

# **PROJECTS FINANCED FROM THE WORLD BANK LOAN completed from 2007 to 2009**



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**Novi Sad 2010.**



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This publication is of educational and information character and it is the result of work and inspiration of a team of associates of the Public Water Management Company "Vode Vojvodine".

The works that have been described herein contributed to achieving a higher level of safety of protection structures-defence lines and improving of quality of drainage systems.

We would like to take this occasion to express our gratitude to financing institutions for their understanding, support, and funds provided for these projects.

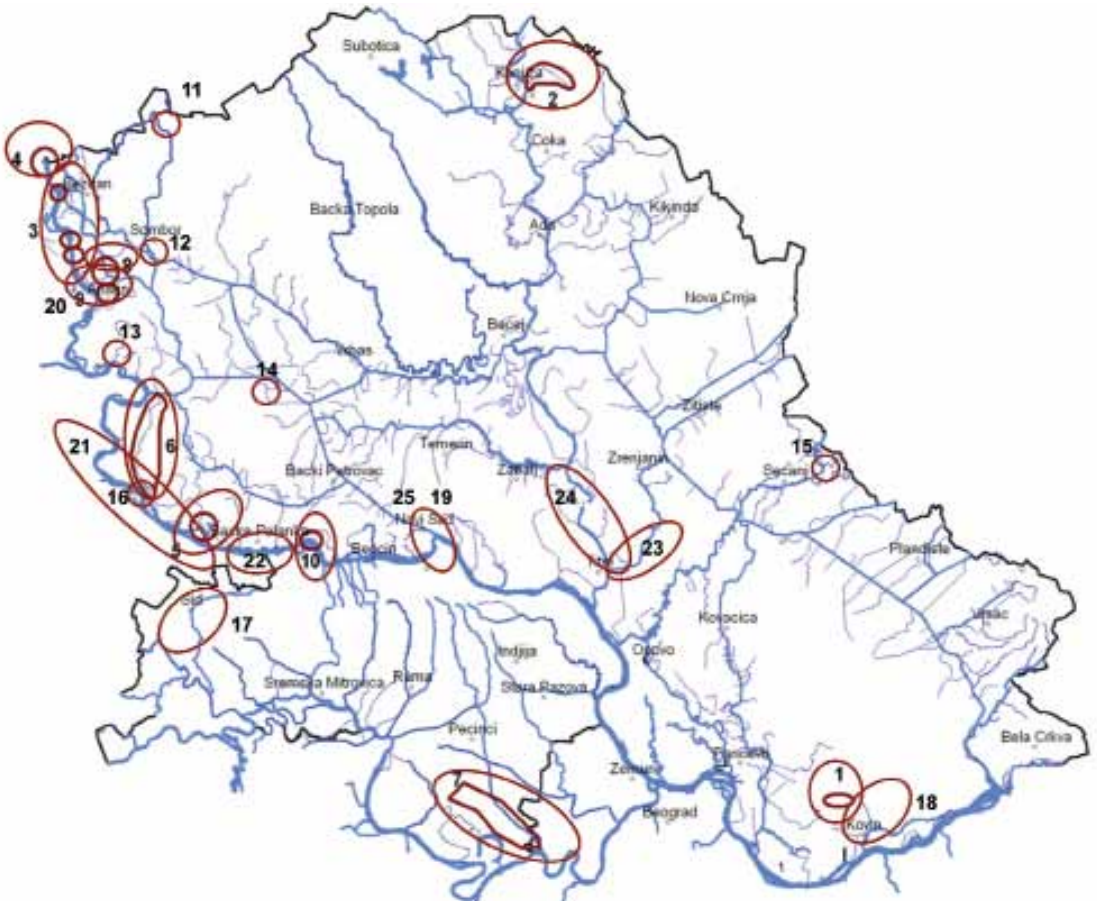
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# PROJECTS FINANCED FROM

