



Ambassade van het  
**Koninkrijk der Nederlanden**



Regional Workshop  
Becici, Montenegro, Dec 9-12, 2008

# HOT SPOTS PROJECT - MACEDONIA

# Project Components



Component 1: Environmental clean-up and remediation of env. hot spots  
- Macedonia

Radovis Municipality: Bucim copper mine

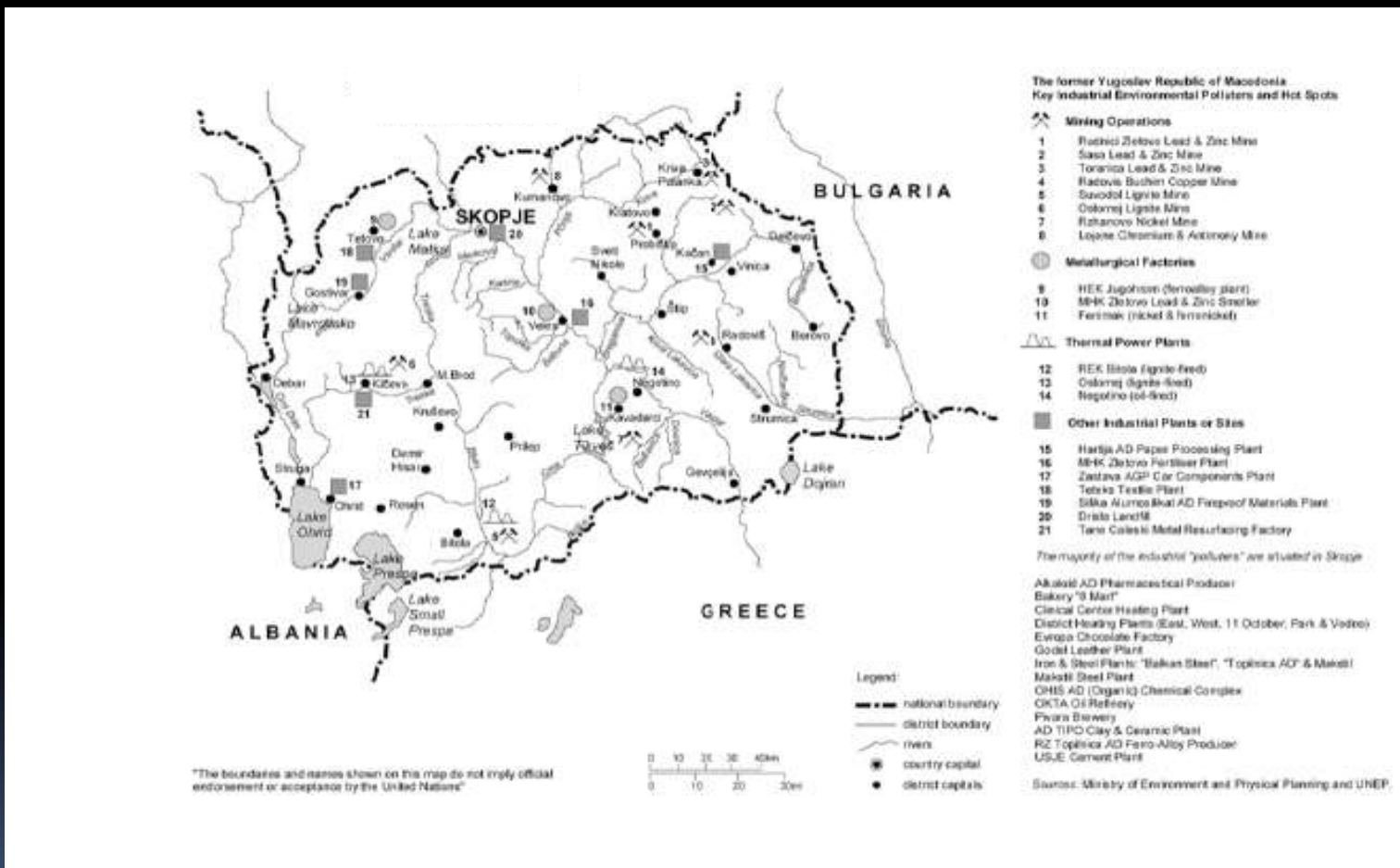
Lipkovo Municipality: Abandoned mine and chromium & antimony  
benefaction plant Lojane

Component 2: Demonstration and information sharing

Component 3: Strengthen supply of professional consultancy services

The Hot Spots Project in Macedonia is fully in line with ongoing activities/projects of the Ministry of Environment and Physical Planning, as well as the key national strategic & planning documents.

# Key industrial polluters and hotspots in Macedonia



Source: UNECE. (2002). Environmental Performance Review of the Republic of Macedonia (Online report for the Eighth session of the Committee on Environment Policy): United Nations Economic Commission for Europe: Economic and Social Council.

# Bucim Mine- Radovis



# Bucim mine - Radovis

- The proposed intervention is based on the EIA Study (June 2006) and are aimed at addressing the historical pollution and prevention of the future pollution in two main respects:
  1. by designing a system for collection and treatment of the waters from the mining zone, the tailing pond and the waste-rock dump, thus eliminating the pollution of Topolnicka River;
  2. undertaking measures for protection of air, i.e. approximately 30 ha of the tailing dump will be re-cultivated with re-vegetation of the tailings dam, in addition to irrigation system for provision of water to keep the dry un-cultivated areas wet.

# Water Protection Measures Bucim Mine

PFP 21/2008 - Feasibility Assessment and Main Technical Design:

- Feasibility Assessment :
  - Collect and analyze all available data;
  - Perform necessary surveys, laboratory tests, sampling and site investigations needed for feasibility assessment of various alternatives for water protection and clean up;
  - Assess the current pollution of soil, surface and groundwater;
  - Identify possible collection and remediation/treatment alternatives, and analyze technical, environmental, and financial feasibility of each of the identified viable treatment technologies;
  - Identify possibilities for mineral/metal extraction from the mining waters and its viability for commercial exploitation;
  - Elaborate the analyzed alternatives;
  - Provide recommendations on the most feasible option, based on multi-criteria analysis;
- Main Technical Design of remediation and clean-up measures for waters in a sustainable and cost-effective manner and by employment of innovative technological solutions.

# Water Protection Measures Bucim Mine - Criteria for selection of alternatives

- Coverage
  - individual technological units: open pit, technological processes, waste rock dump, tailings dump and Bucim lake,
  - area (in hectares) protected by the system
  - surface and groundwater
- Innovativeness
  - innovative technological design
- Effectiveness
  - quality of water released
  - conformity with legal requirements
  - level of remediation of existing pollution
  - demonstrated feasibility
- Efficiency
  - overall energy consumption
  - energy consumption per unit treated water
  - maintenance & operation expenditures
  - reagents usage
  - lifespan of equipment and structures
- Sustainability
  - O&M costs upon decommission of the mine
  - cost recovery by utilization of extracted concentrate from treated water
  - simplicity of operation
- Investment cost
  - Preliminary investment cost
  - Net Present Value – long-term

