Technical Assistance for the Improvement of the Navigation Conditions on the Danube

founded by EU and Romanian Government

ISPA measure 2002 RO 16 PA 011

Short Presentation
Prepared by:

Alexandru Balcu – Trapec S.A.

INTRODUCTION

- The Danube river basin is the heartland of Central and Eastern Europe.
- The main river is among the longest (ranked 21) in the world and the second longest in Europe. It has a total length of 2,857 km from its source at a height of 1,078 m in the Black Forest, Germany to its delta on the Black Sea, Romania.
- Between the source and the delta, the main Danube river falls a total height of 678 m and its characters varies from a mountain stream to a lowland river.
- Upstream of the Danube delta the mean flow of the river is about 6,550 m^3/s with maximum and minimum discharges of 15,540 m^3/s and 1610 m^3/s respectively.
- The basin can be divided into upper, middle and lower region (according to the geological structure and geography) and the Danube delta.

Morphohydrological situation of the study area

- The Danube sector situated between Chiciu – Calarasi and Braila, known also under the name of the moors of Ialomita and Braila, represents a particular area of the Danube valley, with a great morphohydrographical diversity.
- Braila Moor is located between the Dobrogea tableland in the East and the Romanian Plain in the west. The absolute altitude of the alluvial plain is between 6-7m near Braila and almost 14 – 16m at Ialomita.
- In natural regime, the morphohydrographical structure of the moors is the consequence of a long river erosion and sedimentation action, having as result the development of a network of natural levels, bogs and channels.

STUDY OBJECTIVES

- General objective of the project is to promote sustainable mobility.
- Immediate objectives of the project are to improve the navigation conditions on the Calarasi – Braila sector of the Danube.
- The above mentioned mainly imply the performance of river training works so as to meet the recommendations of the Danube Commission, but also include a package of small-size measures aiming and ensuring that the best conditions for a high economic return are met.

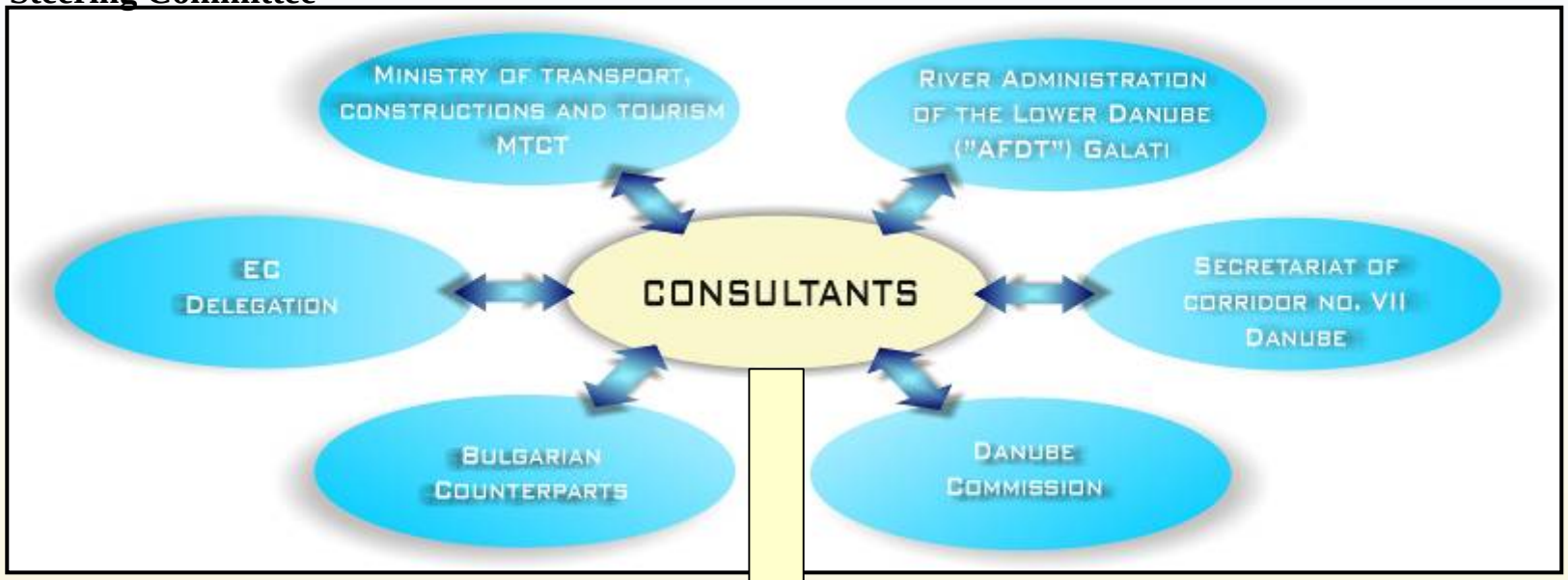
SCOPE OF PROJECT:

- Avoiding of degradation and “aging” state of the riverbed;
- Assurance of navigation conditions in compliance with the stipulations of Danube Commission (-2.50m under ENR), for low water levels;
- Realising of the balance between the dredging and maintenance works and structure works which can diverse the flows on the Old Danube;
- Minimal interventions which assure the natural conservation of the river;
- Local proposed works has effect for low water levels only;
- Favourable distribution of flows between Danube and the lateral branches.

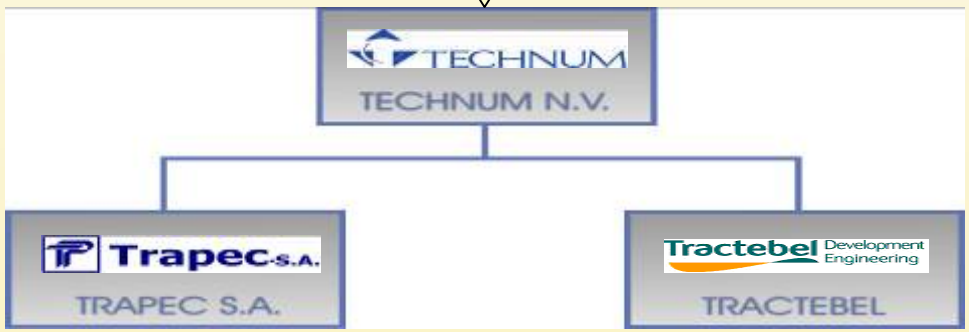
STUDY METHODOLOGY

- Collection of data
- Update on river status
- Present navigation conditions
- Establishment of technical solutions
- Cost estimates and phasing of the works
- Cost-benefit analysis

Steering Committee



Consultants



PROJECT TASKS:

1. Feasibility Study for the followings:

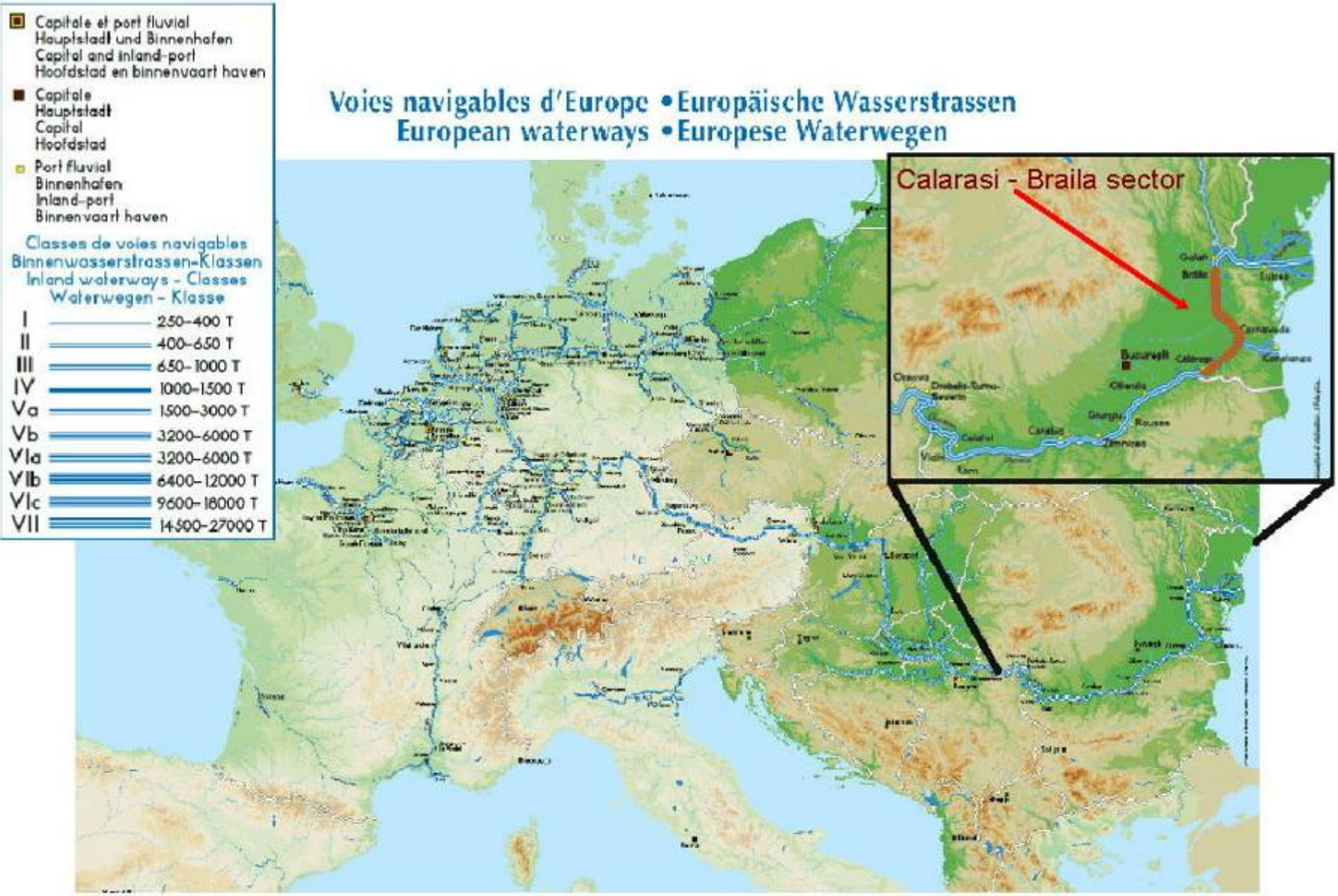
- Measure 1 – Improvement of navigation conditions on the Danube between Calarasi (km 375) and Braila (km 175).
- Measure 2 - Correction of the Danube riverbed in order to fit out the Danube's fairway in accordance with European requirements, for the Batin sector (km 531 – km 521).
- Measure 3 - Extension of Calafat port infrastructure and systematization of the port rail device.

2. Environment Impact assessment and Public Consultation for the above 3 measures.
3. ISPA Application for a package of priority measures concerning the Calarasi – Braila measure.
4. Detailed design for the ISPA financed measures (Calarasi – Braila section)
5. Tender Documents for the ISPA financed measures (Calarasi – Braila section)

Measure 1 – Improvement of navigation conditions on the Danube between Calarasi (km 375) and Braila (km 175).

Danube – Transport Corridor

- Navigation on Danube represents a traditional old activity
- Transport infrastructure is essential for the economical development of the region
- The sector between Calarasi and Braila is an important sector of the Pan-European corridor no. VII. In the same time, it assures the connection between the fluvial Danube and the Danube – Black Sea navigable canal, as well as with the maritime Danube.


Capitale et port fluvial
Hauptstadt und Binnenhafen
Capital and inland-port
Hoofdstad en binnenvaart haven
Capitale
Hauptstadt
Capital
Hoofdstad
Port fluvial
Binnenhafen
Inland-port
Binnenvaart haven
Classes de voies navigables
Binnenwasserstrassen-Klassen
Inland waterways - Classes
Waterwegen - Klasse
I 250-400 T
II 400-650 T
III 650-1000 T
IV 1000-1500 T
Va 1500-3000 T
Vb 3200-6000 T
VIa 3200-6000 T
VIb 6400-12000 T
VIc 9600-18000 T
VII 14500-27000 T
Voies navigables d'Europe • Europäische Wasserstrassen
European waterways • Europese Waterwegen
Calarasi - Braila sector
Bucuresti
Cernavoda
Constanta

Pan - European Transport Corridor number VII

Framing on European Strategies regarding the transport On Low Danube

- Regarding the interest of the development of the transport infrastructure in the extended future Europe, it was considered as necessary the financing of a project which remove some deficiencies and implement the results of some studies regarding the navigation on Low Danube, such as:

  - Danube River Development Strategy, F. Harris – 1994
  - Regional Study for the Danube Corridor Development Plan - Kienbaum und Partner – 1996
  - Study to Improve Navigation on the Danube, in Bulgaria and Romania, F. Harris - 1999

European regulations for navigation on Low Danube

Danube Convention

For Calarasi – Braila Sector, the navigation parameters established by the Danube Commission refer to:

- 2.5m minimum depth under ENR
- 180 – 150 m navigable channel width
- Minimum curve radius of 1000 m

Historical and Geographical Aspects

- An important aspect for the historic development of the Danube is the Bala branch, which started to flow around 1920 enabling a short cut of the Old Danube via the Borcea. As a consequence, the Lower Old Danube started to silt-up resulting in shallow areas during low and medium river discharges.
- River training works started just before 1970 on the Lower Old Danube and the dredging volumes have been considerable amounting to some 700,000 m^3/year in the period 1980 to 1990. This emphasises the heavy sedimentation of the Lower Old Danube due to the short cut through the Bala.
- After 1990 the maintenance dredging decreased considerably due to the budget restrictions, and as result the discharges via the Lower Old Danube decreased further.

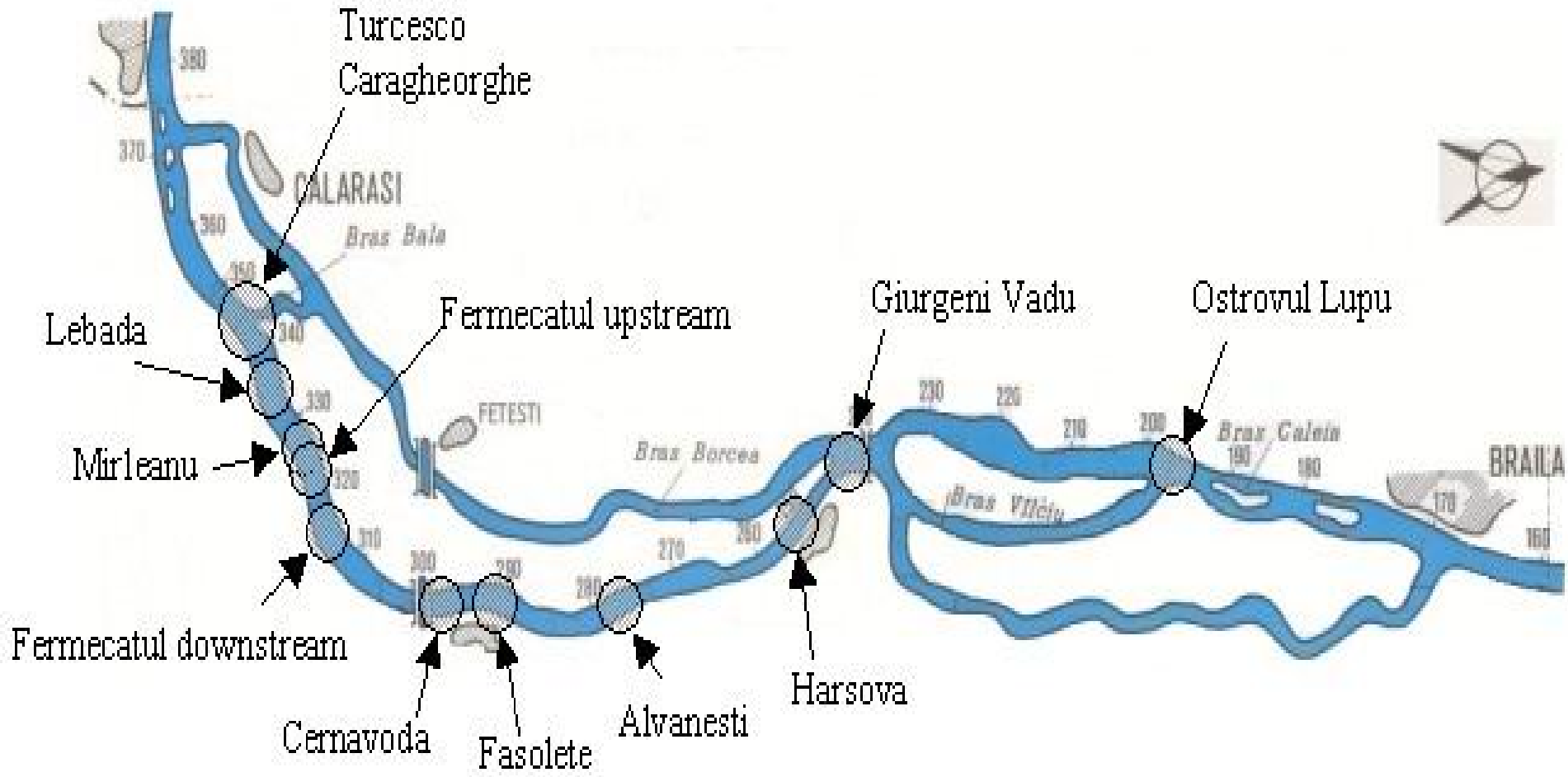
- Old Danube branch is located on the eastern side of the moor and it spreads between km 373 and km 241. Until km 346 it is navigable. The average width of the riverbed is 480 m at Izvoarele (upstream) and 380 m at Harsova (downstream) and the average depths are 12m at Izvoarele and 8 m at Harsova.
- Borcea branch is located in the west side, laying out between km 373 and km 241, having 110 km length and average width of 165 m on the upper Borcea and 350 m on the lower Borcea. The average depths are 4.90m on the upper Borcea and 11.2m on the lower Borcea.
- Bala branch detaches from the Old Danube at km 346 and it is discharging in Borcea branch at km 68 (on Borcea). Bala branch has a length of 11 km, an average width of 90 m , medium depth of 7.5 and average area of section of 3.000 m^2.

Navigation aspects

- During the dry seasons, on the main branch of Danube, between km 346 (Bala branch outlet upstream) and km 300 (outlet Danube – Black Sea Canal), the flow of Danube diminishes, having as result the decreasing of the water depths in the fairway under 2.5m (in some critical points the depth is of 1.40m). We face this situation almost 160 days/year in average.

- Due to this situation, the navigation is diverted on Bala – Borcea secondary branch . Using this secondary branch, the distance between Calarasi and Cernavoda increases with almost 110 km. In the same time, due to the reduced dimensions of Bala – Borcea navigation channel, only one-way direction navigation can be made. Moreover, the large ship convoys must be dismantling on 2-3 unit formations.

- Poor evolution of water flows started, more over 30 years, the rapid activation of Bala and downstream Borcea branches together with the major erosion of the banks and adjacent territories and the alluvial deposition of the Danube between Harsova and Braila. The navigation is diverted on Caleia branch, which cannot assure the navigation widths.



Critical Points on Calarasi – Braila Sector

Hydrological conditions

The situation mentioned above is due to the followings:

- Unfavourable distribution of flows between the main branch of Danube and branches Bala – Borcea. Usually, the distribution is 20% on the main branch and 80% on Bala-Borcea branch. During the very dry seasons (as is happened in 2003) the flow on the main branch decreased up to 13%.
- “Aging” of the main Danube riverbed, due to the lack of the water.
- Major erosions on Bala branch and on downstream Borcea branch and sediment deposition on Danube, downstream by Harsova.

Effects on utilities

The facts mentioned above has as results:

- Reducing of navigable overall size of the fairway
- Increasing of dragging works and maintenance works volumes.
- Reducing of water supply, including the water for irrigation and for the cooling system of Cernavoda Electrical Nuclear Plant

Scope of Works

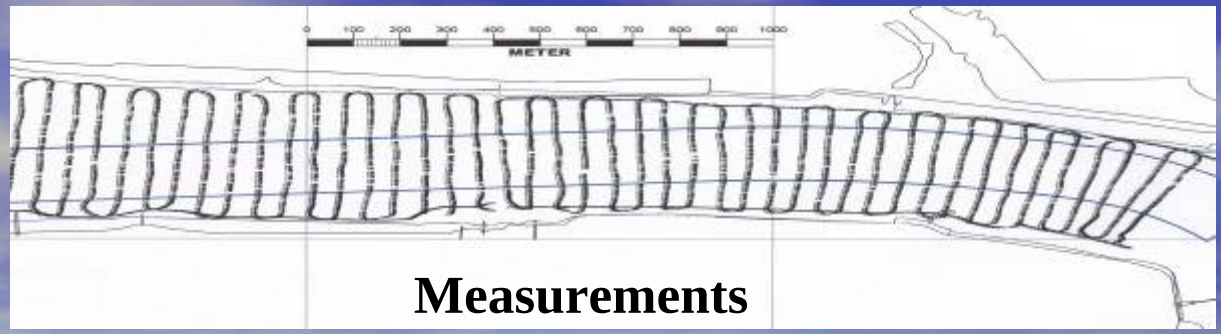
The project purpose is the rehabilitation of the riverbed and the improving of the hydro-morphological conditions in the critical points

Project Stages

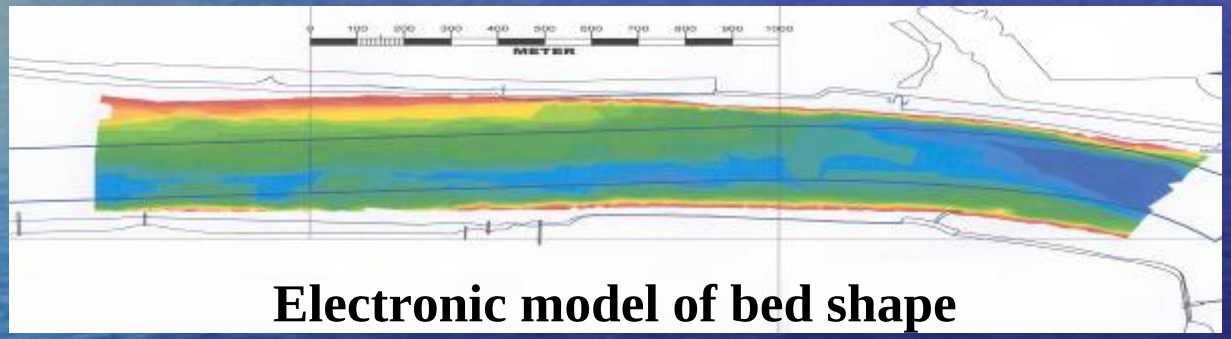
1. Geotechnical surveys
2. Topographical and bathymetrical surveys
3. Mathematical modelling
4. Design

Geotechnical Survey

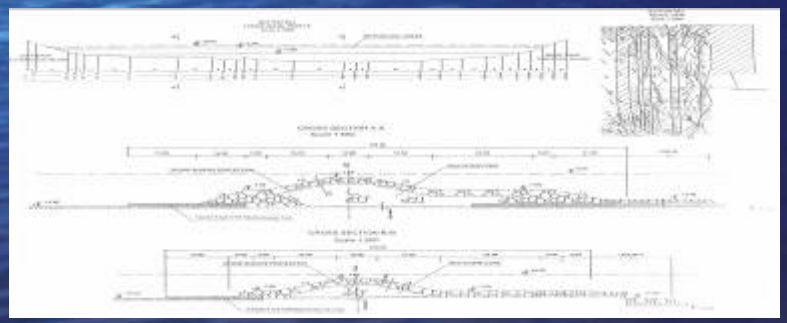
- The geotechnical study included in field and laboratory investigations analysis, with the purpose of physical – mechanical and state characteristics assessment, regarding existing soils in Danube River, upon which the designed works will be founded.
- In field investigations consisted of geotechnical drillings, with ground sampling and sounding test blow sounds.
- The result analyze, refinement and