<b>REHABILITATION OF DRAINAGE SYSTEMS</b>		
1.	Bavaniste (Municipality of Kovin)	643,856
2.	Novi Knezevac (Municipality of Novi Knezevac)	34,149,896
3.	Plavna (Municipality of Odzaci)	124,637,936
4.	Tovarnik (Municipality of Pecinci)	35.885.659
5.	Remediation of the inflow canal of the Pumping Station Kupusina	12,354.656
PLAN FOR THE YEAR 2010		
6.	Boris Blato (Municipality of Sid)	122,776,448
7.	Oberlan gravitation (Municipality of Kovin)	63,768,241
8.	Construction of 5 AB bridges with the span of 10-15 m	41,000,000
<b>REHABILITATION OF PROTECTIVE WATER MANAGEMENT FACILITIES</b>		
9.	The Danube River, left bank, rehabilitation, sector D.12 – sand ballast, stone cover layer	29,858,352
10.	The Danube River, left bank, rehabilitation, sector D.11 – reloading wells	2,533,677
11.	The Danube River, left bank, rehabilitation, sector D.12 – embankment, groynes	44,467,736
PLAN FOR THE YEAR 2010		
12.	Mobile equipment for the defence line of the City of Novi Sad	160,000,000
13.	The Danube River, left bank, rehabilitation, sector D.12 – embankment, continuation	60,000,000
14.	The Danube River, left bank, rehabilitation, sector D.11 – dike, embankment	137,000,000
15.	Reconstruction of the dike on the right bank of the Bega River	145,000,000
16.	Reconstruction of the dike on the left bank of the Tisza River	837,000,000
17.	Construction of the central storage for the needs of flood control	50,000,000
<b>TOTAL VALUE OF WORKS:</b>		<b>1,908,787,325 RSD 1.908.787.325 дин</b>

# THE WORLD BANK LOAN



# PROJECT: Rehabilitation of the drainage system of Bavaniste Canal



Value of the works: 6,438,568 RSD

Rehabilitation of the catchment area of Bavaniste Canal includes the main canal and 2 secondary canals.

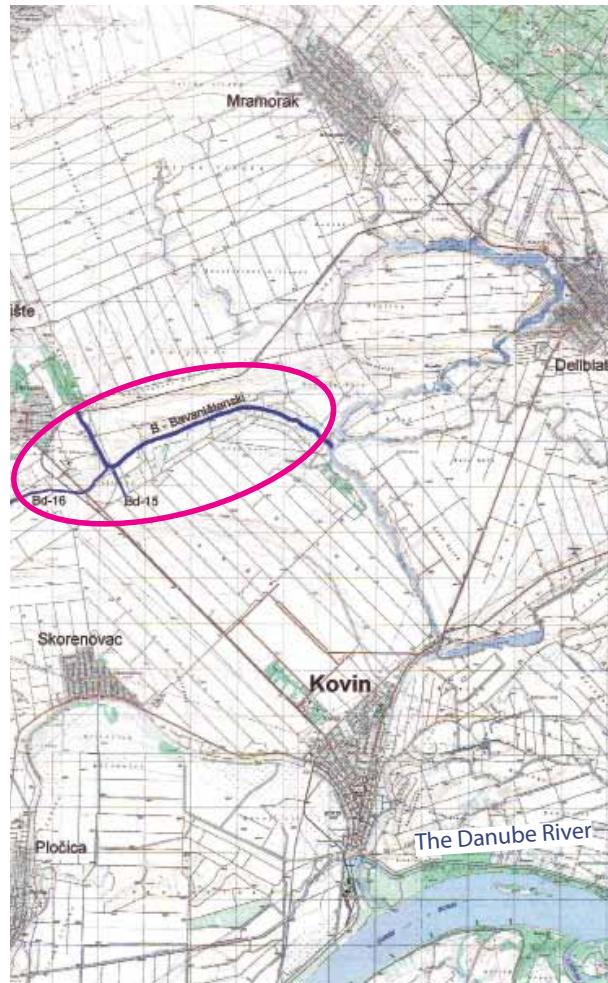
The gross surface of the catchment area is 4,240 ha and it includes the territory with 6,160 inhabitants, and 500 agricultural holdings.

The Bavaniste Canal flows into the Crna Bara Lake at km 4+900 and its function is to take all surplus water from this territory.

The rehabilitation of the B Canal in the length of 11+065 km and secondary Bd-15 and Bd-16 canals in their entire length was proposed after the survey of the current status.

The works that were carried out included detailed survey of the canal profile, preparation works of cleaning of the Canal from woody vegetation, cleaning (demudding), planning and regulation of the canal (flattening of slopes).

The works were completed in March 2007.



# PROJECT: Rehabilitation of the drainage system of Novi Knezevac Canal



Value of the works: 26,225,736 RSD

Rehabilitation of the catchment area of Novi Knezevac Canal includes the main canal, 4 secondary canals, and reconstruction of the pumping station Novi Knezevac.

The catchment area of Novi Knezevac is located in the most northern part of Banat and it includes the gross catchment area of 20,343 ha (18,000 ha net), i.e. the territory with 11,800 inhabitants and 180 agricultural holdings.