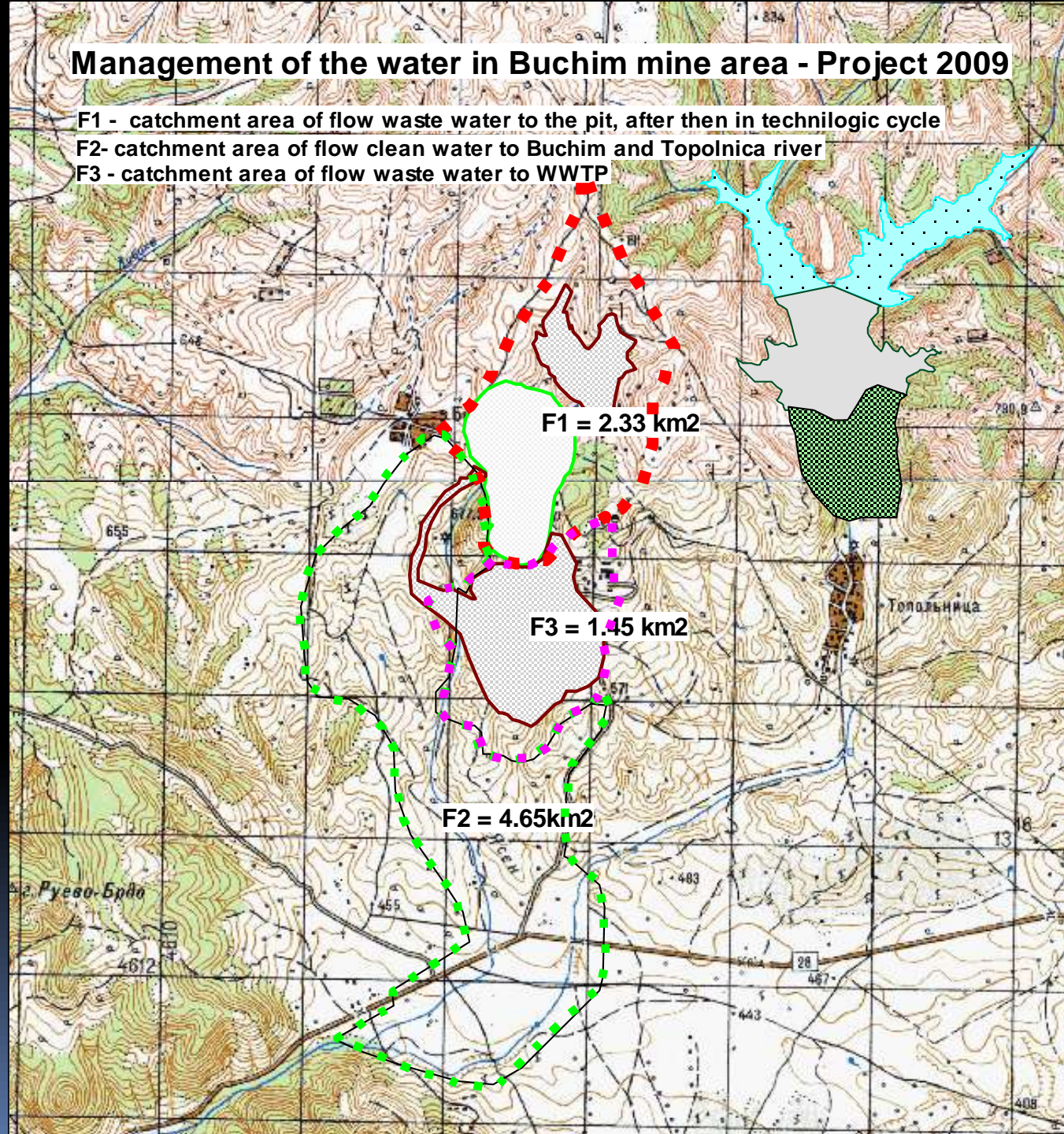
# Water Protection Measures Bucim Mine

- Feasibility Assessment and Main Technical Design :
  - PFP 21/2008 published in April 2008, contract with Consultant BT-Engineering, Sofia, Bulgaria was signed on July 18<sup>th</sup>, 2008, and the activities begun is planned on July 28<sup>th</sup>, 2008. Contract amount : 165.500 € (257,788.16 USD in May 2008)
  - Draft Feasibility Assessment Report submitted;
    - COMPLEX & COMPREHENSIVE INVESTIGATIONS
    - Water Management
    - Wastewater treatment

Water  
Protection  
Measures  
Bucim Mine  
Zones  
of  
intervention

## Management of the water in Buchim mine area - Project 2009

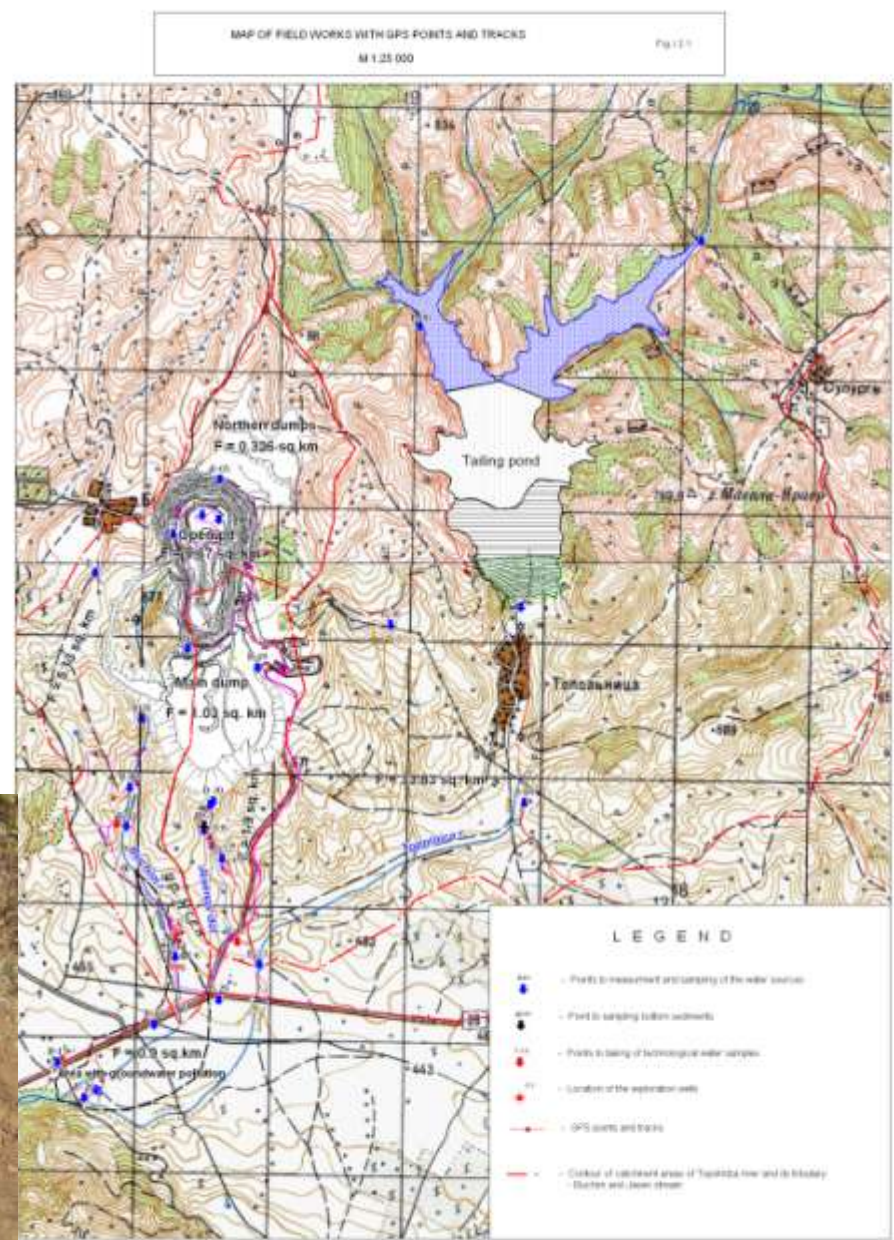
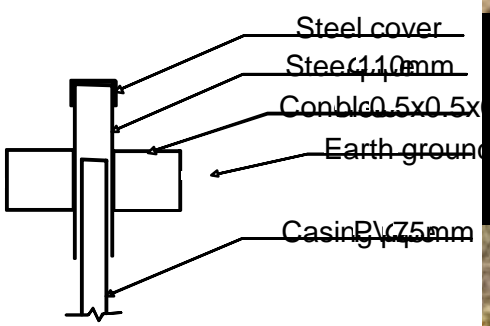
- F1 - catchment area of flow waste water to the pit, after then in technologic cycle
- F2 - catchment area of flow clean water to Buchim and Topolnica river
- F3 - catchment area of flow waste water to WWTP



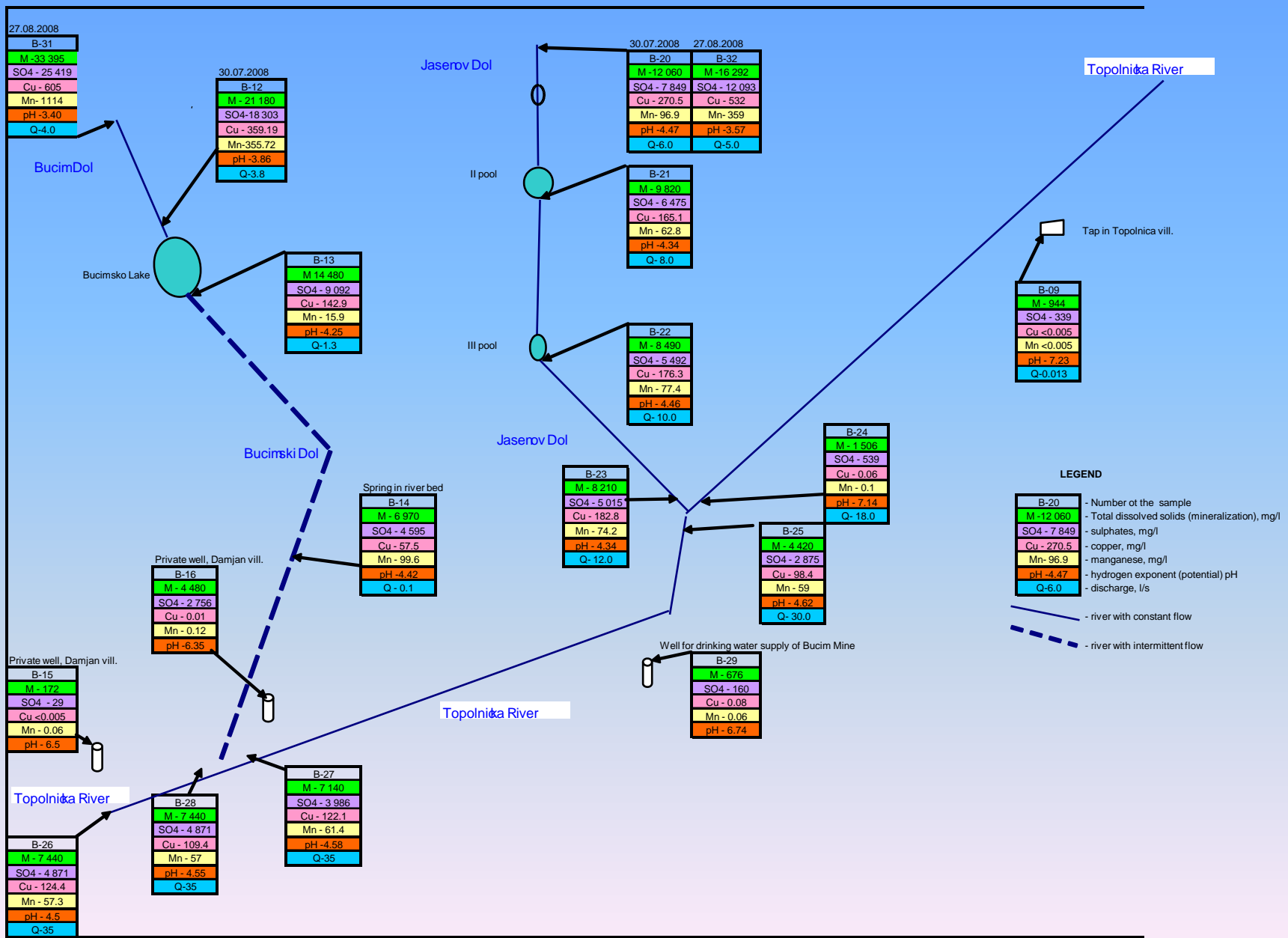
# Water Protection Measures Bucim Mine Investigations