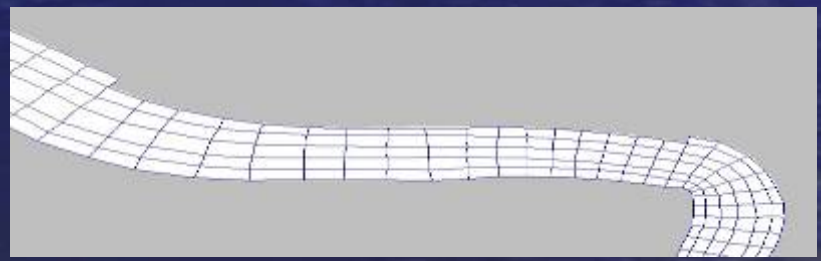
Measurements



Electronic model of bed shape



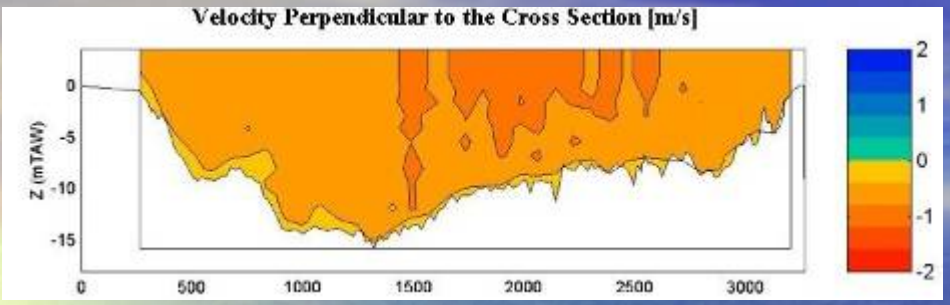
Design

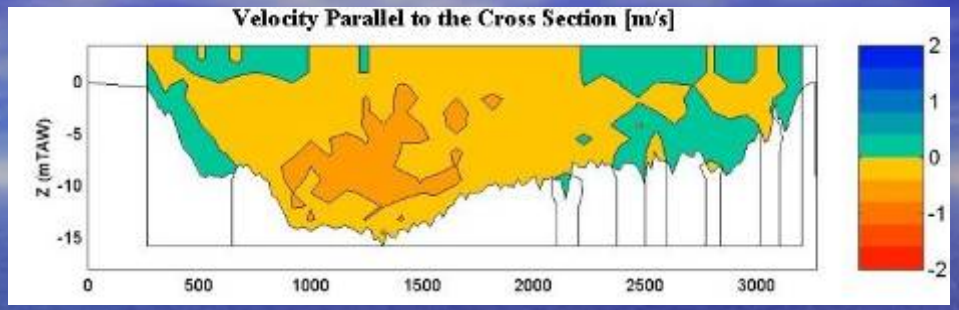


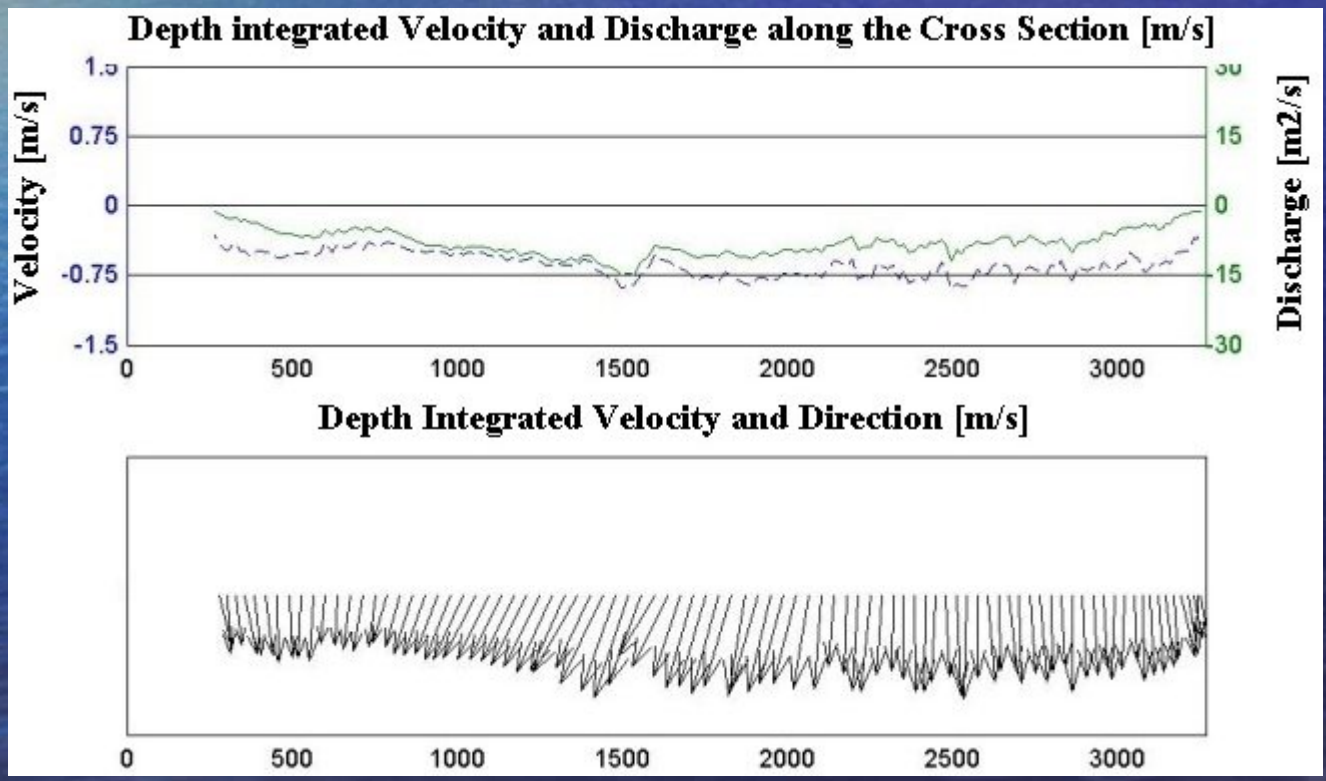
Mathematical Model

Hydrographical, Topographical and Flow Meassurements

Velocities measurements using ADCP equipment







Mathematical Modelling

Introduction

- The numerical model includes hydrodynamic and sediment transport conditions.
- The hydrodynamic model allows studying the flow conditions, i.e: water levels, flow direction and flow discharge.
- With the sediment transport model, the sedimentation patterns and the morphological evolution at the critical points are studied.

Modelling Tasks

- Correction of flow distribution between Danube and Bala branch
- Correction of flow distribution between Danube and Caleia branch
- Similar corrections on some smaller branches

Mathematical software

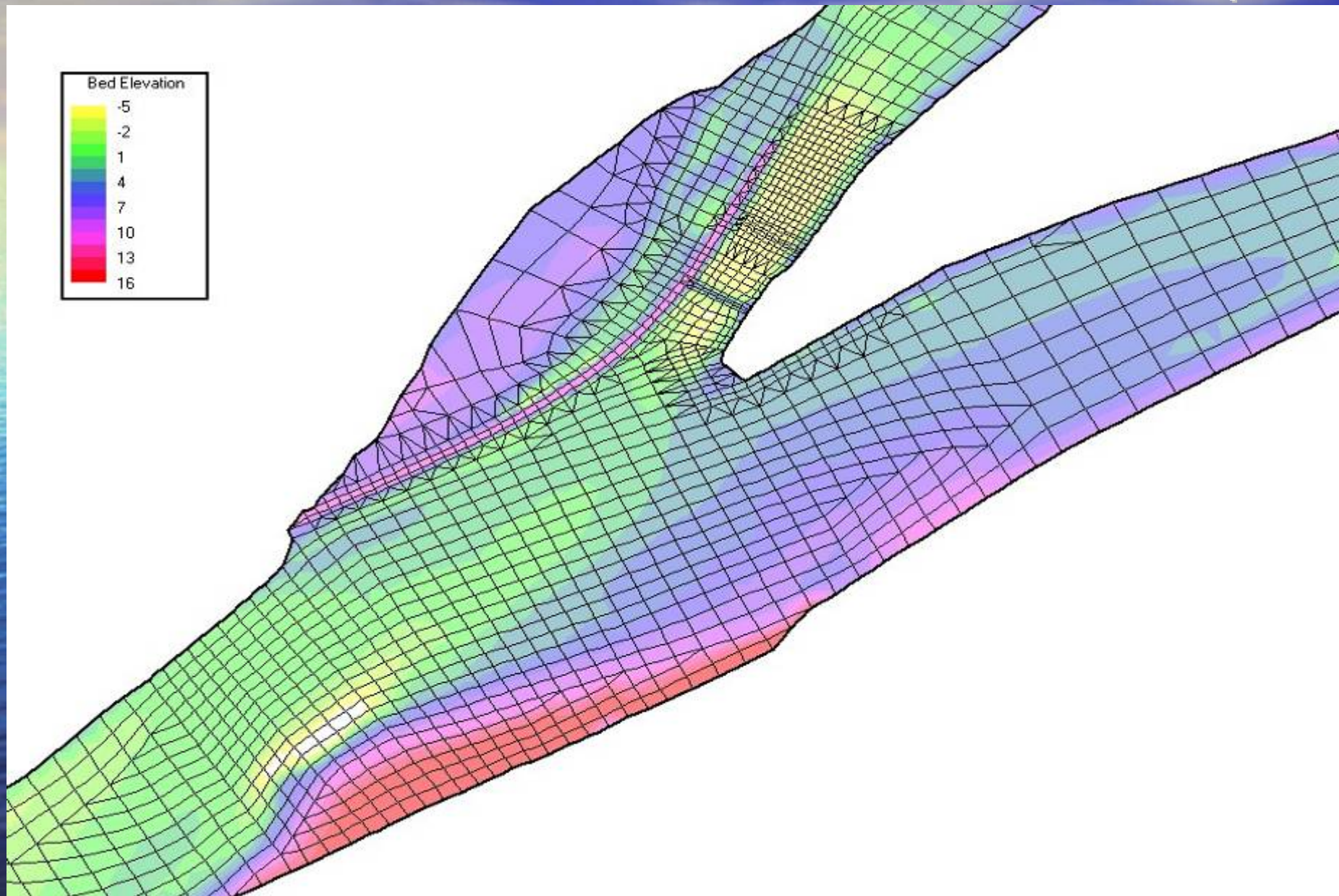
- Hydrodynamic computation were done with software RMA2 Version 7.3D and RMA11 Version 4.2B. RMA2 is a two-dimensional finite element model for hydrodynamic systems and RMA11 is a state of the art water quality model designed for the simulation of the transport and erosion/deposition of suspended sediments.

- An assemblage of one/two-dimensional elements has been used in the same network; 1D elements are present in secondary branches, while 2D elements are used in the main navigation branch.

Hydrodynamic Model

- The 2D numerical model gives the flow conditions in the area of the study; additionally, the flow field results are used as input data by the sediment transport model.
- The model covers from upstream in Silistra (km 380), to downstream in Braila (km 165). The main branches: Bala, Vilciu and Macin have been included.
- A total of 30,000 nodes, 3,000 2D and 1,000 1D elements form the finite element network of the model.

Mathematical Model Mesh - Example



Sediment Transport Model

- The model aimed to study the sediment transport patterns (erosion/deposition) at the critical navigation points and used the network and results from the 2D hydrodynamic model.
- The numerical model gives the sediment movement trends and an estimative of the sedimentation/erosion rates.
- As in the hydrodynamic model, two open boundary conditions have been used for the sediment transport simulations: upstream in Silistra and downstream in Braila

Simulation of scenarios

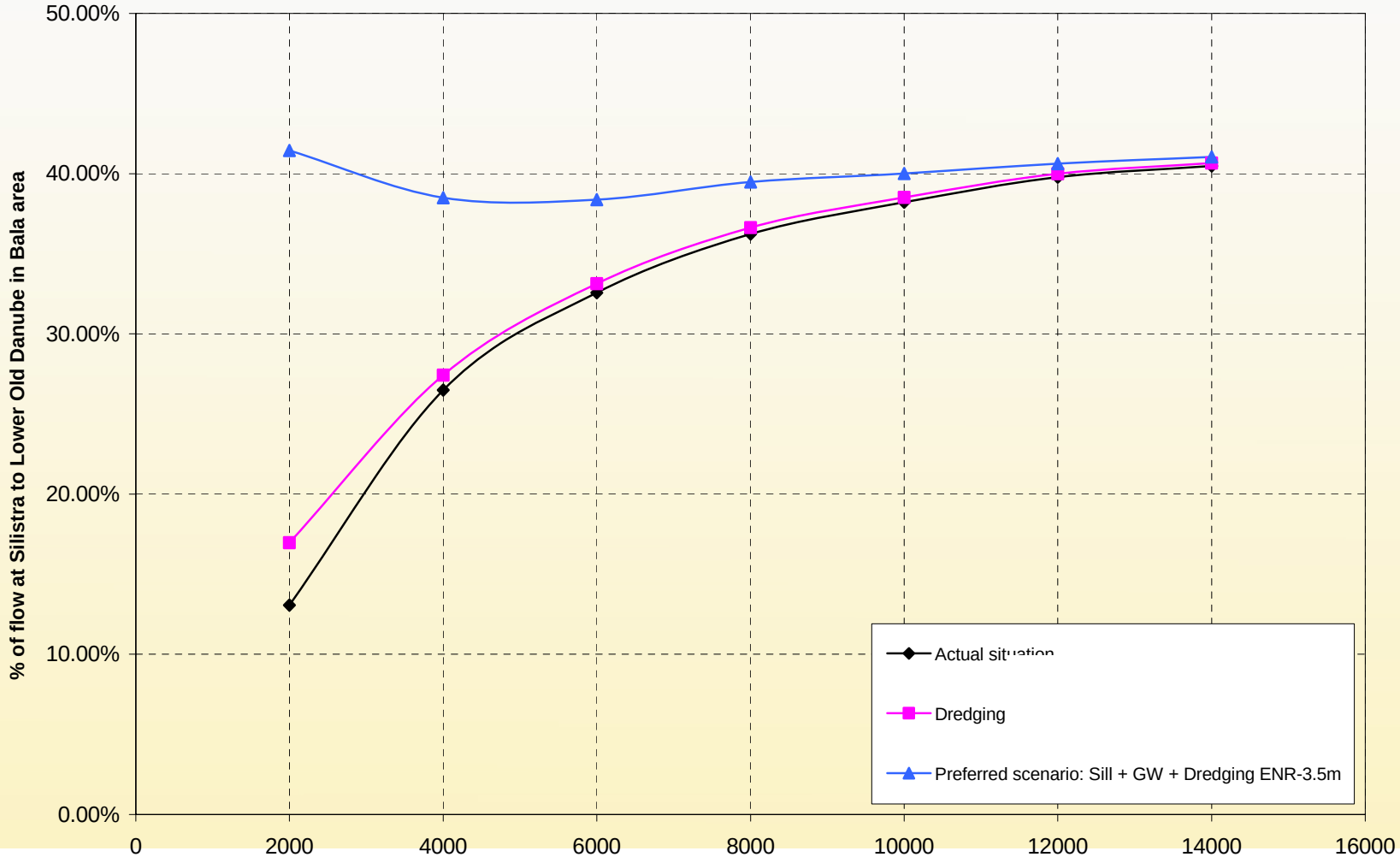
- The simulation of different strategies, or even separate items from a strategy have been used by the complete, detailed model.

Output Results

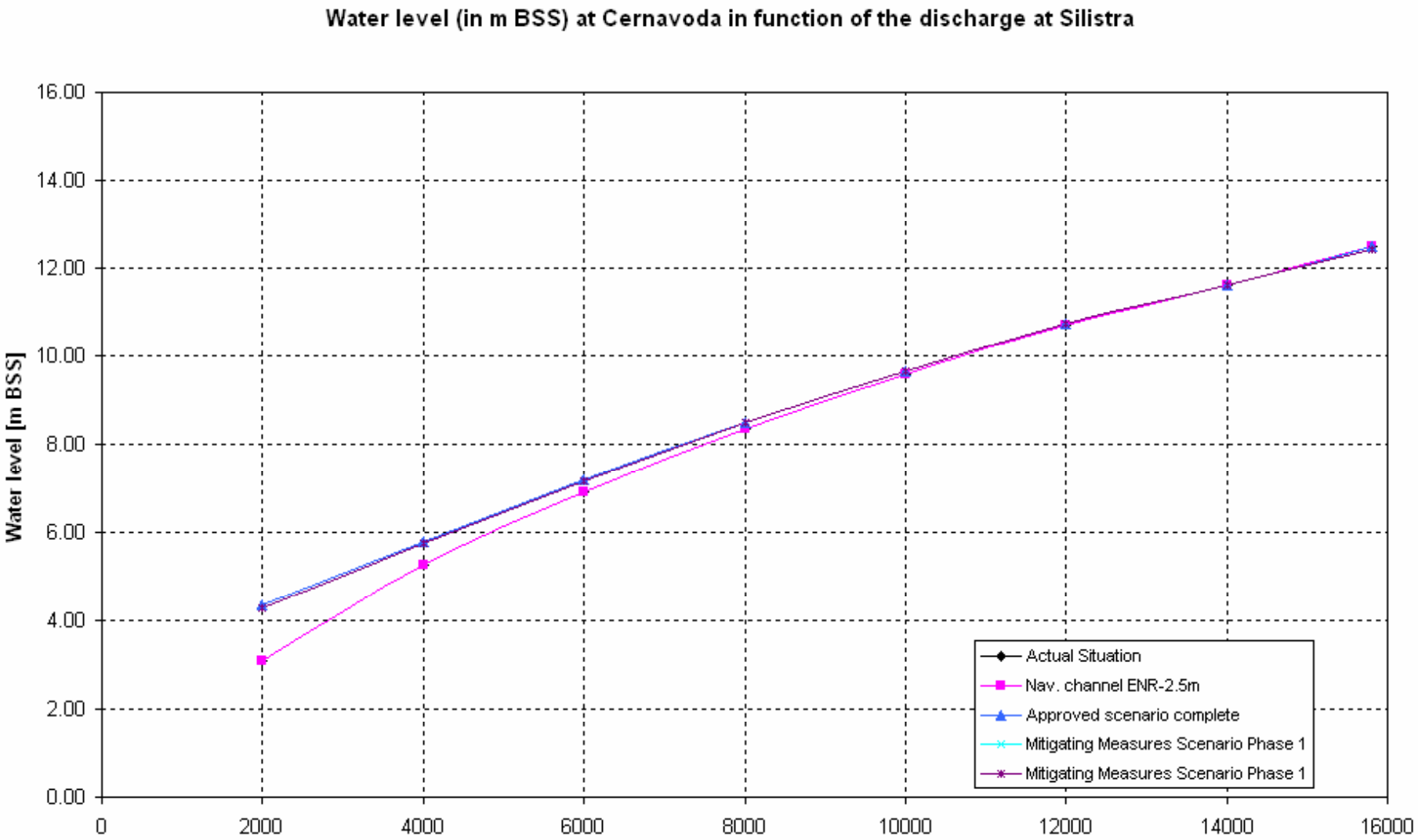
- Expected water level changes along the Danube
- Expected changes in flows because of redistribution
- Expected flow velocities in the navigation channel but also near the banks

Correction of flow distribution

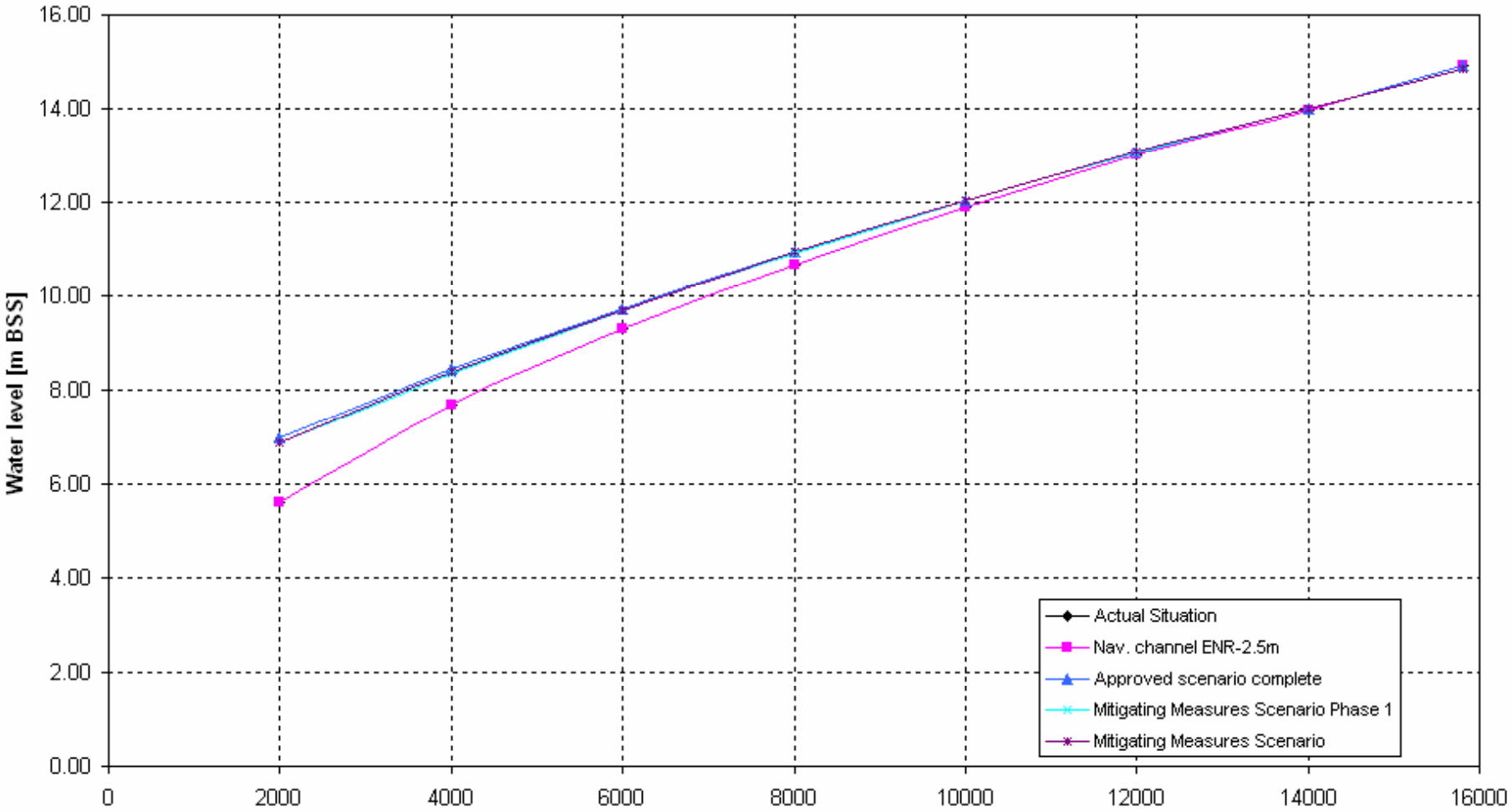
Discharge distribution to Lower Old Danube for the preferred scenario compared to the actual situation and a scenario with only dredging



Effects on water levels on Old Danube



Water level (in m BSS) at Izvoarele in function of the discharge at Silistra



DESIGN

MEASURE 1: Improvement of the navigation conditions on the Danube between Calarasi and Braila, and accompanying measures

