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Laboratory analysis report

No. 12120297

*Project: ENVIRONMENTAL RESPONSE TO
MINING EXPANSION IN TIMOČKA KRAJINA*

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1. INTRODUCTION

Anahem d.o.o. Laboratory (hereinafter referred to as Anahem) from Belgrade (Serbia) was appointed by Asociation ZA Drinking Fountains, Zaječar, to carry out the sampling and laboratory analyses of water, sediments and ichthyofauna in the rivers of the Crni Timok, the Veliki Timok, the Borska reka, the Pek, the Dunav at the confluence of the Timok within the Project "ENVIRONMENTAL RESPONSE TO MINING EXPANSION IN TIMOČKA KRAJINA".

The purpose of the study is to investigate existing situation and further monitoring of harmful effects of mining and urban development on the environment in Timočka Krajina. In order to estimate existing situation, based on the previous campaign carried out from 31.08.2022 to 03.09.2022. samples were taken at the ten locations described in the next chapter. Figure 1 shows the map of the area - Timočka Krajina.



Figure 1. Map of Timočka Krajina

Sampling was carried out in the period from 05.12.2022 to 11.12.2022. Sample analysis was done in accordance with the scope defined by offer 12051609, which included:

The analysis of the samples was done in accordance with the scope defined by the offer 12051609, which included:

- Physico-chemical analyzes: 1) Water: color, odor, temperature, electrical conductivity, pH, concentration of dissolved oxygen, as well as concentration of SO_4^{2-} , Cl^- , PO_4^{3-} , NO_3^- , NH_3 , As, Cd, Cu, Fe, Mn, Ni, Pb, Hg, Zn, Co, Sr, S, Ca, Mg, K, Na and

Cr; organic and microbiological pollution. 2) Sediment: color and concentration of Mn, Ni, Co, Sr, As, Cd, Cr, Hg, Cu, Pb and Zn; radioactivity. 3) Ichthio fauna samples: radioactivity and Cd, Pb, As, Cu, Hg, Cr, Co, Ni, Mn, Zn, Fe and Hg concentration.

2. LOCATIONS OF SAMPLING POINTS

2.1. River Pek

In order to determine the quality of the river Pek, as well as the impact of mining in Majdanpek, which together with flotation and landfills is a potential source of pollution, sampling was carried out on the rivers shown in Figure 2. Figure 3 shows a satellite view of the sampling points, and Table 1 shows the GPS coordinates. and sample labels.



Figure 2. Representation of the rivers on which the sampling was carried out

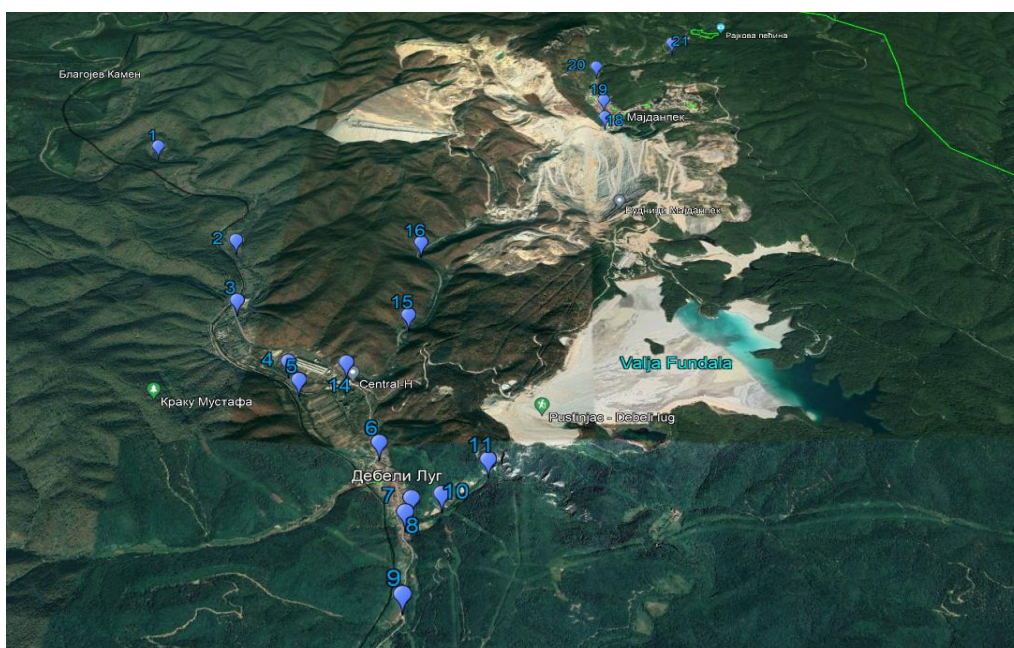


Figure 3. Satellite view of sampling points

Table 1. GPS coordinates of sampling locations and sample IDs (No. - Location marked on the map)

No.	Sample ID		Location	N	E
	Water	Sediment			
1	1212029701	5212029701	River Pek	44.414995	21.869618
2	1212029702	5212029702	River Pek	44.397731	21.885422
3	1212029703	5212029703	River Pek	44.388414	21.888026
4	1212029704	5212029704	River Pek after the confluence of Mali Pek and Veliki Pek	44.379949	21.896169
5	1212029705	5212029705	Veliki Pek before merging with Mali Pek	44.377536	21.897906
6	1212029706	5212029706	Veliki Pek after the confluence of the Todorove reka	44.370125	21.908082
7	1212029707	5212029707	Veliki Pek after the inflow of the Crna reka	44.364134	21.912263
8	1212029708	5212029708	Crna Reka before flowing into Veliki Pek	44.362683	21.911812
9	1212029709	5212029709	Crna Reka	44.354931	21.912550
10	1212029710	5212029710	Veliki Pek before the confluence of the Crna reka	44.364527	21.915326

11	1212029711	5212029711	Veliki Pek downstream from the tailings in Valja Fundata	44.368027	21.919870
13	1212029713	5212029713	Veliki Pek (Village Leskovo)	44.314412	21.941813
14	1212029714	5212029714	Mali Pek before merging with Veliki Pek	44.379771	21.902878
15	1212029715	5212029715	Mali Pek after the open-pit mine in Majdanpek	44.386000	21.909274
16	1212029716	5212029716	Mali Pek posle površinskog kopa u Majdanpeku	44.396873	21.909542
18	1212029718	5212029718	Mali Pek before the open-pit mine in Majdanpek	44.420099	21.934019
19	1212029719	5212029719	Mali Pek after the sewage inlet	44.42374	21.93399
20	1212029720	5212029720	Mali Pek before the sewage inlet	44.431045	21.933070
21	1212029721	5212029721	Mali Pek	44.436257	21.945308

2.2. Borska reka, Brestovačka reka, Kriveljska Reka, Bela Reka, Timok

Upstream from Bor, the Borska reka is directed into the Kriveljska Reka through a tunnel, in order to open an open-pit copper mine in its valley. Downstream from Bor, municipal waste water, untreated mine water and waste water from metallurgy and basic chemistry plants are discharged into the bed of the former watercourse. A large amount of flotation tailings flows into the river, flooding the banks of this river and Veliki Timok downstream from its mouth. It flows through the villages of Slatina and Vražognac. The analysis of the samples taken from the rivers shown in Figure 4 was carried out in order to determine the pollution of the Timok River based on the analysis of samples from the rivers that flow into it.

Water and sediment samples of the Crni Timok River were taken in order to determine the impact of mining and the release of toxic substances on water quality, as well as on ichthyofauna. This is particularly significant because of the Timok trout, an autochthonous species, which is particularly threatened by the discharge of wastewater from the Čukaru Peki mine. Also, samples of the Brestovačka Reka, Kriveljska Reka and Bela Reka were taken at representative locations in order to determine potential pollution.