Installation of the drillings

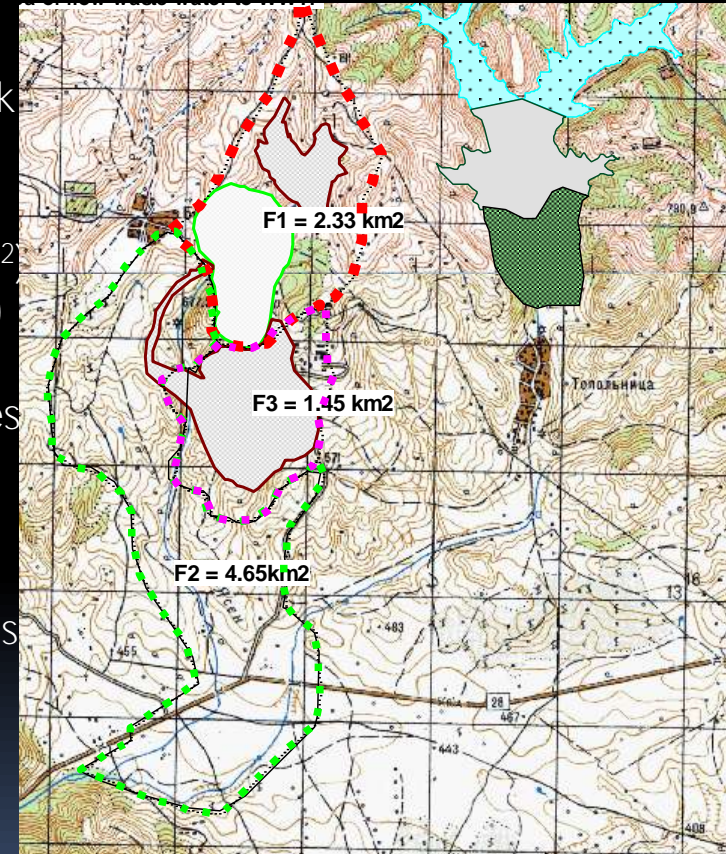


# Water Protection Measures Bucim Mine - Investigations



# Water Protection Measures Bucim Mine

- Feasibility Assessment– Water Management
  - A. Prevention of discharge of polluted waters outside the concession area of Bucim Mine namely (Bucimski Dol and Jasenov Dol, ground waters & Topolnicka River);
    1. The waters from the water catchment area (2.33 km<sup>2</sup>) of the open pit mine with annual volume of 630 000 m<sup>3</sup>/y are pumped without additional treatment to the benefaction plant of Bucim Mine – these facilities are already constructed;
    2. The clean waters from the water catchment area of Bucimski (4.65 km<sup>2</sup>) with annual volume of 441 000 m<sup>3</sup>/y are collected and transported through trenches into Bucimski Dol by solving of two tasks:
      - Ensuring maximum possible runoff and self treatment of the river downstream;
      - drainage and supply of the ground waters with fresh waters, which gradually will lead to clean-up of the ground waters;



# Management of the water in Buchim mine area - Project 2009

F1 - catchment area of flow waste water to the pit, after then in technologic cycle