THE WORKS ARE SPLITED IN TO:

- WORKS IN STAGE I
- WORKS IN STAGE II

WORKS IN STAGE I

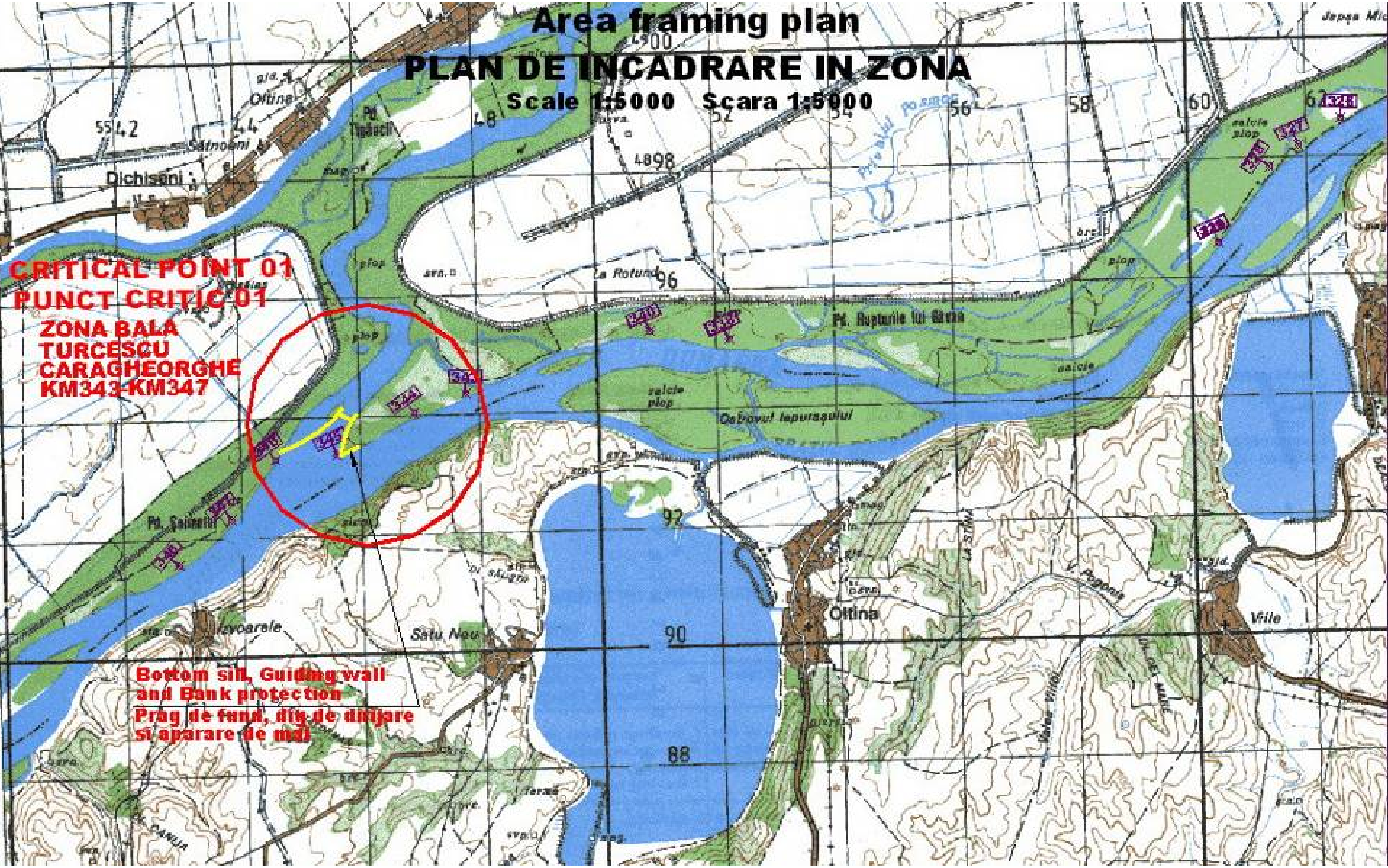
- Critical point 01 – Bala and Caragheorghe
- Critical point 02 – Epurasu Branch
- Critical point 10 – Caleia and Ostrovo Lupu area

WORKS IN STAGE II

- Critical point 03A – Seica upstream
- Critical point 03B – Seica downstream
- Critical point 04A – Ceacaru
- Critical point 04B – Fermecatu
- Critical point 07 – Fasolele Island
- Critical point 08 – Bank protection at km267 - km268+500
- Critical point 09 – Bank protection at km233 - km232

STAGE I

CRITICAL POINT 01 – BALA



Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000   Scara 1:5000
CRITICAL POINT 01
PUNCT CRITIC 01
ZONA BALA
TURCESCU
CARAGHEORGHE
KM343-KM347
Bottom sill, Guiding wall
and Bank protection
Prag de fund, dig de dirijare
si aparare de mal
Dichiseni
Oltina
Satu Nou
Izvoarele
Viile
Ostrovul Iepurasului
Pd. Rupturile lui Găvan
La Rotunda

The proposed works will balance the flow distribution to a reasonable share, close to the natural distribution on high water levels situation, which will increase to 40% the share of the flow going on the Old Danube branch, with negligible influences on flood situations.

The technical solution was analysed and optimized using a dedicated mathematical model and it will consist of:

- **a guiding wall** to reduce the width of the water current on the Bala branch entrance, and to direct the flow toward the Old Danube branch
- **a bottom sill** to reduce the cross-sections on the Bala mouth in order to adjust the flow distribution between the two riverbed branches

-additional **works** needed **for protecting the riverbed and the banks** against erosion, consisting in riverbed protection for a length of 300m downstream from the sill, and on the same length bank protections will be rehabilitated/constructed

The **dredging works on Caragheorghe** sand bar, aim to calibrate the riverbed by shaping the appropriate fairway as provided by the Danube Commission. Together with the works on the Bala entrance, the dredging works on Caragheorghe will contribute to an appropriate adjustment of the flow distribution and to ensure the required fairway parameters on the main Danube branch.


GENERAL PLAN
PLAN DE ANSAMBLU
Scara 1:5000
GUIDING WALL
DIG DE DIRIJARE
FRAG DE FUND
BOTTOM SILL
BALA BRANCH
BRATUL BALA
I. TURCESCU
BANK PROTECTION
APARARE DE MAL
FAIRWAY
SENAL NAVIGABIL

Guiding Wall L = 2114 m

The works consist of:

1) Faggot mattresses of 0.60m thickness to land and 0.75m to Bala branch, ballasted with sorted raw stone of 10-30 kg/piece;

1) Geotextile on slopes;

1) Stone blocks revetment
   - sill upstream and downstream - 200–600 Kg/piece of 1m thickness
   - nearby the sill – 0.5 – 2 to/piece of 1.2 m thickness

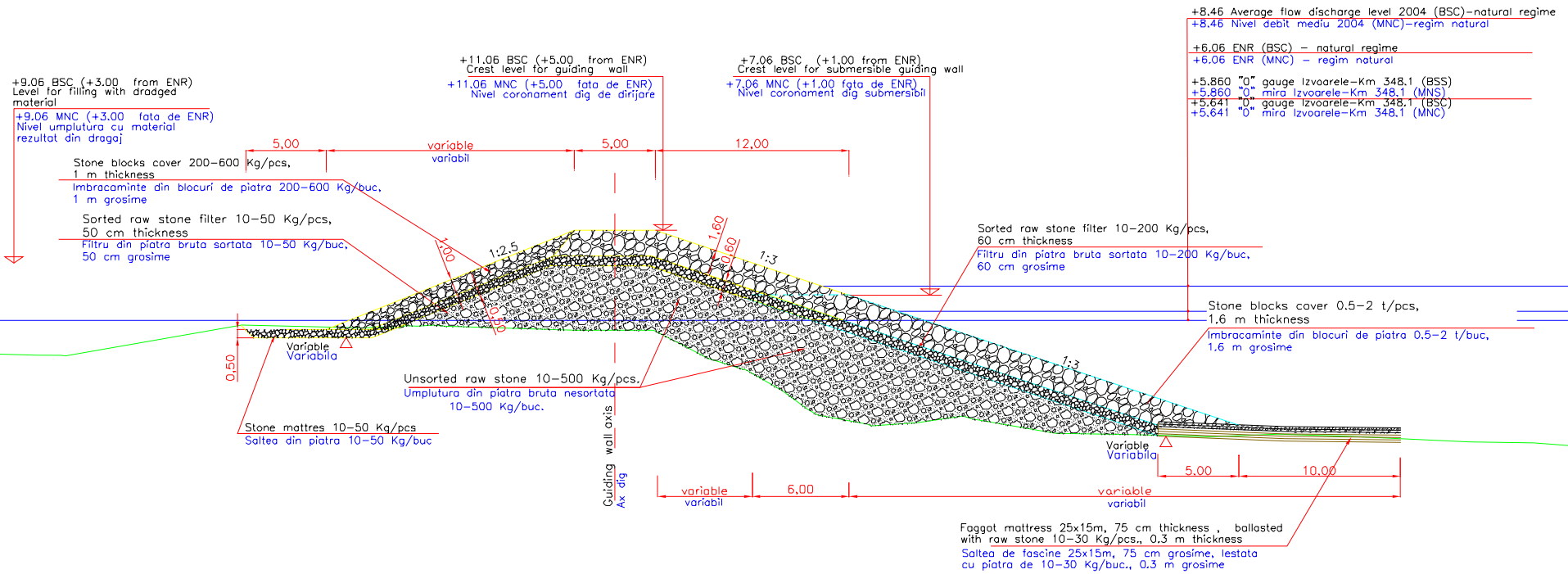
1) Sorted raw stone filter
   - sill upstream and downstream - 10 – 50 kg/piece of 0.50m thickness
   - nearby the sill – 5 – 200 kg/piece of 0.60 m thickness

1) Unsorted raw stone of 10 – 500 kg/piece;

1) Quarry stone prism of 150 – 300 kg/piece;

PROFIL TRANSVERSAL DIG DE DIRIJARE TIP
CROSS SECTION GUIDING WALL TYPE

SCARA 1:200 – SCALE 1:200



Bank Protections

On Turcescu Island L = 1147 m

The works consist of :

1) Faggot mattresses ballasted with sorted raw stone of 10 – 30 kg/piece

1) Geotextile on slopes

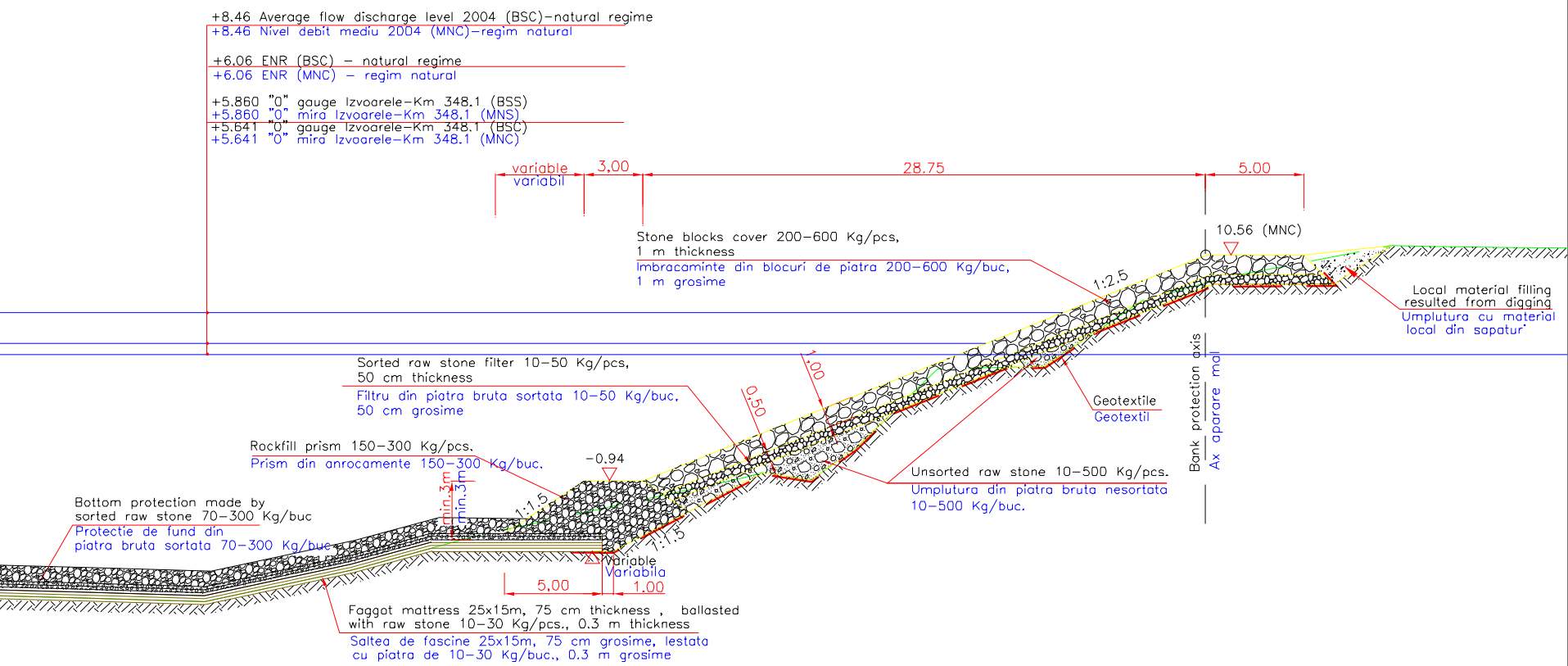
1) Stone blocks revetment
   - sill upstream and downstream - 200–600 Kg/piece of 1m thickness
   - sill area – 0.5 – 2 t/piece of 1.2 m in thickness

1) Sorted raw stone filter
   - sill upstream and downstream - 10 – 50 kg/piece of 0.50m thickness
   - sill area – 5 – 200 kg/piece of 0.60 m thickness

1) Unsorted raw stone filling of 10 – 500 kg/piece;
2) Quarry stone prism of 150 – 300 kg/piece;

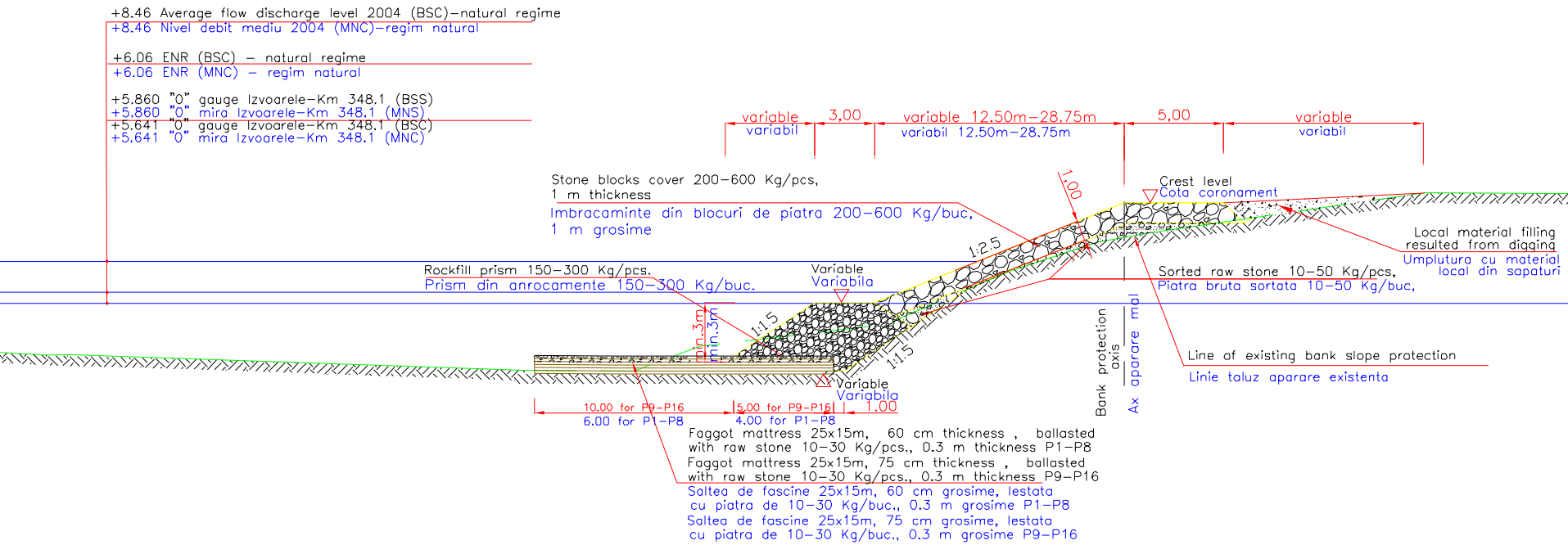
PROFIL TRANSVERSAL APARARE MAL TIP
CROSS SECTION BANK PROTECTION TYPE

SCARA 1:200 – SCALE 1:200



PROFIL TRANSVERSAL APARARE MAL TIP
CROSS SECTION BANK PROTECTION TYPE

SCARA 1:200 – SCALE 1:200



Bottom sill

L = 195 m

The works consist of:

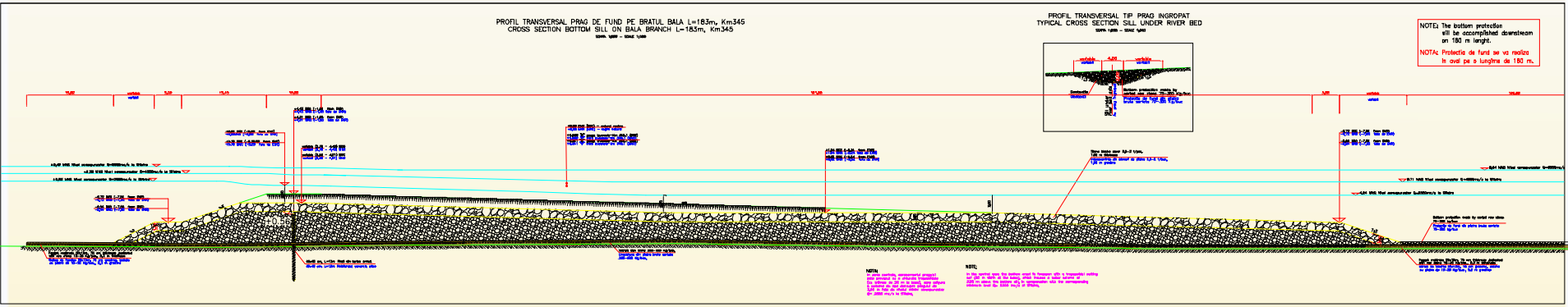
1) Faggot mattresses of 0.75m thickness ballasted with sorted raw stone of 10-30 kg/piece;

1) Riverbed protection with sorted raw stone of 70-300 kg/piece;

1) Stone block revetment of 0.5-2 to/piece of 1.60m thickness;

1) Sorted raw stone of 200 – 600 kg/piece;

1) Reinforced concrete piles of 0.40x0.40m – L = 12m, at 1.0m inter-axe


PROFIL TRANSVERSAL PRAG DE FUND PE BRATUL BALA L=183m, Km345
CROSS SECTION BOTTOM SILL ON BALA BRANCH L=183m, Km345
PROFIL TRANSVERSAL TIP PRAG INGROPAT
TYPICAL CROSS SECTION SILL UNDER RIVER BED
NOTE: The bottom protection will be accomplished downstream on 180 m lenght.
NOTA: Protectia de fund se va realiza in aval pe a lungime de 180 m.

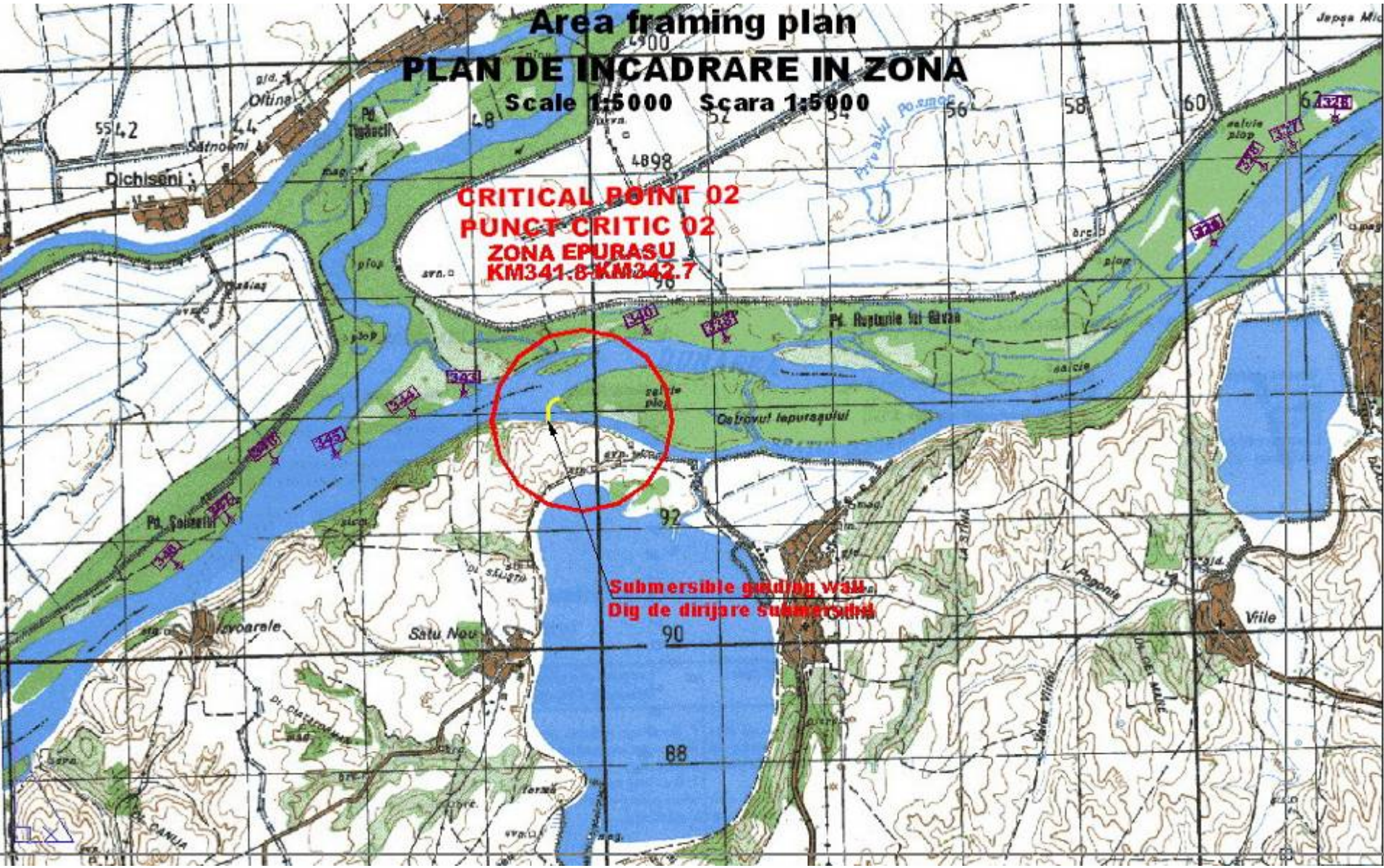
Critical Point 02

Epurasu

Following works have been provided:

- **Submersible guiding wall** at the entrance of Epurasu branch, which rebuilds and completes the existing structures, having a variable crest level, between +9,50 and +11,00m MNC (between +3,55m and +5,05m from ENR), L=580 m.

- **bank protection** on the downstream area, after the dam is embedded in the island bank, L= 56m.


Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000 Scara 1:5000
CRITICAL POINT 02
PUNCT CRITIC 02
ZONA EPURASU
KM341.8-KM342.7
Submersible guiding wall
Dig de dirijare submersibil
Dichiseni
Satu Nou
Vrile
Ostrovul Iepurasului


GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000 scara 1:5000
DUNAREA
DANUBE
FAIRWAY
SENAL NAVIGABIL
INSULA EPURASU
SUBMERSIBLE GUIDING WALL
DIG DE DIRIJARE SUBMERSIBIL
PT
PD
PP
PP
PP

Guiding Wall
L = 580 m

The works consist of:

Faggot mattresses of 0.60m thickness ballasted with sorted raw stone of 10-30 kg/piece.

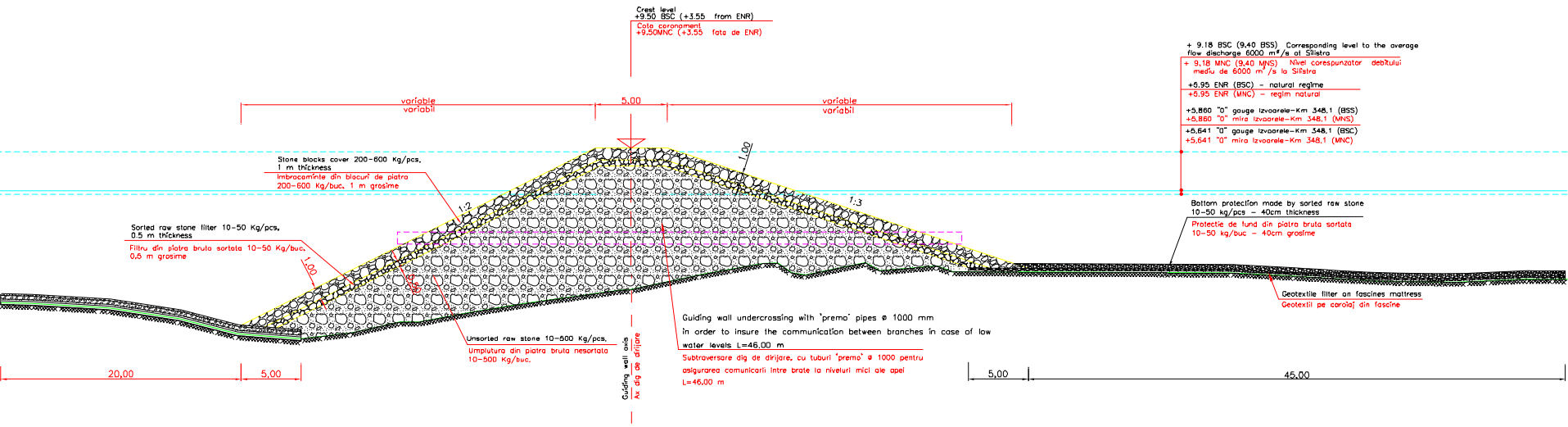
Bottom protection made of sorted raw stone of 10 – 50 kg/piece;

Stone block revetment of 200 – 600kg/piece of 1.00m thickness;

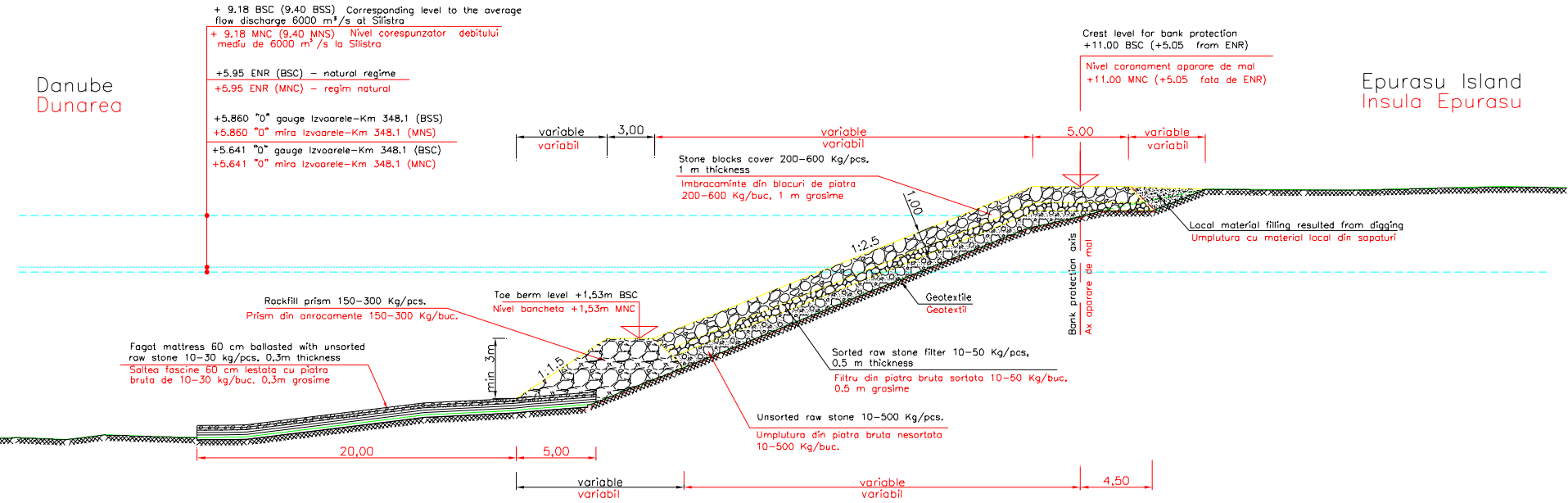
Sorted raw stone filter of 0 – 50 kg/piece of 0.50m thickness;

Unsorted raw stone of 10 – 500 kg/piece.

TYPICAL PROFILE FOR SUBMERSIBLE GUIDING WALL / PROFIL TIP DIG DE DIRIJARE SUBMERSIBIL

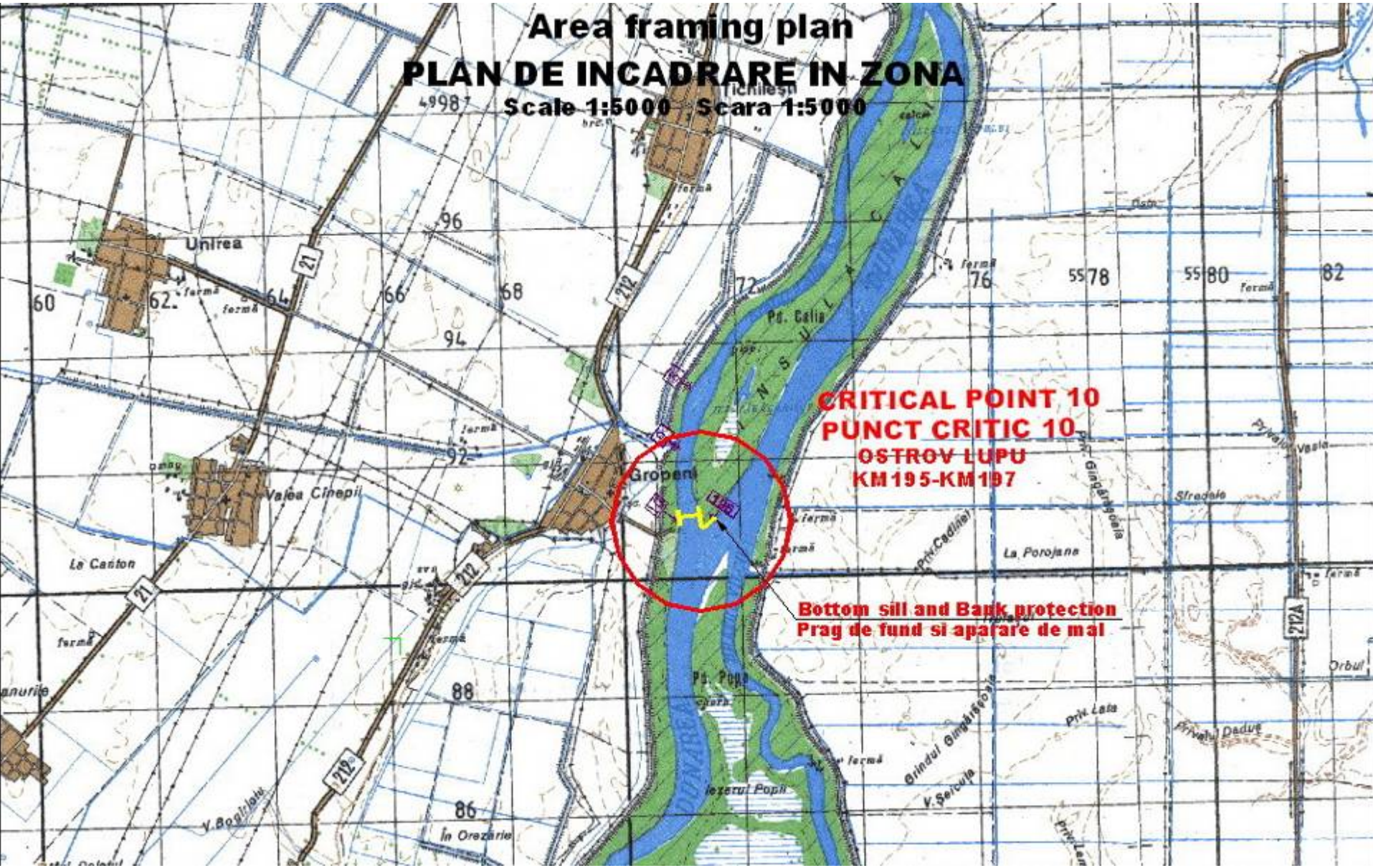


TYPICAL PROFILE FOR BANK PROTECTION / PROFIL TIP APARARE DE MAL



Critical Point 10

Ostrovo Lupu


Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000 Scara 1:5000
CRITICAL POINT 10
PUNCT CRITIC 10
OSTROV LUPU
KM195-KM197
Bottom sill and Bank protection
Prag de fund si aparare de mal
Unirea
Valea Cinepii
Groperi
La Caston
La Porojana
Pd. Popa
Iezerul Popii
In Orezarie
Pd. Calia
Tichilesti
DUNAREA
21
212
212A

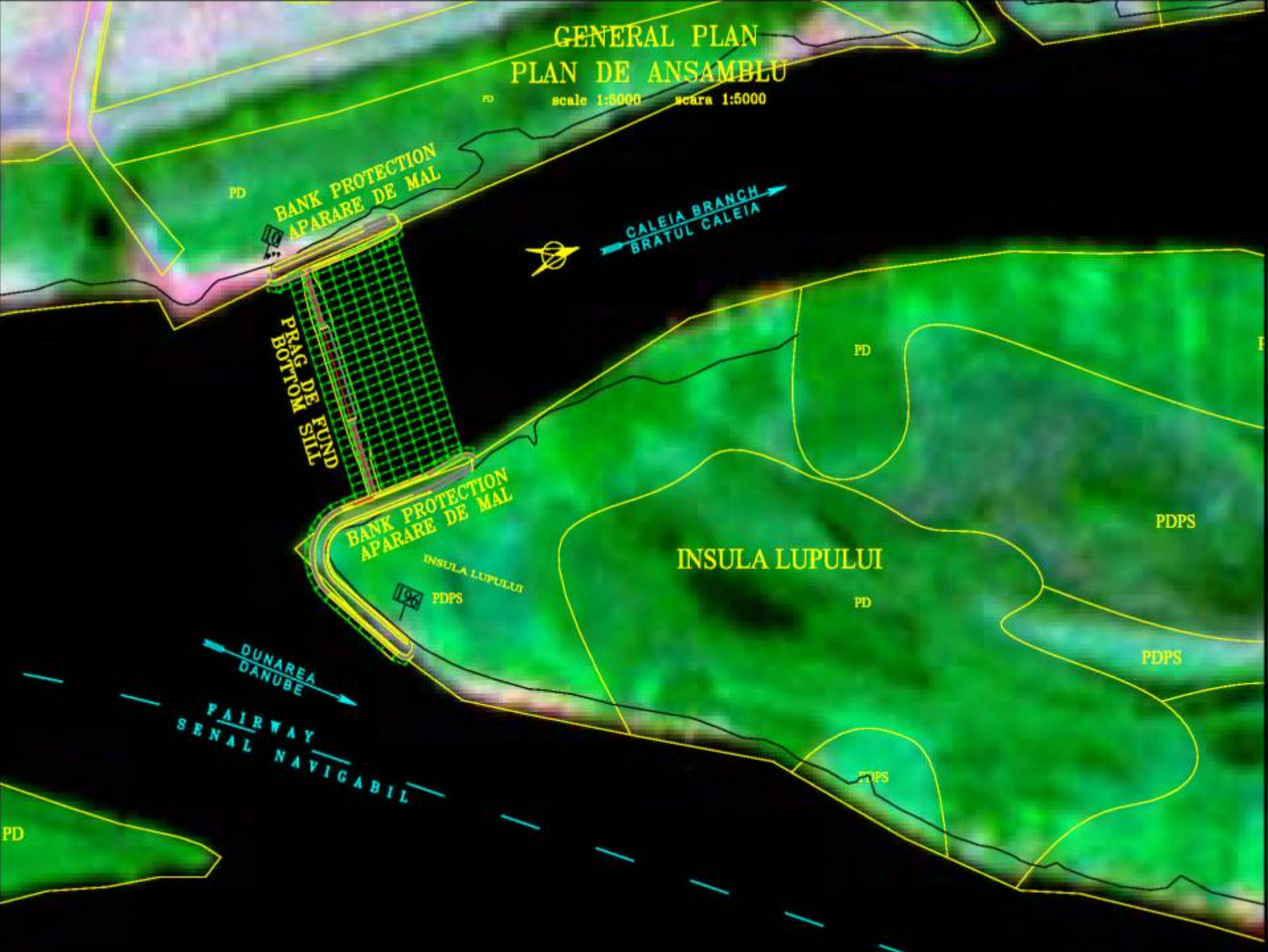
The **bottom sill** is arranged on the central area in order to insure the fairway. Therefore the level at crest is various:

- on the central area with the length of 155m the level at crest is -2,02m MNC (-3,88 from ENR)
- towards the left bank, on a length of 92m, the level at crest is +1,18m MNC (-0,68 from ENR)
- towards the right bank, on a length of 124m, the level at crest is +1,18m MNC (-0,68 from ENR)

Correlated with the works on Caleia bifurcation (Ostrovo Lupu) some **dredging works** are proposed on the bifurcation area in order to reshape the fairway and to support a balanced flow among the two branches.

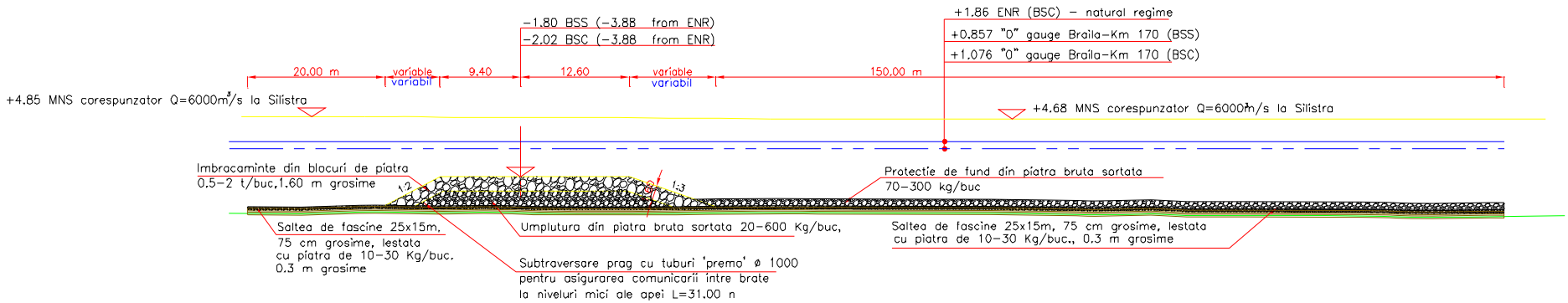
The designed length of the **bank protections** is:

- **type 1** – on the left left of Danube L=145m;
- **type 2** – on the right bank of Caleia branch L=395m;
- **type 3** – on the left bank of Caleia branch L=245m.


GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000 scara 1:5000
PD
BANK PROTECTION
APARARE DE MAL
CALEIA BRANCH
BRATUL CALEIA
PRAG DE FUND
BOTTOM SILL
PD
PDPS
INSULA LUPULUI
INSULA LUPULUI
PDPS
PD
PDPS
DUNAREA
DANUBE
FAIRWAY
SENAL NAVIGABIL
PDPS
PD

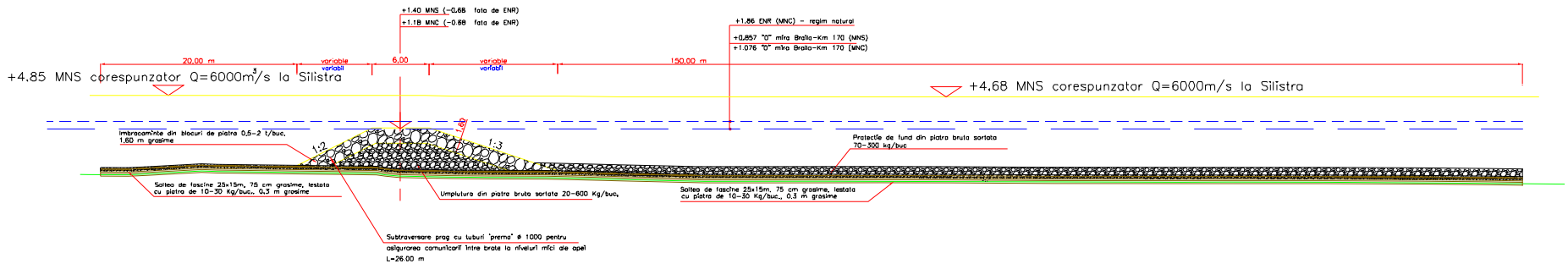
PROFIL TRANSVERSAL PRAG DE FUND PE BRATUL CALEIA L=371m, Km196
CROSS SECTION BOTTOM SILL ON CALEIA BRANCH L=371m, Km196

SCARA 1:500 – SCALE 1:500



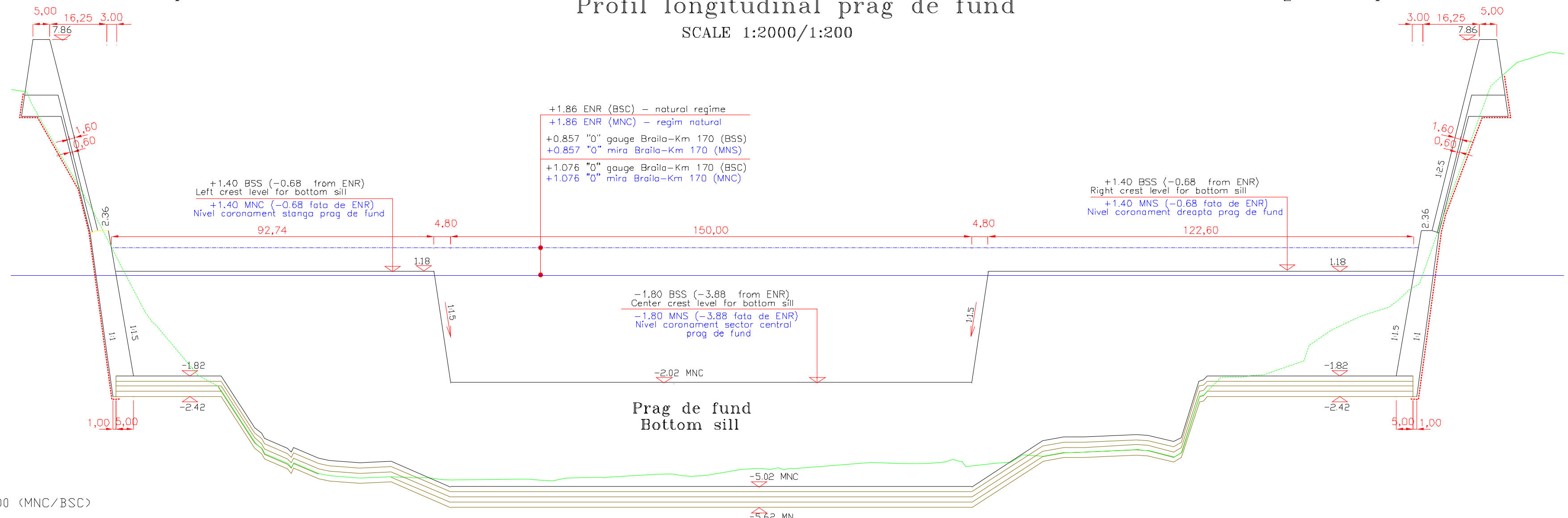
PROFIL TRANSVERSAL PRAG DE FUND PE BRATUL CALEIA L=371m, Km196 (zona laterala)
CROSS SECTION BOTTOM SILL ON CALEIA BRANCH L=371m, Km196 (side area)