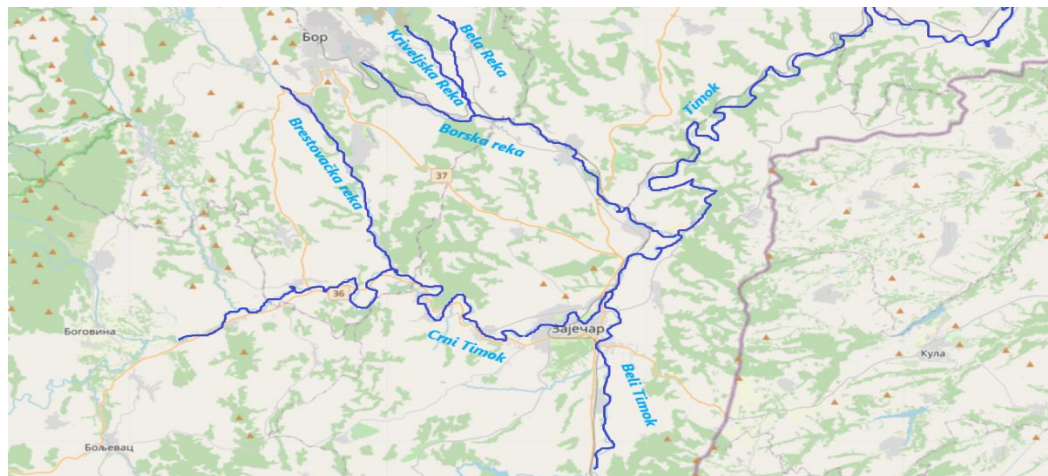


Figure 4. Representation of the rivers on which the sampling was carried out

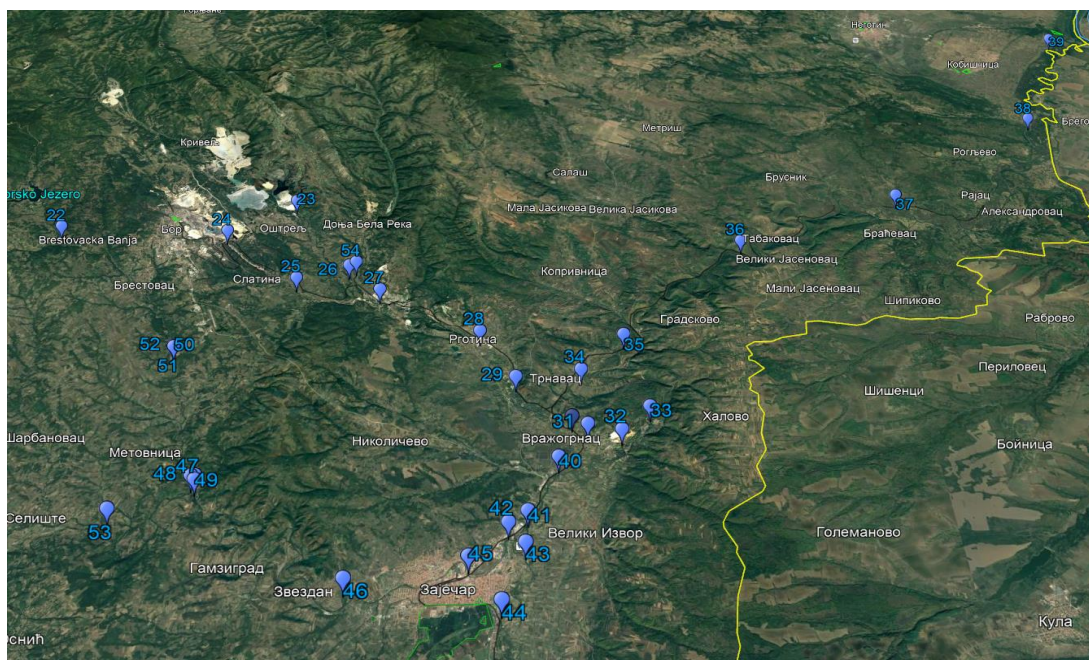


Figure 5. Satellite view of sampling points

Table 2. GPS coordinates of sampling locations and sample IDs (No. - Location marked on the map)

Br.	Sample ID		Location	N	E
	Water	Sediment			
22	1212029722	5212029722	Brestovačka reka	44.063510	22.039811
23	1212029723	5212029723	Kriveljska Reka	44.080470	22.165888
24	1212029724	5212029724	Borska reka immediately after the mine	44.061187	22.132179
25	1212029725	5212029725	Borska reka downstream from the mine	44.033762	22.176378

26	1212029726	5212029726	Kriveljska Reka	44.04095	22.20291
27	1212029727	5212029727	Borska reka after the confluence of the Kriveljske Reke	44.027306	22.221530
28	1212029728	5212029728	Borska reka	44.00520	22.275564
29	1212029729	5212029729	Borska reka	43.982367	22.294760
30	1212029730	5212029730	Borska reka	43.964114	22.322127
31	1212029731	5212029731	Borska reka	43.960730	22.329556
32	1212029732	5212029732	Reka Timok before confluence with Borske reke	43.958245	22.345467
33	1212029733	5212029733	Reka Timok after confluence with Borske reke	43.968669	22.359203
34	1212029734	5212029734	Reka Timok	43.986188	22.326500
35	1212029735	5212029735	Reka Timok	44.003664	22.348134
36	1212029736	5212029736	Reka Timok	44.056234	22.414643
37	1212029737	5212029737	Reka Timok	44.085536	22.507940
38	1212029738	5212029738	Reka Timok	44.140915	22.605564
39	1212029739	5212029739	Timok before the confluence with Dunav	44.209075	22.646174
40	1212029740	5212029740	Reka Timok nakon spajanja reke Crni Timok i Beli Timok	43.946431	22.316044
41	1212029741	5212029741	Reka Timok after the confluence of the Crni Timok and Beli Timok	43.924469	22.302808
42	1212029742	5212029742	Reka Crni Timok before confluence with the Beli Timok	43.919952	22.294547
43	1212029743	5212029743	Reka Beli Timok before confluence with the Crni Timok	43.912481	22.302315
44	1212029744	5212029744	Reka Beli Timok	43.891712	22.293281
45	1212029745	5212029745	Reka Crni Timok (after bathing area of Popova Plaža)	43.907331	22.278259
46	1212029746	5212029746	Crni Timok River before the entrance to Zaječar	43.899286	22.226646

47	1212029747	5212029747	Crni Timok after the confluence with Brestovačka river	43.936827	22.152898
48	1212029748	5212029748	Crni Timok before the confluence with Brestovačka river	43.938343	22.150727
49	1212029749	5212029749	Brestovačka Reka - before the confluence with Crni Timok	43.938519	22.152586
50	1212029750	5212029750	Brestovačka reka immediately after the inflow of wastewater from the mine	43.996735	22.123899
51	1212029751	5212029751	The place of discharge of the waste canal from the new Čukaru Peki mine into the Brestovačka reka (the waste canal from the Čukaru Peki mine)	43.997501	22.123934
52	1212029752	5212029752	Brestovačka reka without the impact of wastewater from the mine	43.997015	22.123402
53	1212029753	5212029753	Crni Timok before the confluence of the Brestovačka Reka	43.925043	22.118361
54	1212029754	5212029754	Bela Reka	44.042994	22.206340

The locations where a fish sample was taken for laboratory analysis, on the basis of which the potential pollution of ichthyofauna can be assessed, are shown in table 4.

Table 4. Locations and sample IDs of fish samples*.

Br.	Lokacija	Oznaka uzoraka
1.	Reka Timok (before the confluence with Dunav)	4212029701
2.	Reka Timok	4212029702

*Uzorci dostavljeni Anahemu

3. TECHNIQUES AND METHODS

3.1. Sampling and analysis of water

Sampling and laboratory analysis of surface and groundwater was performed according to standard and validated accredited methods. The following methods for sampling were used: SRPS EN ISO 5667-1, SRPS EN ISO 5667-3, SRPS EN ISO 5667-4, SRPS EN ISO 5667-6, and SRPS EN ISO 19458. The field analytes were tested at the site. A portable fridge was used to keep samples cold during their transport to the laboratory. Laboratory analyses of water samples were made by using methods given in Table 5.

Table 5. List of methods used for the surface water analysis.

Parameter	METHOD
FIELD MEASUREMENTS	
Water temperature	EPA 170.1
pH Value	EPA 150.1
Conductivity	EPA 120.1
Dissolved Oxygen (O ₂)	EPA 360.1
LABORATORY MEASUREMENTS	
Color	SRPS EN ISO 7887
Odor	DML 2.7
Sulfates (SO ₄ ²⁻), Chloride (Cl ⁻), Orthophosphates, Nitrate (NO ₃ ⁻), Nitrite (NO ₂ ⁻)	ISO 10304-1
Ammonium ion (NH ₄ -N)	SRPS ISO 7150-1
Cadmium (Cd), Nickel (Ni), Lead (Pb), Zinc (Zn), Cobalt (Co)	EPA 200.8
Arsenic (As), Copper (Cu), Chromium (Cr) Total, Iron (Fe), Manganese (Mn), Strontium (Sr), Sulphur	SRPS EN ISO 11885
Magnesium, Potassium, Calcium, Sodium	ISO 14911
Phenols	SRPS ISO 6439
Petroleum hydrocarbons (C10-C40)	ISO 9377-2
Surface active agents (such as lauryl sulfate)	SM 5540C
AOX	DML 2.2
MICROBIOLOGY MEASUREMENTS	
Fecal coliform count in 100 ml MPN Colilert	DML 2.9
Total coliform count in 100 ml MPN Colilert	DML 2.9
Intestinal enterococci	DML 2.10
Aerobic heterotrophic bacteria	SRPS EN ISO 62220

3.2. Sampling and analysis of sediment

Accredited methods were used for sediment sampling and analysis. The sediment sampling procedure was performed according to the SRPS ISO 5667-12 method. Laboratory analyzes of sediment samples were performed using the methods given in Table 6.

Table 6. List of methods used for sediment analysis.

Parameter	METHOD
Metals: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Nickel (Ni), Zinc (Zn), Manganese (Mn), Cobalt (Co), Strontium (Sr)	EPA 3051A/EPA 6010c
Clay content	ISO 11277
Content of organic matter	EN EN TC WI
Content of radionuclides	SRPS EN ISO 18589-3

3.3. Analysis of fish samples

Table 7 shows the methods used for the analysis of fish samples.

Table 7. List of methods used for the analysis of fish samples.

Parameter	METHOD
Cobalt (Co), Nickel (Ni), Manganese (Mn), Chromium (total)	DML 1.1
Cadmium (Cd), Lead (Pb), Arsenic (As), Mercury (Hg), Copper (Cu), Iron (Fe), Zinc (Zn)	SRPS EN 15763
Content of radionuclides	IAEA TRS 295

4. EXPERIMENTAL RESULTS

4.1. Limit values of pollutants in surface waters and criteria for assessing the quality of sediment and permitted methods of handling washed sediment.

Table 8. Regulated limit values of parameters for surface water
(Official Gazette RS, No 50/2012)..

