 0.03						6:50AM 0.04			4:17PM 0.03					7:14AM 0.04		
Wind (km/h)	10 ENE	15 E	20 ESE	10 E	5 E	10 NNW	15 WNW	20 W	15 NNW	5 WNW	10 SE	15 W	25 W	30 W	30 WSW	35 W	30 W	25 W
	Today's sea temperature in Agigea is 9.1 °C (*Statistics for 19 Apr 1981-2005 – mean: 10.2 max: 13.6 min: 7.7 °C*)																	
Summary	clear	clear	cloudy	cloudy	light rain	light rain	cloudy	cloudy	cloudy	rain shwrs	rain shwrs	cloudy	cloudy	cloudy	cloudy	clear	clear	some clouds
Rain mm	-	-	-	-	1	2	-	-	-	1	1	-	-	-	-	-	-	-
Temp °C	11	10	10	9	8	8	8	9	11	12	12	12	11	9	9	10	14	16
Chill °C	10	8	8	7	7	7	5	6	9	12	11	10	8	5	5	6	12	15
Sunrise	-	-	-	-	-	-	-	6:13	-	-	-	-	-	-	-	6:13	-	-
Sunset	-	-	7:52	-	-	-	-	-	-	-	7:54	-	-	-	-	-	-	-

Tide datum: Mean Lower Low Water (Satellite).

Figure 2 – Meteorological condition [5]

4. Water level monitoring

To monitor the water level on the two canals, stations are located in the following locations (Figure 3):
- Item 1 - Agigea lock (two twin locks), located on the Danube - Black Sea Canal at Km 1 + 934 - 2 measuring points, 1 upstream and 1 downstream;
- Pos. 2 - Cernavoda lock (two twin locks), located on the Danube - Black Sea Canal at Km 60 + 305 - 2 measuring points, 1 upstream and 1 downstream;
- Pos. 3 - Ovidiu lock (two twin locks), located on the White Gate - Midia Canal, Năvodari at Km 15 + 230 - 2 measuring points, 1 upstream and 1 downstream;
- Item 4 - Năvodari lock (two twin locks), located on the White Gate - Midia Canal, Năvodari at Km 25 + 477 - 1 measuring point upstream, 1 measuring point downstream, 1 measuring point SAS1, 1 measuring point SAS2;
- Item 5 - Cernavoda Pumping Station (SPC) - 2 measuring points, 1 upstream and 1 downstream;
- Item 6 - Port Medgidia - 1 measuring point;
- Item 7 - Basarabi port - 1 measuring point;
- Item 8 - Port Luminita - 1 measuring point.

The water level considered in a survey is that transmitted by the nearest station.

