PART II

PILOT PROJECT

CHAPTER 4 PILOT PROJECT

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4.1 Objectives of the Pilot Project

The purpose of the Pilot Project (P/P) was to understand the situation of soil contamination of the P/P area and, at the same time, through on-job-training (OJT), to implement capacity development for management of soil contamination to governmental institution and local organisations. The results of the P/P study can be used as a case study for understanding the situation of the other similar mine areas in Macedonia.

4. 2 Content of the Pilot Project

The General Survey, Detailed Survey and Additional Survey, as shown in Table 4.1, were carried out in the P/P area. The study items and work achievements of the P/P are given below and in Table 4.1.

- Seminar concerning the P/P
- General Survey
    - Stage-1 soil survey: 400m grid soil survey
    - Stage-2 soil survey: 200m grid soil survey
    - River bottom sediments survey
    - Surface water survey
    - Drilling wells and monitoring of groundwater
    - Drilling survey in tailings dams
- Progress Report
- Second Workshop
- Detailed Survey
    - Stage-3 (1) soil survey: 100m grid soil survey
    - Stage-3 (2) soil survey: 50m grid soil survey
    - Crops Survey
    - 5m deep drilling survey
- Distribution map of heavy metal concentration
- GIS data construction work
- Compilation of survey results
- Action Plan
- Interim Report
- Third Workshop
- Additional Survey
    - Groundwater and surface water survey
    - Additional crop and soil survey

The field work of the P/P was carried out from late May 2006 to the middle of July 2007, and the chemical analyses were completed by end of July 2007.

4.3 Flow of the Pilot Project

The P/P was conducted following the flow chart shown in Figure 4.1

Prior to the commencement of the P/P study, a seminar was held on May 31, 2006. The P/P survey consisted of two separate surveys; General survey and Detailed survey. The former was conducted between late May to late September 2006 and the latter between early October to late December 2006. The results of P/P survey were analyzed and compiled from the middle of January to the middle of February 2007.

4.3.1 General Survey

The surface soil survey was conducted at four different grids of 400m, 200m, 100m and 50m grids by narrow down method, aiming at understanding of the situation of heavy metals concentration, cause and mechanism of soil contamination in the P/P Area. In the General Survey, 400m grid and 200m grid surveys of surface soil sampling were conducted and, in addition to them, river bottom sediments and surface water were collected from the typical streams of the P/P area. Further, drilling of monitoring wells and drilling of tailings dam were conducted during the General Survey.

(1) Surface Soil Survey: For understanding an outline of the heavy metal concentrations of the whole area of P/P Area, 400m grid sampling was, at first, conducted covering a whole area of the P/P Area. Based on the results of 400m grid soil survey, then, the 200m grid soil survey was conducted in the area of high heavy metal concentrations extracted by the 400m grid survey to narrow down the area of high heavy metal concentration.

(2) Tailings Survey：For understanding the chemical nature of the tailings materials of tailings dam, two drill holes, one each at the Old and the New Tailings Dams, were drilled.

(3) River bottom Sediments Survey: River bottom sediments were collected at 6 locations of the main stream of the Zletovska and Kiselica rivers for understanding the heavy metal concentration of the river bottom sediments.

(4) Surface water Survey: Surface water was collected at 6 locations same as the locations of river bottom sediments, for evaluation of the surface water in the P/P Area.

(5) Groundwater Monitoring: A total of 12 monitoring wells for monitoring groundwater were drilled in the potential area of the soil contamination to understand groundwater contamination. The monitoring of groundwater was conducted once in a month continuously for 6 months starting from August 2006 to January 2007.

Table 4.1 Works Completed for the Pilot Project

Stage of Survey		Survey Item		Approximate Amount: Number of Grid: Content Analysis	Approximate Amount: Number of Grid: Elution Analysis *1	Approximate Amount: Total	Unit	Remarks
Phase 1		Tailings (Tailings dam) and others		20	20	40	piece	Tailings, mineralized zone, etc.
Phase 1		Background survey		20	20	40	piece	Outside of P/P area：24 components
Phase 2	General Survey	Surface soil	400m grid	679	141	820	piece	Stage-1 Survey：10 components *2
			200m grid	536	54	590	piece	Stage-2 Survey（20% of Stage-1 area)
		Sediments		-	-	6	piece	Kiselica Rivers, Zletovska River
		Surface water		-	-	6	piece	Kiselica River, Zletovska River
		Groundwater	Drilling	-	-	12	hole	Kiselica River, Zletovska River: Total 135m
			Chemical analysis	-	-	72	piece	Chemical analysis：6 months × 12
		Tailings dam	Drilling	-	-	2	hole	Old TD: 40m, New TD: 28m *3
			Chemical analysis	36	36	72	piece	Old and New TDs
		Ground water		2	-	2	piece	Old and New TDs
	Detailed Survey	Surface soil	50m grid	800	80	880	piece	Stage-3 Survey
			100m grid	288	29	317	piece	Stage-3 Survey
		Deeper soil	Drilling	-	-	50	hole	5m deep/hole =240.5m
			Soil and sediments	400	40	440	piece	8 samples/hole
		Crops		-	-	104	piece	Wheat (84), Corn (16), Rice (4)
Phase 3	Additional Survey	Groundwater and surface water	Well water	-	-	95	piece	95 water wells
			River water	-	-	31	piece	36 of rivers and water springs
		Crop Survey *4	Wheat Crop	-	-	(32)	piece	32 wheat samples
			Soil	(32)	(32)	(64)	piece	Same location to wheat samples

*1: Conducted for 10% of Content Analysis samples except for 400m grid soil samples.