SCARA 1:500 – SCALE 1:500



Longitudinal profile bottom sill
Profil longitudinal prag de fund

SCALE 1:2000/1:200

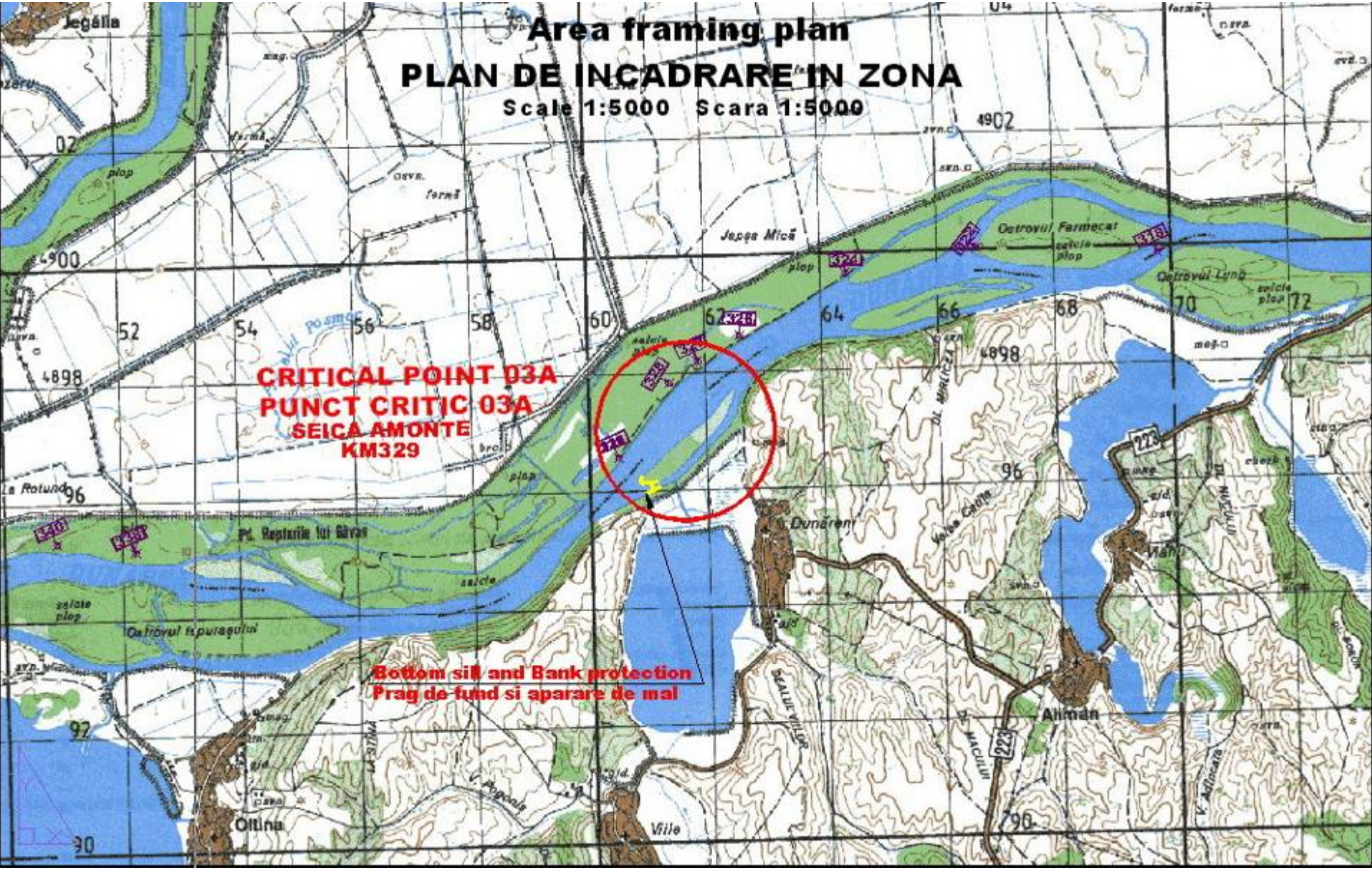


BOTTOM SILL LEVEL / COTA PRAG DE FUND	1.18, 1.18, 1.18, 1.18, 1.18, –2.02, –2.02, –2.02, –2.02, –2.02, –2.02, –2.02, –2.02, –2.02, 1.18, 1.18, 1.18, 1.18, 1.18, 1.18, 1.18
SLOPE / PANTA	0.0% 121.6; 4.8; 0.0% 150.0; 4.8; 0.0% 165.8
GROUND LEVELS / COTE TEREN	6.42, 5.80, 4.44, 2.23, 1.30, –0.38, –1.01, –1.82, –2.14, –3.27, –4.08, –4.34, –4.59, –4.71, –4.78, –4.75, –4.77, –4.79, –4.86, –4.89, –4.81, –4.84, –4.78, –4.76, –4.75, –4.67, –4.73, –4.70, –4.58, –4.50, –4.54, –4.49, –4.33, –4.36, –4.33, –4.24, –4.43, –4.38, –4.32, –4.11, –4.15, –4.04, –4.04, –3.98, –4.04, –2.42, –1.99, –1.87, –1.80, –1.58, –0.79, –0.51, –0.18
CUMULATIVE DISTANCES / DISTANTE CUMULATE	400.00, 20.00, 380.00, 20.00, 360.00, 20.00, 340.00, 325.37, 320.57, 320.00, 20.00, 300.00, 20.00, 280.00, 20.00, 260.00, 20.00, 240.00, 20.00, 220.00, 20.00, 200.00, 20.00, 180.00, 170.57, 165.77, 160.00, 20.00, 140.00, 20.00, 120.00, 20.00, 100.00, 20.00, 80.00, 20.00, 60.00
PROFILE NO. / PROFIL NR.	22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1
HORIZONTAL GEOMETRY / ALINIAMENTE SI CURBE	447.00

STAGE II

Critical Point 03A

Seica upstream


Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000 Scara 1:5000
CRITICAL POINT 03A
PUNCT CRITIC 03A
SEICA AMONTE
KM329
Bottom sill and Bank protection
Prag de fund si aparare de mal
Jegălia
Jepşa Mică
Ostrovul Fermecat
Ostrovul Lung
Pct. Resturile lui Gâvan
Ostrovul Ispurăşului
Dunăreni
Ahmân
Oltina
Ville

The **bottom sill** has a length at crest of L=108,80m (between the protection slopes), and a crest level of +8,68m MNC.

The **bottom sill** is founded on a 0, 75m thick faggot mattress, in order to avoid the immersion of stone into the riverbed alluvial material. The faggot mattress was extended upstream on a length of approximately 17m and downstream on min. 100m.

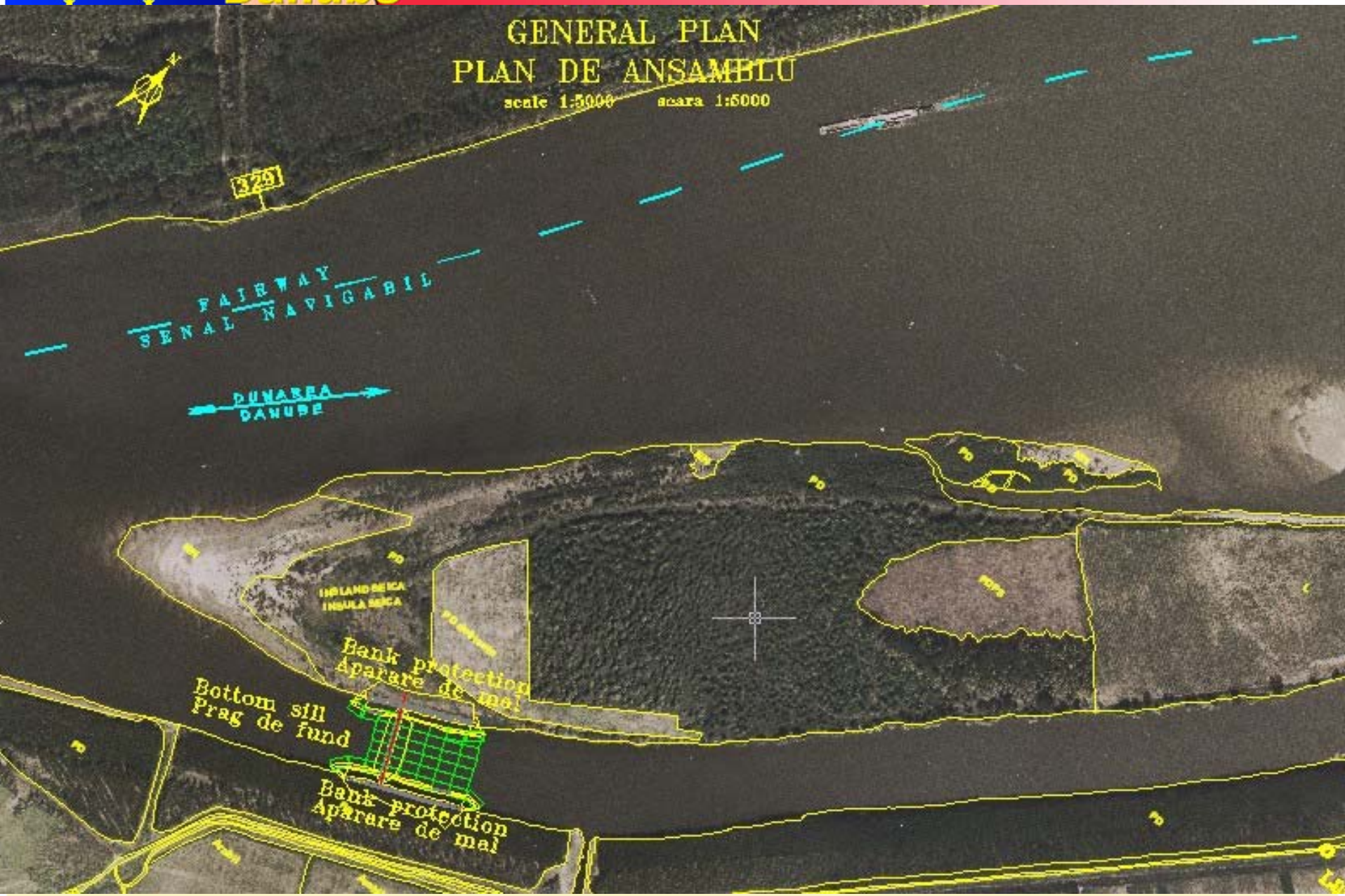
The designed **bank protections** length is:

-on left side L=195m

-on right side L=220m

The **bank protection** has a crest level of +10,00m MNC and a 3m width.

The **bank protection** slope is of 1:2,5.


GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000
scara 1:5000
325
FAIRWAY
SENAL NAVIGABIL
DUNAREA
DANUBE
INSULA MICA
Bank protection
Aparare de mal
Bottom sill
Prag de fund
Bank protection
Aparare de mal

Bottom sill L = 108.80 m

The works consist of:

1) Faggot mattresses of 0.60m thickness ballasted with sorted raw stone of 10-30 kg/piece;

1) Bottom protection made of sorted raw stone of 10-50 kg/piece of 0.40m thickness;

1) Stone block revetment of 200-600 kg/piece of 1.0m thickness;

1) Sorted raw stone of 10-50 kg/piece of 0.50m thickness;

1) Filling made of unsorted raw stone of de 10 – 500 kg/piece.

Bank Protections

-left bank L = 195 m
- right bank L = 220 m

The works consist of:

1) 0.60m thickness fascine mattresses ballasted with sorted raw stone of 10-30 kg/piece.

1) Geotextile on slopes;

1) Revetment made of stone blocks of 200 – 600 kg/piece of 1.00m in thickness;

1) Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness;

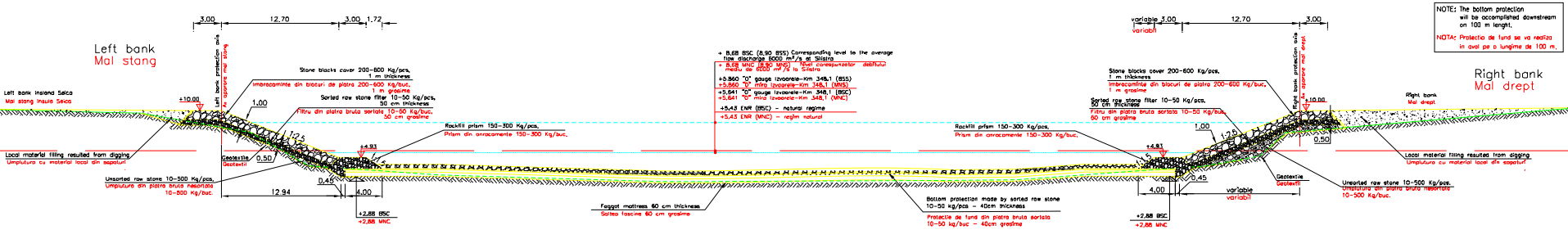
1) Filling made of unsorted raw stone of 10 – 500 kg/piece;

1) Quarry stone prism of 150 – 300 kg/piece.

TYPICAL PROFILE FOR BANK PROTECTION / PROFIL TIP APARARE MAL

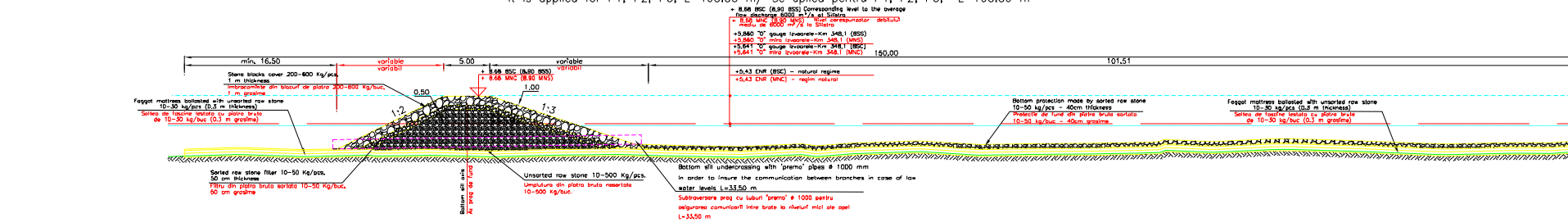
It is applied from profile 1 to profile 8, L=390m for left bank/ Se aplica de la profilul 1 la profilul 8, L=390m pentru malul stang

It is applied from profile 1 to profile 8, L=440m for right bank/ Se aplica de la profilul 1 la profilul 8, L=440m pentru malul drept



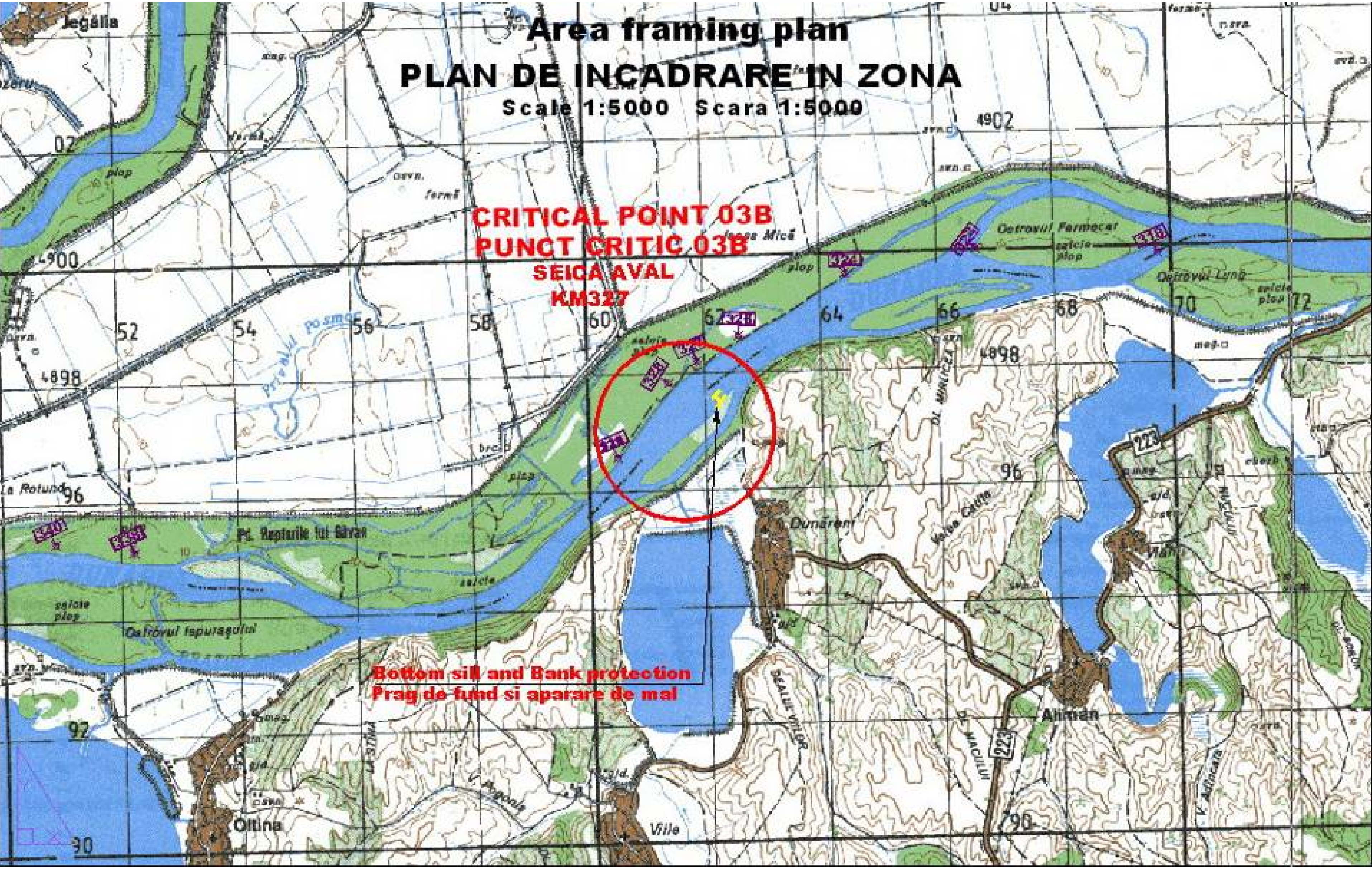
TYPICAL PROFILE FOR BOTTOM SILL / PROFIL TIP PRAG DE FUND

It is applied for P1, P2, P3, L=108.80 m/ Se aplica pentru P1, P2, P3, L=108.80 m



Critical Point 03B

Seica downstream


Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000 Scara 1:5000
CRITICAL POINT 03B
PUNCT CRITIC 03B
SEICA AVAL
KM327
Bottom sill and Bank protection
Prag de fund si aparare de mal
Jegălia
Ostrovul Farmecat
Ostrovul Lung
Ostrovul Ispuraşului
Dunăreni
Aliman
Oltina
Viile
223

The **bottom sill** has a length at crest of L=105,00m (between the protection slopes), and a crest level of +8,68m MNC.

The **bottom sill** is founded on a 0,75m thick faggot mattress, in order to avoid the immersion of stone into the riverbed alluvial material. The faggot mattress was extended upstream on a length of approximately 20,00m and downstream on min. 100m.

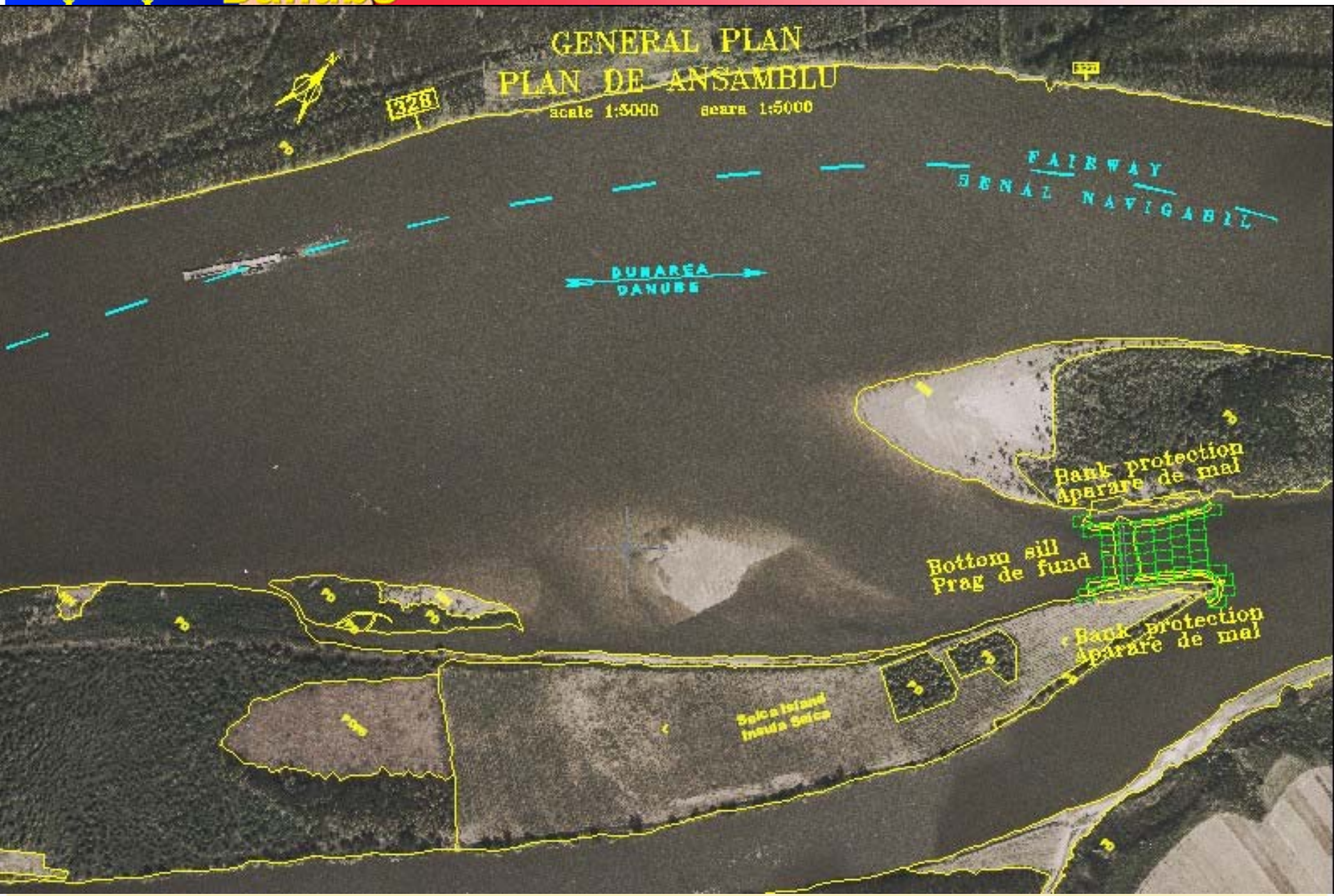
The designed **bank protections** length is:

-on left side L=180m

-on right side L=225m

The **bank protection** has a crest level of +10,00m MNC and a 3m width.

The **bank protection** slope is of 1:2,5.


GENERAL PLAN
PLAN DE ANSAMBLU
Scale 1:5000
Scara 1:5000
328
FAIRWAY
SENAL NAVIGABIL
DUNAREA
DANUBE
Bank protection
Aparare de mal
Bottom sill
Prag de fund
Bank protection
Aparare de mal
Salca Island
Insula Salca

Bottom Sill L = 105 m

The works consist of :

- 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.
- Bottom protection made of sorted raw stone of 10–50kg/piece;
- Revetment made of sorted raw stone of 200 – 600kg/piece of 1.0m thickness;
- Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness;
- Filling made of unsorted raw stone of 10 – 500 kg/piece.

Bank Protections

- left bank L = 180 m
- right bank L = 225 m

The works consist of:

1) 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.

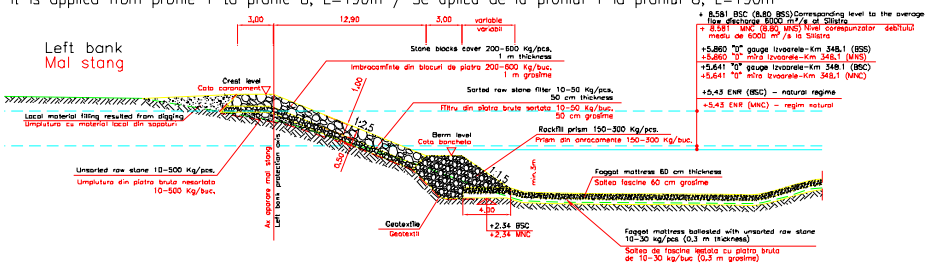
1) Geotextile on slopes;

1) Revetment made of sorted raw stone of 200 – 600kg/piece of 1.0m thickness;

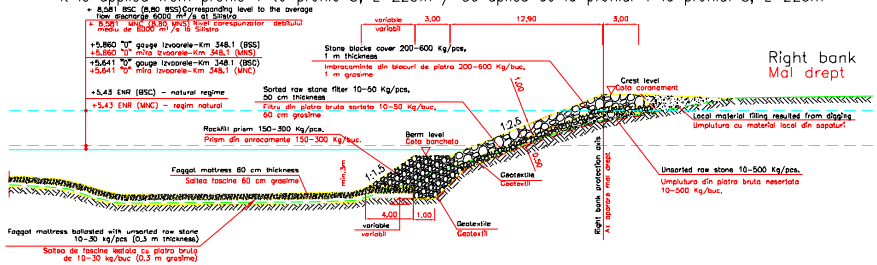
1) Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness;

1) Filling made of unsorted raw stone of 10 – 500 kg/piece;
2) Quarry stone prism of 150 – 300 kg/piece.