Parameter	Limit values ¹				
	I class	II class	III class	IV class	V class
pH value	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	<6.5 or <8.5
Suspended solids, mg/L	25	25	-	-	-
Dissolved oxygen, mg O ₂ /L	8.5	7.0	5	4	<4
Oxygen saturation, %	90-110	70-90	50-70	30-50	<30
BOD ₅ , mg O ₂ /L	1.8	4.0	7	25	>25
COD (K ₂ Cr ₂ O ₇), mg O ₂ /L	10	15	30	125	>125
Consumption of KMnO ₄ , mg O ₂ /L	5	10	20	50	>50
Total organic carbon (TOC), mg/L	2.0	5.0	15	50	>50
Nutrients					
Total nitrogen, mg N/L	1	2	8	15	>15
Nitrate, mg N/L	1.5	3.0	6	15	>15
Nitrite, mg N/L	0.01	0.03	0.12	0.3	>0.3
Ammonia nitrogen, mg N/L	0.10	0.30	0.6	1.5	>1.5
Un-ionized ammonia, mg NH ₃ /L	0.005	0.025	-	-	-
Total phosphorus, mg P/L	0.05	0.10	0.4	1	>1
Orthophosphate, mg P/L	0.02	0.10	0.2	0.5	>0.5
Salinity					
Chloride, mg/L	50	100	150	250	>250
Total residual chlorine, mg HOCl/L	0.005	0.005	-	-	-
Sulfates, mg/L	50	100	200	300	>300
Total mineralization, mg/L	<1000	1000	1300	1500	>1500
Conductivity at 20°C, µS/cm	<1000	1000	1500	3000	>3000
Metals, µg/L					
Arsenic	<5	10	50	100	>100
Cadmium	-	-	-	-	-
Copper	5 (T=10) 22 (T=50) 40 (T=100) 112 (T=300)	5 (T=10) 22 (T=50) 40 (T=100) 112 (T=300)	500	1000	>1000
Zinc	30 (T=10) 200 (T=50) 300 (T=100) 500 (T=500)	300 (T=10) 700 (T=50) 1000 (T=100) 2000 (T=500)	2000	5000	>5000
Chromium (total)	25	50	100	250	>250
Chromium III (dissolved)	-	-	-	-	-
Chromium VI (dissolved)	-	-	-	-	-
Iron (total)	200	500	1000	2000	>2000
Boron	300	1000	1000	2500	>2500
Lead (dissolved)	-	-	-	-	-
Manganese (total)	50	100	300	1000	>1000

Mercury	-	-	-	-	-
Nickel (dissolved)	-	-	-	-	-
<i>Organic substances</i>					
Phenol compounds, µg/L	<1	1	20	50	>50
Petroleum hydrocarbons ²	without	without	without	without	without
Surface active agents, µg/L	100	200	300	500	>500
AOX, µg/L	10	50	100	250	>250
<i>Microbiology</i>					
Fecal coliforms, cfu/100ml	100	1000	10000	100000	>100000
Total coliforms, cfu/100ml	500	10000	100000	1000000	>1000000
Intestinal enterococci, cfu/100ml	200	400	4000	40000	>40000
Aerobic heterotrophic bacteria, cfu/100ml	500	10000	100000	750000	>750000

According to the Regulation on the categorization of watercourses ("Official Gazette of the RS", No. 5/68), the Pek River belongs to Class III from its source to its confluence with the Danube. Crni Timok from the source to Zaječar and from Zaječar to the confluence the Borska river belongs to the II.

The criteria for assessing the quality of the sediment and the permitted ways of dealing with washed sediment (Official Gazette RS, No 50/2012) are shown in table 9.

Table 9. The criteria for assessing the quality of the sediment and the permitted ways of dealing with washed sediment

Class	Criteria	Ways of handling washed sediment
0	≤ Target value	The concentrations of pollutants in the sediment are at the level of the natural background. Sediments can be dislodged without special protection measures.
1	> Target value and ≤ Limit value	The sediment is slightly polluted. During dislocation, disposal is permitted without special protection measures in a zone up to 20 m wide in the vicinity of watercourses.
2	> Limit value and ≤ Verification limit	
3	> Verification level ≤ Remediation value	The sediment is polluted. It is not allowed to dispose of it without special protective measures. It is necessary to store it in controlled conditions with special protection measures in order to prevent the spread of polluting substances in the environment.
s4	> Remediation value	Extremely polluted sediments. Remediation or storage of ground material in controlled conditions with special protection measures is mandatory to prevent the spread of pollutants into the environment.

4.2. Analysis of water and sediment

4.2.1. Analysis results - water and sediment quality – Majdanpek area

The results of the analysis of water samples - Majdanpek area are shown in table 10.1 and 10.2

Table 9.1 Results of water sample analysis - Majdanpek area (Sample ID 12120297xxa)

Location:	Reka Pek	Reka Pek	Reka Pek	Reka Pek after the confluence of Mali Pek and Veliki Pek	Veliki Pek before merging with Mali Pek	Veliki Pek after the confluence of the Todorova reka	Veliki Pek after the confluence of the Crne reka	Crna Reka before flowing into Veliki Pek	Crna Reka	Veliki Pek before the confluence of the Crna Reka
Sample ID:	01	02	03	04	05	06	07	08	09	10
Water temperature, °C	5.5	5.6	5.6	5.7	5.4	5.3	5.3	5.9	5.7	5.1
Color	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow
Odor	without	without	without	without	without	without	without	without	without	without
Conductivity $\mu\text{S}/\text{cm}$	1306	1055	993	1049	800	842	761	518	510	865
pH	8.1	8.2	7.9	8.3	8.4	8.1	8.0	8.2	8.1	7.9
Dissolved oxygen mg/l	7.1	7.2	7.1	7.5	7.6	7.7	7.5	7.4	7.5	7.1
Sulfates, mg/l	503	381	350	412	225	268	200	35	30	219
Chlorides, mg/l	18	16	16	17	11	11	10	6	6	11
Orthophosphates, mg/l	0.76	0.63	0.67	0.88	0.97	1.15	0.46	1.1	0.39	0.78
Nitrates mgN/l	0.3	0.46	0.32	0.51	0.24	0.22	0.18	0.27	0.19	0.29
Nitrites mgN/l	0.11	0.12	0.08	0.18	0.05	<0.03	<0.03	<0.03	<0.03	<0.03
Ammonium ion (NH ₄ -N) mgN/l	1.7	2.1	2.6	1.4	0.34	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic, mg/l	0.0014	0.0029	0.0029	0.0045	0.0015	0.0011	0.0013	0.0040	0.0014	0.0030
Cadmium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, mg/l	0.053	0.097	0.098	0.012	0.012	0.010	0.0058	0.0034	0.0012	0.013
Chromium (total), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, mg/l	0.29	0.48	1.5	0.57	0.26	0.15	0.14	0.27	0.17	0.15
Manganese, mg/l	1.0	1.1	1.1	1.2	0.089	0.12	0.094	0.053	0.016	0.13
Nickel, mg/l	0.0064	0.0086	0.0072	0.0083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, mg/l	0.049	0.077	0.070	0.098	0.054	<0.001	<0.001	0.003	<0.001	<0.001
Zinc, mg/l	0.13	0.17	0.18	0.24	0.027	0.026	0.023	0.0083	0.010	0.037
Cobalt, mg/l	0.0064	0.0082	0.0075	0.011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium, mg/l	0.90	0.78	0.74	0.92	0.54	0.56	0.47	0.17	0.16	0.60
Mercury, mg/l	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Magnesium, mg/l	49	36	34	38	15	16	16	8.1	8.8	19
Potassium, mg/l	9.6	8.6	8.8	9.7	7.8	8	6.3	1.7	1.4	8.3
Calcium, mg/l	183	165	162	184	126	136	141	87	97	121

Sodium, mg/l	42	34	33	35	29	30	29	19	20	34
Phenol compounds (such as C2H5OH), µg/L	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Petroleum hydrocarbons, mg/L	0.03	0.04	0.09	0.05	0.05	0.02	0.04	0.04	0.01	0.05
Surface active agents (such as lauryl sulfate), µg/L	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
AOX (adsorbable organic halides), µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal coliforms, MPN/100ml	230	2400	90	<10	750	930	<10	40	<10	<10
Total coliforms, MPN/100ml	230	2400	230	<10	2100	2400	<10	280	<10	<10
Intestinal enterococci, MPN/100ml	930	930	430	1500	2400	230	<10	2400	<10	<10
Aerobic heterotrophic bacteria, cfu/100ml	3 x 10 ⁵	1.4 x 10 ⁶	1 x 10 ⁶	1.1 x 10 ⁶	3.2 x 10 ⁵	1 x 10 ⁴	8 x 10 ⁴	1.1 x 10 ⁵	7 x 10 ⁴	2 x 10 ⁴

Table 10.2 Results of water sample analysis - Majdanpek area (Sample ID 12120297xx)

Location:	The Veliki Pek downstream from the tailings in Valja Fundata	Veliki Pek (Village Leskovo)	Mali Pek before merging with Veliki Pek	Mali Pek after the open-pit mine in Majdanpek	Mali Pek after the open-pit mine in Majdanpek	Mali Pek before the open-pit mine in Majdanpek	Mali Pek after the sewage inlet	Mali Pek before the sewage inlet	Mali Pek
Sample ID:	11	13	14	15	16	18	19	20	21
Water temperature, °C	5.1	4.9	6.4	6.4	6.5	6.8	5.9	5.6	5.5
Color	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow
Odor	without	without	without	without	without	without	without	without	without
Conductivity µS/cm	878	507	1702	1955	1683	610	408	384	340
pH	7.9	7.9	7.7	7.6	7.5	7.4	7.9	8.1	7.7
Dissolved oxygen mg/l	7.6	7.5	7.3	7.4	7.2	5.2	7.7	7.8	7.6
Sulfates, mg/l	249	104	832	962	790	62	67	56	34
Chlorides, mg/l	11	6	28	23	24	23	7	6	5
Orthophosphates, mg/l	0.14	2.19	0.54	0.34	0.42	0.46	0.45	0.23	0.38
Nitrates mgN/l	0.22	0.19	1.49	1.6	2.01	0.18	0.26	0.21	0.3
Nitrites mgN/l	<0.03	<0.03	0.37	0.55	0.5	<0.03	0.03	<0.03	0.04
Ammonium ion (NH₄-N) mgN/l	<0.01	<0.01	5.9	6.3	5.1	5.7	2.4	<0.01	0.53
Arsenic, mg/l	0.0013	0.0013	0.0098	0.0030	0.0028	0.0026	0.0026	0.0019	0.0017
Cadmium, mg/l	<0.001	<0.001	0.0023	0.0021	0.0017	<0.001	<0.001	<0.001	<0.001
Copper, mg/l	0.011	0.021	0.32	0.28	0.19	0.016	0.0017	0.0064	0.0020
Chromium (total), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.023	<0.01
Iron, mg/l	0.13	0.25	6.1	5.3	5.9	0.40	0.12	1.1	0.24
Manganese, mg/l	0.14	0.063	4.2	4.6	3.9	0.094	<0.01	0.048	0.11
Nickel, mg/l	<0.001	<0.001	0.031	0.036	0.025	<0.001	<0.001	0.012	<0.001

Lead, mg/l	0.0011	<0.001	0.050	0.0076	0.0069	0.001	<0.001	0.0028	0.001
Zinc, mg/l	0.040	0.025	0.65	0.66	0.63	0.026	0.028	0.066	0.0075
Cobalt, mg/l	<0.001	<0.001	0.037	0.043	0.031	0.0012	<0.001	<0.001	<0.001
Strontium, mg/l	0.61	0.25	2.0	3.1	2.8	0.25	0.14	0.13	0.14
Mercury, mg/l	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Magnesium, mg/l	17	12	107	119	86	12	14	10	10
Potassium, mg/l	8.7	2.2	11	13	11	6.1	3	2.1	2.7
Calcium, mg/l	138	74	270	277	243	80	71	60	52
Sodium, mg/l	33	23	52	66	62	31	24	22	21
Phenol compounds (such as C ₂ H ₅ OH), µg/L	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Petroleum hydrocarbons, mg/L	0.04	0.019	0.02	0.05	0.011	0.03	0.02	0.01	0.02
Surface active agents (such as lauryl sulfate), µg/L	<30	<30	<30	<30	<30	<30	<30	<30	<30
AOX (adsorbable organic halides), µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal coliforms, MPN/100ml	<10	2400	<10	<10	<10	200	430	40	230
Total coliforms, MPN/100ml	<10	2400	<10	<10	<10	24000	930	90	230
Intestinal enterococci, MPN/100ml	<10	230	930	11000	430	11000	430	230	<10
Aerobic heterotrophic bacteria, cfu/100ml	2 x 10 ⁴	1.7 x 10 ⁵	2.1 x 10 ⁶	1.9 x 10 ⁶	3.6 x 10 ⁶	2.3 x 10 ⁶	6 x 10 ⁴	1 x 10 ⁵	4 x 10 ⁴

The results of the analysis of metal content in sediments are shown in the table 11.