*2: Chemical analyses of 10 components were conducted for all the samples.

*3: TD: Tailings dam.

*4: Crop Survey were carried out by the Ministry of Agriculture, Forestry and Water Economy.

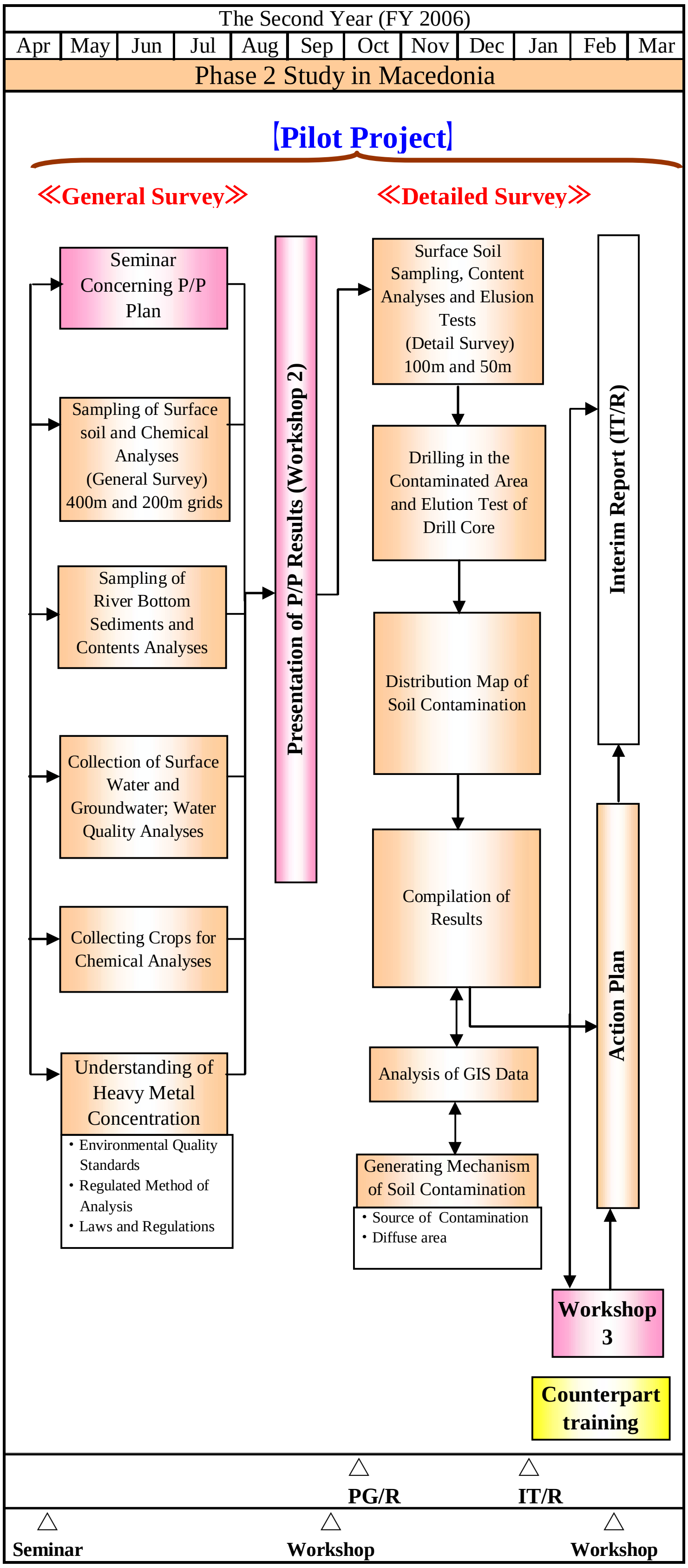


Figure 4.1 Flow Chart of Phase 2 of the Pilot Project

(6) Chemical analysis of Crops: On the basis of the environmental risk assessment for soil contamination by heavy metals related to mining, wheat, corn and rice were collected for chemical analysis.

4.3.2 Detailed Survey

In the Detailed Survey, 100m grid and 50m grid surveys of surface soil sampling were conducted and, in addition to them, the drilling survey of soil was conducted.

(1) Surface Soil Survey: Based on the results of the 400m grid and 200m grid survey, 100m grid survey was conducted mainly over the area of high heavy metal concentration of 400m grid in the highland area, while 50m grid survey was conducted over the area of high heavy metal concentration of 200m grids.

(2) Drilling Survey of Soil: Based on the results of general survey of P/P, the drilling survey of 5m deep was conducted over the area of high heavy metal concentration for the purposes of understanding the vertical profile of heavy metal concentration and defining causes of heavy metal enrichment.

4.3.3 Additional Survey

Based on the results of the Detailed Survey, the Additional Survey was conducted.in Phase 3 (2007).