F2- catchment area of flow clean water to Buchim and Topolnica river

F3 - catchment area of flow waste water to WWTP

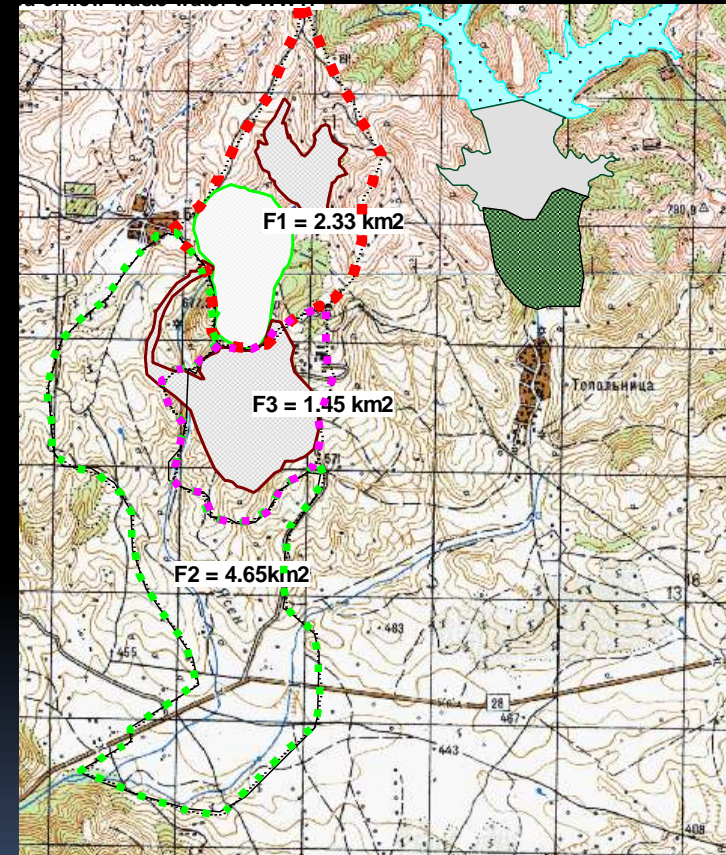
F1 = 2.33 km<sup>2</sup>

F3 = 1.45 km<sup>2</sup>

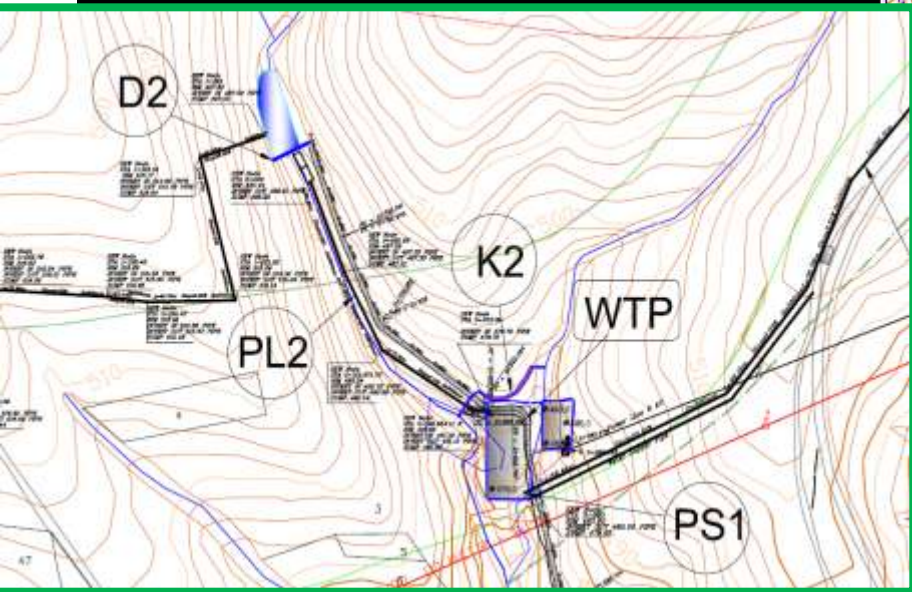
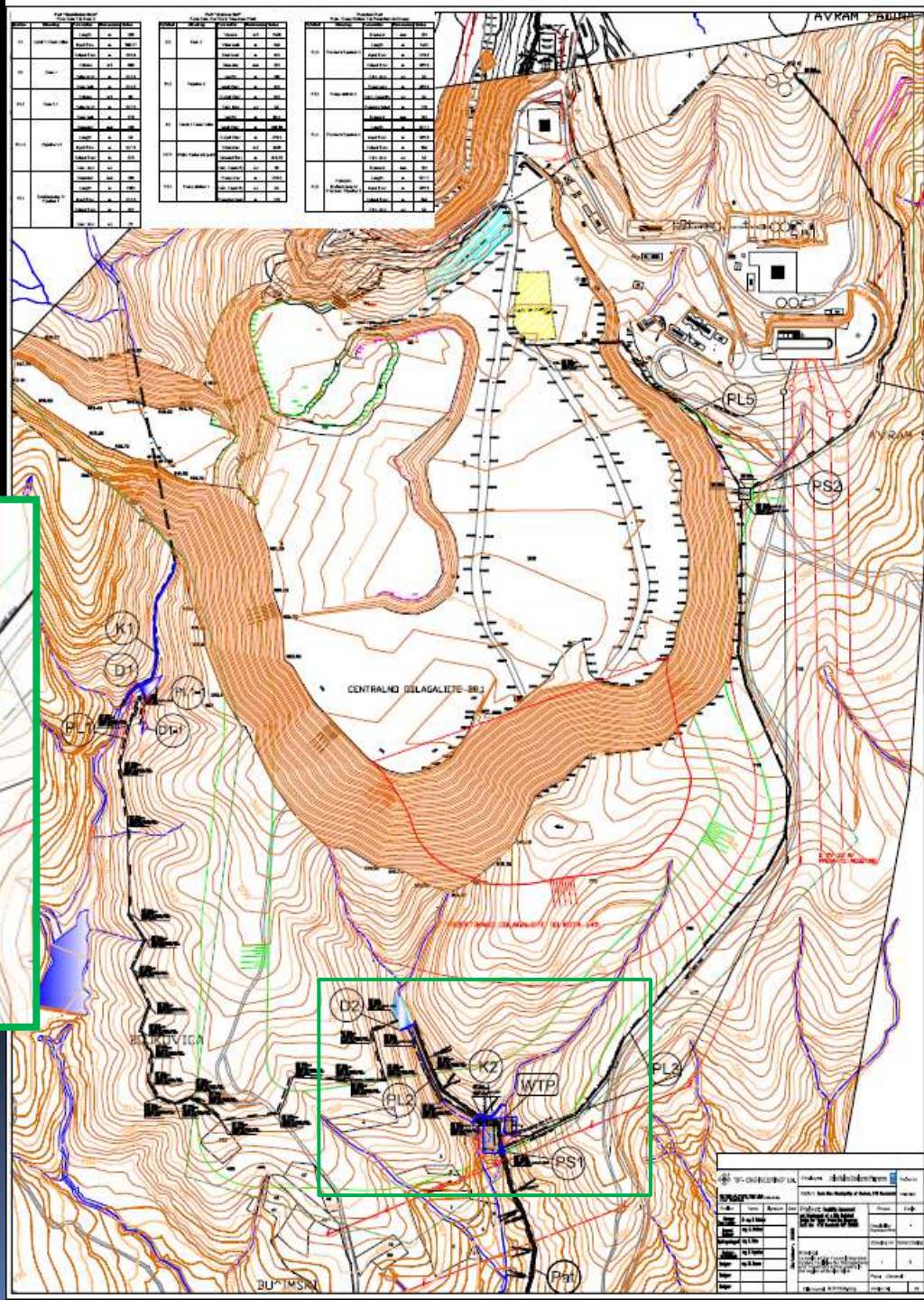


# Water Protection Measures Bucim Mine

- Feasibility Assessment– Water Treatment
  - B. Collection, treatment and management of all polluted waters , including:
    1. Construction of facilities for collection and drainage of the polluted ground and surface waters around the perimeter of the waste rock dump in Jasenov Dol and Bucimski Dol - (1.45 km<sup>2</sup>) with annual volume of 946 000 m<sup>3</sup>/y.
    2. Construction of facility for recovery of the treated waters in the benefaction plant of Bucim Mine or for retention/compensation and/or evaporation on the surface of the waste rock dump.



# Water Management & Water Treatment



No.	Area (sq. m)	Remarks
1	1000	...
2	2000	...
3	3000	...
4	4000	...
5	5000	...
6	6000	...
7	7000	...
8	8000	...
9	9000	...
10	10000	...

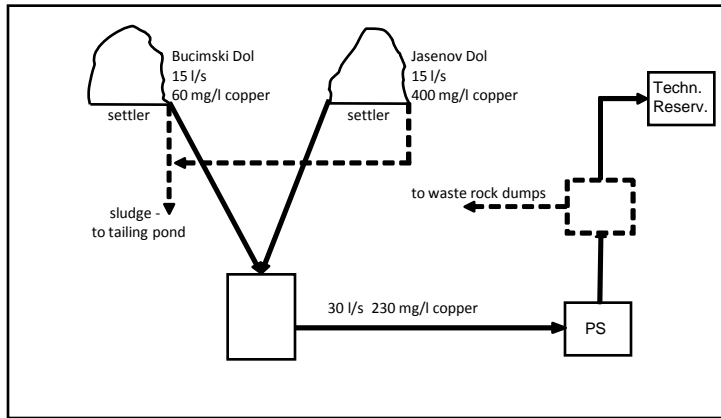
# Water Protection Measures Bucim Mine

## Feasibility Assessment– Water Treatment

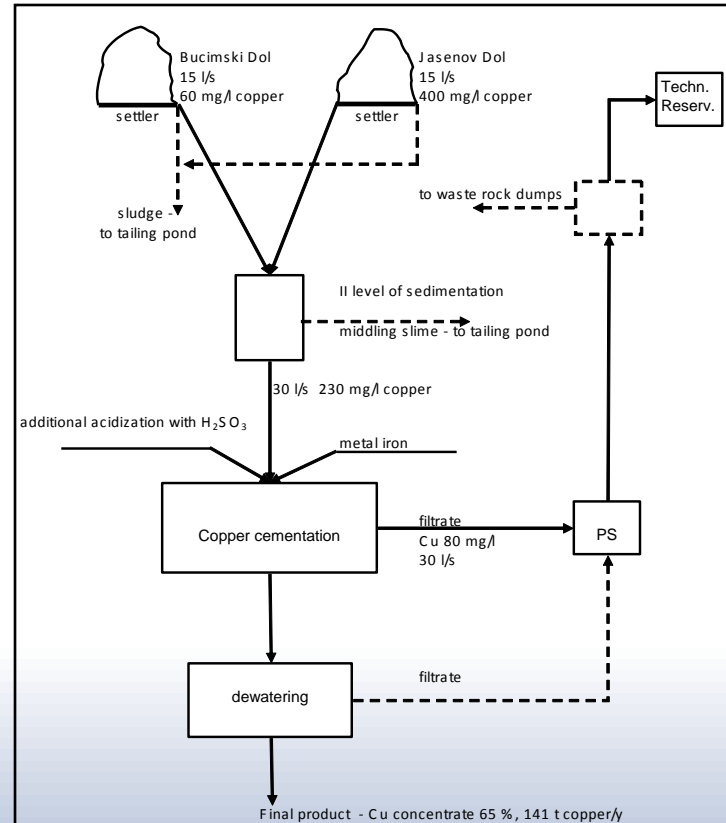
### 4 PRACTICALLY APPLICABLE VARIANTS FOR TREATMENT OF THE POLLUTED WATERS WERE INVESTIGATED:

- copper cementation and supply of the produced copper impoverished waters to the plant as technical return water or to the waste rock dump for irrigation;
- sorption of copper from the polluted waters, generation of product – liquid regenerate with copper contents 20-25 gr/l;
- sorption of copper from the polluted waters, production of liquid regenerate with copper contents 20-25 gr/l, copper cementation from the regenerate with iron for the production of copper concentrate with copper contents 65-70%;
- sorption of copper from the polluted waters, generation of product – liquid regenerate with copper contents 20-25 gr/l, settlement as copper carbonate.