Together with the canals flowing into it, the main Novi Knezevac Canal makes the main drainage direction of this sub-system from the south, north, and east towards the west, namely the Tisza River.

Due to a high significance of Novi Knezevac catchment area, this rehabilitation project includes cleaning of the main canal at the section from km 1+400 to km 8+500, cleaning of secondary canals K-1, K-5, K-11, and K-25 and reconstruction of the pumping station Novi Knezevac. The works on reconstruction of the pumping station included electricity wiring, rehabilitation of the roof, general repair of the pump aggregate III and replacement of the worn out vacuum pipeline. The reconstruction of this pumping station created conditions for dual purpose use of the hydro-reclamation system.

The cleaning of the canal network was completed in August 2007 and reconstruction of the pumping station was completed in November 2008.



# PROJECT: Reconstruction of the pumping station Novi Knezevac



Value of the works: 7,924,161 RSD

Novi Knezevac catchment area is located in the most northern part of Banat and it includes the gross catchment area of 20,343 ha (18,000 ha net), i.e. the territory with 11,800 inhabitants and 180 agricultural holdings.

Due to a high significance of Novi Knezevac catchment area, this rehabilitation project includes cleaning of the main canal at the section from km 1+400 to km 8+500, cleaning of secondary canals K-1, K-5, K-11, and K-25 and reconstruction of the pumping station Novi Knezevac.

The works on reconstruction of the pumping station included electricity wiring, rehabilitation of the roof, general repair of the pump aggregate III and replacement of the worn out vacuum pipeline. The reconstruction of this pumping station created conditions for dual purpose use of the hydro-reclamation system.

The cleaning of the canal network was completed in August 2007 and reconstruction of the pumping station was completed in November 2008.



# PROJECT: Rehabilitation of the PLAVNA Drainage System – the main canal 25 km



Value of the works: 82,827,771 RSD

The catchment area of Plavna covers 12,500 ha of gross surface (12,000 ha net) with the canal network that is 224,525 km long. The catchment area is regulated by canals at the rate of 18m/ha. The river Danube is the recipient and excess water is evacuated via the pumping station Plavna that is electrically driven with the total capacity of 7 m<sup>3</sup>/s. The catchment area covers the territories of two municipalities: Odzaci and Bac.

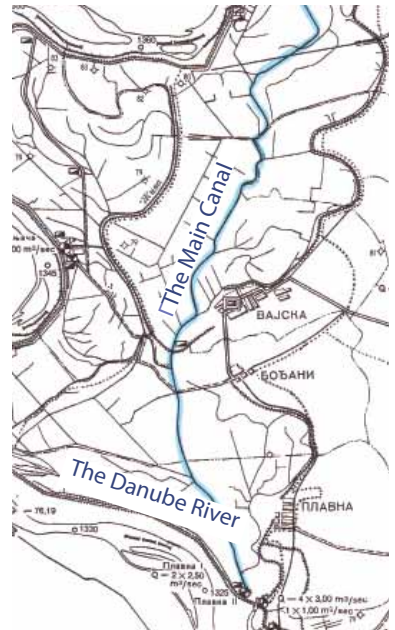
The main canal of the Plavna catchment area is 25 km long. It was reconstructed in accordance with technical documentation from 1969.

Due to a multi-annual negligence and absence of maintenance, the inflow of water up to the pumping station Plavna through the canal network is slower. This means that the pump

does not work with its full capacity during the evacuation of extreme waters and that surface water is retained longer on agricultural land.

The canal network is dimensioned on 20-year frequency of occurrence of high inland water. It covers the territory with 12,000 inhabitants and 1,200 agricultural holdings in villages of Karavukovo, Vajska, Bodjani, and Plavna.

The works lasted for 18 months and they were completed in February 2010.

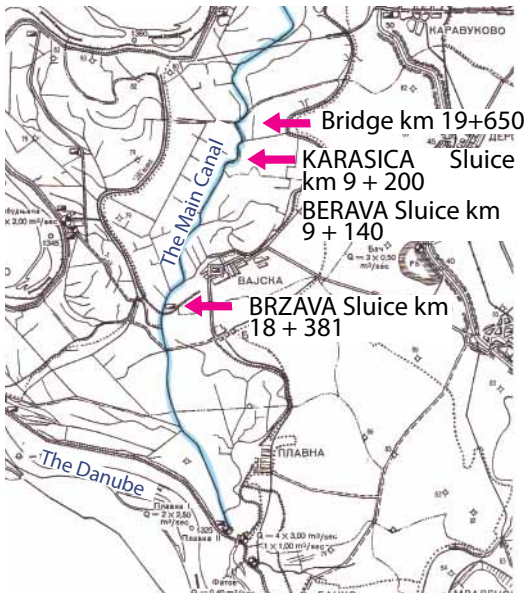


# PROJECT: Rehabilitation of the PLAVNA Drainage System – three sluices on the main canal



## Construction of the AB bridge on the main canal km 19+650

Value of the works: 10,943,560 RSD



In addition to earth works, the following three sluices were rehabilitated on the main canal:

