



ENVIRONMENTAL RESTORATION PLANS AND ACTIVITIES IN SLOVENIA: 1995-1996 PROGRESS REPORT

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Abstract

This report gives a brief status and description of new developments in the remediation activities which are going on at Žirovski Vrh Uranium Mine site during the last two years. The progress of the implementation has slowed down compared to the plans. Reasons for that are: (a) legal problems (responsibilities between two authorized governmental agencies) in the procedure for obtaining location permit for the long-term site remediation of the wide exploitation area, particularly for the mill tailings disposal site; (b) lack of funding. However, some tasks have been performed during this period in the field of investigations, reporting to the authorities, design and to a lesser extent actual implementation. The investigations have concentrated on the hydrology of the site underground waters, radiological site characterization and investigation of locally available materials for constructing the cover of the waste disposal sites. On the basis of RŽV's Environmental Impact Report, Slovenian Health Inspectorate has officially set authorized limits for radioactive pollutants emission for mine water and mill tailings and mine waste disposal sites. Detailed drawings of the mill site decommissioning have been presented to the authorities. Approval by the authorities is expected to be granted soon. This represents the last stage in the procedures for obtaining permissions before the field work at the mill site can be formally started. The problem of the mill tailings earth slide has been successfully solved by constructing geotechnical underground water drainage structures including vertical dewatering wells.

Some research and investigation projects are in progress to promote knowledge on radiological site characterization, water pathway emission of the pollutants and to identify required materials locally available for the mine waste and the mill tailings cover construction. Measurements of the radioactivity in Žirovski Vrh Uranium Mine environment and assessment of its environmental impact are being continued.

1. INTRODUCTION

The Project on Environmental Restoration in Central and Eastern Europe started with the first workshop in Budapest in 1993 to identify radiologically contaminated sites in those countries. Four workshops have followed with different topics closely linked to the environmental restoration of the uranium production sites, problems connected with radiological characterization of the sites and implementation of the sites remediation as well. Thanks to the efforts of the participants a good picture about the status of the uranium production and broad plans for future development in the participating States has emerged.

Compared to the large extent of contaminated sites in some other countries, the situation in Slovenia is rather small, with only one closed down uranium mine. Extensive exploration works in the mine area started in 1968 and the production of yellow cake which commenced in 1984 ended in 1990. The whole project was conceived in the time frame which enabled taking advantage of the accumulated experience in the implementation of environment protection principles. During the period of operation 620 000 tons of ore had been extracted and 452 tons (U_3O_8) of yellow cake produced. Quantities of waste materials - 700 000 tons of mill tailings and 1 600 000 tons of mine waste - on two disposal sites are still awaiting remediation. In the production phase there were 500 employees in the company. The Slovenian parliament passed the Law on Permanent Close-out of Uranium Ore Exploration in 1992, two years after the decision of the Slovenian Government to stop production of yellow cake [1, 2].

At present there are 115 employees in the company. The main task of the company is management of the mine site remediation in a safe and environmentally sound way. Parallel activities are maintenance of the mine and its surface structures, mill buildings and waste sites maintenance as well as protecting the equipment against damage and avoid additional burden to the surroundings. The company is also engaged in contracting the design and engineering works, research and investigations, construction, drilling works etc. The control of environmental impact of the emission of radioactive and chemical pollutants is being continued. The air and water pathways of radioactive pollutants are measured, sampled, analyzed and evaluated.

The whole area of the company owned land amounts to 74 ha, out of which 60 ha are operational areas. Business and storage buildings areas cover 10 000 m² and 8 000 m² cover roofed production areas. During the exploitation 60 km of mine tunnels of cross section from 4 m² to 17 m² were built. The location of the mine and mill facilities is shown in Fig. 1., and the underground structure of the mine in an area of 1.5 km² is given schematically. Vertical elevation of the mine is from 430 m to 580 m which is the highest level.