(1) Additional Groundwater and Surface Water Survey: For further understanding of the heavy metal concentrations of groundwater and surface water in the P/P area, the additional survey of groundwater and surface water covering the whole area of the P/P was conducted.

(2) Crop Survey: Sampling and chemical analysis of 32 pairs of wheat samples and soil samples were conducted to examine yearly variation of Pb in wheat and the relations of Pb concentrations between wheat and soil.

4.3.4 Compilation Work

All the results of surveys of the P/P Area were complied and analyzed for understanding the nature and distribution of high heavy metal concentration in soil, sediments, groundwater and crops, and the mechanism of enrichment of heavy metals in the P/P area was considered.

4.4 Present Condition of the Pilot Project Area

The P/P Area is located in the Zletovica Basin in Probistip, covering the area of 201.5km^2.

4.4.1 Topography

The P/P area is topographically classified into areas of mountain, hill, terrace, flat plain and river plain. The mountainous area, with elevation of 700m to 1,000m, occupies the northern part of the P/P area, showing steep mountainous topography. The hills occur continuously from the mountains, stretching southward. In the area west of the Zletovska River, the hills are distributed being aligned in four parallel lines of the northwest-southeast direction. They show cuesta topography reflecting the distribution of the geological unit. The hills rise approximately 100m higher than the surrounding flat plain. Along the west side of the Zletovska River and southeast part of the area, the hills are partly covered by terrace plains on top.
Three terrace plains of upper, middle and lower plains are observed in the area. The upper terrace plains occur on the top of hills with flat plains of 500m high in the north and flat plains of 400m high in the south. The middle plain with elevation of 470m to 480m only occurs on the east side of the Zletovska River in the northwest of the area. The lower terrace occurs along both sides of Zletovska River, occupying the area of 200m to 1,500m wide. The lower terrace plain is 450m high in the north and 320m high in the south and it is 2m to 4m higher than alluvial river plain.

The alluvial river plain mainly occurs along the Zletovska River and in a small area of its tributaries.

4.4.2 Geology

The P/P area geologically belongs to the Kratovo-Zletovo volcanic area with a wide distribution of Tertiary volcanic rocks to which spatially and paragenetically mineral deposits are associated (Figure 4.2). The volcanic rocks are mainly Miocene and Pliocene of the Tertiary and Pleistocene of the Quaternary in age, and they consist of andesitic to dacitic lavas, dykes and pyroclastic rocks. The pyroclastic rocks are mainly volcanic breccia and tuff, and they are complicatedly distributed with intrusive rock such as porphyrite and lavas.

The Zletovo Mine area, located in the northeastern part of the P/P area, consists of Miocene ignimbrite (dacitic tuff and tuff breccia) and dacitic lava, such as latite, and they are intruded by dyke rocks.

In the other part of the P/P area, northwestern and southern parts, volcano-sedimentary sequences consisting of andesitic to dacitic pyroclatic rocks and sedimentary rocks occur trending in NW-SE direction. The ages of these rocks are Eocene, Miocene, Pliocene and Pleistocene, and they are partly covered by Pliocene andesite lavas. The distribution of NW-SE trending volcano-sedimentary sequences of Tertiary to Quaternary are reflected to the topographic feature, forming NW-SE trending hills in the area.