1. Berava Sluice
2. Karasica Sluice
3. Brzava Sluice

The rehabilitation implies cleaning, washing, sanding and painting of sluices and replacement of the outdated elements.

The works lasted for three months and they were completed in June 2009.

The bridge made of reinforced concrete, with the span of 15 m and founded on piles, was built at the km 19 + 650 section of the main canal.

The construction lasted for three months and it was completed in June 2009.



# PROJECT: Rehabilitation of the PLAVNA Drainage System – secondary canals



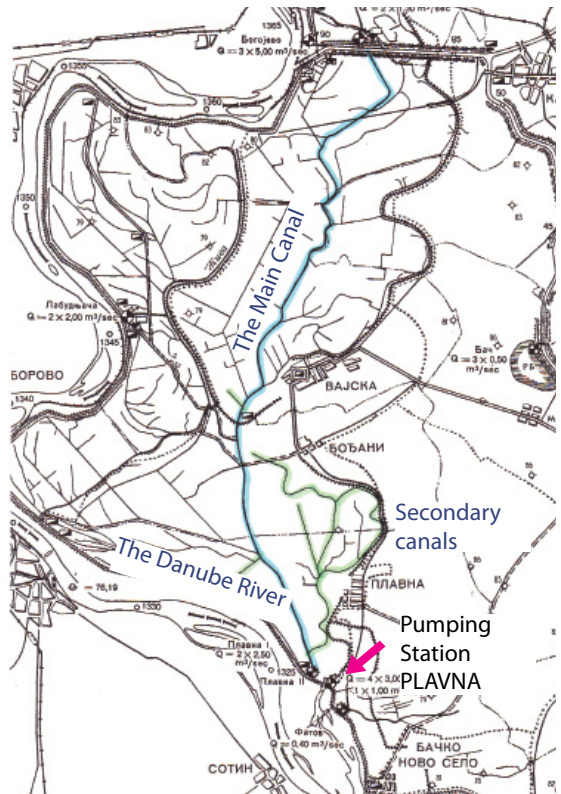
Value of the works: 19,674,714 RSD

The earth works, namely cleaning was carried out not only on the main canal but also on the secondary canals of the Plavna drainage system, in the total length of 18 km.

The works were carried out on the following canals:

- Canal 1.01 from km 0+000 to km 7+825
- Canal 1.01.4 from km 0+000 to km 2+385
- Canal 1.01.4.1 from km 0+000 to km 5+800
- Canal 1.03 from km 0+000 to km 1+275
- Canal 1.06 from km 0+000 to km 0+812.

The works lasted for twelve months and they were completed in March 2010.



**Planned in 2010:**

Rehabilitation of the PLAVNA Drainage System – Pumping Station PLAVNA – general repair of the second aggregate

Estimated value of works: 5,000,000 RSD

# PROJECT: Rehabilitation of TOVARNIK Drainage System



## - Main Canal 13.5 km

Value of the works: 33,200,428 RSD

## - Secondary canals

Value of the works: 3,109,604 RSD

Tovarnik Canal is located in the drainage system of Prograrska Jarcina Canal, in Municipality of Pecinci. The route of Tovarnik Canal stretches in the length of 13.43 km through a natural depression in cadastral municipalities of Ogar and Donji Tovarnik. The gross surface of the catchment area is 3,700 ha (3,600 ha net). There are two settlements in this area – Ogar and Donji Tovarnik with about 2,350 inhabitants and around 500 agricultural holdings.

The total length of the canal network of the entire catchment area is 118,583 m, which makes the density of 32 m/ha.

The works resulted with extending of the canal bed in accordance with the existing documentation for reconstruction from 1988. All the outlets were cleaned and the canal cover was laid down beneath the bridges.

The project included the works on the main canal in the length of 13.5 km and on four secondary canals in the total length of around 4 km.

The works lasted for twelve months and they were completed in March 2010.