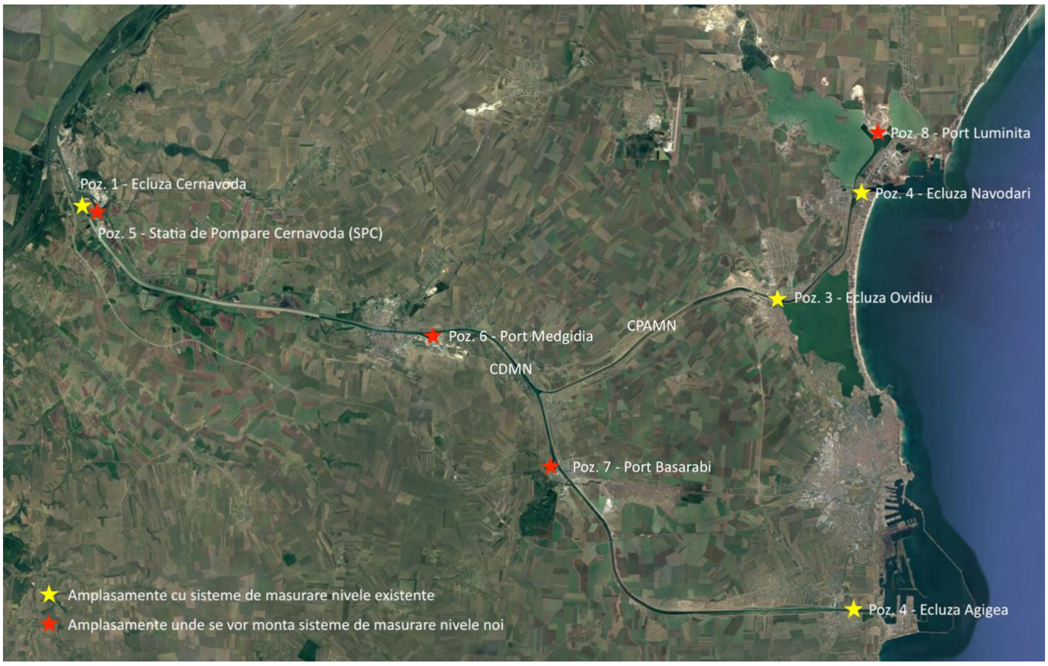


Figure 3 - Outline of water level measurement systems along CDMN and CPAMN

The existing level measurement system has the following functions:
- preventing the opening of the sluice gates when the water levels differ on their two sides;
- determination of the volumes of water transited in the closure process;
- informing the navigators transiting the canal on the water level on the three diversions.

In each measuring area are used to compare two different water level measurement systems (the classic water level measurement system and the automatic water level measurement system). [6]

The classic water level measurement system consists of hydrometric grids located in the mentioned places, where the water levels are read daily.

The classical measuring system is used to compare and verify the data provided by the automatic measuring system.

The automatic level measuring system consists of an installation equipped with a float and a piezoresistive transducer, both mounted in a telelimnimetric tube.

Types of automated systems used:
- Measuring system with hydrostatic pressure sensor (Figure 4);
- Measuring system with optical encoder sensor (Figure 5);
- Measurement system with radar sensor (Figure 6).