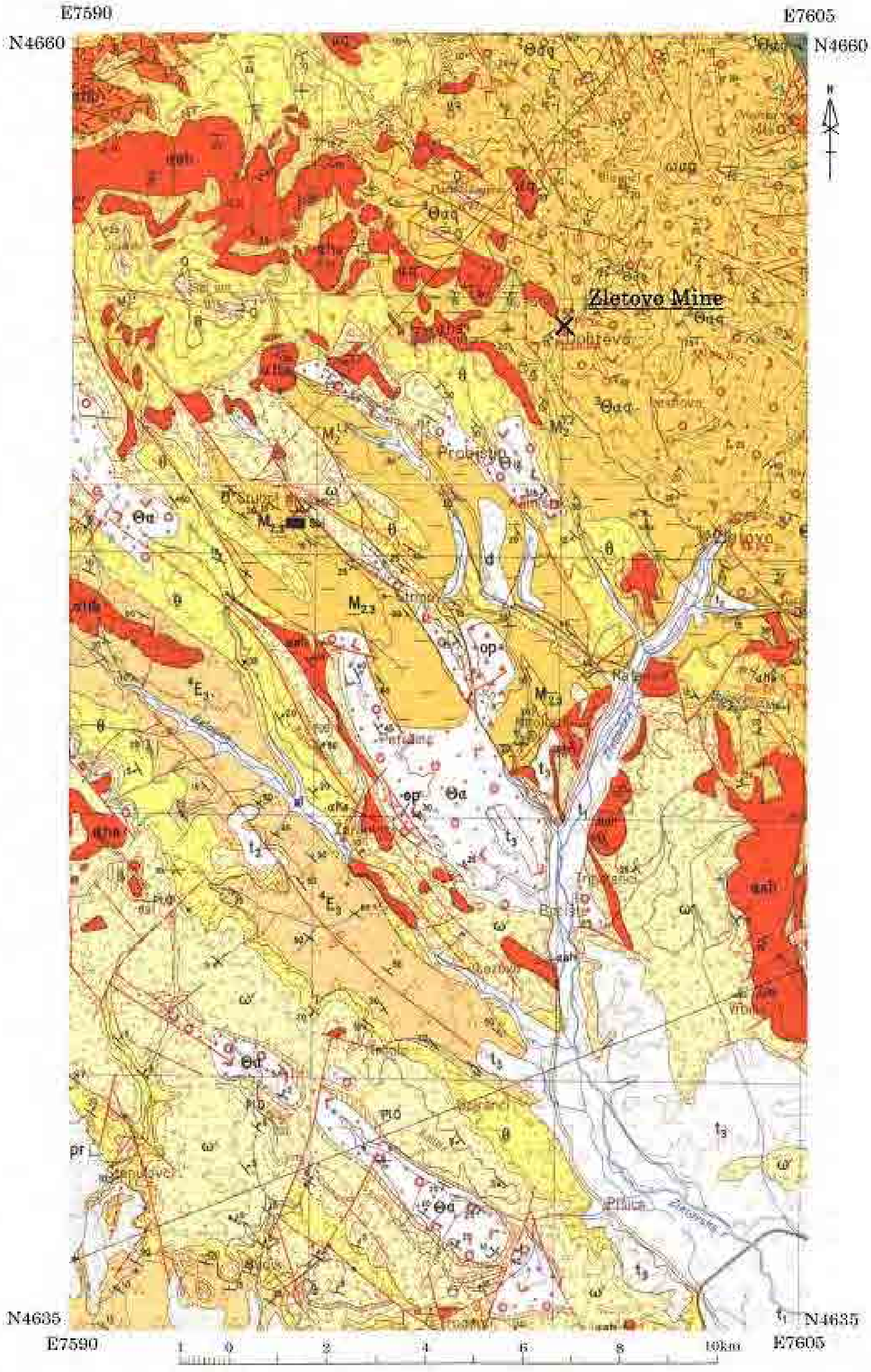


Figure 4.2 Geological Map of the Pilot Project Area

Legend of the Geological Map

Holocene

- Alluvium
- Lower terrace
- Upper terrace
- Diluvium
- Proluvium
- Old river terrace

Pleistocene

- Hydrothermal quartz
- Oppal breccia
- Andesite tuff
- Hornblende augite andesite
- Andesite ignimbrite
- Tuffaceous carbonate rock

Pliocene

- Dacitoid
- Augite hornblende biotite andesite
- Andesite breccia
- Hornblende augite biotite andesite
- Andesite tuff

Miocene

- Marl, tuffaceous sand and clay
- Marl, tuffaceous sand and bitominous clay
- Breccia of dacite composition
- Pale greenish gray ignimbrite of dacite composition
- Grayish pink ignimbrite of dacite composition
- Dark gray ignimbrite of dacite composition

Eocene

- Upper zone of flysch, clay, sand and othres

4.4.3 Hydrology

All the rivers in the P/P area belong to the Zletovska River system, which starts from the north near the Bulgarian border and flows north to south in the eastern part of the P/P area before reaching to Bregalnica River (Figure 4.3). The main rivers in the P/P area, other than the Zletovska River, are Koritnica River, Kiselica River and Belocica River, and all of them flow into the Zletovska River from the west.

The Zletovo Mine is located in the upstream area of Koritnica River and the tailings dam is located along a tributary of Kiserica River. There is no significant river system observed to the east of the Zletovska River. The planned irrigation areas of the Zletovica Basin Water Utilisation Improvement Project are located in the area of the Zletovska, Kiserica and Belocica Rivers.

4.4.4 Land Use and Vegetation

Conifer forest and shrub cover the northern part of the mountainous area of the P/P area (Figure 4.4). The areas between mountain and hills are used for pastures for sheep and cattle.

Vineyard and orchard are mainly found in the area of topographic turning point between mountain-hills and hills-flat plains. In the orchard, mostly apple and pear are grown and partly sour cherry, plum and walnut are observed. The agriculture land is, partly, observed on the hills, but the hills are mainly occupied by pasture land and shrub. Agriculture land, mostly used for cultivation of wheat, occupies part of the hills and flat areas between the hills. Idle farmland, cultivated in the past and planed to be cultivated in the future, is observed in the southwest part of the area.

Rice used to be widely cultivated in the lower terrace area along the Zletovska River, but because of the low market price of rice, the areas were gradually transferred to corn and wheat fields. In some places, partitions of rice fields still remain in the area and different crops are cultivated each year depending on situation.