Table 11. Results of analysis of metal content (mg/kg) in river sediments - Majdanpek area (sample ID 52120297xx)

	ID uzorka	As	Cd	Cr	Cu	Hg	Pb	Ni	Zn	Co	Sr	Mn
Location												
Reka Pek	01	112	5.4	27.3	1283	0.13	320	77.6	968	24	79	2062
	MDK ¹	56	2.5	67.4	76.5	0.4	153	18.7	217	-	-	-
	MDK ²	106	6.2	256	76.5	0.6	951	18.7	743	-	-	-
	MDK ³	106	23.2	256	191	2.1	951	24	1115	-	-	-
	MDK ⁴	106	37.2	256	404	12.9	951	112	1115	-	-	-
Reka Pek	02	79.5	5.7	30.9	1605	0.11	393	82.9	931	25	92	1612
	MDK ¹	57	2.5	68.8	78	0.4	155	19.4	222	-	-	-
	MDK ²	108	6.3	261	78	0.7	967	19.4	760	-	-	-
	MDK ³	108	23.6	261	195	2.1	967	24.9	1140	-	-	-
	MDK ⁴	108	37.8	261	412	13.1	967	116	1140	-	-	-
Reka Pek	03	96.2	5.9	32.9	1801	0.1	410	87.2	964	24	82	1701
	MDK ¹	56.3	2.5	67.8	76.9	0.4	153	18.9	218	-	-	-
	MDK ²	107	6.2	258	76.9	0.6	955	18.9	748	-	-	-
	MDK ³	107	23.3	258	192	2.1	955	24.3	1122	-	-	-
	MDK ⁴	107	37.3	258	406	12.9	955	113.4	1122	-	-	-
Reka Pek after the confluence of Mali Pek and Veliki Pek	04	117	6.9	18.3	1777	0.11	438	77.4	1227	27	86	2289
	MDK ¹	54.2	2.4	61.6	73.8	0.4	148	15.8	206	-	-	-
	MDK ²	103	6.1	234	73.8	0.6	923	15.8	706	-	-	-
	MDK ³	103	22.7	234	184	2	923	20.3	1059	-	-	-
	MDK ⁴	103	36.4	234	390	12.5	923	94.8	1059	-	-	-

Veliki Pek before merging with Mali Pek	05	57.3	2.8	36.6	335	0.12	96.3	96.4	437	24	73	1537
	MDK ¹	63	2.6	106	87.1	0.4	170	38	272	-	-	-
	MDK ²	120	6.4	403	87.1	0.7	1061	38	933	-	-	-
	MDK ³	120	24.2	403	218	2.4	1061	48.9	1400	-	-	-
	MDK ⁴	120	38.7	403	460	15	1061	228	1400	-	-	-
Veliki Pek after the confluence of the Todorova reka	06	15.5	1.0	28.8	154	< 0.05	6.2	43.3	62.6	14	67	466
	MDK ¹	54.3	2.5	50.4	73.9	0.4	148	10.2	198	-	-	-
	MDK ²	103	6.3	192	73.9	0.6	924	10.2	677	-	-	-
	MDK ³	103	23.5	192	185	1.9	924	13.1	1016	-	-	-
	MDK ⁴	103	37.6	192	390	12.2	924	61.2	1016	-	-	-
Veliki Pek after the confluence of the Crne reke	07	25.1	1.2	35.8	223	< 0.05	8.0	50.1	58.9	15	37	537
	MDK ¹	53	2.4	51.2	71.9	0.4	145	10.6	193	-	-	-
	MDK ²	100	6.1	195	71.9	0.6	903	10.6	663	-	-	-
	MDK ³	100	22.8	195	180	1.9	903	13.6	994	-	-	-
	MDK ⁴	100	36.4	195	380	12	903	63.6	994	-	-	-
Crna Reka before flowing into Veliki Pek	08	14.1	0.9	32	35	< 0.05	7.2	43.7	46.8	11	23	358
	MDK ¹	54.3	2.5	52	74	0.4	148	11.0	199	-	-	-
	MDK ²	103	6.2	198	74	0.6	925	11.0	682	-	-	-
	MDK ³	103	23.4	198	185	2.0	925	14.1	1023	-	-	-
	MDK ⁴	103	37.5	198	390	12.2	925	66	1023	-	-	-
Crna Reka	09	22.2	1.0	30.5	24	< 0.05	8.1	52.3	61.1	15	20	440
	MDK ¹	53.6	2.5	50.8	73	0.4	147	10.4	196	-	-	-
	MDK ²	102	6.2	193	73	0.6	914	10.4	670	-	-	-
	MDK ³	102	23.1	193	182	1.9	914	13.4	1005	-	-	-
	MDK ⁴	102	37	193	385	12.1	914	62.4	1005	-	-	-
Veliki Pek before the confluence of the Crna Reka	10	37.5	1.1	19.2	623	< 0.05	15.1	40.1	78.9	11	13	566
	MDK ¹	54.3	2.5	52.4	73.9	0.4	148	11.2	199	-	-	-
	MDK ²	103	6.2	199	73.9	0.6	924	11.2	683	-	-	-
	MDK ³	103	23.4	199	185	2	924	14.4	1024	-	-	-
	MDK ⁴	103	37.4	199	390	12.2	924	67.2	1024	-	-	-
The Veliki Pek downstream from the tailings in Valja Fundata	11	59.8	1.5	18.7	801	< 0.05	18.8	50.1	88.9	17	12	519
	MDK ¹	54.6	2.5	52.6	74.4	0.4	149	11.3	200	-	-	-
	MDK ²	104	6.3	200	74.4	0.6	929	11.3	687	-	-	-
	MDK ³	104	23.5	200	186	2	929	14.5	1031	-	-	-
	MDK ⁴	104	37.6	200	393	12.3	929	67.8	1031	-	-	-
Veliki Pek (Village Leskovo)	13	14.1	1.3	7.1	81.8	< 0.05	11.1	35.8	74.2	15	128	640
	MDK ¹	52.2	2.4	52	70.8	0.4	143	11	191	-	-	-
	MDK ²	99	6	198	70.8	0.6	891	11	655	-	-	-
	MDK ³	99	22.3	198	177	1.9	891	14.1	982	-	-	-
	MDK ⁴	99	35.7	198	374	11.9	891	66	982	-	-	-
Mali Pek before merging with Veliki Pek	14	78.1	4.8	12.1	1221	0.09	184	50.7	853	16	55	1896
	MDK ¹	54	2.5	51.6	73.5	0.4	148	10.8	197	-	-	-
	MDK ²	102	6.2	196	73.5	0.6	920	10.8	677	-	-	-
	MDK ³	102	23.3	196	184	1.9	920	13.9	1015	-	-	-
	MDK ⁴	102	37.2	196	388	12.2	920	64.8	1015	-	-	-
Mali Pek posle površinskog kopa u Majdanpeku	15	163	7.4	11.5	2022	0.24	314	79.5	1443	34	43	2161
	MDK ¹	54	2.5	52.6	73.5	0.4	148	11.3	198	-	-	-
	MDK ²	102	6.2	200	73.5	0.6	920	11.3	680	-	-	-
	MDK ³	102	23.2	200	184	1.9	920	14.5	1019	-	-	-
	MDK ⁴	102	37.1	200	388	12.2	920	67.8	1019	-	-	-
Mali Pek after the open-pit mine in Majdanpek	16	109	4.8	17.4	2070	0.082	195	77.9	783	20	56	1557
	MDK ¹	54.8	2.5	55.6	74.6	0.4	149	12.8	203	-	-	-
	MDK ²	104	6.2	211	74.6	0.6	931	12.8	697	-	-	-

	MDK ³	104	23,4	211	187	2	931	16,5	1045	-	-	-
	MDK ⁴	104	37,4	211	394	12,4	931	76,8	1045	-	-	-
Mali Pek before the open-pit mine in Majdanpek	18	61,6	2,9	31,1	887	< 0,05	111	76,6	308	19	42	798
	MDK ¹	57,3	2,5	75,2	78,4	0,4	156	22,6	228	-	-	-
	MDK ²	109	6,2	286	78,4	0,7	971	22,6	780	-	-	-
	MDK ³	109	23,3	286	196	2,1	971	29,1	1170	-	-	-
	MDK ⁴	109	37,4	286	414	13,3	971	135,6	1170	-	-	-
Mali Pek posle uliva kanalizacije	19	48,1	2,9	41,3	488	0,2	77,7	79,9	323	14	59	1268
	MDK ¹	51	2,3	50,4	69	0,4	140	10,2	185	-	-	-
	MDK ²	96,7	5,8	192	69	0,6	873	10,2	635	-	-	-
	MDK ³	96,7	21,9	192	173	1,9	873	13,1	953	-	-	-
	MDK ⁴	96,7	35	192	364	11,7	873	61,2	953	-	-	-
Mali Pek before the sewage inlet	20	27,4	1,1	21,1	229	< 0,05	29,1	53,1	176	8,2	88	1683
	MDK ¹	50,3	2,3	51,6	67,9	0,3	138	10,8	183	-	-	-
	MDK ²	95,3	5,7	196	67,9	0,6	862	10,8	629	-	-	-
	MDK ³	95,3	21,4	196	170	1,9	862	13,9	943	-	-	-
	MDK ⁴	95,3	34,2	196	358	11,6	862	64,8	943	-	-	-
Mali Pek (before Majdanpek)	21	12,4	0,8	27,5	28,5	< 0,05	17,6	37,7	44,2	7,3	83	577
	MDK ¹	54	2,5	52,8	73,5	0,4	148	11,4	198	-	-	-
	MDK ²	102	6,2	201	73,5	0,6	920	11,4	680	-	-	-
	MDK ³	102	23,2	201	184	2	920	14,7	1020	-	-	-
	MDK ⁴	102	37,1	201	388	12,2	920	68,4	1020	-	-	-

MDK¹ – * Target valueMDK² – * Limit valueMDK³ - * Verification LevelMDK⁴ - * Remediation value

* corrected values related to the content of clay and organic matter, in accordance with the Regulation on limit values of polluting materials in surface and underground waters and sediment and deadlines for their achievement ("Official Gazette of RS", No. 50/12).