Main Canal



Secondary canal

# PROJECT: Remediation of the supply canal of the pumping



Value of the works: 12,343,967 RSD

The pumping station Kupusina is located beside the same named settlement in the West Backa. Kupusina Drainage System is surrounded with the Becej-Bezdan Canal on the north and east side and with the Prigrevica-Bezdan Canal on the west side.

The main supply canal leading to the pumping station in Kupusina showed the consequences of erosion of the left and right banks in the length of around 70 m. The soil erosion threatened the structure on the bank. The erosion was caused by the fact that the bank was not secured

with a cover layer so that higher speed of water simply took the existing material away. Removal of the material is most emphasised around the inflow structure where oscillations of the water level are the highest.

The objective of this project is the rehabilitation of the supply canal and laying down of the canal cover on the threatened section. Covering of the canal banks prevented future erosions, which was the essence of rehabilitation works.

The works lasted for six months and they were completed in March 2010.



Supply canal up to the Pumping Station Kupusina



Discharge canal up to the Danube-Tisza-Danube Canal

# PROJECT: Rehabilitation of the dike of Sector D.12, Sombor from Bogojevo to

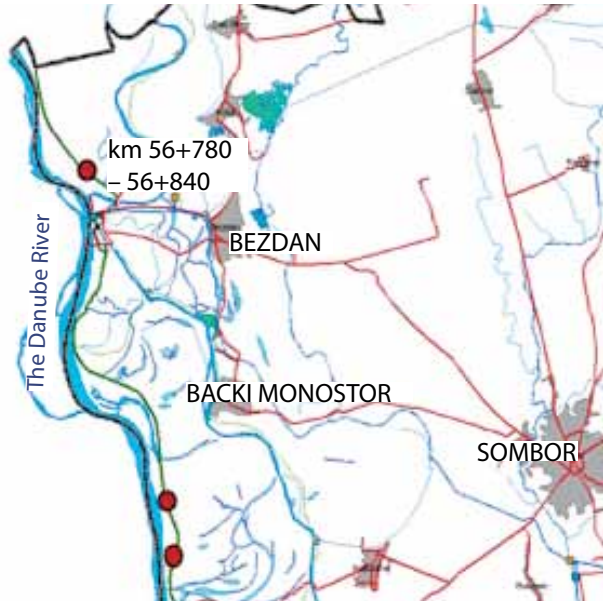


Value of the works: 10,421,690 RSD

On the side facing water, the dike was made of coherent (clay) material. On the defended side, the dike was made of non-coherent sandy material with milder dike slopes and it was covered with thin humus layer. The elevation line of the dike crown has necessary protection height in relation to 1‰ high water.

At this section, the dike was built on a small thickness cover layer so that the problems with high Danube water levels occur in the hinterland of the dike, namely the filtration deformities of the soil of defended terrain occur, which is exceptionally emphasised phenomenon in the defended dike foot. This results with formation of water logging and springs within the defended terrain, namely directly behind the dike foot. The penetration of the dike at the section from km 56+780 to km 56+840 would threaten the Kendjija-Karapandza area within protected natural resort called Special Nature Resort "Gornje Podunavlje", i.e. the surface of around 2,500 ha of agricultural and forest land, large number of heads of game and settlements of Bezdán, Kolut, and Backi Breg with close to 8,300 inhabitants.

The penetration of the dike at the section from km 32+300 to km 37+380 and from km 39+550 to km 39+650 would threaten the Siga-Kazuka area, i.e. the surface of around 5,800 ha and settlements of Backi Monostor and Kupusina with close to 6,200 inhabitants.