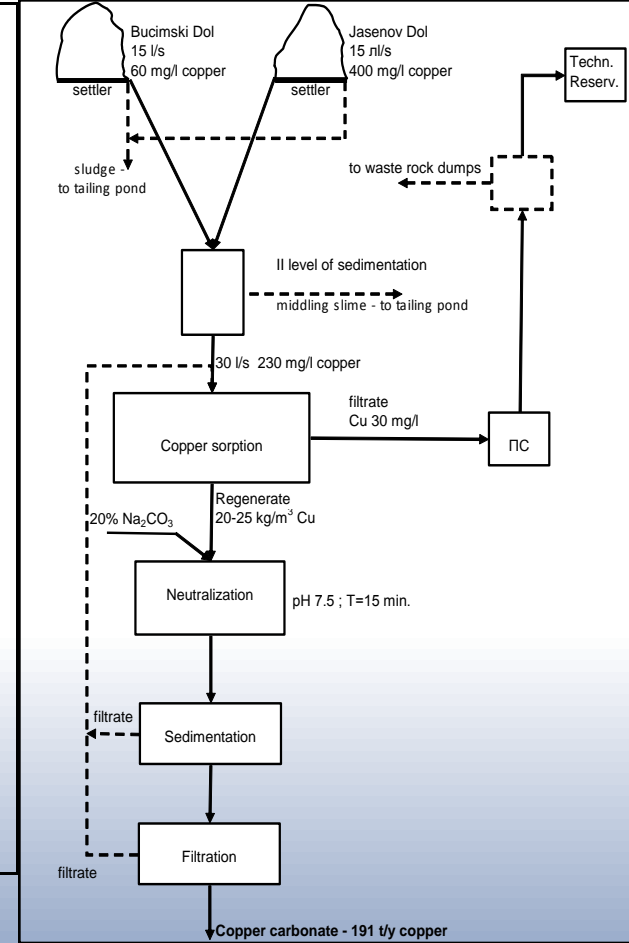
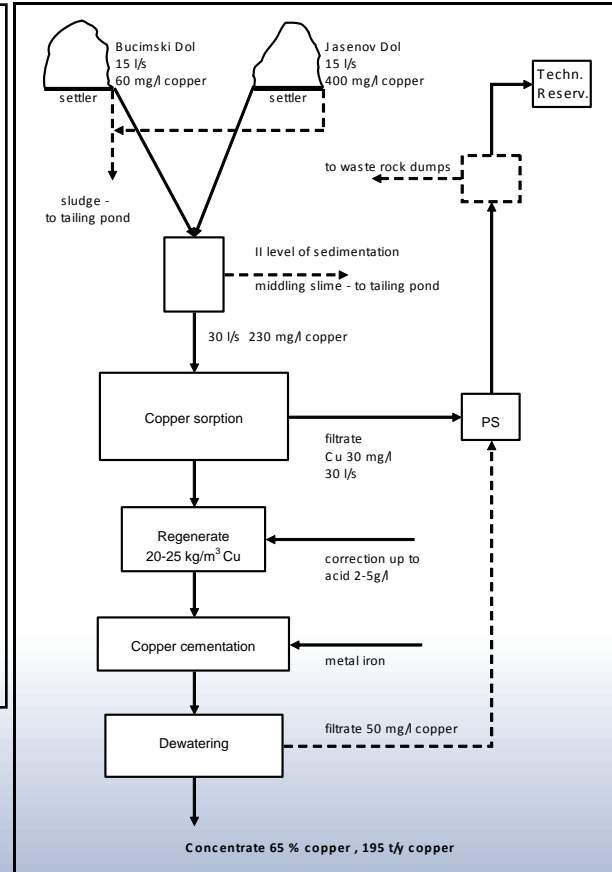
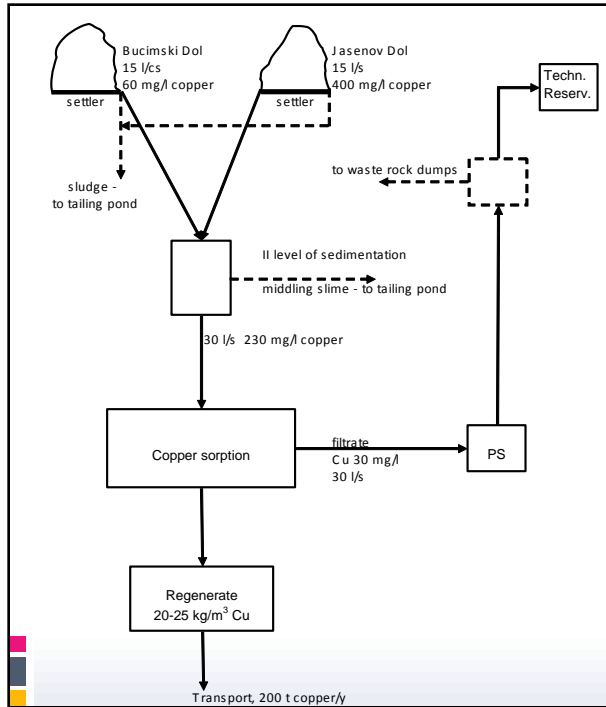
# Variant 0



# Variant I



# Variant II



Variant II-1

Variant II-2

Variant II-3

# Water Protection Measures Bucim Mine - Investment cost of alternatives

ESTIMATED INVESTMENT COST	VARIANTS, €				
	O	I	II.1	II.2	II.3
<b>Water Management</b>	<b>582 188</b>	<b>582 188</b>	<b>582 188</b>	<b>582 188</b>	<b>582 188</b>
Waste water treatment plant					
Construction			373 991	359 290	373 088
Equipment			974 568	1 049 076	1 066 213
<b>Total for WWTP</b>		<b>699 474</b>	<b>1 348 559</b>	<b>1 408 366</b>	<b>1 439 301</b>
<b>Total for Integrated water management system</b>	<b>582 188</b>	<b>1 281 662</b>	<b>1 930 747</b>	<b>1 990 554</b>	<b>2 021 489</b>

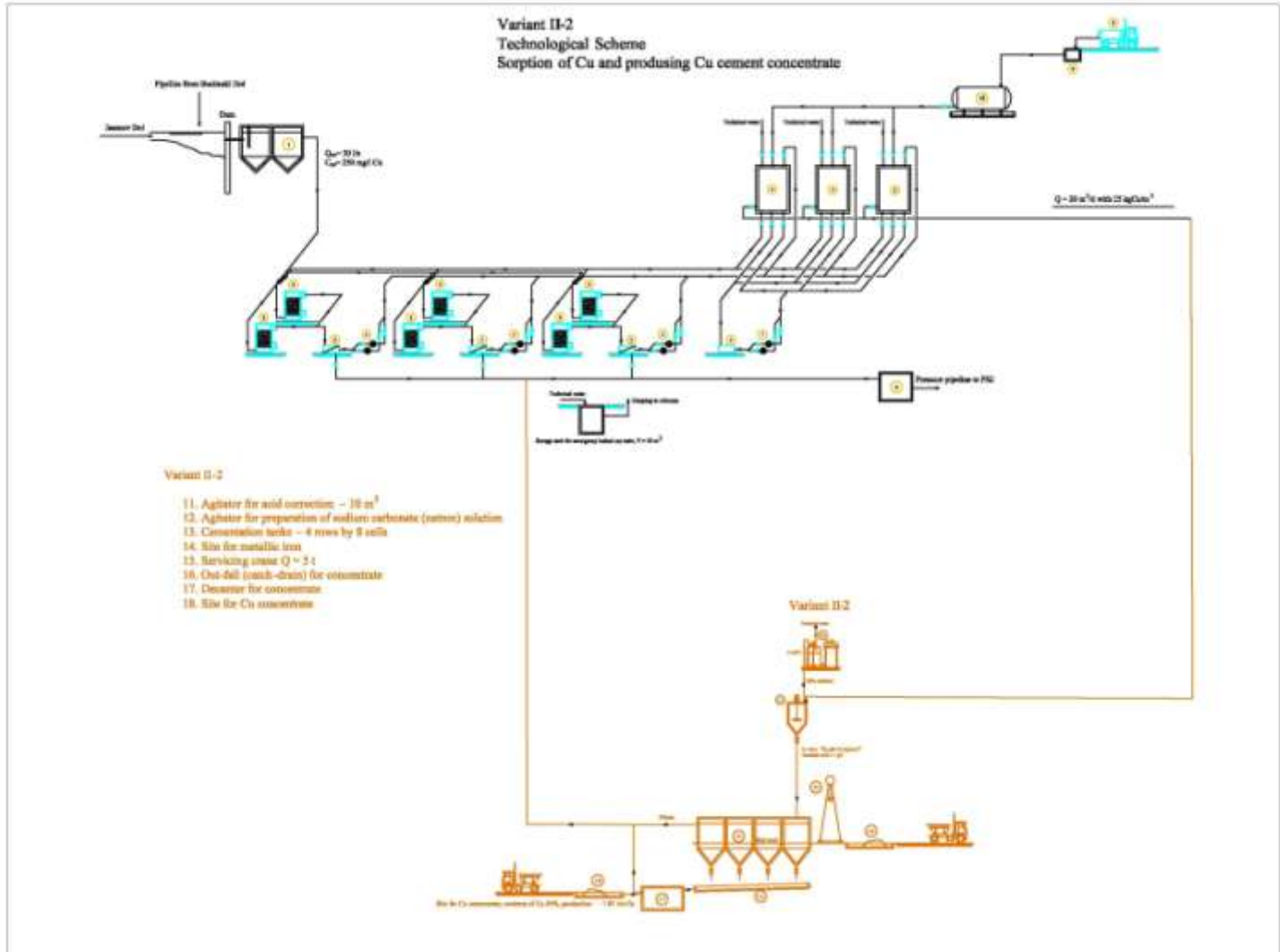
# Water Protection Measures Bucim Mine – techno- economic comparison of alternatives