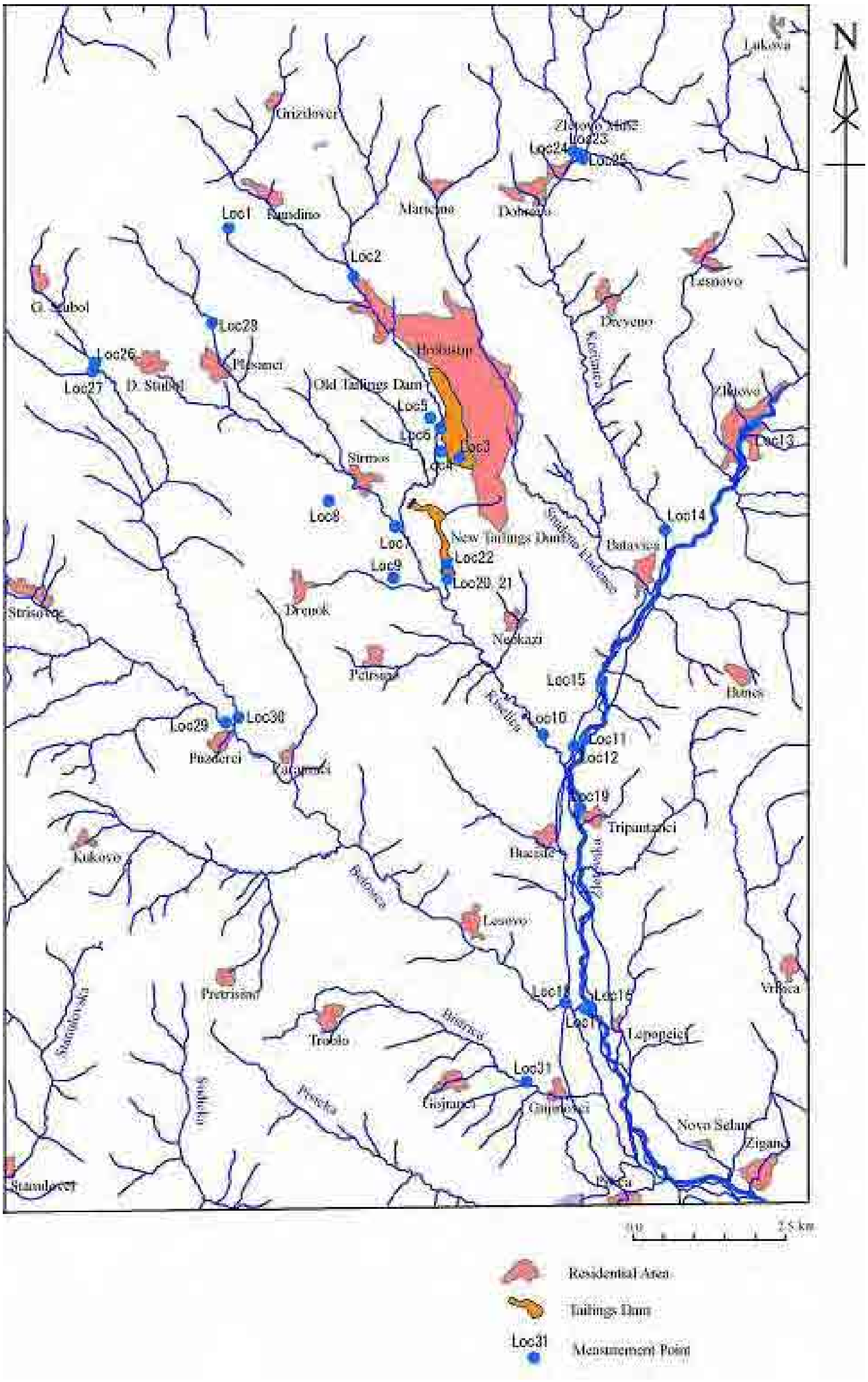


Figure 4.3 Hydrology and Distribution of Residential Areas of the Pilot Project Area