2. NATIONAL CONDITIONS REQUIRING ENVIRONMENTAL RESTORATION

The territory of the Republic of Slovenia is not considerably polluted with radioactivity. The general public opinion is to keep this condition on the low side as much as possible and the use of nuclear energy, ionizing sources and production of radioactive source materials should be minimized in future. The same attitude prevails towards the Uranium Mine Žirovski Vrh. In this case, without doubt, the site remediation must be done professionally and in an environmentally sound manner. The objective is to bring down the equivalent dose commitment from 0.35 mSv to 0.15 mSv or lower for the critical group. Regardless of the small contribution to the equivalent dose commitment the impact on the water environment must be minimized[3].

One of the objectives of site remediation is to return as much of the land as possible back to public use without any institutional control for the long-term future. Active institutional control (long-term maintenance and monitoring of the effluents) has been foreseen for the mine waste disposal site and mill tailings.

3. LEGISLATION, REGULATIONS, POLICIES

Three authorized governmental regulatory agencies exercise control over the uranium mine and its remediation plans from radioactivity point of view: Slovenian Nuclear Safety Administration since 1992, Mining Inspectorate and Health Inspectorate since the start of the mining and milling. Other inspectorates involved are Water Management Inspectorate and Fire Inspectorate. Since the mine and mill operation permits were issued years ago (exploitation permit), and did not include remediation plans, it is clear that the site remediation plans must pass the current procedures applicable to obtaining permit for location and construction. It is also valid for the Uranium Mine Žirovski Vrh. There are also differences of opinion regarding responsibility and interactions of the two governmental administrative agencies: the Slovenian Nuclear Safety Administration and the Mining Inspectorate.