PRIME COST	UNIT	VARIANTS				
		O	I	II.1	II.2	II.3
Treated water	t.m <sup>3</sup> /y	946.08	946.08	946.08	946.08	946.08
Copper in the waters	t/y	217.60	217.60	217.60	217.60	217.60
Extraction through treatment	%		65.00	92.00	90.00	88.00
Processed copper	t/y		141.44	200.19	195.84	191.49
Annual depreisation	€	58 28.80	128 166.19	193 074.68	199 055.44	202 148.91
Salaries	€/g	18 000.00	90 000.00	90 000.00	90 000.00	90 000.00
Consumables						
Iron	kg/kg		1.00		0.30	
Acid	kg/kg		0.07	0.66	0.66	0.66
Electricity	kW/kg (m <sup>3</sup> )		0.03	0.04	0.04	0.05
Electricity	kW/kg (m <sup>3</sup> )	0.06	0.40	0.28	0.29	0.29
Resin	kg/kg			0.05	0.05	0.05
Carbonate	kg/kg				0.05	0.88
Transport	€/kg			1.00		
Subtotal		<b>0.06</b>	<b>1.49</b>	<b>2.03</b>	<b>1.39</b>	<b>1.93</b>
Labor	€/kg		0.64	0.45	0.46	0.47
Amortization			0.91	0.96	1.02	1.06
<b>Prime Cost</b>	<b>€/kg</b>		<b>3.04</b>	<b>3.44</b>	<b>2.86</b>	<b>3.45</b>
<b>Annual Expenses</b>	<b>thousand €</b>	<b>132.28</b>	<b>429.53</b>	<b>689.47</b>	<b>560.54</b>	<b>661.22</b>
Operational costs for management of the waters	€/m <sup>3</sup>	0.14	0.45	0.73	0.59	0.70
Expected incomes						
From realization of the products	thousand €/y		367.01	519.46	508.16	496.87
From economies in the purchase of technical water	thousand €/y	55.82	55.82	55.82	55.82	55.82
<b>Total incomes</b>	<b>€</b>	<b>55.82</b>	<b>422.83</b>	<b>575.27</b>	<b>563.98</b>	<b>552.69</b>
<b>Annual result</b>	<b>thousand €/y</b>	<b>-76.46</b>	<b>-6.70</b>	<b>-114.20</b>	<b>3.440</b>	<b>-108.53</b>
<b>for 1 m<sup>3</sup> treated water</b>	<b>€/m<sup>3</sup></b>	<b>-0.08</b>	<b>-0.01</b>	<b>-0.12</b>	<b>0.004</b>	<b>-0.11</b>

# Variant II-2

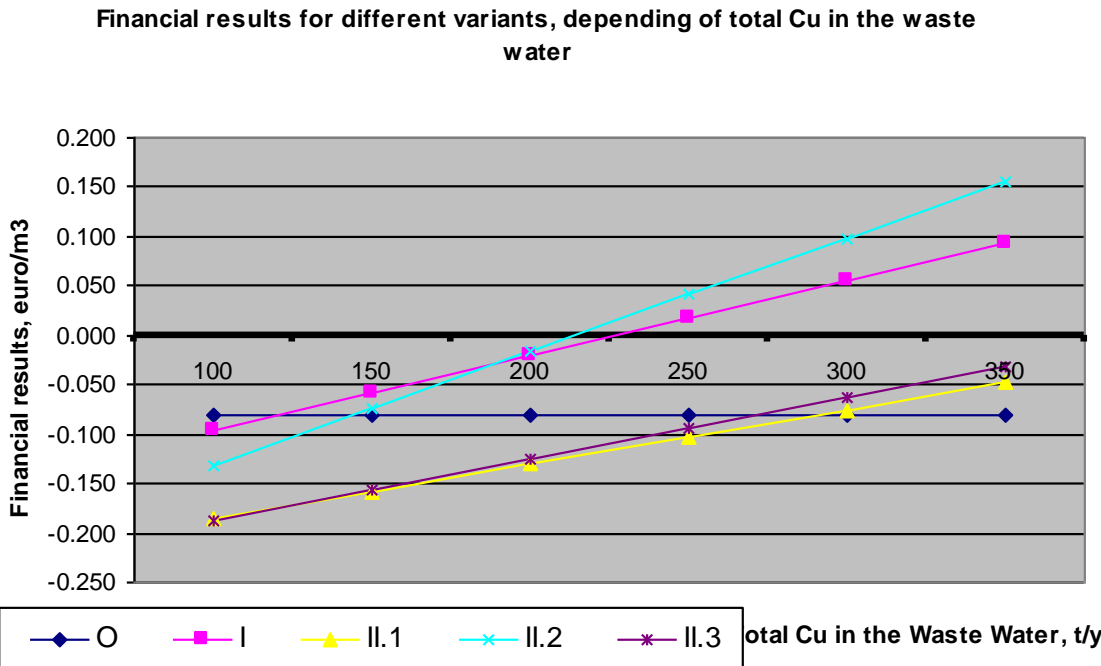
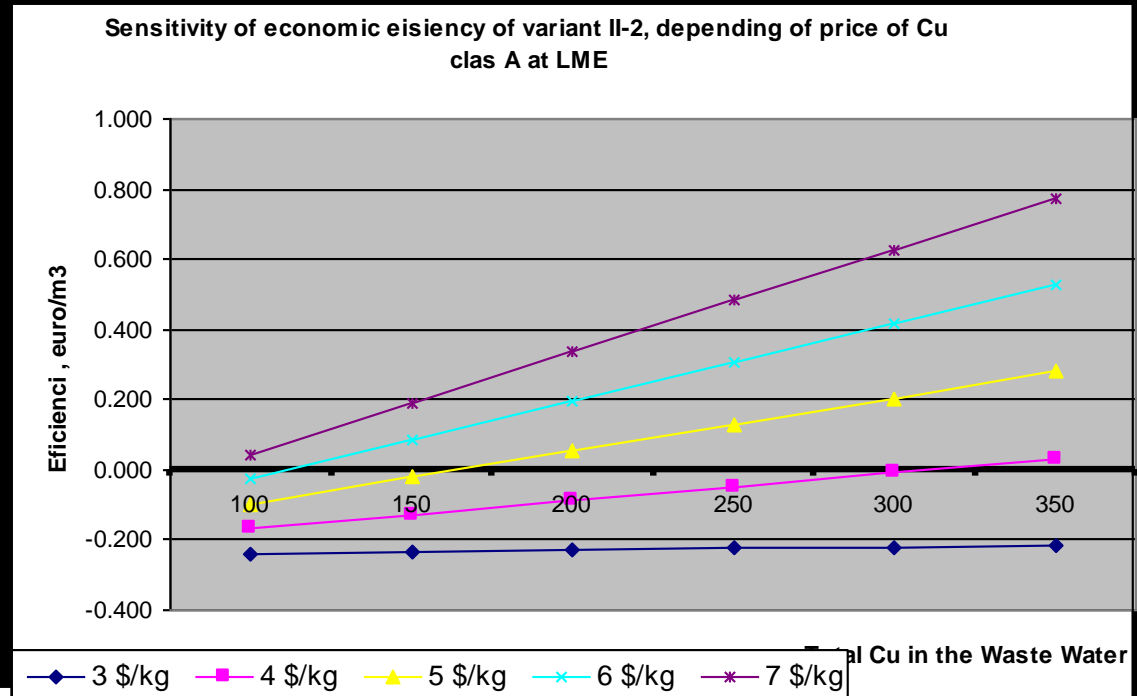
- Variant II-2 copper sorption; regeneration of the enriched sorbent for the generation of liquid regenerate and copper cementation of the produced regenerate at following parameters:
  - Average volume of polluted water – 30 l/s
  - copper contents in the polluted waters – 230 mg/l;
  - copper contents in the copper impoverished waters – 30 mg/l;
  - final product – copper concentrate – 65-70% copper;
  - annual production – 195 t copper;
  - technological parameters of the process – copper sorption of the released polluted waters on ion-exchange resin at reduction of the copper contents from 230 to 30 mg/l, supply of the produced copper impoverished filtrate to the plant for technical return water or to the waste rock dump for irrigation and regeneration of the enriched sorbent by regeneration solution 100 – 120 gr/l of sulphuric acid for the production of liquid regenerate with copper contents of 20-25 gr/l and residual acid of 40-50 gr/l. The mixture of the filtrate with the waters from the tailing pond is in proportion 1:10. Copper cementation of the produced regenerate at presence of iron and 3-5 gr/l of residual acid.