Table 12. Results of analysis of radionuclide content (Bq/kg) in river sediments - Majdanpek area

Sample ID:	¹³⁷ Cesium	²³⁸ Uranium	⁴⁰ Potassium	²²⁶ Radium	²³² Thorium
1	<1	<3	392	16	15
2	3	<3	326	12	11
3	2	<3	316	11	11
4	2	<3	316	15	12
5	<1	<3	220	9	9
6	2	<3	355	11	8
7	2	<3	324	11	14
8	3	<3	351	14	12
9	2	<3	327	12	13
10	<1	<3	620	9	12
11	3	<3	594	16	13
13	<1	<3	402	12	7
14	2	<3	267	19	9
15	<1	<3	243	15	9
16	<1	<3	339	16	9
18	<1	<3	444	21	14
19	5	<3	79	4	4
20	<1	<3	<6	<2	<2
21	3	<3	308	11	14

4.1.2. Analysis results - water and sediment quality - Bor and Zaječar area

The results of the analysis of water quality parameters are shown in tables 13.1, 13.2 and 13.3.

Table 13.1 Results of the analysis of water quality parameters - Bor and Zaječar area (sample ID 12120297xx)

Location:	Brestovačka reka	Kriveljska Reka	Borska reka immediately after the mine	Borska reka downstream from the mine	Kriveljska Reka	fter the confluence of the Kriveljska Reka	Borska reka	Borska reka	Borska reka	Borska reka	Reka Timok before confluence with the Borska reka
Sample ID:	22	23	24	25	26	27	28	29	30	31	32
Water temperature, °C	6.4	8.4	10.1	9.2	8.1	8.2	8.3	8.1	8.2	8.5	7.6
Color	Slightly yellow	Slightly yellow	Orange	yellow	Slightly yellow	Slightly yellow	yellow	yellow	yellow	yellow	Slightly yellow
Odor	without	without	without	without	without	without	without	without	without	without	without
Conductivity µS/cm	420	1655	1305	1294	1671	1276	1221	1172	1253	1211	539
pH	7.8	7.3	6.8	7.2	7.8	7.6	7.7	7.4	7.5	7.8	7.9
Dissolved oxygen mg/l	7.5	6.9	6.4	6.5	6.8	7.1	7.2	7.5	7.4	7.5	7.4
Sulfates, mg/l	63	689	517	510	856	481	503	498	531	599	27
Chlorides, mg/l	21	18	76	38	18	26	21	24	26	26	12
Orthophosphates, mg/l	0.3	0.46	0.47	0.43	0.02	0.93	0.18	0.16	0.58	0.12	0.13
Nitrates mgN/l	0.15	0.33	1.1	0.56	0.41	0.44	0.39	0.83	0.52	0.39	0.23
Nitrites mgN/l	<0.03	0.05	0.38	0.22	0.06	0.17	0.17	0.24	0.17	0.19	0.1
Ammonium ion (NH ₄ -N) mgN/l	0.19	1.1	5.8	5.8	1.5	5.4	5.4	5.1	5.7	5.7	1.8
Arsenic, mg/l	0.0076	0.0021	0.016	0.016	0.0038	0.010	0.01	0.025	0.023	0.018	0.016
Cadmium, mg/l	<0.001	0.0010	0.0011	0.0014	<0.001	0.0012	0.0014	0.0017	0.0015	0.0015	<0.001
Copper, mg/l	0.0011	1.8	0.76	0.80	2.6	1.2	1.6	1.7	1.5	1.3	0.0045
Chromium (total), mg/l	<0.01	0.020	0.042	0.033	0.022	0.027	0.046	0.036	0.035	0.024	<0.01
Iron, mg/l	0.14	6.1	42	35	11	25	21	28	31	24	0.082
Manganese, mg/l	0.050	3.5	2.9	2.3	3.7	2.1	1.9	2.0	2.1	1.8	0.017
Nickel, mg/l	<0.001	0.026	0.015	0.018	0.031	0.024	0.032	0.021	0.023	0.019	<0.001
Lead, mg/l	<0.001	0.0035	0.0053	0.062	0.0042	0.0061	0.019	0.035	0.025	0.020	<0.001
Zinc, mg/l	0.0086	0.14	0.45	0.38	0.26	0.38	0.34	0.43	0.52	0.79	0.011
Cobalt, mg/l	<0.001	0.053	0.031	0.028	0.059	0.031	0.027	0.026	0.027	0.024	<0.001
Strontium, mg/l	0.19	1.2	0.72	0.66	1.4	0.81	0.74	0.76	0.79	0.75	0.16
Mercury, mg/l	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.00057	<0.0003	<0.0003	<0.0003	<0.0003
Magnesium, mg/l	12	59	55	50	63	46	51	46	51	44	9.6
Potassium, mg/l	1.2	6.2	8.1	9.3	7.9	7.2	6.1	7.9	8.2	7.4	2.4
Calcium, mg/l	58	279	184	183	317	210	193	203	209	231	92
Sodium, mg/l	25	55	56	52	59	48	52	47	51	49	25
Phenol compounds (such as C ₂ H ₅ OH), µg/L	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.00057	<0.0003	<0.0003	<0.0003	<0.0003

Petroleum hydrocarbons, mg/L	0.01	0.03	0.019	0.02	0.018	0.017	0.018	0.017	0.019	0.02	0.03
Surface active agents (such as lauryl sulfate), µg/L	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
AOX (adsorbable organic halides), µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal coliforms, MPN/100ml	<10	<10	2400	4600	<10	11000	90	230	90	230	210
Total coliforms, MPN/100ml	<10	<10	2400	24000	<10	11000	230	2400	90	2400	11000
Intestinal enterococci, MPN/100ml	<10	24000	11000	11000	<10	24000	24000	4600	930	11000	24000
Aerobic heterotrophic bacteria, cfu/100ml	2 x 10 ⁴	9 x 10 ⁴	3.2 x 10 ⁶	1.9 x 10 ⁷	1.3 x 10 ⁵	3.8 x 10 ⁶	2.7 x 10 ⁶	3.5 x 10 ⁶	3.6 x 10 ⁶	2.6 x 10 ⁷	1 x 10 ⁶

Table 13.2 Results of the analysis of water quality parameters - Bor and Zaječar area (sample ID 12120297xx)

Location:	Reka Timok after the confluence of the Borska reka	Reka Timok	Reka Timok	Reka Timok	Reka Timok	Reka Timok	Timok before the confluence with Dunav	Reka Timok after the confluence of the Crni Timok and Beli Timok	Reka Timok after the confluence of the Crni Timok and Beli Timok	Reka Crni Timok before confluence with Beli Timok	Reka Beli Timok before confluence with Crni Timok
Sample ID:	33	34	35	36	37	38	39	40	41	42	43
Water temperature, °C	7.8	7.7	7.6	8.1	7.8	7.4	7.3	8.3	9.2	8.8	9.0
Color	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow
Odor	without	without	present	without	without	present	without	without	present	without	without
Conductivity µS/cm	614	631	629	640	640	640	639	500	472	453	500
pH	7.4	7.9	7.9	7.9	7.8	7.9	7.9	7.9	7.8	7.9	7.7
Dissolved oxygen mg/l	7.1	7.3	7.6	7.7	7.6	7.7	7.7	7.4	7.3	7.1	7.2
Sulfates, mg/l	81	87	93	91	93	89	94	57	37	27	29
Chlorides, mg/l	13	14	14	14	14	16	14	10	10	7	14
Orthophosphates, mg/l	0.37	0.74	0.85	0.59	0.24	0.58	1.01	0.68	0.3	0.71	0.06
Nitrates mgN/l	0.23	0.16	0.21	0.23	0.33	0.21	0.28	0.15	0.18	0.15	0.12
Nitrites mgN/l	0.13	0.15	0.08	0.18	0.15	0.11	0.09	0.09	0.07	0.06	0.06
Ammonium ion (NH ₄ -N) mgN/l	1.5	2.4	2.1	4.8	4.6	3.3	2.2	2.3	2.9	2.1	1.6
Arsenic, mg/l	0.0030	0.0024	0.0028	0.0026	0.0020	0.0020	0.0020	0.0012	0.0013	0.0019	0.0014
Cadmium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, mg/l	0.12	0.10	0.086	0.045	0.032	0.024	0.021	0.0062	0.0040	0.0061	0.0011
Chromium (total), mg/l	0.013	0.019	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, mg/l	1.6	1.4	0.28	0.27	0.19	0.16	0.14	0.12	0.081	0.19	0.049
Manganese, mg/l	0.17	0.24	0.23	0.18	0.13	0.087	0.066	0.014	0.018	0.039	0.010
Nickel, mg/l	0.0098	0.014	<0.001	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001