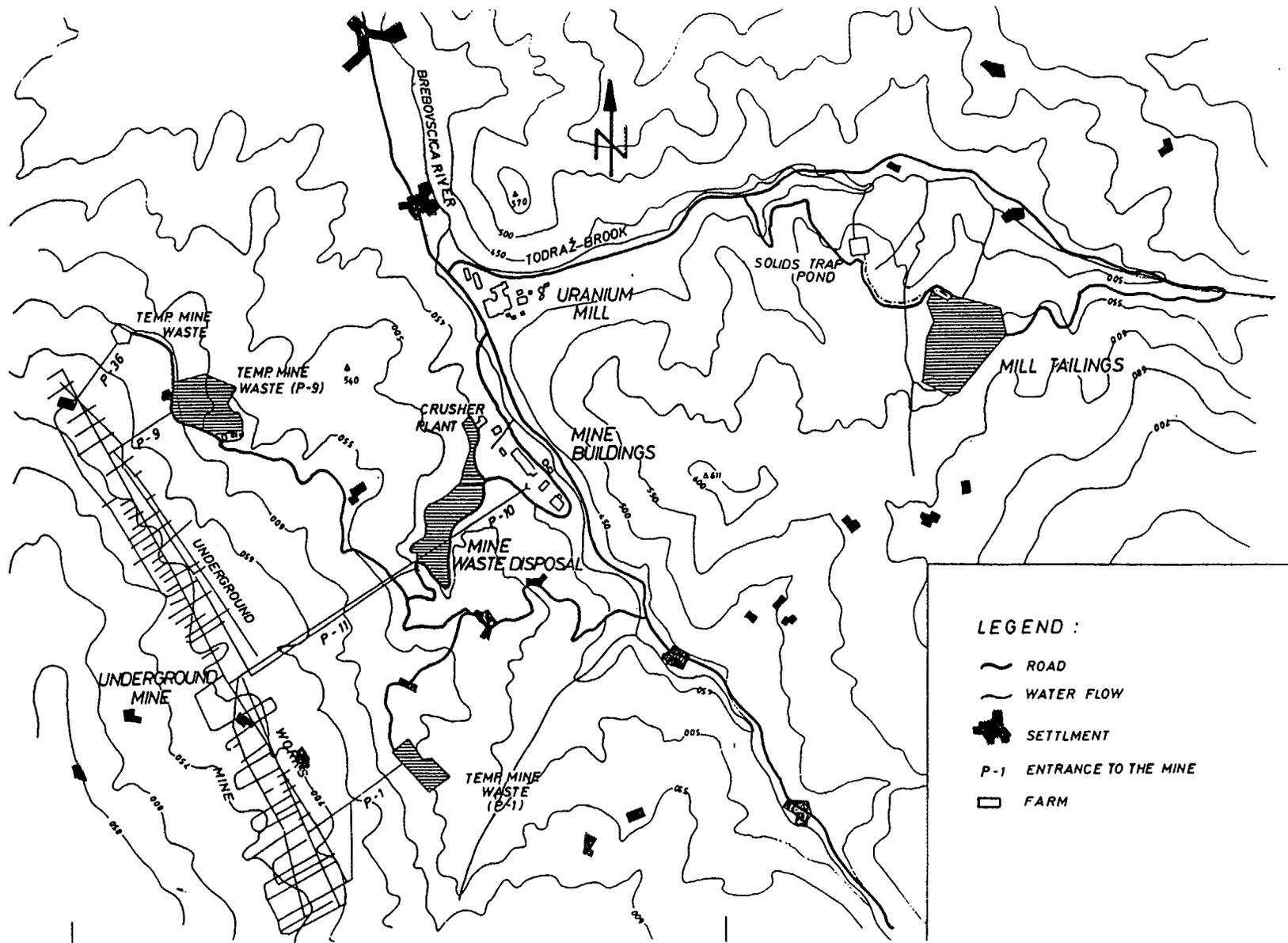


FIG. 1. Uranium Mine Zirovski Vrh Production Site.

As reported previously the mill site location permit (the decommissioning part for some process buildings) was granted in September 1995 [2]. The construction permit (the decommissioning of the equipment and demolition of some buildings) is expected to be granted in October 1996.

Application for location permit for the whole mine exploitation (production) site remediation including Environmental Impact Report had been addressed to the authorities almost a year ago [4]. This permission has been held up since the Slovenian Nuclear Safety Administration questioned the proposed mill tailings siting solution, e.g. the existing place. They have asked for additional safety evaluations on the long-term location of the mill tailings [5]. However, a limited location permit for all mine exploration area was granted very recently. The exemptions are the mill tailings and the mine waste disposal sites.

Authorized limits for different points of emission were officially granted to the Žirovski Vrh Mine by the Health Inspectorate. Some of them are given as maximal concentration limits and also as yearly maximum limits. Table I indicates authorized limits. Radon-222 exhalation rate must be below 0.7 Bq/m².s for mill tailings disposal site and below 0.1 Bq/m².s for mine waste disposal site. Two different numbers are given due to different contribution to the equivalent dose commitment from these two sources by the air pathway. Mill tailings are located above the average winter temperature inversion layer and mine waste disposal site is located under the temperature inversion layer. Due to laminar air flow movement the impact of the lower site is much larger than that from the mill tailings. Gamma dose rate must be below 0.2 µGy/h for all remediated areas. Annual effective dose to a member of a critical group must be below 0.3 mSv [3].

TABLE I. AUTHORIZED LIMITS

	Uranium		Radium 226		Other Bq/m ³
	µg/L	kg/year	Bq/m ³	MBq/year	
ENTRANCE CONTROL POINT					
Run off mine water	250	170	60	50	
Mine waste disposal drainage water	510	85	40	25	100 ^a
Mill tailings ²²² Rn exhalation rate					0.7 ^c
Mine waste disposal site ²²² Rn exhalation rate					0.1 ^c
EXIT CONTROL POINT					
Todraž Brook - collector of all mill tailings waters			60	50	
Brebovščica River - collector of all Žirovski mine area waters	50 ^b		40		

a - Sum of Th-230, Pb-210, Po-210

b - Regulation on Hygienic Irreproachability of the Drinking Water [9].