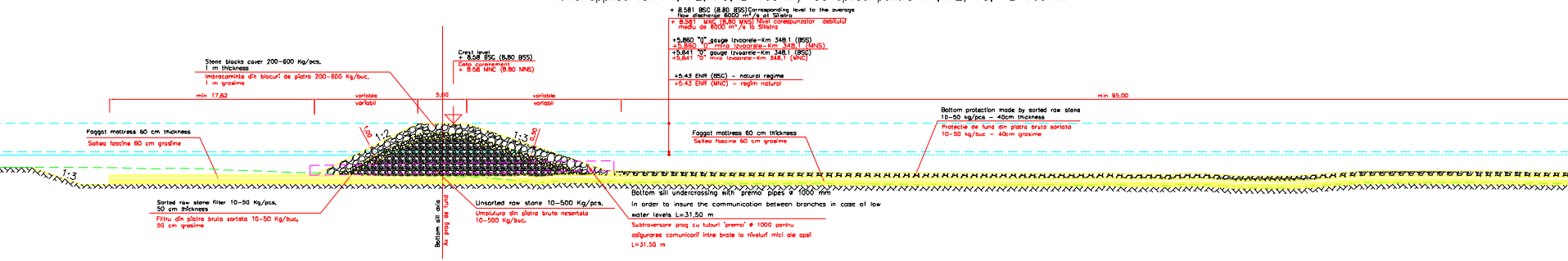
TYPICAL PROFILE FOR LEFT BANK PROTECTION / PROFIL TIP APARARE MAL STANG
It is applied from profile 1 to profile 8, L=190m / Se aplica de la profilul 1 la profilul 8, L=190m



TYPICAL PROFILE FOR RIGHT BANK PROTECTION / PROFIL TIP APARARE MAL DREPT
It is applied from profile 1 to profile 8, L=225m / Se aplica de la profilul 1 la profilul 8, L=225m

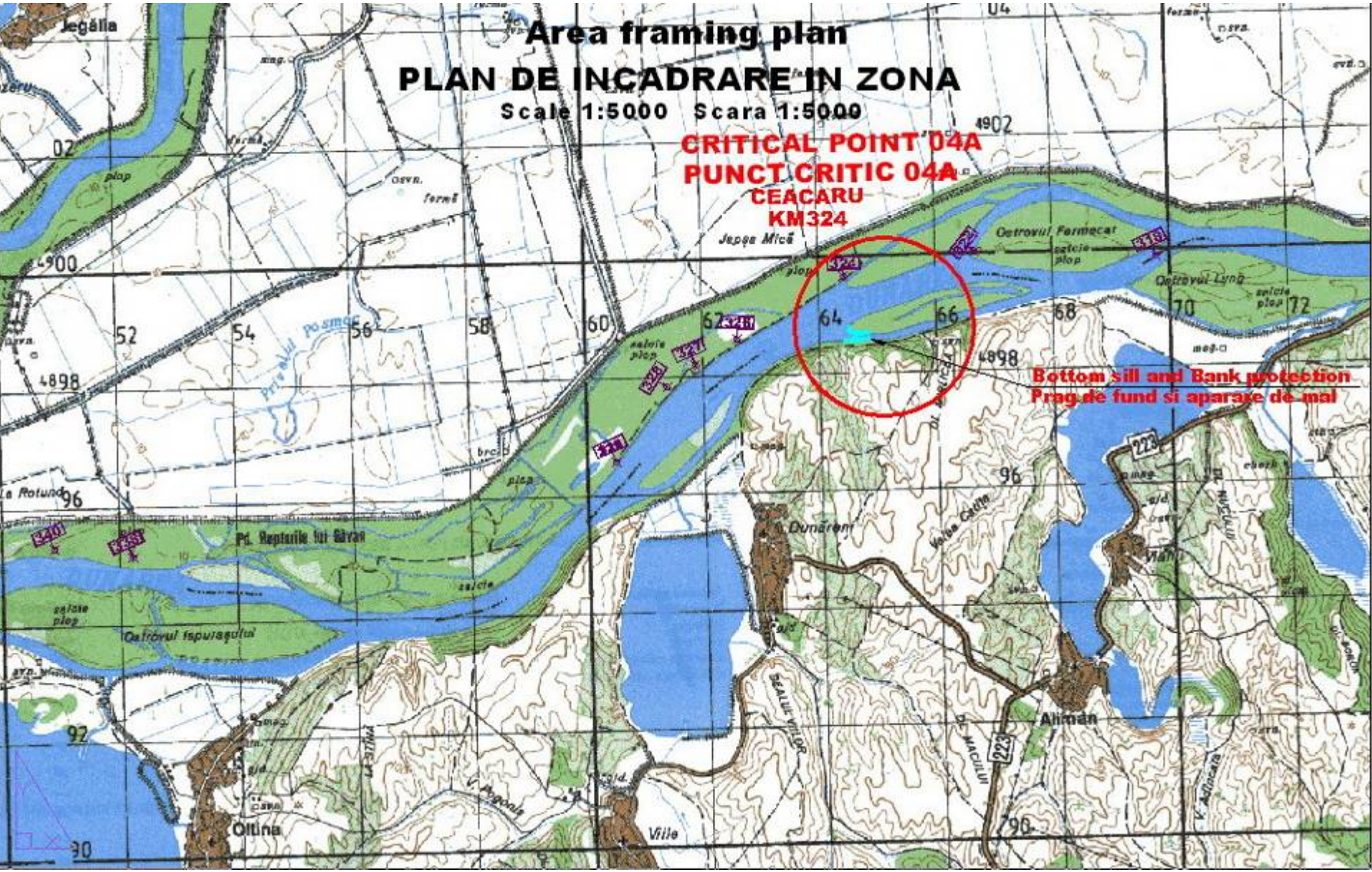


TYPICAL PROFILE FOR BOTTOM SILL / PROFIL TIP PRAG DE FUND
It is applied for P1, P2, P3, L=105 m/ Se aplica pentru P1, P2, P3, L=105 m



Critical Point 04A

Ceacaru


Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000 Scara 1:5000
CRITICAL POINT 04A
PUNCT CRITIC 04A
CEACARU
KM324
Bottom sill and Bank protection
Prag de fund si aparate de mal
Jegălia
Ostrovul Fermecat
Ostrovul Lung
Ostrovul Ispravnicului
Pd. Reperile lui Găvan
Dunăreni
Oltina
Vile
Ahmân
Jepşa Mică

The **bottom sill** has a length at crest of L=141,65m (between the protection slopes), and a crest level of +8,38m MNC.

The **bottom sill** is founded on a 0,75m thick faggot mattress, in order to avoid the immersion of stone into the riverbed alluvial material. The faggot mattress was extended upstream on a length of approximately 15,00m and downstream on min. 100m.

The designed **bank protections** length is:

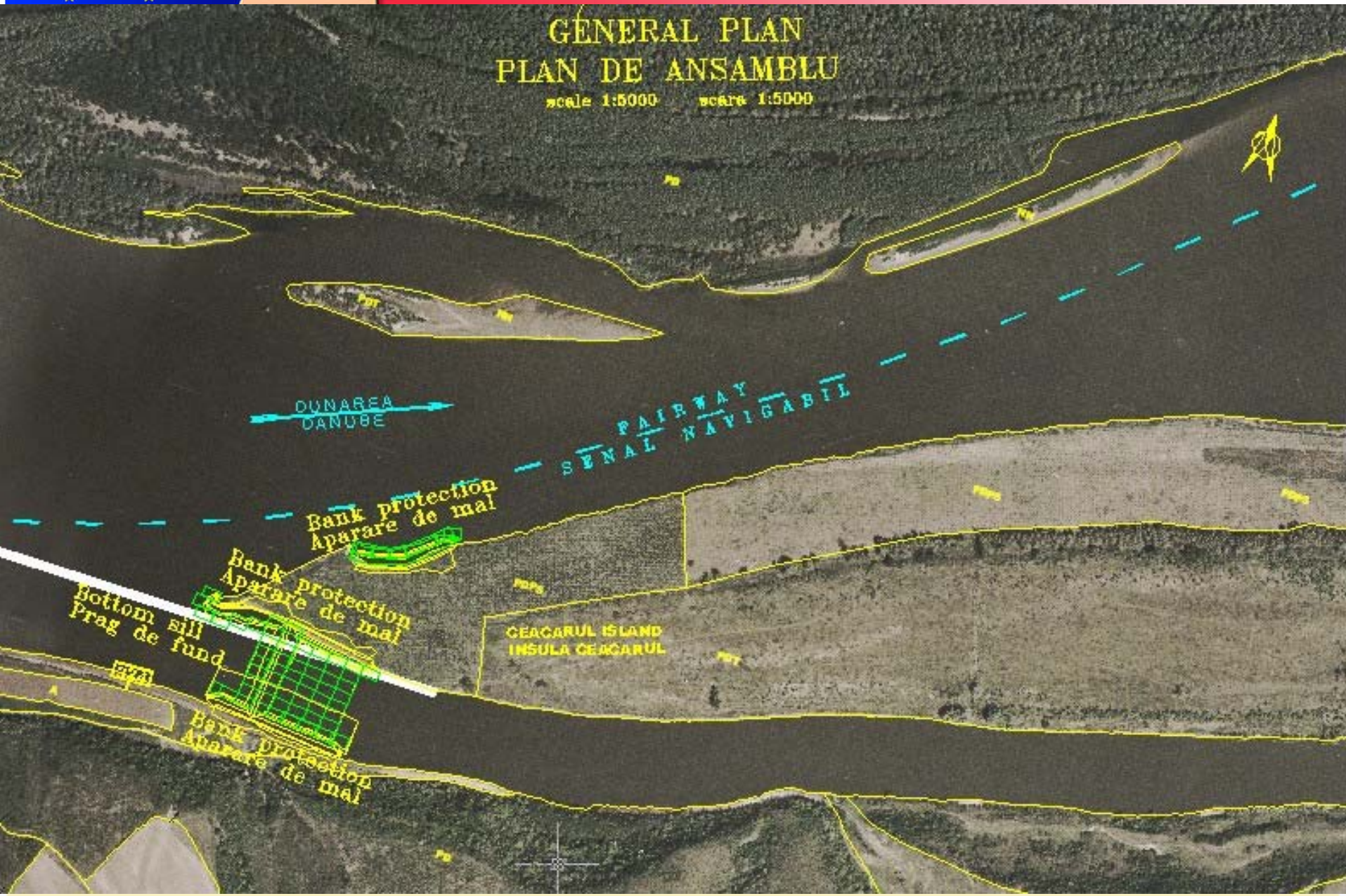
-on left bank of Ceacaru island L=300m

-on right bank of Ceacaru island L=220m

-on right bank of Danube L=150m

The **bank protection** has a crest level of +10,00m MNC and a 3m width.

The **bank protection** slope is of 1:2,5.


GÉNERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000
scara 1:5000
DUNAREA
DANUBE
FAIRWAY
SENAL NAVIGABIL
Bank protection
Aparare de mal
Bank protection
Aparare de mal
Bottom sill
Prag de fund
CEACARUL ISLAND
INSULA CEACARUL
Bank protection
Aparare de mal

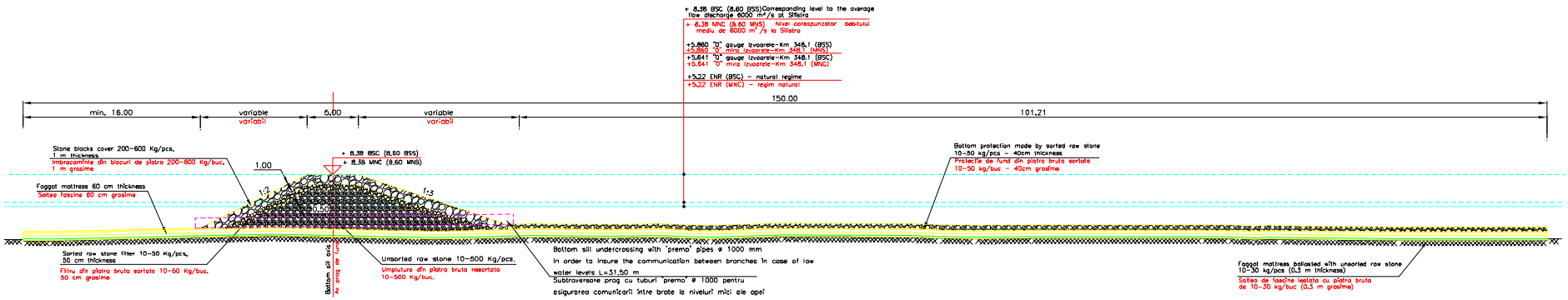
Bottom sill L = 141.65 m

The works consist of :

- 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.
- 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.
- Bottom protection made of sorted raw stone of 10–50kg/piece;
- Revetment made of sorted raw stone of 200 – 600kg/piece of 1.0m thickness;
- Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness;
- Filling made of unsorted raw stone of 10 – 500 kg/piece.

TYPICAL PROFILE 1 FOR BOTTOM SILL / PROFIL TIP 1 PRAG DE FUND

It is applied for P1, P2, P3, L=141.65 m/ Se aplica pentru P1, P2, P3, L=141.65 m



Bank Protections

- left bank L = 300 m
- right bank L = 220 m
- Danube bank L = 150 m

The works consist of:

1) 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.

1) Geotextile on slopes;

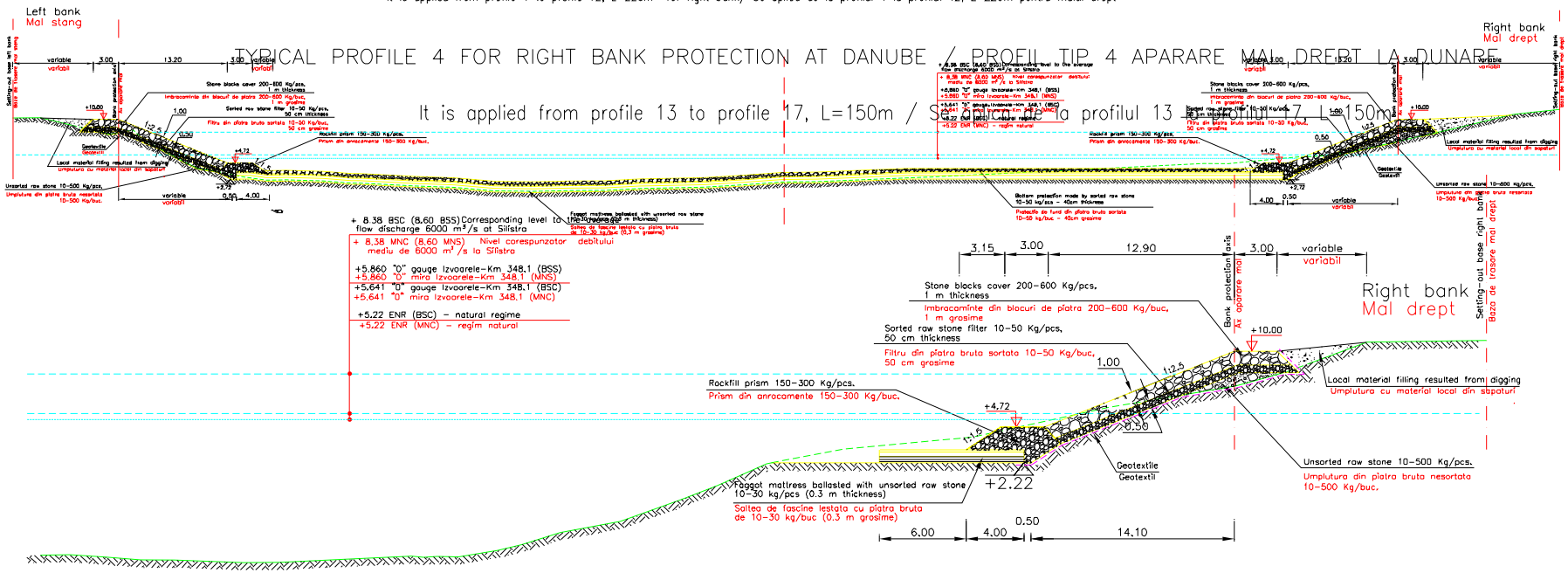
1) Revetment made of sorted raw stone of 200 – 600kg/piece of 1.0m thickness;

1) Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness;

1) Filling made of unsorted raw stone of 10 – 500 kg/piece;
2) Quarry stone prism of 150 – 300 kg/piece.

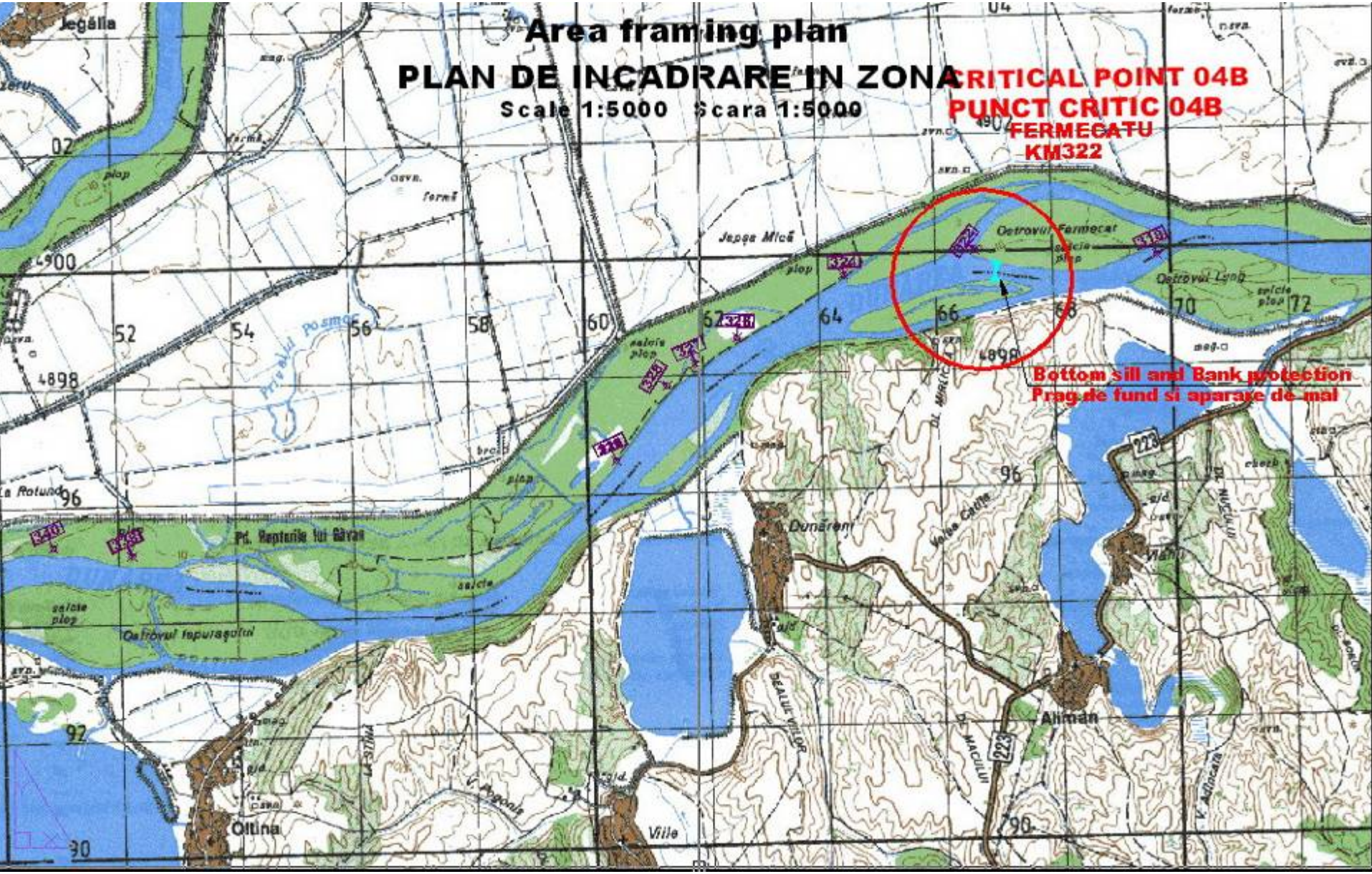
TYPICAL PROFILE 3 FOR BANK PROTECTION CEACARU ISLAND / PROFIL TIP 3 APARARE MAL INSULA CEACARU

It is applied from profile 4 to profile 12, L=213m for left bank/ Se aplica de la profilul 4 la profilul 12, L=213m pentru malul stang
It is applied from profile 4 to profile 12, L=220m for right bank/ Se aplica de la profilul 4 la profilul 12, L=220m pentru malul drept



Critical Point 04B

Fermecatu


Area framing plan
PLAN DE INCADRARE IN ZONA
Scale 1:5000 Scara 1:5000
CRITICAL POINT 04B
PUNCT CRITIC 04B
FERMECATU
KM322
Bottom sill and Bank protection
Prag de fund si aparate de mal
Jegălia
Ostrovul Fermecat
Ostrovul Lung
Dunăreni
Oltina
Ville
Aliman
Ostrovul Ispurașoiul

The **bottom sill** has a length at crest of L=232,00m (between the protection slopes), and a crest level of +8,68m MNC.

The **bottom sill** is founded on geotextile laid on 0,30m thick faggot grid, in order to prevent the immersion of stone into the riverbed alluvial material.

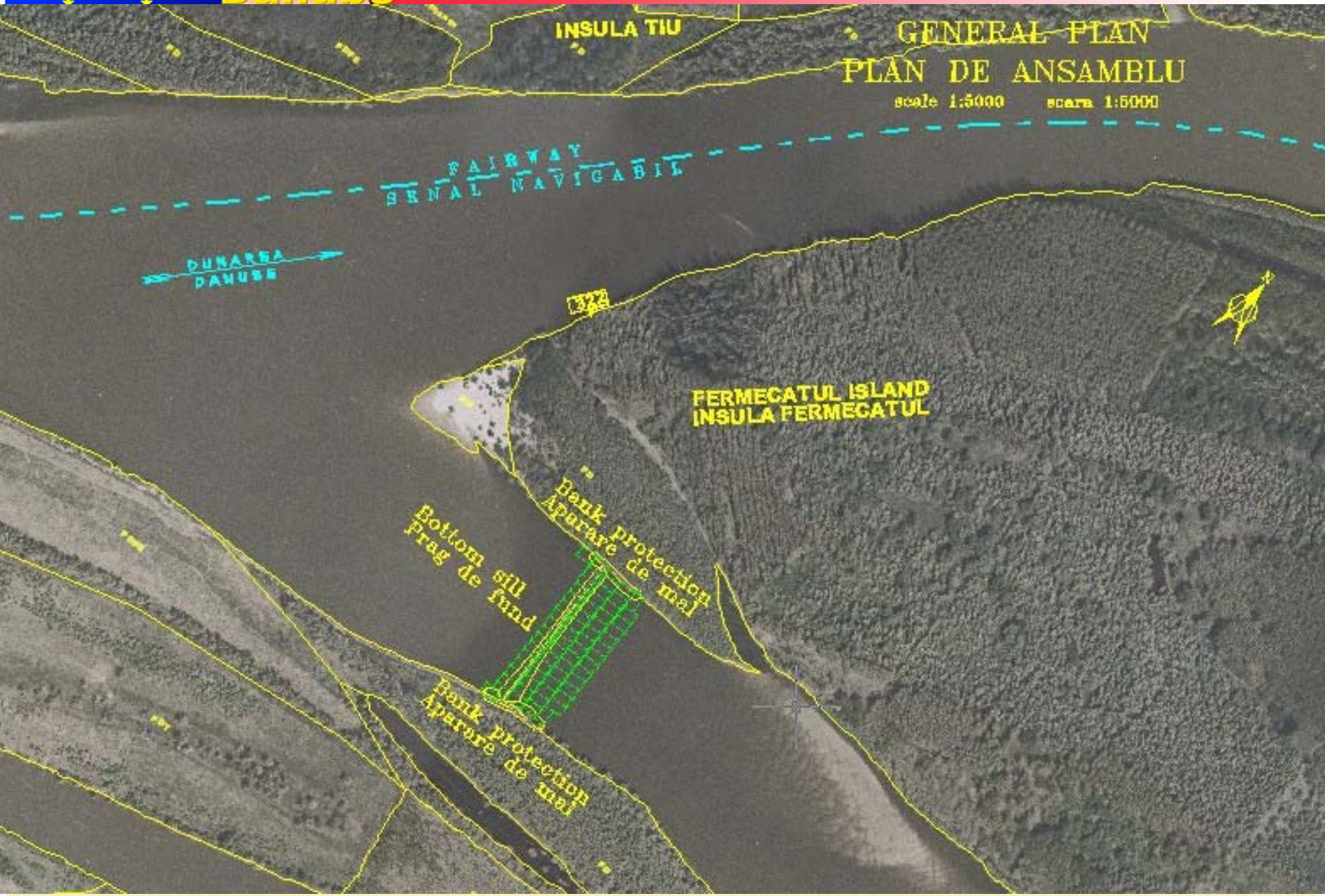
The designed **bank protections** length is:

-on left bank L=85m

-on right bank L=86m

The **bank protection** has a crest level of +9,28m MNC and a 3m width.