# Variant II-2



# Variant II-2

## Sensitivity Analysis



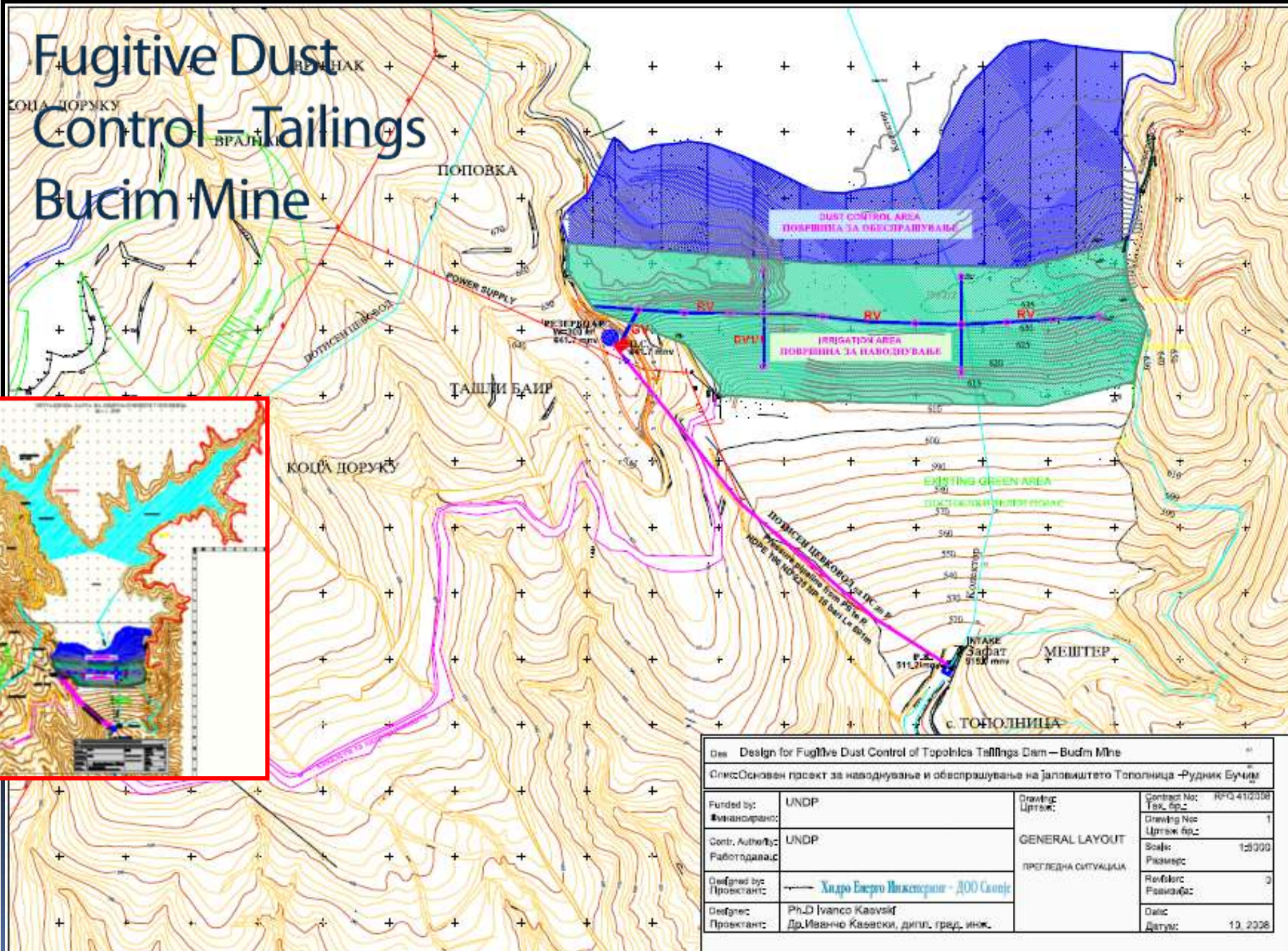
# Water Protection Measures Bucim Mine

- Feasibility Assessment and Main Technical Design
  - The recommended, self-sustainable and financially viable alternative exceeds the project Budget ( Variant 2.II est. ~ 1.990.000 €) and is by far preferred by all stakeholders; The Variant has been selected for further elaboration of detailed Main Design;
  - Completion deadline: 10 Dec 2008 –Draft Final Design
- Forthcoming activities
  - Review of the Final Design
  - Completion by Jan 2009
  - ToR, tendering – Jan –Mar 2009
  - Construction works April 2009

# Fugitive Dust Control – Tailings Bucim Mine

- Afforestation:
  - Procurement of fertile soil for 10 ha of tailings dam (RFP35/2008) -16.500 m<sup>3</sup> soil procured and applied. Contractor: Tehnika - Radovis.
  - Bucim Mine = Supervising Engineer , Soil Quality Control = Agricultural Institute Skopje; Task completed in November.
  - Afforestation of 10 Ha of the Tailings dam (RfQ 51/2008) – planting 35.000 seedlings, grass for 10 hectares and organic manure – completed 80%. Implementation 05 November – 05 December 2008.
  - Major setback: Torrent rainfall – highest recorded ever hit Radovis on Dec 04, 2008. Disaster proclaimed by the Govt. Of Macedonia.
- Dust Control and Irrigation System - Tailings Dam Bucim Mine
  - Technical design – Part 1, comprising Intake, pumping station, pipeline and new water reservoir V=300 m<sup>3</sup> has been completed
  - Part 2 of the design comprising stable and mobile irrigation equipment, water cannons for wetting of the dry surfaces, and connection of the existing pipeline and equipment with newly designed equipment/reservoir
  - Review of the Designs ongoing

# Fugitive Dust Control – Tailings Bucim Mine



<b>Des:</b> Design for Fugitive Dust Control of Topolnica Tailings Dam – Bucim Mine Слес: Основен проект за наводнување и обеспрашување на таложистето Тополница – Рудник Бучим			
Funded by / Финансирано:	UNDP	Drawing / Цртач:	Contract No: КРГ 410208
Cont. Authority / Работодавец:	UNDP	GENERAL LAYOUT / ПРЕГЛЕДНА СИТУАЦИЈА	Drawing No: Цртак бр. 1
Designed by / Проектант:	Хидро Енерго Инженеринг - ДОО Скопје	Scale / Размер:	1:5000
Designer / Проектант:	Ph.D Ivanco Kavoski / Др. Иванчо Кавески, дипл. град. инж.	Revised / Ревизија:	0
		Date / Датум:	12. 2028

# Fugitive Dust Control – Tailings Bucim Mine



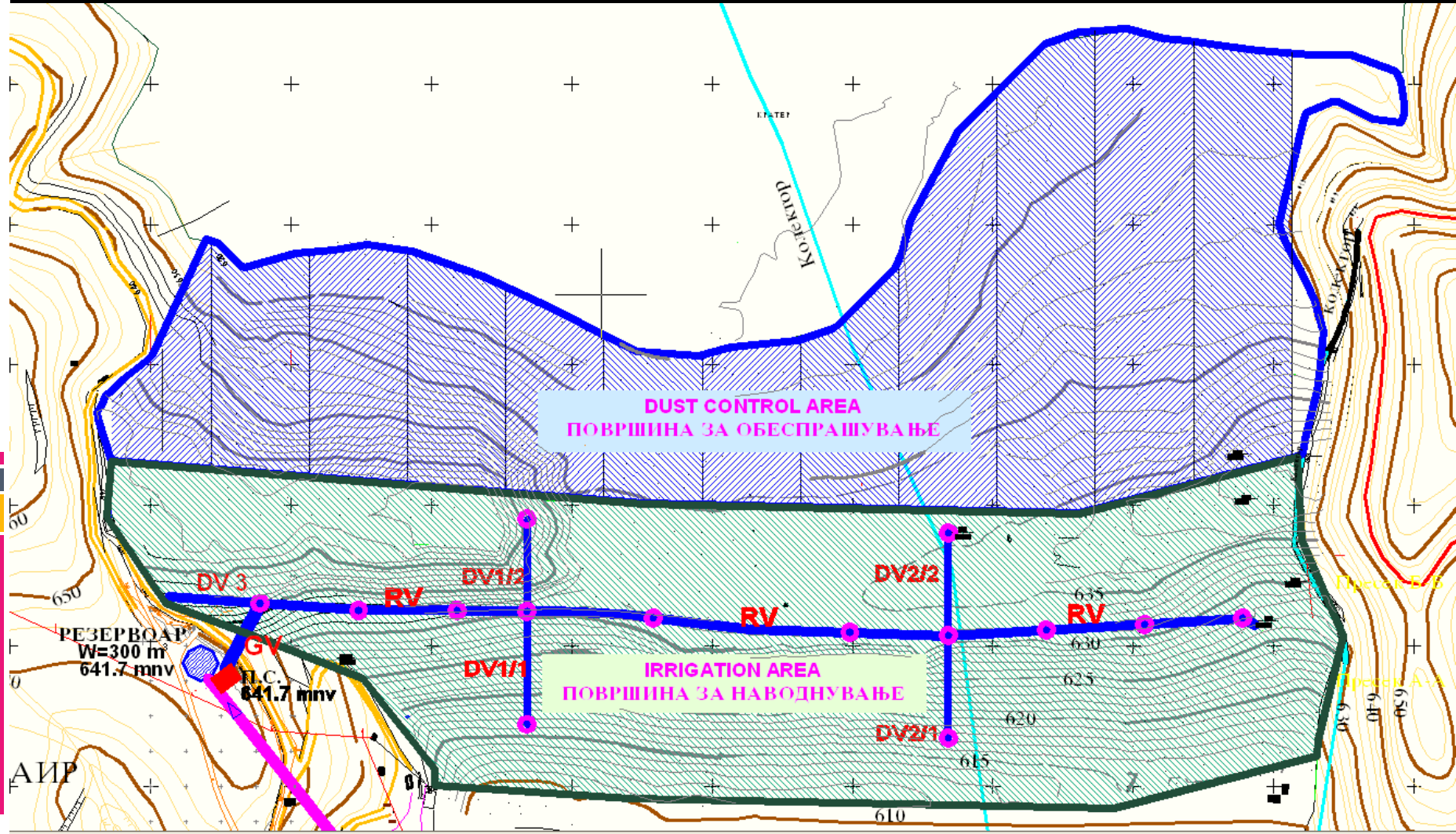
# Fugitive Dust Control – Tailings Bucim Mine