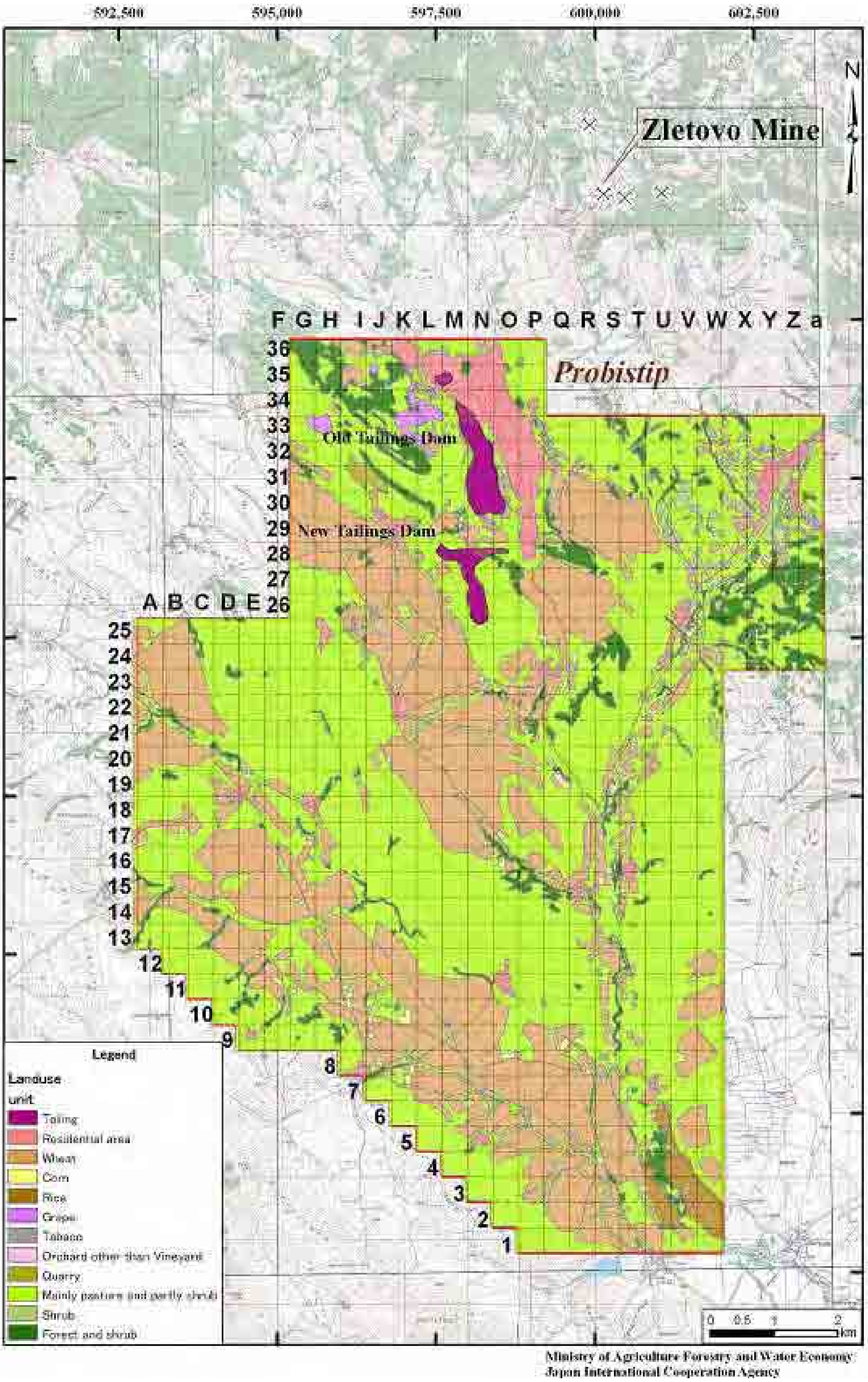


Figure 4.4 Land Use and Distribution of Crops in the Pilot Project Area

4.4.5 Agriculture in Probistip

Agricultural production is currently very important to the local economy in Probistip. The climate in Probistip is suitable for arable crops, in particular wheat. Table 4.2 shows the agricultural production in Probistip Municipality in 2005. As shown in the table, the main agriculture products of Probistip are wheat and barley in addition to some vegetables and fruits.

Table 4.2 Agricultural Production in Probistip in 2005

Type of Agriculture	Surface Area (ha)	Production (kg/ha)	Total Production (kg)
Wheat	2,700	3,000	8,100,000
Barley	1,300	2,900	3,770,000
Corn	380	2,000	760,000
Other plants	50	2,500	125,000
Potatoes	80	10,000	800,000
Beans	50	1,000	50,000
Watermelon	40	8,000	320,000
Other gardening cultures	110	-	150,000
Barley	100	1,000	100,000

Source: Agro-economical aspects of agriculture in Probistip Municipality (2006).
(Diploma work by the Faculty of Agricultural Science and Food, University of Skopje)

4.4.6 Water Use

The majority of the drinking water supply for people in Probistip and nearby villages is taken from 35 groundwater wells (7m to 9.5m deep) between Ratavica and Drac. From the pumping station in Ratavica, the water is pumped up to a holding tank near Probistip, treated with chlorine, and supplied to Probistip townsite and many surrounding villages (Neokazi, Petrsino, Strmos, Plesenci, Maricino, Dobrevo and Dolni Stubol). Several of these villages are downstream of the tailings dam, but most of their water supply is taken from groundwater at Ratavica - Drac. Figure 4.5 shows the water supply systems.