Lead, mg/l	0.0044	0.0017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0021	<0.001
Zinc, mg/l	0.027	0.027	0.032	0.017	0.016	0.011	0.011	0.0072	0.0097	0.014	0.0092
Cobalt, mg/l	0.0026	0.0034	0.0031	0.0022	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium, mg/l	0.16	0.23	0.024	0.34	0.23	0.23	0.23	0.14	0.12	0.14	0.30
Mercury, mg/l	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Magnesium, mg/l	10	14	14	19	15	16	16	9.3	8.8	9.7	14
Potassium, mg/l	1.8	2.6	3.1	3.1	3.0	2.9	3.0	2.1	2	1.8	3.2
Calcium, mg/l	80	106	107	92	108	102	98	91	86	78	82
Sodium, mg/l	24	27	27	29	27	27	27	23	22	22	25
Phenol compounds (such as C ₂ H ₅ OH), µg/L	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Petroleum hydrocarbons, mg/L	0.018	0.02	0.019	0.018	0.019	0.03	0.02	0.01	0.02	0.03	0.02
Surface active agents (such as lauryl sulfate), µg/L	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
AOX (adsorbable organic halides), µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal coliforms, MPN/100ml	24000	11000	2400	930	230	390	<10	46000	24000	4600	<10
Total coliforms, MPN/100ml	46000	24000	2400	2400	230	640	<10	46000	24000	24000	<10
Intestinal enterococci, MPN/100ml	46000	24000	11000	2400	930	230	90	11000	46000	4600	<10
Aerobic heterotrophic bacteria, cfu/100ml	1.7 x 10 ⁶	2.5 x 10 ⁵	1.4 x 10 ⁵	1.6 x 10 ⁵	5 x 10 ⁴	7 x 10 ⁴	7 x 10 ⁴	4.4 x 10 ⁵	9.5 x 10 ⁵	3.3 x 10 ⁶	2 x 10 ⁴

Table 13.3 Results of analysis of water quality parameters - Bor and Zaječar area (sample ID 12120297xx)

Location:	Reka Beli Timok	Reka Crni Timok (after bathing area of Popova Plaža)	Crni Timok River before the entrance to Zaječar	Crni Timok after the confluence with Brestovačka Reka	Crni Timok before the confluence of the Brestovačka Reka	Brestovačka river before flowing into Crni Timok	Brestovačka reka immediately after the inflow of wastewater from the mine	Waste canal from the Čukaru Peki mine	Brestovačka without the influence of wastewater from the mine	Crni Timok before the confluence of the Brestovačka Reka	Bela Reka
ID uzoraka:	44	45	46	47	48	49	50	51	52	53	54
Water temperature, °C	8.3	9.2	9.0	9.5	8.9	8.4	8.3	7.4	8.4	9.7	7.6
Color	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow	Slightly yellow
Odor	without	without	without	without	without	without	without	without	without	without	without
Conductivity µS/cm	484	455	448	479	445	603	505	903	586	447	591
pH	8.3	7.9	7.8	8.0	7.9	7.9	8.0	7.9	7.8	7.9	8.1
Dissolved oxygen mg/l	7.2	7.3	7.1	7.3	7.1	7.4	7.5	7.8	7.7	7.3	7.2
Sulfates, mg/l	32	28	19	39	23	83	96	111	79	18	44
Chlorides, mg/l	13	9	7	11	7	21	21	53	21	7	11

Orthophosphates, mg/l	0.61	0.47	0.24	0.47	0.34	0.69	1.25	0.9	0.78	0.22	0.47
Nitrates mgN/l	0.22	0.24	0.15	0.36	0.21	0.25	0.34	1.24	0.51	0.12	0.2
Nitrites mgN/l	0.05	<0.03	<0.03	0.03	<0.03	0.09	0.12	0.06	0.16	<0.03	0.06
Ammonium ion (NH ₄ -N) mgN/l	0.58	0.18	0.21	0.27	0.24	0.79	1.1	0.27	0.24	0.02	0.11
Arsenic, mg/l	0.0017	0.0010	0.0017	0.0017	<0.001	0.0059	0.0058	0.0047	0.0064	<0.001	0.0023
Cadmium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, mg/l	0.0023	0.0032	0.0034	0.0079	0.0018	0.037	0.021	0.016	0.021	0.0018	0.0092
Chromium (total), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, mg/l	0.1	0.098	0.11	0.11	0.12	0.11	0.11	0.051	0.12	0.15	0.12
Manganese, mg/l	<0.01	0.019	0.019	0.022	0.024	0.019	0.024	0.014	0.025	0.028	0.023
Nickel, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0011	<0.001	<0.001	<0.001	<0.001
Zinc, mg/l	0.028	0.0043	0.0062	0.027	0.0048	0.0066	0.008	0.0079	0.0094	0.0057	0.0073
Cobalt, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium, mg/l	0.21	0.099	0.12	0.11	0.079	0.25	0.23	0.63	0.24	0.079	0.077
Magnesium, mg/l	12	7.6	8.8	8.6	6.2	16	19	31	18	6.4	20
Potassium, mg/l	3	1.4	1.5	1.5	1.3	2.6	2.4	3.7	2.4	1.3	1.9
Calcium, mg/l	78	79	71	85	83	91	88	124	82	85	92
Sodium, mg/l	24	20	20	21	19	27	32	58	30	18	23
Phenol compounds (such as C ₂ H ₅ OH), µg/L	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003
Petroleum hydrocarbons, mg/L	0.019	0.018	0.019	0.02	0.03	0.02	0.017	0.018	0.019	0.02	0.03
Surface active agents (such as lauryl sulfate), µg/L	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
AOX (adsorbable organic halides), µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Fecal coliforms, MPN/100ml	90	230	230	90	40	140	2400	<10	930	230	90
Total coliforms, MPN/100ml	230	230	230	2400	90	640	2400	230	2400	230	230
Intestinal enterococci, MPN/100ml	<10	230	90	2400	230	390	2400	<10	230	230	230
Aerobic heterotrophic bacteria, cfu/100ml	3 x 10 ⁴	6 x 10 ⁴	1.3 x 10 ⁵	7 x 10 ⁴	2 x 10 ⁴	7 x 10 ⁴	1 x 10 ⁴	7 x 10 ⁴	9 x 10 ⁴	1 x 10 ⁵	1 x 10 ⁴

The results of the analysis of metal content in sediments are shown in table 14.

Table 14. Results of analysis of metal content (mg/kg) in river sediments - Bor and Zaječar area (sample ID 52120297xx)

Location	Sample ID	As	Cd	Cr	Cu	Hg	Pb	Ni	Zn	Co	Sr	Mn
Brestovačka reka	22	21,8	1,3	6,8	58,4	< 0,05	12,9	30,8	53,1	16	126	727
	MDK ¹	54,1	2,5	52,2	73,7	0,4	148	11,1	199	-	-	-
	MDK ²	103	6,2	198	73,7	0,6	922	11,1	680	-	-	-
	MDK ³	103	23,3	198	184	2	922	14,3	1020	-	-	-
	MDK ⁴	103	37,3	198	389	12,2	922	66,6	1020	-	-	-
Kriveljska Reka	23	20,3	1,5	17,5	3693	0,085	15,5	68,5	138	21	211	651
	MDK ¹	55,7	2,5	59,6	76,1	0,4	152	14,8	210	-	-	-
	MDK ²	106	6,3	227	76,1	0,6	946	14,8	720	-	-	-
	MDK ³	106	23,6	227	190	2	946	19	1079	-	-	-
	MDK ⁴	106	37,8	228	401	12,6	946	88,8	1079	-	-	-
Borska reka immediately after the mine	24	136	4,5	40,1	3599	0,16	190	68,1	754	18	64	476
	MDK ¹	53,6	2,5	52,6	72,9	0,4	147	11,3	197	-	-	-
	MDK ²	102	6,1	200	72,9	0,6	914	11,3	675	-	-	-
	MDK ³	102	23	200	182	1,9	914	14,5	1012	-	-	-
	MDK ⁴	102	36,8	200	385	12,1	914	67,8	1012	-	-	-
Borska reka downstream from the mine	25	171	5,7	45,5	5176	0,17	119	78,6	1030	40	119	500
	MDK ¹	55,5	2,5	59	75,7	0,4	151	14,5	209	-	-	-
	MDK ²	105	6,3	224	75,7	0,6	943	14,5	715	-	-	-
	MDK ³	105	23,5	224	189	2	943	18,6	1073	-	-	-
	MDK ⁴	105	37,6	224	400	12,6	943	87	1073	-	-	-
Kriveljska Reka	26	15,1	2,7	11,8	1570	< 0,05	10,2	45,8	94,6	28	151	606
	MDK ¹	54	2,5	52,4	73,5	0,4	148	11,2	198	-	-	-
	MDK ²	102	6,2	199	73,5	0,6	920	11,2	679	-	-	-
	MDK ³	102	23,2	199	184	1,9	920	14,4	1019	-	-	-
	MDK ⁴	102	37,2	199	388	12,2	920	67,2	1019	-	-	-
Borska reka after the confluence of the Kriveljska Reka	27	459	4,8	25,9	269	0,058	15	91,8	715	30	71	408
	MDK ¹	54,2	2,5	53,2	73,8	0,4	148	11,6	199	-	-	-
	MDK ²	103	6,2	202	73,8	0,6	923	11,6	684	-	-	-
	MDK ³	103	23,3	202	185	2	923	14,9	1026	-	-	-
	MDK ⁴	103	37,2	202	390	12,2	923	69,6	1026	-	-	-
Borska reka	28	125	3,2	15,9	1504	< 0,05	46,2	52,8	377	26	110	188
	MDK ¹	52,4	2,4	54,2	71,1	0,4	144	12,1	194	-	-	-
	MDK ²	99,4	6	206	71,1	0,6	895	12,1	663	-	-	-
	MDK ³	99,4	22,3	206	178	1,9	895	15,6	995	-	-	-
	MDK ⁴	99,4	35,7	206	376	12	895	72,6	995	-	-	-
Borska reka	29	214	3,8	28,4	3483	0,061	98,9	87,1	537	23	174	549
	MDK ¹	52	2,4	50,8	70,5	0,4	142	10,4	189	-	-	-
	MDK ²	98,6	6,0	193	70,5	0,6	888	10,4	649	-	-	-
	MDK ³	98,6	22,3	193	176	1,9	888	13,4	973	-	-	-
	MDK ⁴	98,6	35,7	193	372	11,8	888	62,4	973	-	-	-
Borska reka	30	158	3,8	18	2084	0,06	55	72,3	320	27	185	423
	MDK ¹	53,2	2,4	55,2	72,3	0,4	146	12,6	197	-	-	-
	MDK ²	101	6,0	210	72,3	0,6	908	12,6	676	-	-	-
	MDK ³	101	22,6	210	181	1,9	908	16,2	1014	-	-	-
	MDK ⁴	101	36,2	210	382	12,1	908	75,6	1014	-	-	-