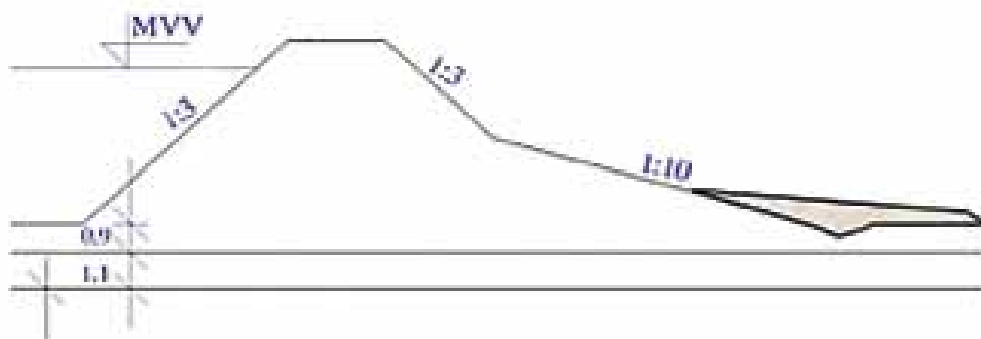


# On the left bank of the Danube, on the state border with Hungary

The sand ballast was built in the defended terrain covering micro-depressions and a thin soil layer, and toggling into the defended dike foot. Filling of sandy material up to the planned elevation line results with rehabilitation of the subject sections, namely elimination of threats of occurrence of filtration deformities, i.e. fluidisation and suffosion of the cover layer at the spot of its damage. After filling of the material, the upper surface and ballast slope were covered with humus and planted with grass.

Rehabilitation of those sections of the first defence line dike and the terrain in the dike hinterland stopped further filtration deformation processes and a weak spot in the defence line was eliminated, providing the dike and defended area with a higher level of safety.

The works were carried out during 2008.



# PROJECT: Rehabilitation of the stone cover Danube, sector D.12 Sombor, from Bogoje

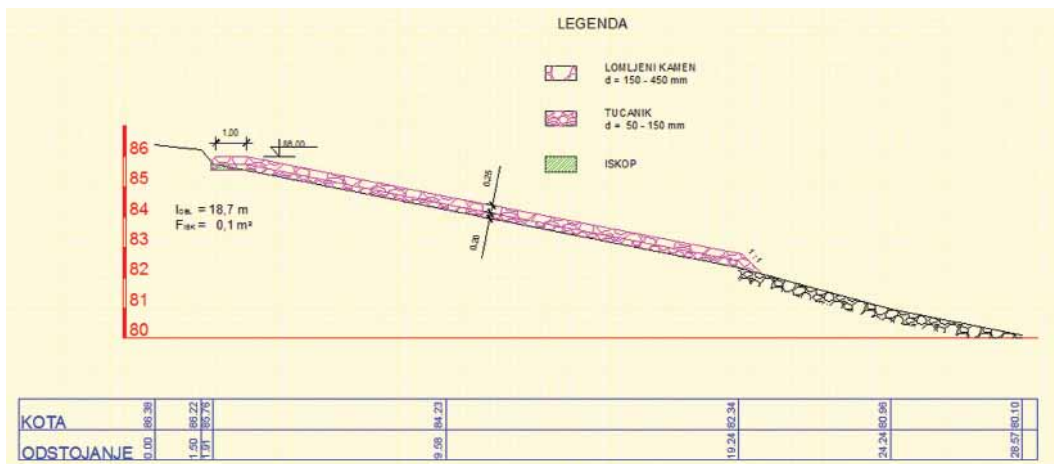


Value of the works: 19,436,662 RSD

Regulation structures on the left bank of the Danube have the role to fortify and stabilise the banks in the vicinity of the first defence line dikes. The damages caused by ice have been registered on the embankment section from km 1431+060 to km 1430+740. The upper part of the embankment collapsed and slid into water, and dike foot that was at the distance of 30 m started caving in. The penetration of the first defence line dike would threaten the Kendjija-Karapandza area within the protected natural resort – Special Nature Resort “Gornje Podunavlje”, i.e. around 2,500 ha of agricultural and forest land and a large number of heads of game in our territory and settlements of Bezdán, Kolut, and Backi Breg with close to 8,300 inhabitants. Water would spread to the territory of Hungary since there are no border dikes.



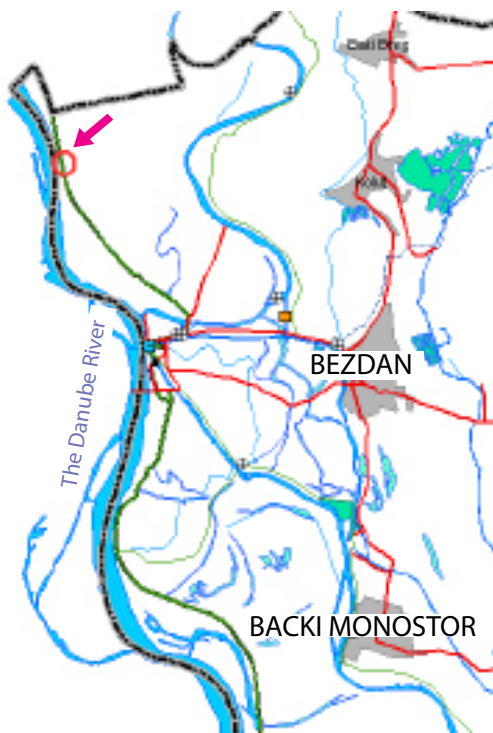
# of the dike on the left bank of the vo to the state border with Hungary