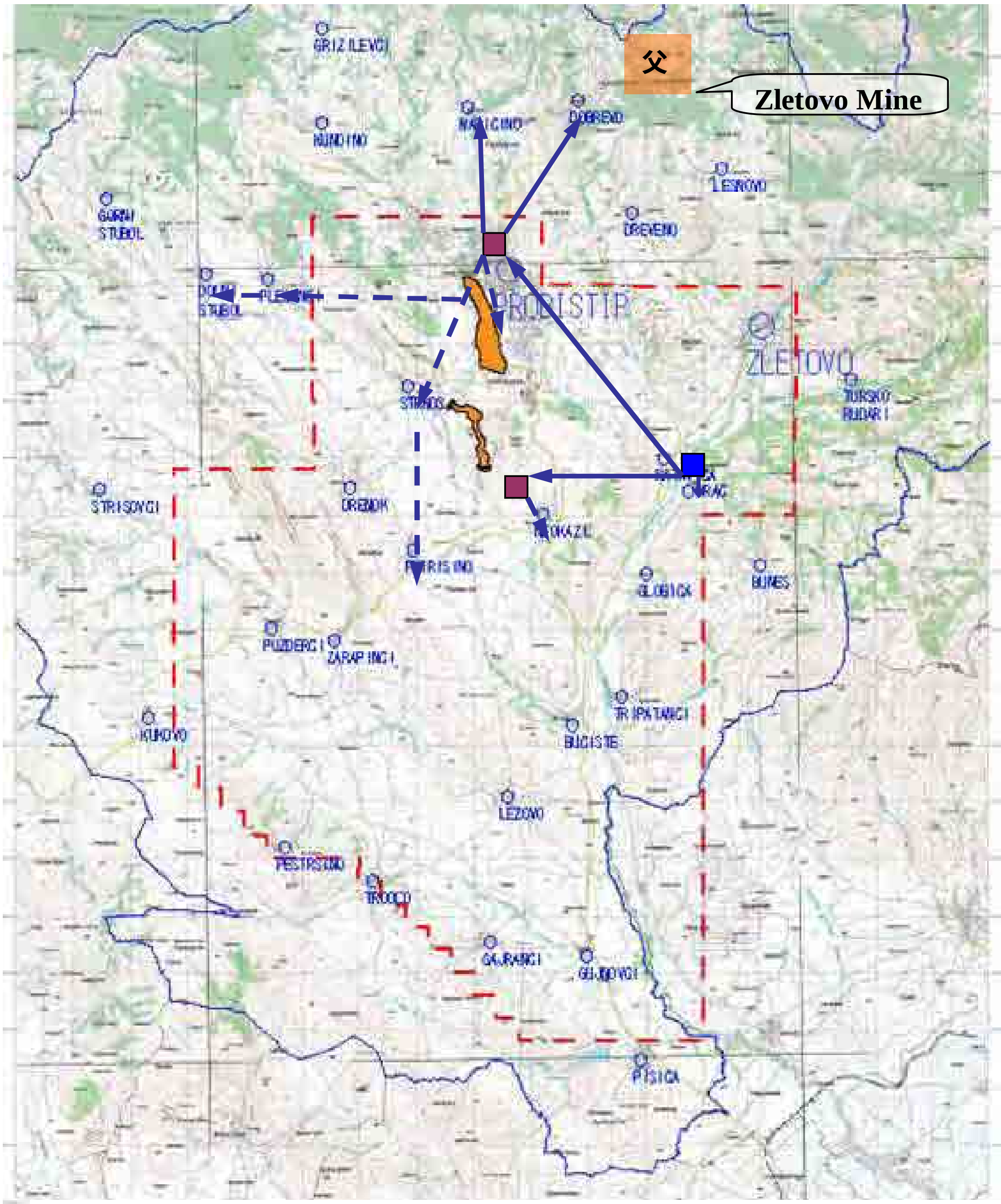
Several of the households, farms and businesses in Probistip and other villages that are supplied by the Municipal Water Company also have their own private groundwater wells, but these are mainly used for irrigation purposes for vegetables and crops. In the villages that are not supplied by the Municipal Water Company, the community uses water from springs and groundwater wells for drinking water and irrigation. It is estimated that approximately 25% of households in Probistip have their own groundwater wells, although it is reported that a higher proportion of houses have wells in Zletovo and some villages.

The depth of the private groundwater wells varies depending on the groundwater levels, and typically are 5m to 10m deep. For example, in Ratavica, the private wells are 7 to12m deep, but in Tripitanci there is a shared well that has a depth of 4 to 5m.

4.4.7 Irrigation

Irrigation is a major problem for agricultural activities in the Probistip area and the construction of the multipurpose regional Hydro-System "Zletovica" (HSZ) presents positive opportunities to improve the agricultural production in Probistip through improved irrigation.

Apart from the fields near to the Zletovska River, the main irrigation water for crops comes from private groundwater wells, particularly for the large number of small farms and households that grow their own crops and vegetables. In addition at Pisica and surrounding areas in the south of the P/P area, there is some irrigation from the reservoir that was constructed in 1976.



Pumping Station and holding tank of Probistip Municipal Water Supply Company
Route of pumped water by Probistip Municipal Water Supply Company
Reservoir tank of Probistip Municipal Water Supply Company
Route of water supply by gravity by Probistip Municipal Water Supply Company

Figure 4.5 Locations of Towns and Villages in Probistip Municipality and Water Supply by Probistip Municipal Water Supply Company

4.4.8 Socio-economic situation

The town of Probistip, including the surrounding villages in an area of rural agricultural land, is an example of the social challenges in Macedonia at present. Probistip Municipality has a population of about 16,200 within about 329km^2. The municipal boundary includes the town of Zletovo, as well as the main town of Probistip. The population of Probistip town is about 10,800.

The growth of Probistip increased with the development of the lead/zinc mines (Zletovo) from the 1950s, as well as a large battery factory. Infrastructure development and population expansion gradually transformed Probistip into a town with one of the strongest local economies in Macedonia.

However, from the late 1970s the Municipality has suffered from economic crisis and lack of demand for the mining products, and the challenges have continued through the period when Macedonia has developed as an independent country. The battery factory is currently running at a very low capacity and many small enterprises that depended on the mining and battery industry have been affected.

There are many small villages in the area, but most have a lack of modern infrastructure in terms of water supply, electricity, etc. Agriculture has recently been the most important sector for Probistip Municipality. Crops such as wheat, corn, rice, numerous types of fruit, and tobacco, are grown, and there is some livestock.

Although the socio-economic situation in Probistip Municipality is difficult, the re-opening of the Zletovo mine is starting to have a positive social impact on the area of Probistip, with increased employment and related service needs. The construction of the multi-purpose regional hydro system (Zletovica), and the P/P on soil contamination are positive opportunities to greatly improve the social, economic and environmental situation in Probistip.