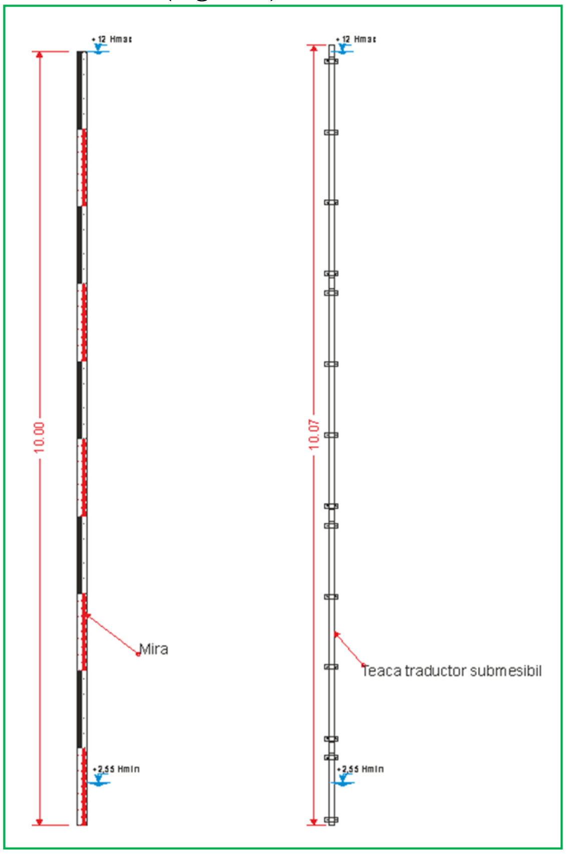


Figure 4 – Hydrometric station with submersible level transducer and mirrors

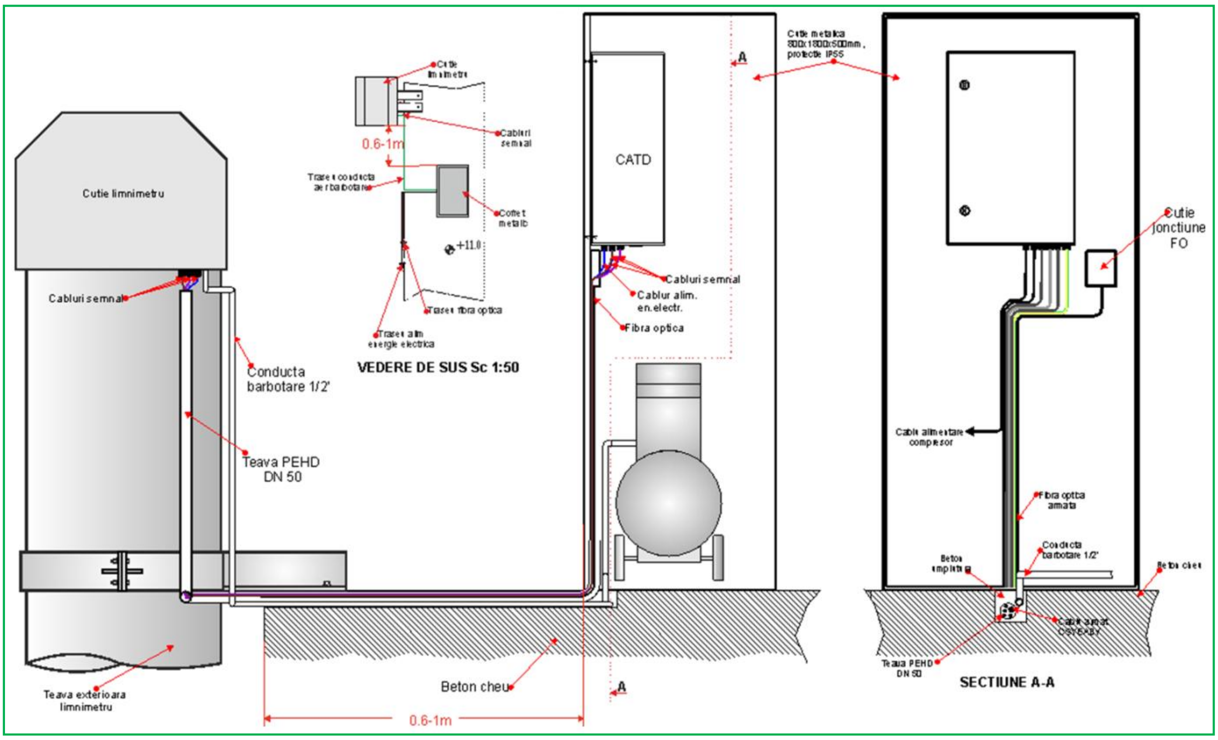
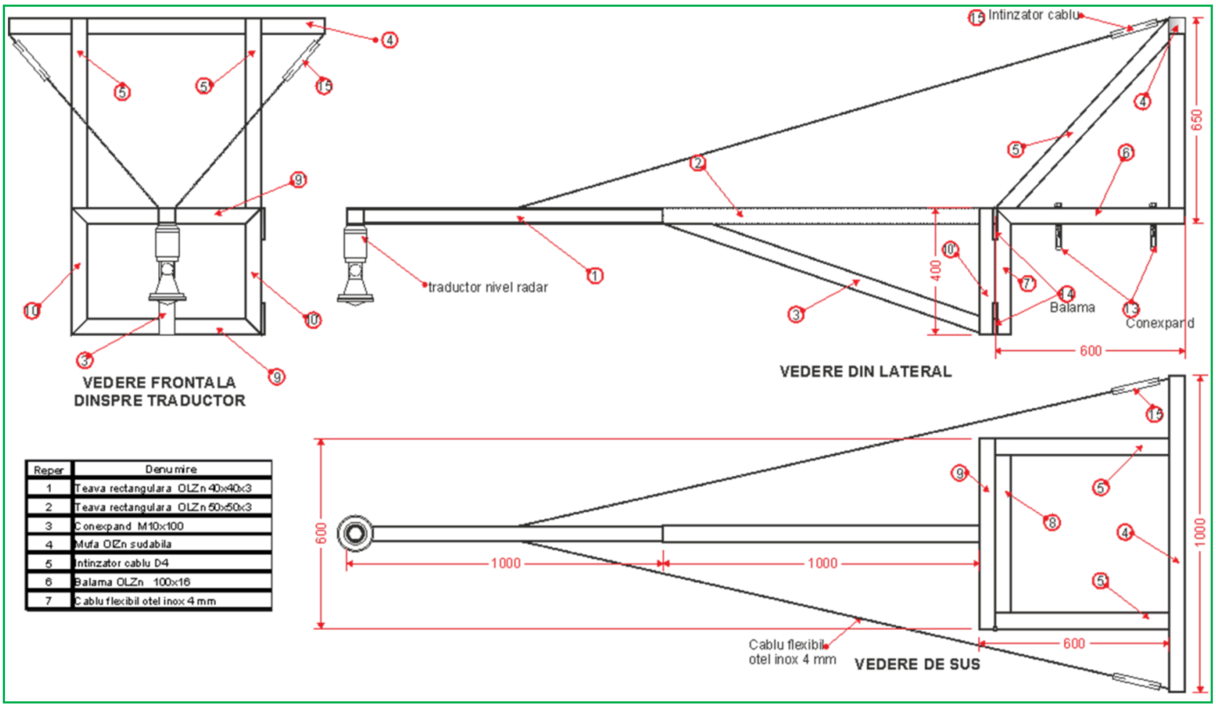