c - Bq/m².s

4. RADIOLOGICAL CHARACTERIZATION

Corresponding radiological characterization of the Žirovski Vrh Uranium Mine site was given in Environmental Impact Report [4]. Annual effective dose for a member of a critical group was estimated to be from 0.3 to 0.37 mSv/year [6, 7, 8]. Uranium and Radium-226 average concentrations in Brebovščica River are 13 $\mu\text{gU}/\ell$ and 7 Bq $^{226}\text{Ra}/\text{m}^3$ respectively. Uranium concentration in Brebovščica River swings up to 25 $\mu\text{gU}/\ell$ due to the Brebovščica River flow changes. The mass flow of Uranium with the run off mine water is quite regular. Gamma dose rates in the region range from 100 nGy/h to 200 nGy/h as background. Exceptionally, uranium ore bearing surface rocks with gamma dose rates up to 5000 nGy/h can be detected as a natural occurrence.

In the last two years additional bore holes were drilled for underground water quality investigation at mill site, the mine waste disposal site and at the control point below the whole mine facilities site (borehole BS 26), Fig. 2 [6, 9]. The table II shows the comparison of the obtained results for the mill site and the control point of the underground water against the maximum concentration of constituents for ground water protection stated in the US NRC report [10]. Also the borehole No. 3 disclosed some solid uranium contamination under the yellow cake precipitation site. The area is limited to a few tens of square meters, certainly, this is the source of uranium contamination of the mill site underground water.

Generally the surfaces of the mine area are less contaminated than the mill areas. Gamma dose rate is up to 1000 nGy/h (background 160 nGy/h), Alpha surface contaminations are from 0 to 18.3 Bq/100 cm^2 (average 0.7 Bq/100 cm^2), Beta surface contaminations from 0 to 330 Bq/100 cm^2 (average 7.8 Bq/100 cm^2).

Areas and process buildings are radioactively contaminated as follows. Gamma dose rates are from 30 to 1 600 nGy/h, Alpha surface contamination from 0 to 37 Bq/100 cm^2 , Beta surface contamination from 0 to 6 000 Bq/100 cm^2 . Radon-222 concentrations are from 50 to 13 000 Bq/ m^3 of air (one case), average under 250 $^{222}\text{Rn}/\text{m}^3$ [3].

5. ACTIVE PROJECTS UNDERWAY

As mentioned in earlier papers Uranium Mine Žirovski Vrh site remediation is progressing very slowly [2, 6] for the reasons already mentioned. Irrespective of this, some activities are in progress. Details are given below.

5.1. Investigations and design works

(a) Chemical and radiological monitoring of the entrance and exit points is continued for air and water pathways on previously determined schedule.

(b) New bore holes have been drilled for underground water investigation in the vicinity of the mine waste disposal site and mill tailings. The results have not been studied yet, radiological contamination has been detected [9].

In some cases radioactive contamination of ground water have been detected such as at the mill site. Old borehole (VPO-1 drilled in 1993) was contaminated by the movement of the plume of contaminated ground water (detected in 1996), lower concentrations have been observed in the second borehole (VPO-2 drilled in 1993) than in the observing year 1994. This was possibly due to migration and dilution processes[9, 12].

(c) Locally available materials (tuffs, loamy sandstones, clays and bentonites) for engineered cover of the mill tailings and mine waste are investigated as well. Their permeability and confinement of Radon-222 are studied as well as the mechanical properties.

(d) Case studies for mill tailings and mine waste site emission of radioactive and chemical pollutants have been carried out, including some modeling and calculations to forecast long-term impacts by water pathways.