The **bank protection** slope is of 1:2,5.


INSULA TIU
GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000
scara 1:5000
FAIRWAY
SENAL NAVIGABIL
DUNAREA
DANUBE
FERMECATUL ISLAND
INSULA FERMECATUL
Bank protection
Aparare de mal
Bottom sill
Prag de fund
Bank protection
Aparare de mal

Bottom Sill L = 232 m

The works consist of :

- 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.
- 0.60m thickness faggot mattresses ballasted with sorted raw stone of 10-30 kg/piece.
- Bottom protection made of sorted raw stone of 10–50kg/piece;
- Revetment made of sorted raw stone of 200 – 600kg/piece of 1.0m thickness;
- Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness.

Bank Protections

- left bank L = 85 m

- right bank L = 86 m

The works consist of:

1) 0.60m thickness faggot matresses ballasted with sorted raw stone of 10 – 30 kg/piece;

1) Geotextile on slopes;

1) Revetment made of stone blocks of 200 – 600 kg/piece of 1.0m thickness;

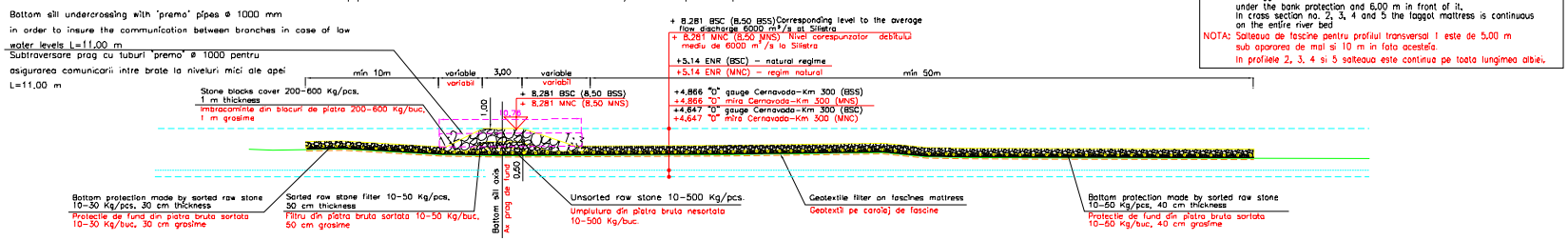
1) Sorted raw stone filter of 10 – 50 kg/piece of 0.50m thickness;

1) Filling made of unsorted raw stone of 10 – 500 kg/piece

1) Quarry stone prism of 150 – 300 kg/piece;

TYPICAL PROFILE 1 FOR BOTTOM SILL / PROFIL TIP 1 PRAG DE FUND

It is applied for P1, P2, P3, L=241 m/ Se aplica pentru P1, P2, P3, L=241 m

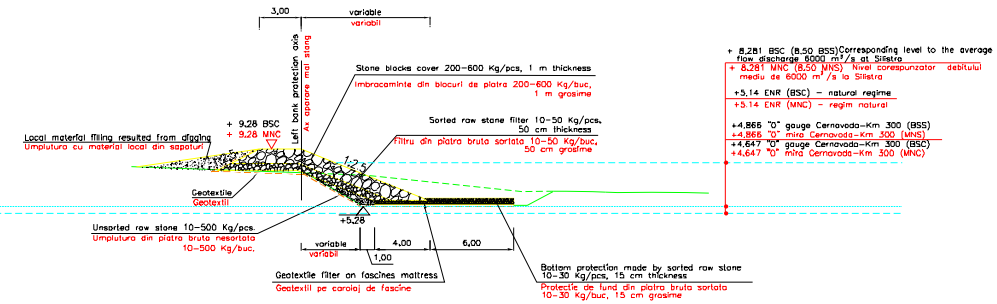


NOTE: The faggot mattress in cross section no 1 is 4.00 m under the bank protection and 6.00 m in front of it. In cross section no. 2, 3, 4 and 5 the faggot mattress is continuous on the entire river bed

NOTA: Salteaua de fascine pentru profilul transversal 1 este de 5,00 m sub apararea de mal si 10 m in fata acesteia. In profilele 2, 3, 4 si 5 salteaua este continua pe toata lungimea albiei.

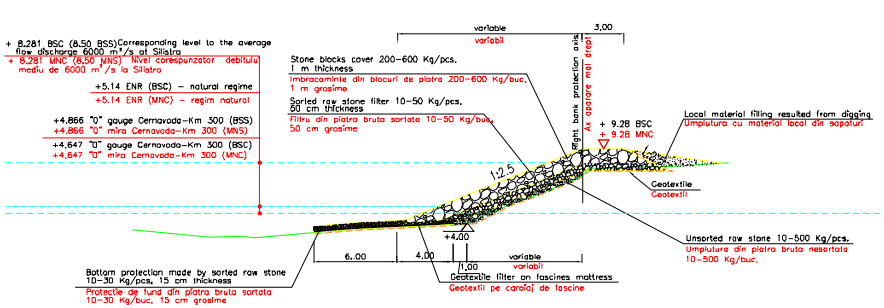
TYPICAL PROFILE 2 FOR LEFT BANK PROTECTION / PROFIL TIP 2 APARARE MAL STANG

It is applied from profile 1 to profile 5, L=108m / Se aplica de la profilul 1 la profilul 5, L=108m



TYPICAL PROFILE 3 FOR RIGHT BANK PROTECTION / PROFIL TIP 3 APARARE MAL DREPT

It is applied from profile 1 to profile 5, L=133m / Se aplica de la profilul 1 la profilul 5, L=133m

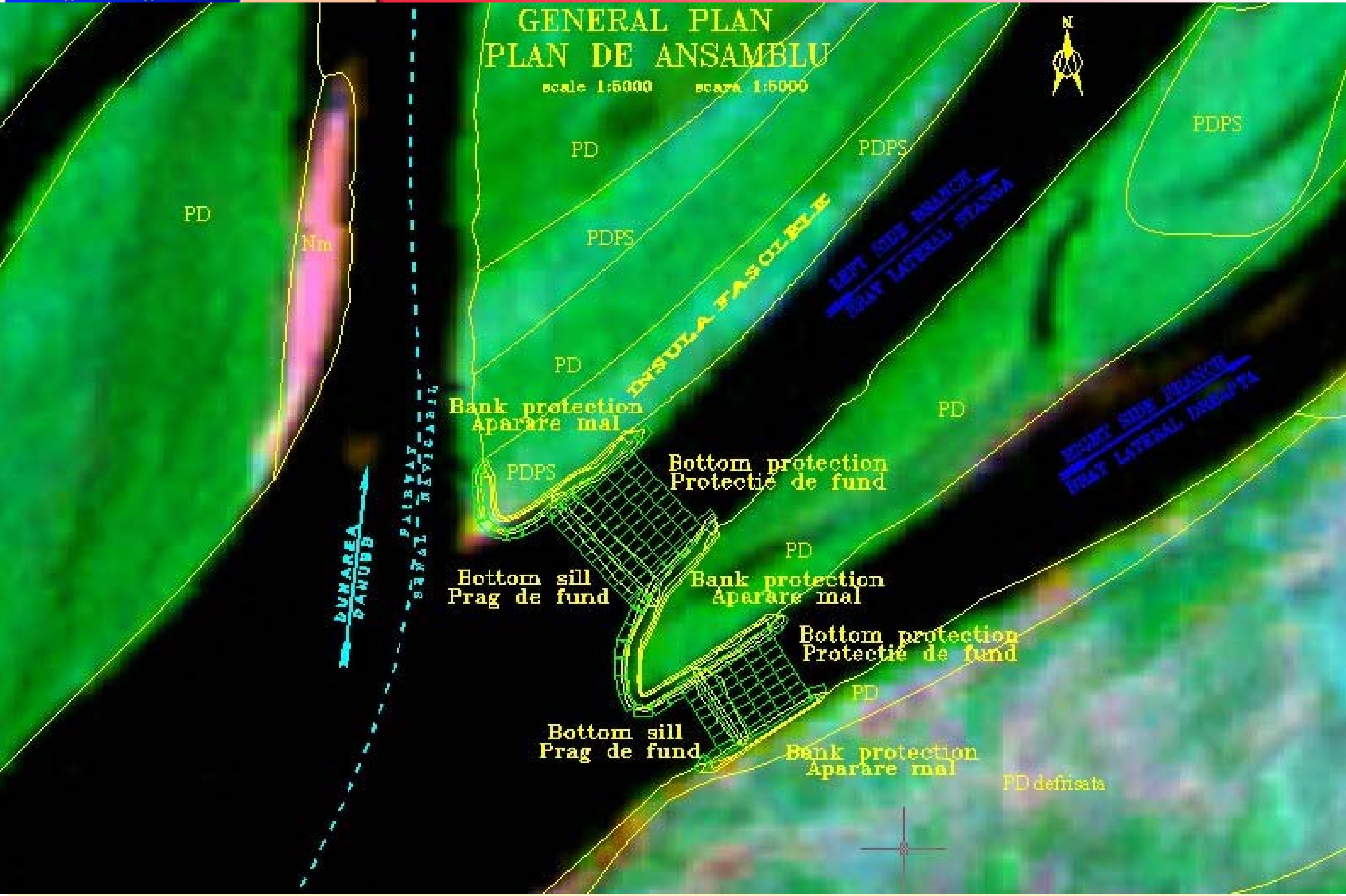


Critical Point 07
Fasolele Island

In this area there are detaching from the Danube two branches to the left, which limit Fasolele island.

The works provided for this critical point consist of:

- works on the left lateral branch:
  - bottom sill
  - bank protections
- works on the right lateral branch:
  - bottom sill
  - bank protections

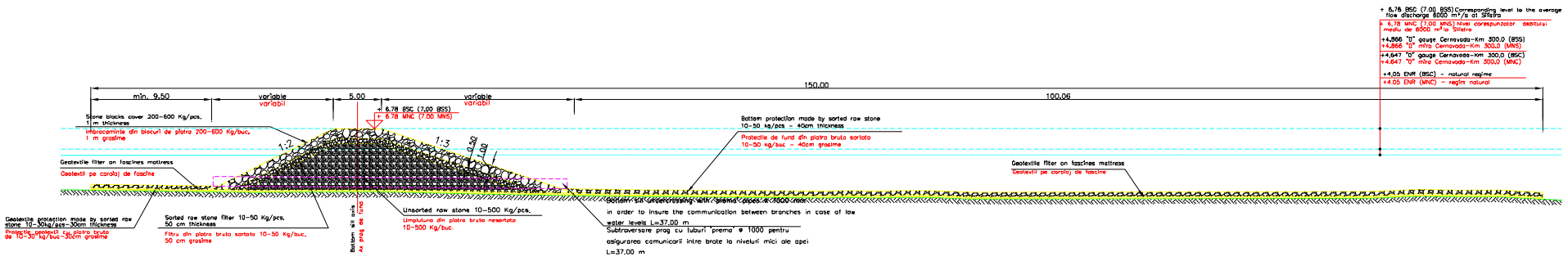

GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000 scara 1:5000
N
PD
PDPS
Nm
PD
PDPS
PDPS
PD
INSULA FASOLELE
Bank protection
Aparare mal
PD
PDPS
Bottom protection
Protectie de fund
DUNAREA
DANUBE
PD
Bottom sill
Prag de fund
Bank protection
Aparare mal
Bottom protection
Protectie de fund
PD
Bottom sill
Prag de fund
Bank protection
Aparare mal
PD defrisata

A. Works on the left lateral branch

The **bottom sill** has a length at crest of L=214,00m (between the protection slopes), and a crest level of +6,78m MNC.

The **bottom sill** is founded on geotextile laid on 0,30m thick faggot grid, in order to prevent the immersion of stone into the riverbed alluvial material.

PROFIL TRANSVERSAL TIP PENTRU PRAG DE FUND BRAT LATERAL STANGA



The designed **bank protections** length is:

-on left bank L=215m

-on right bank L=283m

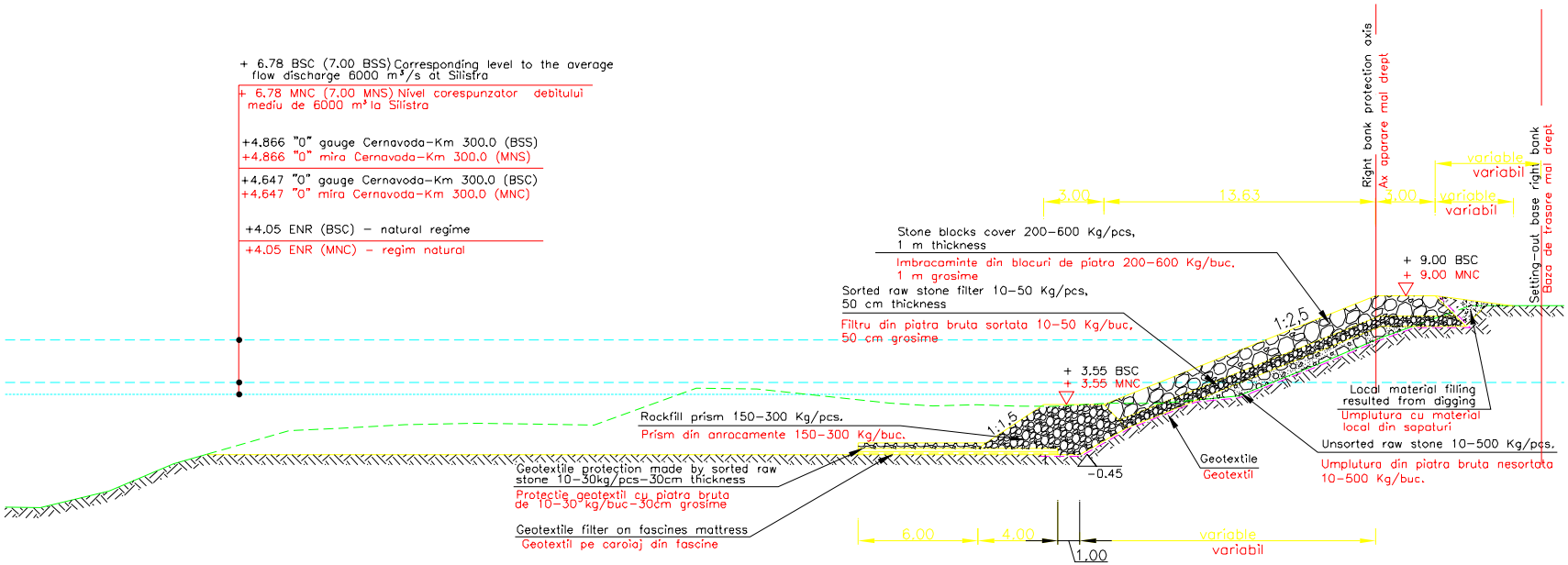
The **bank protection** has a crest level of +9,00m MNC and a 3m width.

The **bank protection** slope is of 1:2,5.

TYPICAL CROSS SECTION 2 FOR BANK PROTECTION LEFT SIDE BRANCH

PROFIL TRANSVERSAL TIP 2 PENTRU APARARE MAL BRAT LATERAL STANGA

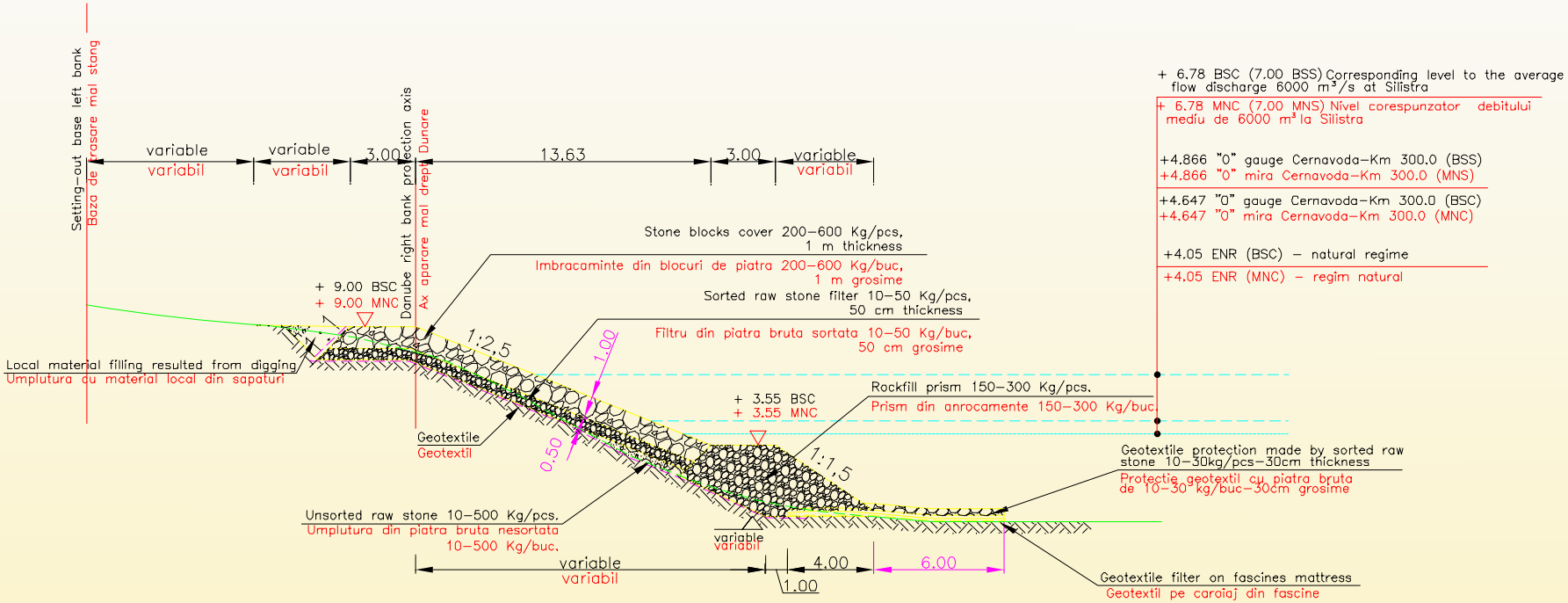
It is applied for profile 1 and 2 / Se aplica la profilul 1 si 2



TYPICAL CROSS SECTION 1 FOR BANK PROTECTION LEFT SIDE BRANCH

PROFIL TRANSVERSAL TIP 1 PENTRU APARARE MAL BRAT LATERAL STANGA

It is applied from profile 1d to profile 5d / Se aplica de la profilul 1d la profilul 5d

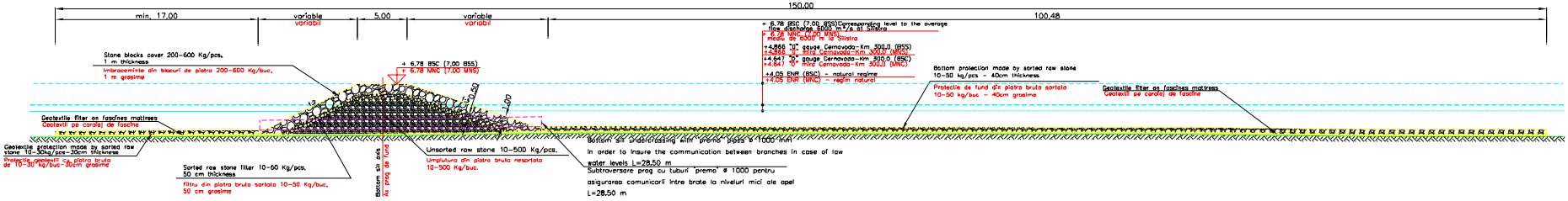


B. Works on the right lateral branch

The **bottom sill** has a length at crest of L=127,00m (between the protection slopes), and a crest level of +6,78m MNC.

The **bottom sill** is founded on geotextile laid on 0,30m thick faggot grid, in order to prevent the immersion of stone into the riverbed alluvial material.

PROFIL TRANSVERSAL TIP PENTRU PRAG DE FUND BRAT LATERAL DREAPTA



The designed **bank protections** length is:

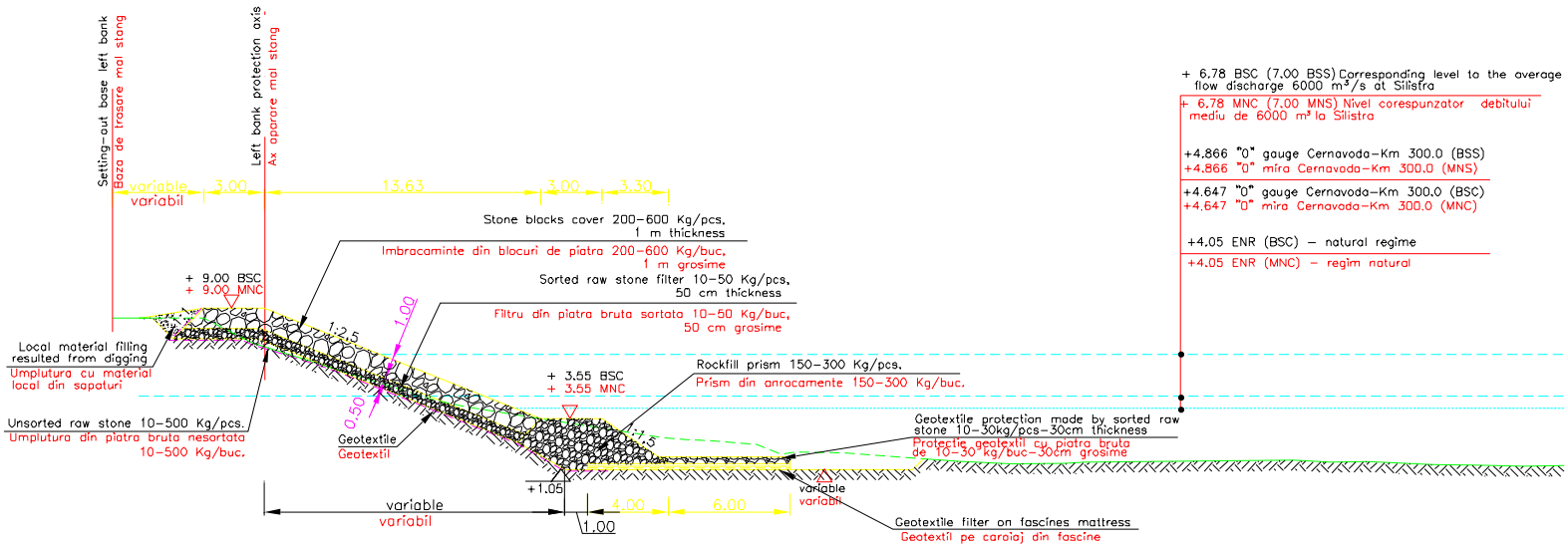
-on left bank L=268m

-on right bank L=216m

The **bank protection** has a crest level of +9,00m MNC and a 3m width.