Figure 5 – Hydrometric station with encoder level transducer with float - general assembly



Reper	Denumire
1	Teava rectangulara OLZn 40x40x3
2	Teava rectangulara OLZn 50x50x3
3	Conexpand M10x100
4	Mufa OlZn sudabila
5	Intinzator cablu D4
6	Balama OLZn 100x16
7	Cablu flexibil otel inox 4 mm

Figure 6 – Hydrometric station with submersible level transducer and radar level transducer

Hydrodynamic groomers are fitted in all locations (Figure 7).

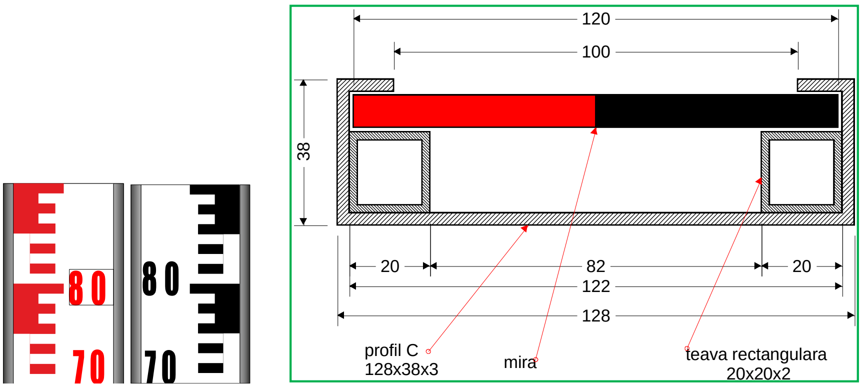


Figure 7 - Hydrodynamic sight and support

Water level data on the two canals is updated daily on-line on different site. [11], [12]

Hydrographic support system

For a good correction during the measurements, especially multibeam where the best possible positioning accuracy is needed, a static monitoring receiver is used, placed in a known location (Figure 8).

Figure 8 - Base station located in the Cernavoda area

For this purpose, along the entire length of the Danube and the navigable canals, a support system was set up for the hydrographic works, consisting in the installation of geodetic terminals used as reference points (Figure 9) [7].

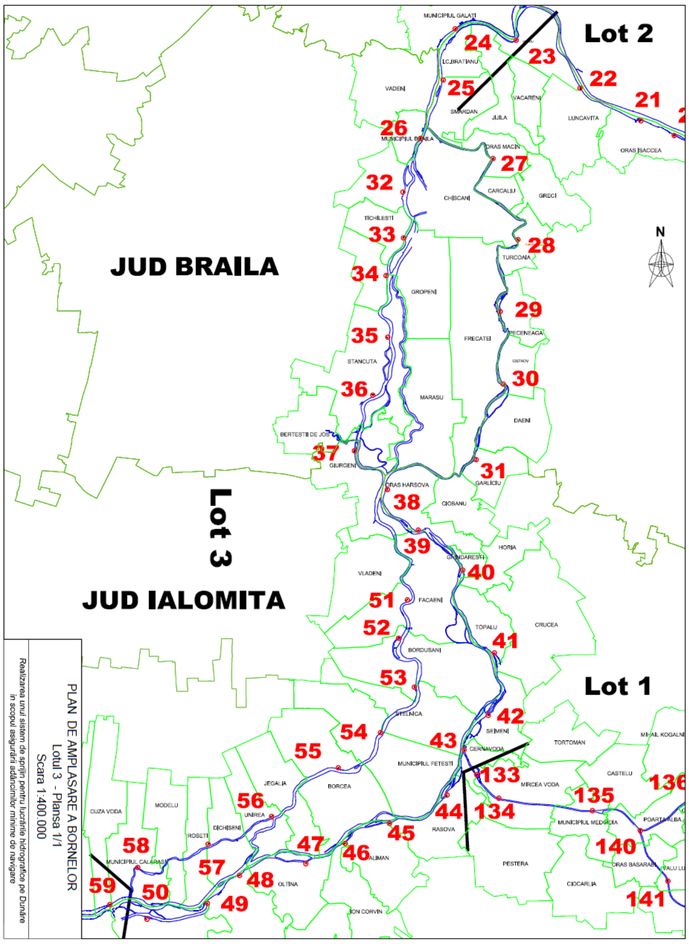


Figure 9 - Terminal location plan

Before starting the survey, it must be established the stations from where data will be collected regarding the water level and the measurement interval and also must done a verification of receipt of corrections from reference stations and accuracy according to requirements.