# Fugitive Dust Control – Tailings Bucim Mine



# Fugitive Dust Control – Tailings Bucim Mine

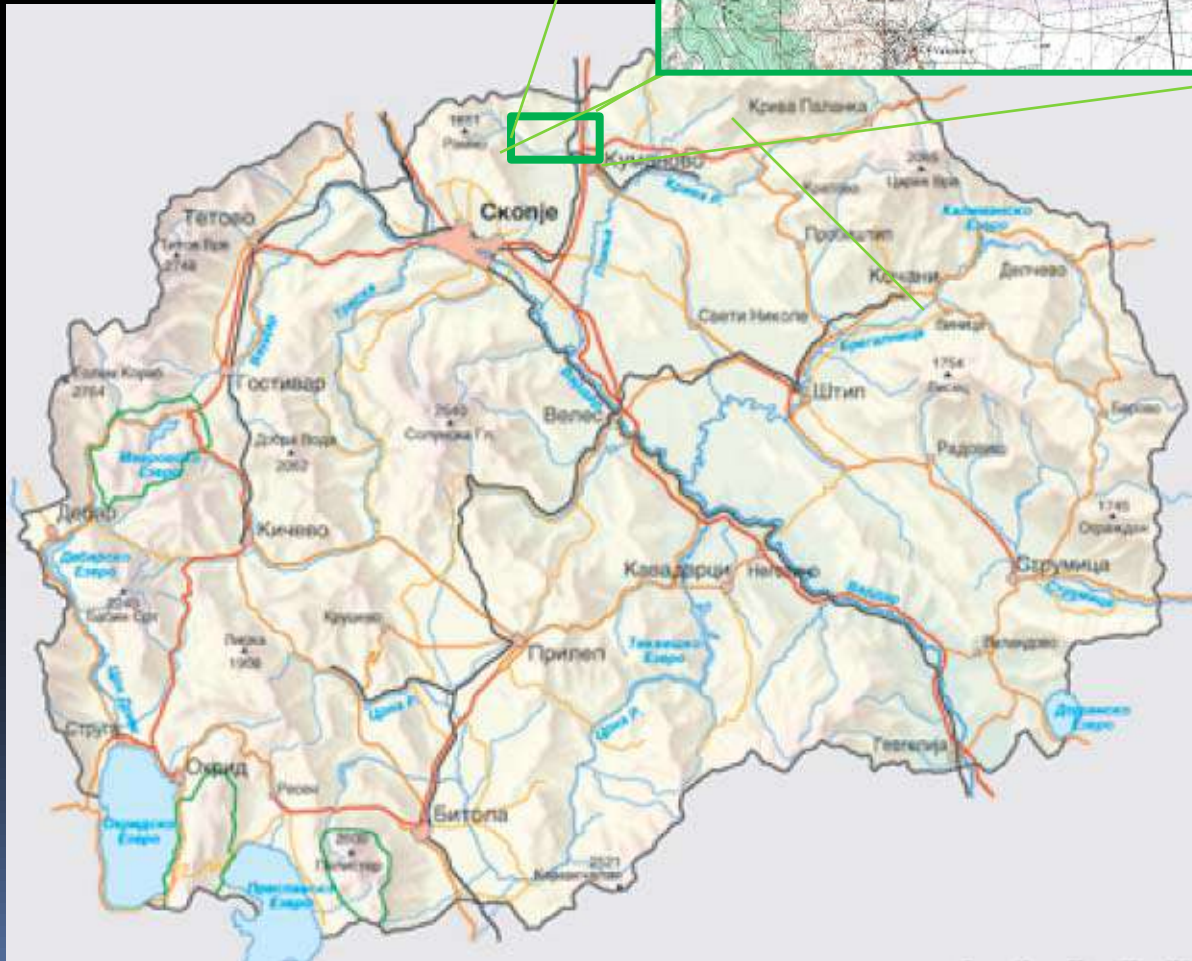


# Fugitive Dust Control – Tailings Bucim Mine

Air pollution prevention –construction & installation costs (estimated):

- Cultivation / vegetation of the tailings dam 10 ha
  - ~ 140.000 US\$
  
- Irrigation/water spraying system for fugitive dust control
  - Part 1            Intake, Pumping & Reservoir  
~ 250.000 US\$
  - Part 2            Booster Pump, Dust Control & Irrigation Equipment  
~ 140.000 US\$

# Lojane Mine



# Lojane Mine, Lipkovo Municipality

- Lojane, Chromium and Antimony Beneficiation Plant and abandoned Mine, active in the period from 1923 till 1979
- After the cessation of mining activities, complete infrastructure i.e. production facilities (underground workings), beneficiation (flotation and smelting -ore frying) facilities, waste dump and tailings ponds, as much as storage yards, silo's and workshops were abandoned without undertaking any conservation measures
- The Mine is identified as one of the industrial contaminated sites - **“hot spot” within the National Environmental Action Plan (2006) and the National Plan for Waste Management (2005).**
- The most affected area is between the villages Lojane, Vaksince and Tabanovce.
- Specifically, there are sources of contamination with heavy and toxic metals (As, Hg, Cr<sup>6+</sup>, Sb) along the old adits, roads and ruined objects, polluting water and soil and entering the food chain, affecting, thus much wider area.

# Lojane

- Identified sources of pollution include:
  - ore waste dump (20.000 tons)
  - arsenic concentrate (15.000 tons)
  - flotation tailings dump (300.000 tons with average concentration 1-2 % of As and 1-2 % of Sb)
  - ore smelting and frying facility, transportation routes and storage yards (including 2500 barrels of  $As_2O_3$ )



# Lojane Mine

- No substantive progress in Lojane Mine situation. PMB should also discuss further actions.
- Until now, the concessionaire Farmakom MB showed intention to excavate the deposits rich with Antimony (and Arsenic) and ship them for processing in Serbia. The procedure for obtaining necessary permits have been enacted only, with no further activities.
- For a working permit (issued by the Ministry of Economy) consent of other line ministries is needed. The Ministry of Environment and Physical Planning (MEPP) has agreed to issue a consent upon preparation of a Environmental Impact Report (shortened procedure as compared to full EIA Study)
- A meeting has been organized by the Project between Farmakom MB and MEPP on November 21<sup>st</sup>, 2008.
- The MEPP has specified a two-month deadline for submission of the Report: 21 January 2009.
- If the shortened EI Report is not submitted by the deadline, the MEPP shall examine the existing concession agreement and revoke its consent.
- The project Team, including the Expert/ Consultant, Prof. Mirakovski, shall follow the development of the plan of Farmakom MB and in parallel examine all possibilities of Project involvement in Lojane. All alternatives will be checked and reported to the PMB by Jan 15<sup>th</sup>.

# Challenges

## BUCIM MINE

- The recommended, self-sustainable and financially viable alternative exceeds the project Budget ( Variant 2.II est. ~ 1.990.000 €) and is by far preferred by all stakeholders;
- Further consultations are needed and decisions have to be made on Project management Board level. The consultations refer to the possibility to raise additional funds in order to implement the most viable water protection measure.
- Possibility to save some funds for water protection measures exist if we stick to original plan of activities – excluding thereby the tech. solution for water saving by use of drainage water from Topolnica Tailings Dam; - this however changes Project tendering plans and will for sure hamper planned delivery in 2008....
- The prices of metals, namely copper, have dropped significantly on the world markets. The price of copper is currently approximately 3.500 US\$/ton, by far bellow the break-even price of Bucim Mine. Operations with this prices following February 2009 may create losses for the Mine. This may impair the possibility or the wish for investment in environmental protection by Bucim Mine.

## LOJANE MINE

- Unresolved

# Component 2 Demonstration & Information Sharing

- The first study tour, in October 2008 is completed (20-24 October). Three remediation spots in Czech Republic visited;
- Hot Spots Programme (officially Western Balkans Environmental Programme) web site is close to completion and already posted at the web. Staff training for web site management completed. All national projects will have also pages with specific texts in English and local languages and training for updating of the web site by focal points in each participating office was conducted by Regional unit (RPMU);
- Study Tour for Macedonian stakeholders- Bucim Mine 3, Municipality of Radovis 2, MEPP 2 and The Project 2 participants, is planned for 3-5 Dec in Bulgaria – visit of remediation and copper extracting facilities – similar to Bucim situation;
- Information workshop/round table is planned for December 16<sup>th</sup> 2008..
- Focus Groups – survey of public awareness – announcement to be made by CO.

## Component 3

# Strengthening Of The Professional Consultancy Services

- Database of environmental practitioners:
  - Questionnaires for individual practitioners and for companies/institutions /organizations developed; Call for expression of Interest published in July, applications received (papers & UNDP web site – CEI 40/2008)
  - Call for expression of Interest re-announced CEI 69/2008)
  - ToR for Market survey has been developed & tendered. Consultant Selected: MR. Konstantin Siderovski, M.Sc.
  - A Survey of the market undertaken by a questionnaire widely distributed to stakeholders in the environmental sector. First Draft Report Expected by Dec 10<sup>th</sup>, 2008.



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HOT SPOTS      THANK YOU!  
PROJECT - MACEDONIA