The **bank protection** slope is of 1:2,5.

TYPICAL CROSS SECTION FOR BANK PROTECTION RIGHT SIDE BRANCH
PROFIL TRANSVERSAL TIP PENTRU APARARE MAL BRAT LATERAL DREAPTA



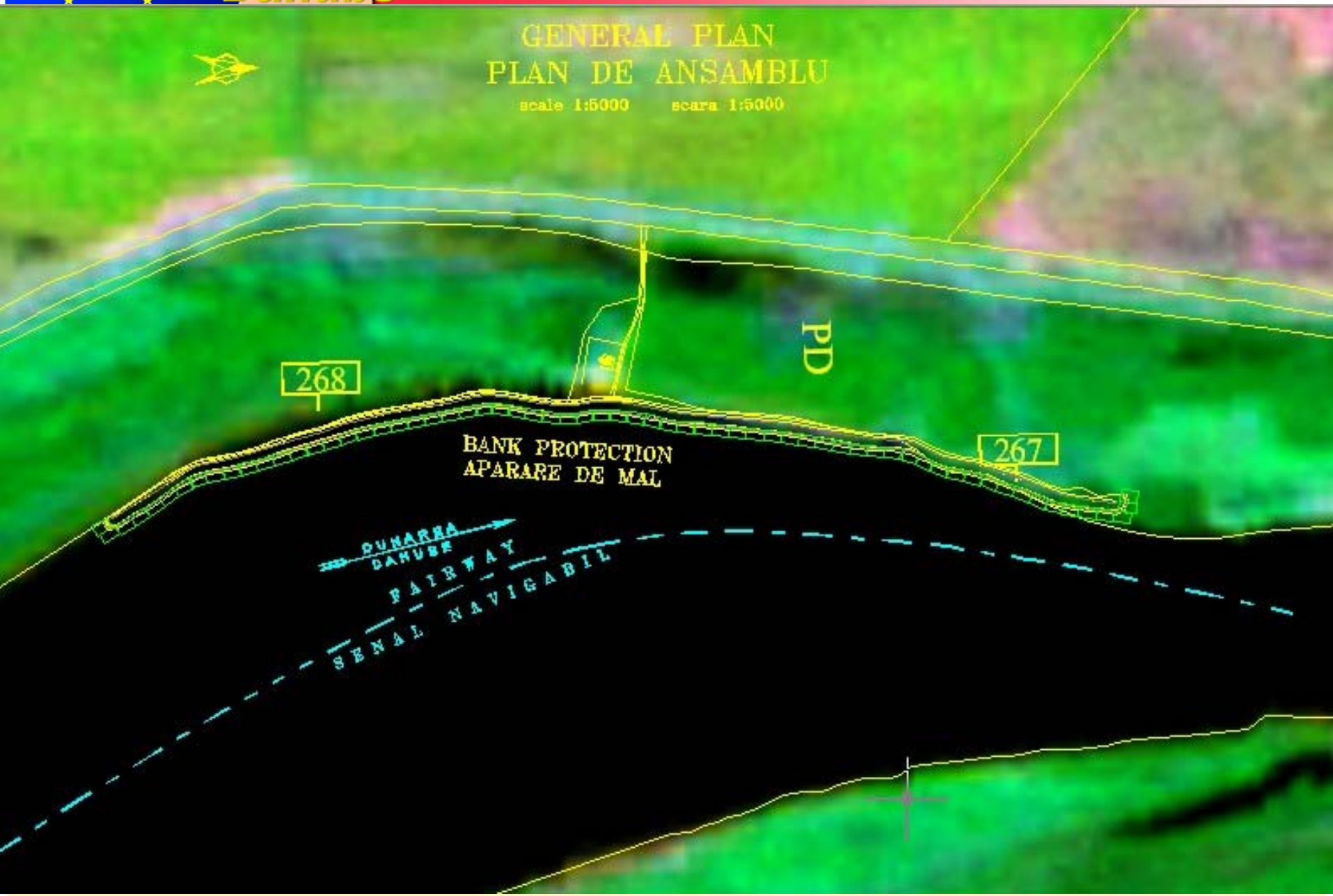
Critical Point 08
Atarnati

At this critical point the works consist of the left **bank protection** on a length of 1531m between km268+400 – km266+850.

On this area, the left bank is concave because of the Danube water erosion.

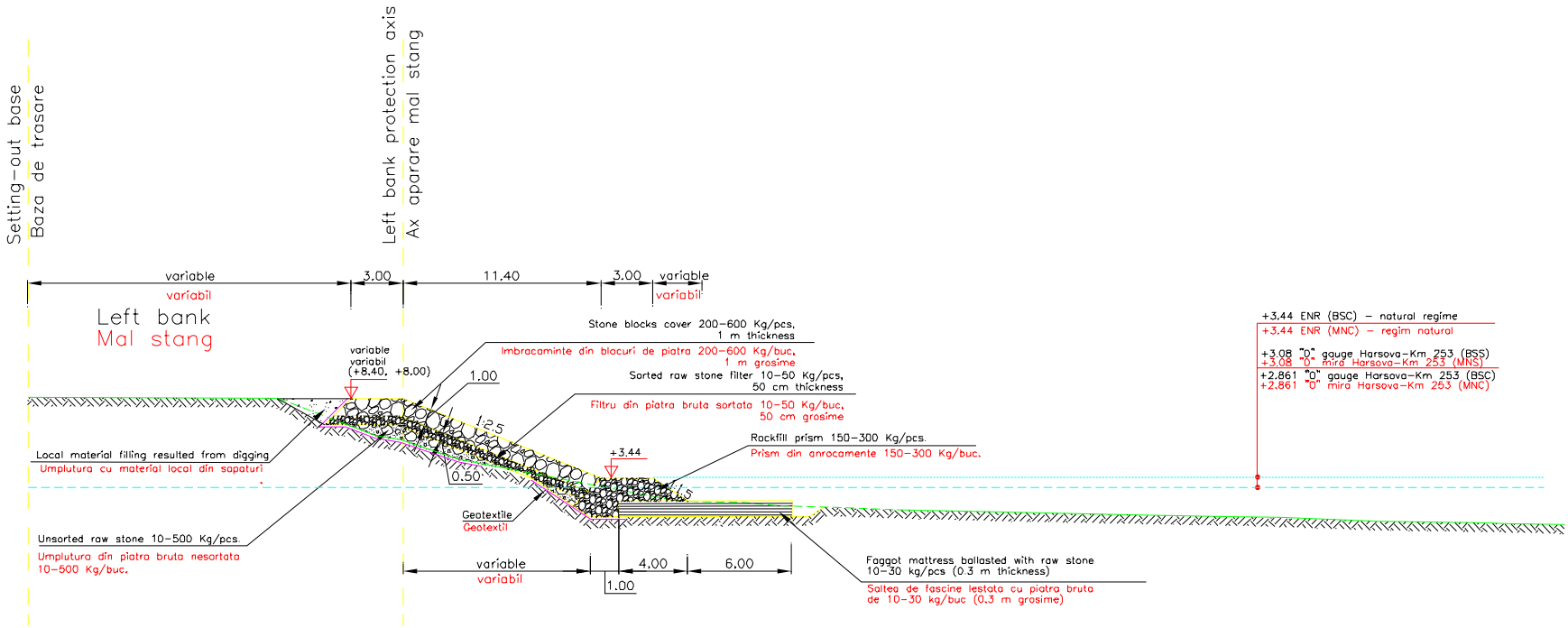
The **bank protection** has a level at crest of +8,40m (MNC) and a width of 3m.

The **bank protection** has a slope of 1:2,5 and leans on a rock fill prism (150 – 300 kg/piece) laid on a 0,75 cm thickness faggot mattress (ballasted with sorted raw stone of 10 – 30 Kg/piece, 30 cm thick).


GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000
scara 1:5000
PD
268
267
BANK PROTECTION
APARARE DE MAL
DUNAREA
DANUBE
FAIRWAY
SENAL NAVIGABIL

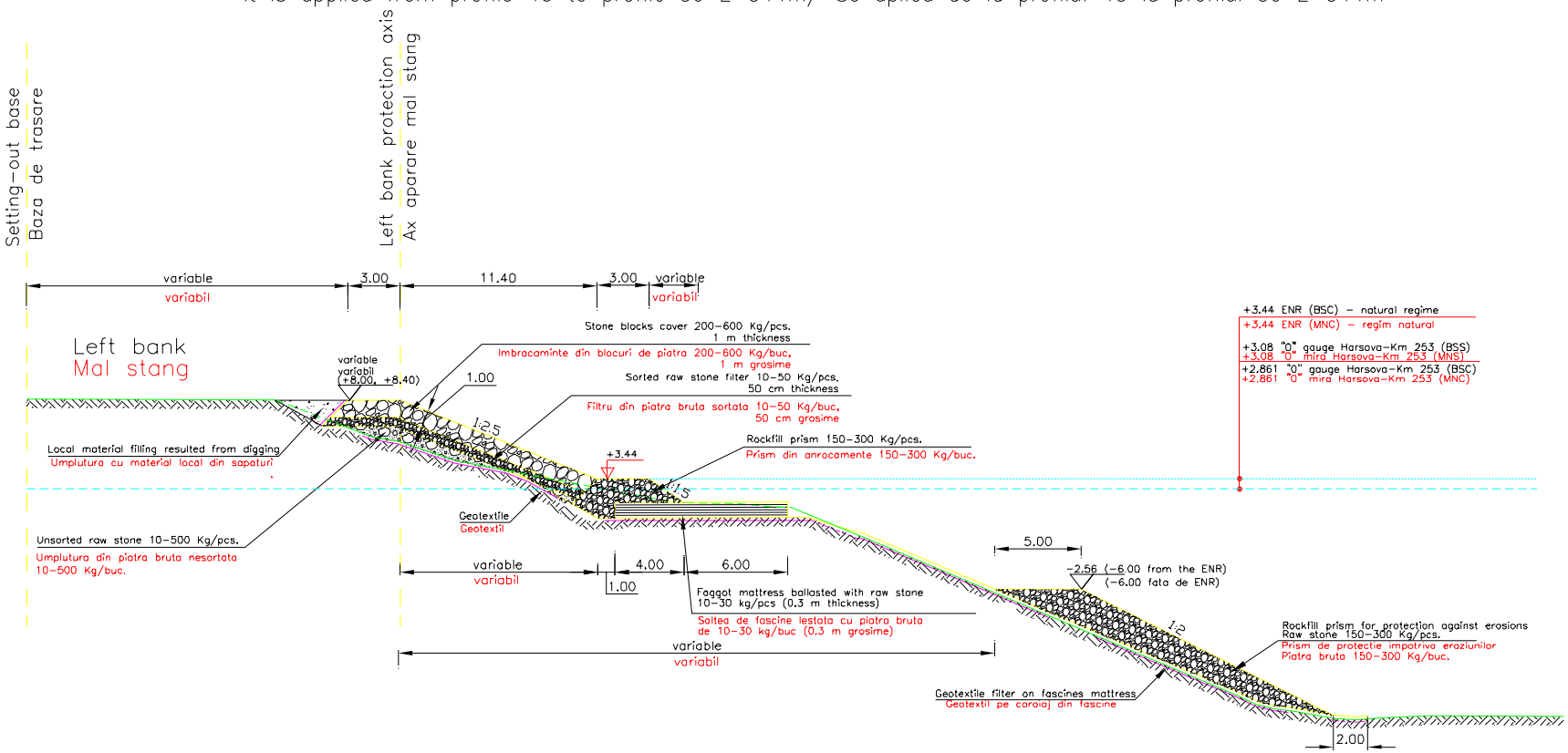
TYPICAL PROFILE 1 FOR LEFT BANK PROTECTION / PROFIL TIP 1 APARARE MAL STANG

It is applied from profile 1 to profile 39 L=1024.50m/ Se aplica de la profilul 1 la profilul 39 L=1024.50m



TYPICAL PROFILE 2 FOR LEFT BANK PROTECTION / PROFIL TIP 2 APARARE MAL STANG

It is applied from profile 40 to profile 59 L=544m/ Se aplica de la profilul 40 la profilul 59 L=544m



Critical Point 09

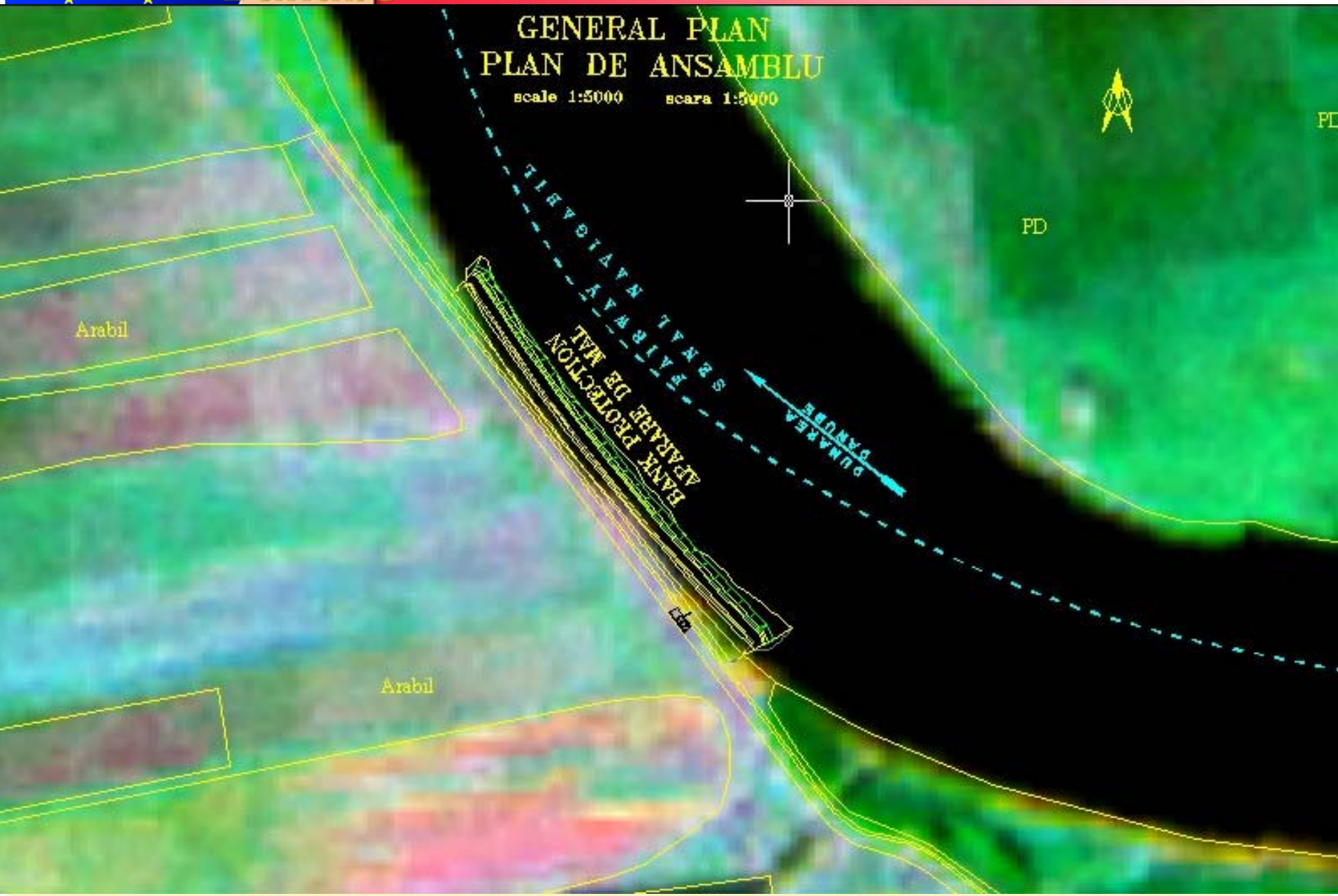
Varsaturii

At this critical point the works consist of the left **bank protection** on a length of 679m between km233+100 – km232+421.

On this area the left bank is concave, the fairway is towards the left bank, the waves generated by ships and the blocks of ice, determining their erosions.

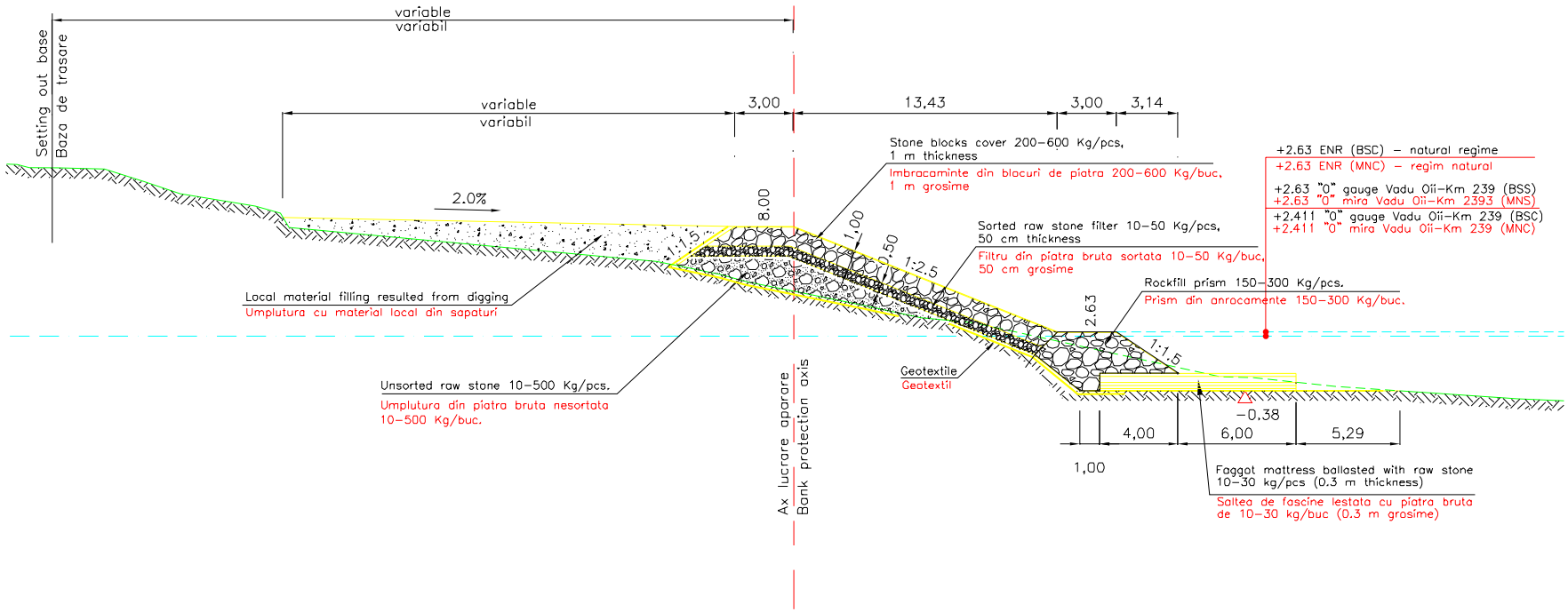
The **bank protection** has a level at crest of +8,00m (MNC) and a width of 3m.

The **bank protection** has a slope of 1:2,5 and leans on a rock fill prism (150 – 300 kg/piece) laid on a 0,75 cm thickness faggot mattress (ballasted with sorted raw stone of 10 – 30 Kg/piece, 30 cm thick).


GENERAL PLAN
PLAN DE ANSAMBLU
scale 1:5000
scara 1:5000
Arabil
Arabil
PD
PD
BANK PROTECTION
APARARE DE MAL
DUNAREA
DANUBE

TYPICAL PROFILE FOR BANK PROTECTION / PROFIL TIP APARARE MAL

It is applied from profile 1 to profile 27, L=679m / Se aplica de la profilul 1 la profilul 27, L=679m



ENVIRONMENTAL IMPACT ASSESSMENT

- Proposed solutions have taken into account the engineering and economical considerations, but obviously environmental restrictions, especially the impact of dredging on the Danube delta. The proposed solutions considered the effect of floods and assured that the proposed works have been designed to support floods with return periods of at least 100 years.

- The EIA study has been elaborated according to the ***European EIA Directive which has been transposed in Romania by Governmental Decision (GD) no. 918/2002. This GD establishes the framework procedure for environmental impact assessment of public or private projects likely to have significant impact on environment.***

- ***The present project, although is defined as project for navigation condition improvement, may be defined as project for rational management of Danube water project for preservation the ecosystems from Ialomita Pond.***

MEASURES RESULTING FROM THE PROJECT OF THE NEGATIVE IMPACT ELIMINATION, REDUCING AND COMPENSATION

1. Reduction of dredging volumes

- Several variants were analysed regarding the number and position of the critical points and the optimal measures of providing navigation conditions in these critical points. Finally, 8 critical points/sectors were established with hydrotechnical works (Bala, Epurasu, Seica upstream, Seica downstream, Ceacaru, Fasolele, bank protection km 267 – km 268+500, bank protection km 233 – km 232, Ostrovo Lupu).

- The necessary dredging volumes have been of 312,193 m^3 . The dredging volumes represent a necessary minimum to provide the navigation dimensions of the channel during the execution of works.

- The dredged material is proposed to be discharged into water; by doing so, the interventions on the fauna and flora habitat are minimal.

2. Profile of the bottom sill

- Excepting the submerged sills from Bala and Ostrovo Lupu, all the bottom sills are provided with two culverts of 1.00m diameter. These culverts enable communication from upstream to downstream and the movement of the aquatic fauna in the sill area.

- The sills are designed in such a way that the crest level corresponds to the mean flow level of the Danube.

- For flows higher than the mean flow, the sills get discharged, the flowing regime being the present one.

3. Execution of works

- The necessary works will be executed mostly with floating equipment. Under these circumstances, site organisation located on land will occupy small land areas where the activity will be reduced as well.

- Access roads and equipment circulation on land will be insignificantly. Circulation of land equipment will be limited strictly to the bank area, on a land stretch of a few meters.

- Bank profile will be reshaped for bank protection and bottom sill

- Execution of works will be permanently supervised by the representatives of environment authorities.

4. Ecological rehabilitation of land areas affected during the execution of works

- The project provides the required funds for demolition of site organization constructions, land leveling and planting and replanting of the affected areas.

5. Monitoring of working points from hydrological and morphological points of view

- **The project provides at least two stages. The second stage of execution of works starts at least one year after the first one.**
- **The project also provides remarks and elevation of bathymetric profiles in the working sectors. Measures will be taken in relation to the monitoring results and project correction.**

6. Restriction on execution period

- Protection of ichthyiofauna, primarily sturgeon population was taken into consideration when the chart of execution of works was elaborated.

- Bottom sills and jetties will be executed during July – August and November – February. During these seasons the surgeon do not run along the Danube.

7. Provision of migration conditions of ichtyofauna, primarily sturgeons.

- **In the central part of the two sills, the crest have been lowered to create a nappe of min. 3.20m height over the sills in order to enable movement of sturgeon during the period of minimal flows.**

8. Strict monitoring of the works impact on biodiversity

- The project provides funds for monitoring (with the help of specialized institutions) the impact of works on flora and fauna species protected on national and international level by the “Red List” of IUNC, Law no. 462/2001 and Berna Convention (Law no. 13/1993).

- There is a proposal to create a monitoring center for biodiversity, placed near the jetty on Bala arm inside the site organisation.

9. Restocking of Danube in Calarasi – Braila sector

- **Sturgeons;**
- ***Cyprinus carpio***
- ***Silurus glanis***
- ***Other species of fish as result of the monitoring activity interpretations***

Thank you!