Acquisition of hydrographic data

The planning of the survey lines must be done in such a way as to achieve the necessary overlap to meet the established standard. Data density will vary depending on survey method, water depth and requirements. Survey method will be determined by available survey equipment, personnel and site conditions. [8] A single beam system will provide lower data density. [9] With a multibeam system, the deeper the water, the less dense the data will be, unless multiple passes are made. The type of survey will dictate data redundancy or data overlay requirements.

The regular system of sounding lines will be supplemented by a series of cross lines for checking and evaluating the measurement of depths and surveyed positions. Cross lines will be acquired and processed to the same standards of accuracy and data quality as required for main lines and will be included as the final bathymetric product of the survey. [10] Cross lines should have a good distribution over depth ranges so that maximum comparisons are made from one level to another.

Bathymetric data processing

The processing of bathymetric data involves the following steps:

- The transformation of depths into absolute elevations for each measured point;
- Sorting the points by selecting the points that correspond qualitatively;

- Saving from the work matrix in XYZ type files;
- Converting points into 3D raster files;

5. Conclusions

The steps performed for the execution of hydrographic works on the Danube - Black Sea Canal (CDMN) and the White Gate - Midia Năvodari Canal (CPAMN), next to Constanţa harbor is very important to establish the following bathymetric measurements.

Before starting the survey, it must be established:

- The stations from where data will be collected regarding the water level and the measurement interval;
- Verification of receipt of corrections from reference stations and accuracy according to requirements.

Following the bathymetric measurements on the two canals, the areas are identified where the deposits in the canal ditch exceed 1 m due to clogging, landslides or landslides. It was found that:

- The area between km 64 + 200 ÷ 64 + 600 CDMN (near km 299 of the Danube), is subject to the phenomenon of sanding with about 30,000 m3 / year (comparison of studies conducted in the last 10 years). 11],[12]
- On the area between km 13 + 130 ÷ 17 + 600 CPAMN the navigable canal was clogged with materials detached from the undeveloped shores that reach a diameter of more than 2 m. These represent a problem for navigation in the area. The multitude of obstacles makes it difficult to identify and mark them.

References

[1] Institutul de proiectări pentru transporturi auto, navale şi aeriene, Regulament de exploatare şi întreţinere Canal Dunăre - Marea Neagră, Bucureşti, RO: IPTANA, 2012.

[2] Institutul de proiectări pentru transporturi auto, navale şi aeriene, Regulament de exploatare şi întreţinere Canal White Gate - Midia - Năvodari, Bucureşti,RO: IPTANA, 2012.

[3] Malvern Instruments Ltd. , Mastersizer 3000, User manual, Malvern, GB: Malvern Instruments Ltd. , 2013.

[4] Hydro-Bios Apparatebau GmbH, Operating Instructions for Bottom Sampler acc. to van Veen, Altenholz, DE: Hydro-Bios Apparatebau GmbH, 2020.

[5] Forecast, „Tide-Forecast.com," [Interactiv]. Available: https://www.tide-forecast.com. [Accesat 19 4 2021].

[6] Organizaţia Hidrografică Internaţională, S44 - IHO STANDARDS FOR HYDROGRAPHIC SURVEYS, 2020.

[7] Hemisphere GNSS Inc, Vector V320 GNSS Smart Antenna - User guide, Scottsdale, AZ: Hemisphere GNSS Inc, 2018.

[8] Teledyne Marine Company, RiverRay ADCP User manual, Poway, CA: Teledyne RD Instruments, 2009.

[9] Valeport Limited, SoundBar 2 operation manual, Totnes, GB: Valeport Limited, 2003.

[10] Kongsberg Maritime AS, EA440 - Reference manual, Kongsberg, NO: Kongsberg Maritime, 2020.

[11] http://acn.ro/index.php/ro/ants
[12] https://danubeportal.com/waterLevel/filterWRM

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