Borska reka	31	723	6,6	23,3	3052	0,084	108	89,2	537	36	126	534
	MDK ¹	53,2	2,4	60,8	72,3	0,4	145,5	15,4	201	-	-	-
	MDK ²	101	5,9	231	72,3	0,6	907	15,4	690	-	-	-
	MDK ³	101	22,3	231	181	2	907	19,8	1035	-	-	-
Reka Timok before the confluence of the Borska reka	32	17,6	1,1	48,2	55,2	0,15	30,1	61,2	91,7	12	78	285
	MDK ¹	31,7	1,3	50,8	40,1	0,3	91,8	10,4	113	-	-	-
	MDK ²	60,2	3,2	193	40,1	0,4	572	10,4	388	-	-	-
	MDK ³	60,2	12,2	193	100	1,4	572	13,4	583	-	-	-
Reka Timok after the confluence of the Borska reka	33	129	6,2	24,6	3140	0,24	85,6	86,2	451	31	160	1019
	MDK ¹	48,8	2,0	82,6	65,8	0,4	134,6	26,3	201	-	-	-
	MDK ²	92,6	5,0	314	65,8	0,6	839	26,3	690	-	-	-
	MDK ³	92,6	18,6	314	164	2	839	33,8	1036	-	-	-
Reka Timok	34	101	7,2	29,8	2867	0,18	71,5	91,5	494	44	130	2637
	MDK ¹	34,8	1,2	82	44,8	0,3	99,6	26	148	-	-	-
	MDK ²	66,1	3,1	312	44,8	0,5	621	26	509	-	-	-
	MDK ³	66,1	11,6	312	112	1,7	621	33,4	763	-	-	-
Reka Timok	36	77,6	12,1	35,5	1374	< 0,05	40,1	107	229	22	36	360
	MDK ¹	48,5	2,2	55,8	65,2	0,3	134	12,9	180	-	-	-
	MDK ²	91,9	5,4	212	65,2	0,6	834	12,9	617	-	-	-
	MDK ³	91,9	20,2	212	163	1,8	834	16,6	925	-	-	-
Reka Timok	37	737	59,2	47,5	7654	0,14	106	296	1230	52	77	1986
	MDK ¹	46,2	2	55,2	61,7	0,3	127,9	12,6	170,8	-	-	-
	MDK ²	87,6	5,1	210	61,7	0,6	797,6	12,6	585,5	-	-	-
	MDK ³	87,6	19,1	210	154,4	1,8	797,6	16,2	878,2	-	-	-
Reka Timok	38	134	80,9	18,3	2046	0,13	41,5	373	946	84	107	6454
	MDK ¹	23,5	0,8	58,6	27,7	0,2	71,2	14,3	88,2	-	-	-
	MDK ²	44,5	2	223	27,7	0,4	444	14,3	303	-	-	-
	MDK ³	44,5	7,5	223	69,3	1,3	444	18,4	454	-	-	-
Reka Timok before the confluence of the Dunav	39	186	89,1	31,6	4204	0,22	44,5	346	1371	72	89	3133
	MDK ¹	32,1	1,2	61,6	40,7	0,3	92,8	15,8	123	-	-	-
	MDK ²	60,9	3,1	234	40,7	0,5	578	15,8	421	-	-	-
	MDK ³	60,9	11,6	234	102	1,5	578	20,3	632	-	-	-
Reka Timok nakon spavanja reke Crni Timok i Beli Timok	40	16,2	0,92	47,8	26,9	< 0,05	16,2	69,3	44,3	18	84	481
	MDK ¹	49,9	2,2	64,8	67,4	0,4	137	17,4	192	-	-	-
	MDK ²	94,7	5,4	246	67,4	0,6	856	17,4	659	-	-	-
	MDK ³	94,7	20,4	246	169	1,9	856	22,4	988	-	-	-
Reka Timok after the confluence of the Crni Timok and Beli Timok	41	14,3	1,1	49,2	44,2	0,082	27,9	73,4	98,3	16	89	482
	MDK ¹	35,6	1,4	62,8	45,9	0,3	102	16,4	137	-	-	-
	MDK ²	67,5	3,5	239	45,9	0,5	633	16,4	469	-	-	-
	MDK ³	67,5	13,3	239	115	1,6	633	21,1	704	-	-	-
Reka Crni Timok before confluence with Beli Timok	42	11,1	0,81	23,9	48,6	< 0,05	27,6	56,8	90,9	7,1	88	409
	MDK ¹	42,9	1,8	58,2	56,8	0,3	120	14,1	161	-	-	-
	MDK ²	81,3	4,6	221	56,8	0,5	746	14,1	551	-	-	-
	MDK ³	81,3	17,3	221	142	1,7	746	18,1	826	-	-	-

Reka Beli Timok before confluence with Crni Timok	MDK ⁴	81,3	27,6	221	300	10,8	746	84,6	826	-	-	-
	43	1,6	0,04	14,2	7,5	< 0,05	1,4	41,1	46,6	1,1	19	225
	MDK ¹	53,6	2,5	51,8	72,9	0,4	147	10,9	196	-	-	-
	MDK ²	102	6,2	197	72,9	0,6	914	10,9	672	-	-	-
	MDK ³	102	23,1	197	182	1,9	914	14	1009	-	-	-
Beli Timok	MDK ⁴	102	36,9	197	385	12,1	914	65,4	1009	-	-	-
	44	7,7	0,53	21,2	8,9	< 0,05	6,0	35,6	21,3	9,1	62	232
	MDK ¹	50,4	2,3	51,6	68	0,3	138	10,8	184	-	-	-
	MDK ²	95,5	5,7	196	68	0,6	863	10,8	630	-	-	-
	MDK ³	95,5	21,4	196	170	1,9	863	13,9	945	-	-	-
Reka Crni Timok (after bathing area of Popova Plaža)	MDK ⁴	95,5	34,3	196	359	11,6	863	64,8	945	-	-	-
	45	15,7	1,1	21,7	75,7	< 0,05	32,4	66,4	72,9	15	112	599
	MDK ¹	37,7	1,5	66,4	49,1	0,3	107	18,2	148	-	-	-
	MDK ²	71,5	3,8	252	49,1	0,5	666	18,2	506	-	-	-
	MDK ³	71,5	14,1	252	123	1,6	666	23,4	759	-	-	-
Crni Timok River before the entrance to Zaječar	MDK ⁴	71,5	22,6	252	259	10,3	666	109	759	-	-	-
	46	14,3	1,2	16,9	46,5	< 0,05	18,3	58,2	64,6	19	158	591
	MDK ¹	38,8	1,6	60,8	50,7	0,3	110	15,4	148	-	-	-
	MDK ²	73,6	4	231	50,7	0,5	683	15,4	506	-	-	-
	MDK ³	73,6	15,1	231	127	1,6	683	19,8	758	-	-	-
Crni Timok River after the inflow of the Brestovačka Reka	MDK ⁴	73,6	24,1	231	268	10,3	683	92,4	758	-	-	-
	47	20,4	1,6	18,1	88,9	< 0,05	26,6	59,9	104	20	165	723
	MDK ¹	44,8	1,9	59,6	59,7	0,3	125	14,8	169	-	-	-
	MDK ²	85	4,8	227	59,7	0,6	777	14,8	580	-	-	-
	MDK ³	85	18,1	227	149	1,8	777	19	870	-	-	-
Reka Crni Timok before confluence with Brestovačka Reke	MDK ⁴	85	29	227	315	11,1	777	88,8	870	-	-	-
	48	13,4	1,0	18,9	33,2	0,053	16,1	59,3	70,3	13	75	805
	MDK ¹	44,4	2,0	52,8	59,1	0,3	124	11,4	163	-	-	-
	MDK ²	84,3	4,9	201	59,1	0,5	771	11,4	557	-	-	-
	MDK ³	84,3	18,4	201	148	1,7	771	14,7	836	-	-	-
Brestovačka reka before confluence with Crni Timok	MDK ⁴	84,3	29,4	201	312	10,8	771	68,4	836	-	-	-
	49	12,1	0,98	7,1	61,3	< 0,05	6,2	34,6	71,5	17	142	781
	MDK ¹	45,5	2,0	52,2	60,8	0,3	126	11,1	166	-	-	-
	MDK ²	86,4	5,1	198	60,8	0,5	788	11,1	570	-	-	-
	MDK ³	86,4	19	198	152	1,8	788	14,3	855	-	-	-
Brestovačka reka immediately after the inflow of wastewater from the mine	MDK ⁴	86,4	30,4	198	321	11	788	66,6	855	-	-	-
	50	15,1	0,93	7,5	98,5	< 0,05	10,2	29,7	60,5	15	127	491
	MDK ¹	48,1	2,2	51,8	64,6	0,3	133	10,9	175	-	-	-
	MDK ²	91,2	5,4	197	64,6	0,6	828	10,9	602	-	-	-
	MDK ³	91,2	20,3	197	162	1,8	828	14	902	-	-	-
Place of discharge of the waste channel from the Čukaru Peki mine into the Brestovačka Reka	MDK ⁴	91,2	32,5	197	341	11,3	828	65,4	902	-	-	-
	51	69,8	0,91	19,7	772	0,053	24,1	59,2	58,7	11	165	463
	MDK ¹	37,2	1,6	52,8	48,3	0,3	106	11,4	135	-	-	-
	MDK ²	70,6	3,9	201	48,3	0,5	658	11,4	464	-	-	-
	MDK ³	70,6	14,8	201	121	1,6	658	14,7	697	-	-	-
Brestovačka river without the influence of wastewater from the mine	MDK ⁴	70,6	23,7	201	255	9,8	658	68,4	697	-	-	-
	52	5,7	0,48	6,5	341	< 0,05	6,5	29,9	74,1	12	130	706
	MDK ¹	52,5	2,4	51,4	71,2	0,4	144	10,7	192	-	-	-
	MDK ²	99,6	6	195	71,2	0,6	896	10,7	657	-	-	-
	MDK ³	99,6	22,5	195	178	1,9	896	13,8	986	-	-	-
Reka Crni Timok before confluence with Brestovačka	MDK ⁴	99,6	36,1	195	376	11,9	896	64,2	986	-	-	-
	53	14,6	1,4	22,3	31,5	< 0,05	15,3	61,1	70,2	22	120	647
	MDK ¹	51	2,3	58,6	69	0,4	140	14,3	192	-	-	-
	MDK ²	96,8	5,7	223	69	0,6	873	14,3	657	-	-	-
	MDK ³	96,8	21,3	223	173	1,9	873	18,4	985	-	-	-