The collided part of the embankment from km 1431+060 to km 1430+740 was rehabilitated with inserting of two-layer stone cover made of crushed gravel and stone, with creating of an embankment slant in 1:1.5 ratio. The layer made of crushed gravel that was 20 cm thick was installed on the prepared foundation and a slope (1:1.5) that was created, as well as a layer of roughly crushed stone ( $\varnothing$  150 – 450 mm) that was 25-45 cm thick. The edge that is 1 m wide was created on the upper part. It is going to be paved with cobblestones as well as the remaining part of newly created embankment slope.

Thanks to the works that were carried out the bank was protected and fortified, the process of caving in and closing up of the first defence line, which was located at the distance of 30 m from the bank, was stopped.

The works were carried out during 2008.



# PROJECT: Remediation of the Danube

## D.11. Backa Palanka, from Begec to B

### the dike from Vajska to Mladenovo –



Value of the works: 2,533,677 RSD

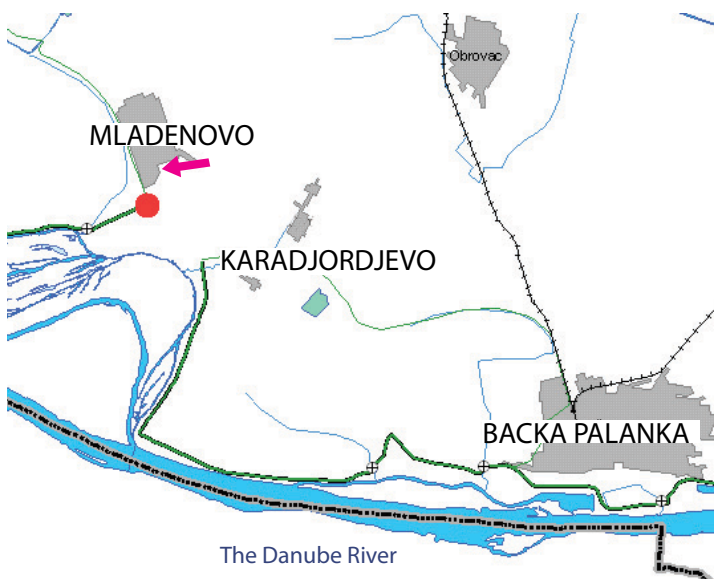
The reconstructed dike disposes with necessary protection height of 1.2 m above the calculated high water. It was built of coherent material from undefended side, and from the defended side it was fortified with hydraulically installed sand and covered with humus layer.

During high water levels of the Danube and flood defence activities, the occurrence of stale water and springs was registered in the undefended area beside the dike foot, at the dike section from km 39+450 to km 39+750.

The penetration of the first defence line dike would threaten the area of around 3,000 ha of arable land and settlements of Mladenovo and Backo Novo Selo with

close to 5,000 inhabitants.

Rehabilitation of the section from km 39+450 to km 39+750 of the dike was carried out by combining vertical and horizontal pipe drainage. Vertical drainage consists of self-discharging vertical wells (13 pieces) that are mutually connected with drainage pipes taking water into the Canal.

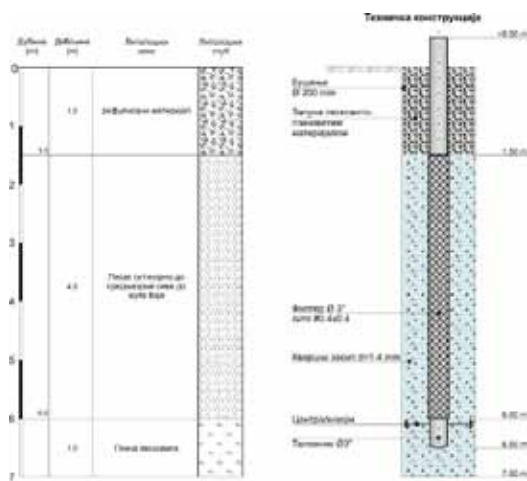


# dike at Mladenovo, Defence sector ogojevo, Technical section D.11.2 reloading wells (battery)



Horizontal pipe drainage enables reloading of soil surface layers and it consists of two arms, the overall length of which is 400 m. Accepted water is discharged into the drainage canal, which belongs to the land reclamation catchment area of Mladenovo.