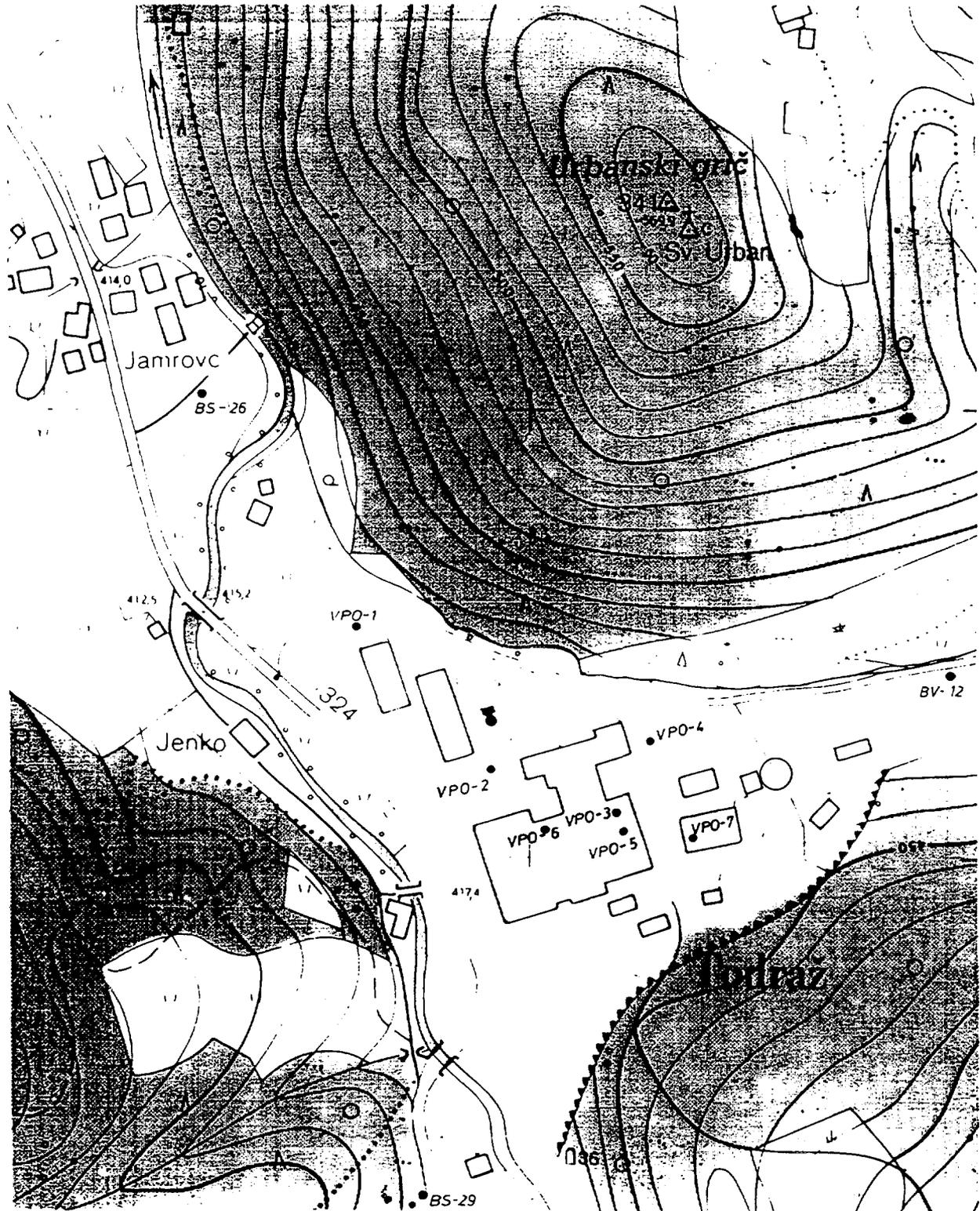


FIG. 2. Location of the Underground Water Control Boreholes at Mill Site.

TABLE II. CHEMICAL COMPOSITION OF THE UNDERGROUND WATER FROM THE MILL SITE BOREHOLES

CONSTITUENT	UNIT	VPO-1 2/2 Sept. 96	VPO-2 2/2 Sept. 96	BS-26 Jul. 96	Max. Conc. of Constituent ^a
Conductivity	mS/cm	0.359	0.555	-	-
pH		8.0	8.0	8.2	-
Ammonia	mg/L	0.11	0.13	<0.1	-
Uranium	mg/L	<0.0005	0.044	<0.009	0.044
Arsenic	mg/L	<1	<1	-	0.05
Barium	mg/L	<0.1	<0.1	-	1.0
Cadmium	mg/L	<0.02	<0.02	-	0.01
Chromium	mg/L	<0.1	<0.1	-	0.05
Lead	mg/L	<0.2	<0.2	-	0.05
Mercury	mg/L	-	-	-	0.002
Selenium	mg/L	-	-	-	0.01
Silver	mg/L	<0.05	<0.5	-	0.05
Nitrate (as N)	mg/L	-	-	-	10
Molybdenum	mg/L	<0.2	<0.2	-	0.1
Zinc	mg/L	0.8	0.03	-	-
Sulphate	mg/L	11	12	4.4	-

a - Subpart A Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites [10]