Reka	MDK ⁴	96,8	34,1	223	364	11,9	873	85,8	985	-	-	-
Bela Reka	54	22,2	1,1	58,2	85,6	0,088	20,9	99,9	73,1	17	61	287
	MDK ¹	32	1,3	52,4	40,5	0,3	92,6	11,2	115,6	-	-	-
	MDK ²	60,7	3,3	199	40,5	0,5	577	11,2	397	-	-	-
	MDK ³	60,7	12,2	199	101	1,5	577	14,4	595	-	-	-
	MDK ⁴	60,7	19,5	199	214	9,1	577	67,2	595	-	-	-

MDK1 – * Target value

MDK2 – * Limit value

MDK3 - * Verification Level

MDK4 - * Remediation value

* corrected values related to the content of clay and organic matter, in accordance with the Regulation on limit values of polluting materials in surface and underground waters and sediment and deadlines for their achievement ("Official Gazette of RS", No. 50/12)..

Tabela 15. Results of analysis of radionuclide content (Bq/kg) in sediments in rivers - Bor and Zaječar area (sample ID 52120297xx)

ID uzorka	¹³⁷ Cesium	²³⁸ Uranium	⁴⁰ Potassium	²²⁶ Radium	²³² Thorium
22	2	<3	404	14	9
23	2	<3	293	10	7
24	<1	<3	252	15	8
25	<1	<3	279	10	9
26	<1	<3	376	10	13
27	<1	<3	289	37	6
28	<1	<3	295	8	6
29	<1	<3	320	9	8
30	<1	<3	280	15	9
31	<1	<3	1880	6	6
32	<1	<3	88	5	5
33	<1	<3	1730	9	6
34	<1	<3	1440	8	8
36	<1	<3	1620	5	7
37	<1	<3	76	8	3
38	<1	<3	33	3	3
38	<1	<3	37	4	4
40	<1	<3	343	28	14
41	<1	<3	1850	13	8
42	<1	<3	42	8	4
43	<1	<3	335	17	21
44	<1	<3	322	12	10
45	3	<3	1770	8	10
46	2	<3	1470	9	7
47	<1	<3	1270	6	6
48	<1	<3	11	<2	<2
49	<1	<3	361	9	8
50	<1	<3	286	8	7
51	3	<3	287	9	11
52	<1	<3	349	11	9
53	<1	<3	1250	5	5
54	<1	<3	213	9	11

4.2.3. Analysis of fish samples

Parameter	Sample ID		MDK
	4212029701	4212029702	
Cadmium, mg/kg	0,041	0,018	0,050
Lead, mg/kg	0,024	0,064	0,30
Arsenic, mg/kg	0,075	0,088	-
Copper, mg/kg	0,42	2,4	-
Chromium (total), mg/kg	<0,001	0,085	-
Cobalt, mg/kg	0,029	0,018	-
Nickel, mg/kg	0,041	0,075	-
Iron, mg/kg	2,8	4,6	-
Manganese, mg/kg	1,9	1,3	-
Zinc, mg/kg	11	15	-
Mercury, mg/kg	0,021	0,057	0,50
Cs-137	<2	<2	150*
Cs-134	<2	<2	
U-238	<3	<3	

MDK- Rulebook on maximum concentrations of certain contaminants in food, Official Gazette of the RS no. 81/2019, 126/2020, 90/2021 and 118/2021, Annex 1.

* Rulebook on the limits of radionuclide content in drinking water, foodstuffs, animal feed, medicines, items of general use, construction materials and other goods put into circulation ("Official Gazette of RS", No. 36/2018).

5. CONCLUSION

Based on the results of laboratory tests, in order to determine the impact of mining on the quality of the rivers - Crni Timok, Veliki Timok, Borska reka, Pek and Dunav in accordance with the Regulation on limit values of pollutants in surface and underground waters and sediment and deadlines for their achievement (" Official Gazette of the RS", no. 50/12) and the Decree on the categorization of watercourses ("Official Gazette of the RS", no. 5/68), it can be concluded that there is pollution in the investigated rivers of Timočka Krajina.

The Pek river is formed by the confluence of two rivers - Veliki Pek and Mali Pek. In order to determine the potential pollution of the mentioned river, samples were taken at the points of interest - Mali Pek before the area of potential pollution, Mali Pek before the sewage inlet, Mali Pek before and after open-pit mine in Majdanpek, Veliki Pek before the area of potential pollution (near the village of Leskovo), Crna Reka, Veliki Pek after the confluence of the Crna Reka, Veliki Pek downstream from the tailings pond in Valja Fundata and finally at the target location - after the mouth of both rivers and the formation of the Pek River, as well as on its further course. By examining the mentioned samples, it can be concluded that:

No contamination was detected in the Mali Pek river sample before the sewage inlet. Further along the river, i.e. Increased retention of ammonium ions, orthophosphate, iron, manganese and sulfate was detected in the water sample after open-pit mine. Microbiological analysis showed contamination with aerobic mesophilic bacteria. Also, the concentration of copper in the sample after surface mining increases and this parameter should be monitored. As for the Veliki Pek River, the values obtained for the analyzed parameters are largely in line with the better quality classes in the part of the stream near the village of Leskovo. However, the quality of the river gradually deteriorates in the further course.

Finally, the analysis showed that in accordance with the above-mentioned Regulations, there is a certain contamination that violates the class of the Pek River, which according to the Regulation falls into Class III. In particular, an increased concentration of sulfate, orthophosphate, iron, manganese and aerobic heterotrophic bacteria was detected.

As for the examination of sediment samples at the mentioned locations, the analysis showed that in the course of the river before the Majdanpek area, no pollution was detected. Before the sewage inflow, concentrations of copper and nickel were detected, which after the inflow exceeded the remediation values. A lower concentration of zinc and cadmium also appears after the inflow of sewage. In its further course, the Mali Pek river passes through the mine, after which concentrations of copper, arsenic, zinc and nickel exceeding the remediation values were detected. Analysis of samples from the Pek River after the confluence of the Mali and Veliki Pek rivers showed contamination of arsenic, copper and zinc with values above remediation, lead concentration above the limit value and nickel above the verification level.

In the further course, i.e. in the sediment sample after the surface mining was detected significant. The assessment of sediment quality is, in accordance with the mentioned Regulation, that the sediment is polluted. The content of the analyzed metals is much higher in the sediment samples than in the water samples, which is a consequence of the continuous flow of water and the fact that a few days before the sampling, it rained heavily.

Analysis of a sample of surface water from the Brestovačka river taken outside the area of potential pollution did not indicate contamination. The results of the analysis of water samples of the Brestovačka River after the inflow of the waste channel from the Čukaru Peki mine show that certain values are slightly increased in relation to the values of the parameters at the location before the inflow, which is related to the heavy rainfall in the days before sampling. The analysis of the Crni Timok river water sample after the Brestovačka river inlet did not show a significant increase in the concentrations of the analyzed parameters. The analysis of sediment samples showed that an increased concentration of copper - above the remediation value - was detected in the sample at the location of the waste channel from the Čukaru Peki mine. There is also a concentration of nickel above the verification level in the tailings sample.

The further course of the Crni Timok is categorized as class II and for the most part corresponds to the same, up to the mouth of the Bor river. The surface water of the Borska reka, from Bor to its confluence with Crni Timok, is categorized as a river of poor quality and belongs to quality class IV. Immediately after the mine near Bor, concentrations of copper, arsenic and nickel above the remediation value were detected in sediment samples. Analysis of the samples showed an increased concentration of sulfate. The color of the samples of this water is brown-yellow. Based on the examination of water samples taken before and after the confluence of the Bor River into Veliki Timok, it can be concluded that the confluence of the Borska reka leads to an increase in the concentration of certain metals in both water and sediment. The biggest detected changes in the water samples are in the concentration of copper, iron and manganese. The further course of the Timok river moves in the direction of the Dunav. Concentrations of metals such as copper, arsenic, cadmium, nickel and zinc were also detected in this part of the river. In chapter 4, the concentrations of the analyzed parameters are given for all investigated locations, as well as the limit values in accordance with the Regulation. The content of the mentioned metals is not negligible and it is necessary to monitor the quality of the water and sediment of the Timok River as well as its tributaries in order to monitor the quality.

6. APPENDIX - Pictures from the field



Mali Pek before the open-pit mine in Majdanpek



Mali Pek after the open-pit mine in Majdanpek



The Veliki Pek downstream from the tailings in Valja Fundata



Merger of Mali and Veliki Pek



Crni Timok (after bathing area of Popova Plaža)



Crni Timok after the confluence of the Beli Timok



River Pek after the confluence of Mali and Veliki Pek



Crna Reka



Veliki Pek (Leskovo Village)



Brestovačka reka



Kriveljska Reka



Borska reka immediately after the mine



Borska reka after the confluence of the Kriveljska Reka



Borska reka



Reka Timok before the confluence with the Borske reke



Borska reka



Reka Timok before the confluence with the Dunav



Reka Timok after the confluence of the Crni and Beli Timok



Brestovača reka before the confluence with the Crni Timok



Crni Timok after the inflow from the Brestovačka reka