Thanks to the works that were carried out in 2008, this area stopped being a weak spot on the defence line. Stale water and springs do not appear any more, which has been confirmed during the extraordinary flood defence in 2009.



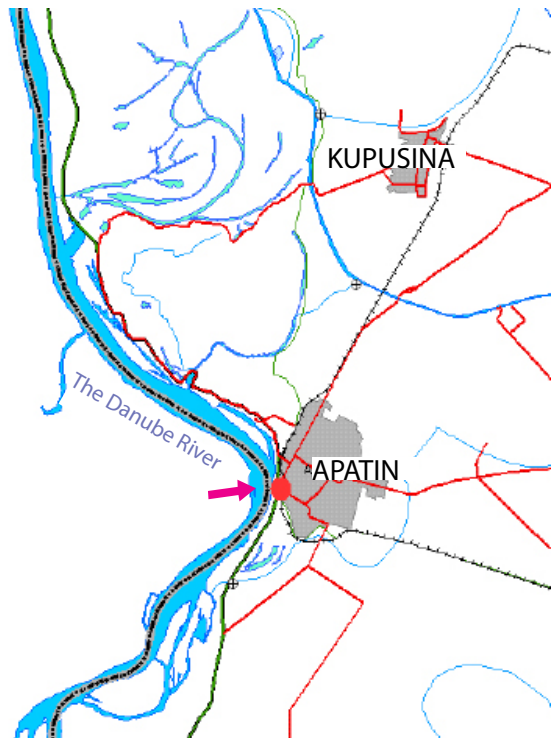
# PROJECT: Remediation of the left Defence sector D.12. Sombor, from Bog



Value of the works: 25,464,816 RSD

The embankment on the left bank of the Danube at Apatin, from km 1401+400 to km 1401+624 ("Stari Kej") is an integral part of the first defence line dike. It is built in the form of slanted quay wall construction made of crushed stone that leans on the dike foot, which is also made of crushed stone. At the section from km 1401+400 to km 1401+479 the dike slopes were partly covered with crushed stone and the dike foot was damaged. In cases when flood waves of the river Danube occur the probability for colliding of outdated embankment increases, namely the threat of dike damaging.

The penetration of the first defence line dike at this site would threaten directly the town of Apatin with 19,500 inhabitants, the territory with close to 12,400 ha of arable land and settlements of Sonta, Svilojevo, and Prigrevica with close to 11,000 inhabitants.



# bank of the Danube at Apatin, ojevo to the state border with Hungary



The embankment foot and carpet were reinforced with crushed stone. The quay wall cover was made of concrete blocks that were laid down horizontally in lines along the 1:2 slope and surfaces covered with blocks were fenced with AB beams. The verge stretches along the middle of the quay wall so that the cover layer is divided in two zones. New AB staircase was built instead of the old staircase. The remediation of the embankment resulted with fortified defence line, increasing of its safety and aesthetic reasons were also satisfied. The works were carried out in 2008 and 2009.



# PROJECT: Remediation of the left bank of the river Danube, Defence sector D.11. Backa Palanka, from Begec to Bogojevo



Value of the works: 19,002,920 RSD

The regulation structures on the left bank of the river Danube, at the section from km 1284+400 to km 1284+000 near Glozan, were built in order to regulate the river flow width, fortify the existing bank and create a new bank. Large scale damages caused by erosive activity of a watercourse, ice, and waves were registered at the groyne no. 2 (km 1284+255). The elevation line of the groyne crown was lowered by 1.50 m compared to the designed elevation line while side slopes and the groyne body were also damaged, in particular on profiles closer to the river main stream. The process of the bank colliding started. The first defence line dike is located at the distance of only 10 to 15 m from the dike foot.

The remediation works that were carried out in order to protect and fortify the bank affected the increase of the safety level of the first defence line dike. The penetration of the first defence line dike would threaten the surface of around 1,700 ha of arable land and settlements of Glozan, Celarevo, and Begec with close to 12,000 inhabitants.

Groyne no. 2 was rehabilitated and the Danube riverbed and banks were stabilised at that site.

A weakened groyne body was filled with crushed gravel that was the foundation for crushed stone up to the designed elevation lines and slopes. Riverbed and banks were stabilised with a carpet made of crushed gravel and crushed stone in order to stop the erosion processes on the riverbed and on the banks.

Thanks to the works that were carried out the regulation structure was remedied and its function was restored, the bank was protected and fortified, the process of its caving in and getting close to the first defence line dike was stopped.

The works were carried out in 2009.



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