(e) Detailed decommissioning design of the mill site is being continued. The drawings were finished for decommissioning of some mill buildings. It is expected that the construction permit will be granted soon. Then, the field works like demolition of structures can officially start.

(f) Detailed drawings for mine waste disposal site improvement of the underground dewatering pipelines have been submitted for approval.

(g) The reasons to initiate activities by the company for obtaining the quality assurance (ISO 9001) certificate have been reviewed. The management believes that the introduction of limited quality assurance procedures will be the most important and demanding long-term task. There is no point in obtaining the quality assurance certificate for the company, because the company will be liquidated when the site is rehabilitated.

(h) Detailed study of the mine waste disposal drainage water flows has been done to determine remediation actions.

(i) The bidding procedure is going on to find a contractor who will design the waste management steps and underground disposal of the wastes from decommissioning of the mill in a part of the mine.

5.2. Implementation activities in the field

(a) The mill tailings drainage tunnel construction was finished along the whole length.

(b) Geomechanical works are being continued to stabilize the mill tailings site. The contractor is drilling the next eight vertical boreholes (wells) to drain underground water via drainage tunnel in order to lower the existing underground water table. There will be 11 out of 21 drainage boreholes installed till the end of the year.

- (c) At the lowest point of the mine some mine dewatering structures were remediated.
- (d) Almost 50 tons of the mill equipment have been dismantled, decommissioned and has been sold for reuse at steel mills. For long-term disposal in the mine, the waste material and equipment are packed into 2 m³ containers and temporarily stored at the mill site.

6. PRIORITIES AND PLANS

The main and most urgent priorities are to obtain all the missing location and construction permits for the exploitation area including the mill tailings and the mine waste disposal sites. This would enable continuation of the rehabilitation works for the whole exploitation area. The key to this is to reevaluate the decision making procedure all over the mill tailings location referring to the three existing possibilities as it has been requested by the Slovenian Nuclear Safety Administration. Then the state has to provide the funds for tailings and mine waste remediation works to be carried out in 1998 and beyond. Steady cash flow as planned is necessary for proper execution of the activities to avoid interruptions after they are started. The financial structure for the next year has already been worked out[13].

7. NEAR -TERM SCHEDULE AND PROSPECTS

The plans for remediation works at the site for the year 1997 are:

- Total decommissioning of the mill equipment.
- Demolition of some process buildings.
- Long-term reinforcement of the mill tailings drainage tunnel.
- Relocation of the mine waste materials from the temporary storage areas.
- Obtaining all the necessary drawings.
- Continuation of the studies and investigations in the field.

8. DIFFICULTIES ENCOUNTERED OR ENVISIONED

Problems expected are the following:

- funding of the project activities in the field of mill tailings disposal and mine waste disposal remediation. These are demanding projects and require steady funding. When the activity is started it is difficult to stop without severe consequences;
- maintenance of the mill tailings surface to keep integrity of the tailings against erosion due to the storm fallout.

Part of the remediation works will be done by contractors in the future, because the skilled workers are leaving the company. The main reasons are limited personnel development and uncertain social status of the employees.

9. CONCLUSION

The delays due to poor funding and planning will make the whole project of Žirovski Vrh Uranium Mine remediation more expensive than it was expected. As side effects of delays problems arise due to lack of trained specialists, maintenance of the mine and mill structures, project and company management, last but not the least the public opinion, etc. Efficient remediation of the uranium production site is as important as the construction.

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