4.4.9 Tailings Dams and Spill Incidents

(1) The Zletovo Mine

The Zletovo Mine is located in the mountainous area, 5km northwest of town of Zletovo and 3.5km northeast of town of Probistip. The main production of the mine is lead and zinc by underground mining, and mining facilities mainly consist of mine adits and mine office in the mining site, tunnel between the mine site and processing plant (at Probistip) for transportation of crude ore, main office and processing plant in Probistip, and tailings dams located in the south of Probistip.

(2) History of the Zletovo Mine

The main events and production of the Zletovo Mine are compiled in Table 4.3. The first mining activities in the Zletovo (Probistip) area were registered even before Roman age. Actual mining evidence and relicts in the area also existed after the Roman age.

In 1926, the Pasic family from Serbia had been owner of the Kratovo-Zletovo Mines, having the concession of exploitation of the mines. In 1928, they sold it to an English company, Selection Trust Limited, and in 1938, all the concession were transferred to the newly established company, Zletovo Mine Limited. The company had commenced systematic surveying from 1929 to 1934 and had constructed the facilities for exploitation and processing of the ore from 1935 to 1941 in Probistip. Actual exploitation of the mine had started after occupation by the Germans in 1941. According to some unofficial data, the production quantity until September 1944 was 70,000t of lead from 130,000t of crude ore.

After the Second World War, normal production was resumed in 1945. At that time, the population of Probistip was 500 people, and then in 1952, Probistip became a municipality.

Table 4.3 History of the Zletovo Mine

Year	History
Roman age	Mining evidence and relicts in the area: Caves, wastes, etc.
1926	Pasic family (Serbian) had been owner of the Kratovo-Zletovo Mines.
1928	English mining company bought Zletovo Mine.
1929 - 1934	Enforcement of exploration in the mine area.
1938	Newly established company was established for operating mining.
1935 - 1941	Mining facilities for exploitation and processing were constructed. In Probistip
1941 - 1944	Mine was occupied by the Germans and produced 70,000t of Pb
1945 - 1952	Mining operation was restarted in 1945. Annual production: 20,205t in 1949, and 203,235t in 1952 as crude ore.
1953 - 1968	Annual production: 200,000t to 280,000t as crude ore.
1971 - 1972	New facilities and equipments were installed.
1973 - 1976	Spill accidents of tailings in Old Tailings Dam: (TD-IV) 290,000m^3 (150,000t).
1976 - 1986	Restoration of broken dams and re-piling by tailings at Dam-IV and V.
1987 - 2003	New Tailings Dam started to pile from 1987.
2003	Mine was closed.
2006 -	INDO Minerals and Metals has started to re-operate Zletovo Mine.

The annual production of ore in 1945 was 20,205t, and in 1949 it reached 203,235t. In the next five years, the annual production maintained the same level as in 1949, and the annual production had increased 2% in each year between 1958 and 1968.

From the beginning of production in 1945 until 1988, a total of 12,623,859t of crude ore has been excavated and a total concentrate of 968,276t of lead and 338,236t of zinc had been produced, according to the detailed research in 1988.

In 1971 and 1972, new facilities and equipment, including a tunnel for transportation of crude ore from the mine site to the processing plant instead of the cable transportation system, were installed in the production process, which resulted with increase of annual production from 280,000t (1968) to 470,000t (1978) in the following years.

During the 1990s the economy of Macedonia also significantly declined by the collapse of former Yugoslavian market and local confcts and further, after 2000, Macedonian's lead-zinc mining and industry faced contamination-related closures, raw material shortages and financial difficulties. In March 2003, the Government decided to close the Zletovo smelter/refinery and chemicals facilities.

In December 2006, over one year after buying Zletovo Mine, INDO Minerals and Metals has started to re-operate the mine and processing plants.

(3) Tailing Dams of the Zletovo Mine

a. Oldest Tailings Dam (TD-I) between 1928 and 1944

It was necessary to construct tailings dam by piling the tailings that occurred by processing the concentrate from crude ore. The tailings that occurred by the operation between 1928 and 1944 were piled at the small tailings dam (TD-I) located at the northwestern side of the processing plant as shown in Figure 4.6.

TD-I dam was constructed by the inter piling method of flat type (Table 4.4 and Figure 4.7). The volume of the oldest tailings is approximately 150,000m^3.

At present, the Oldest Tailings Dams are used as two soccer pitches, consisting of main pitch and sub-pitch. The surface of soccer pitches are covered by 1.10m thick of uncontaminated soil and grass, but a part of surface in and around the TD-I has been confirmed to have a high concentration of heavy metals, and tailings on the side slope of the tailings dam can be directly observed, exposed by local erosion with seepage water. Old tailings still contain very high concentrations of heavy metals including Pb, Zn, Cd, Cu and Mn.

b. Old Tailings Dams (TD-II, III, and IV) between 1945 and 1970s

After the Second World War, the mining operation had re-started from 1945. Although the mining production in 1945 was only 20,205t (as crude ore), the annual production had rapidly increased, and had reached 278,950t in 1968.

The tailing dams (TD-II and III) were newly constructed at the left-bank side along the Kiselica River, located adjacent to the south western part of Probistip town site as shown in Figure 4.6.

TD-II and TD-III dams were constructed by inter piling method of flat type. The volume of the tailings in TD-II and III is approximately 100,000m^3 and 750,000m^3, respectively (Table 4.4).

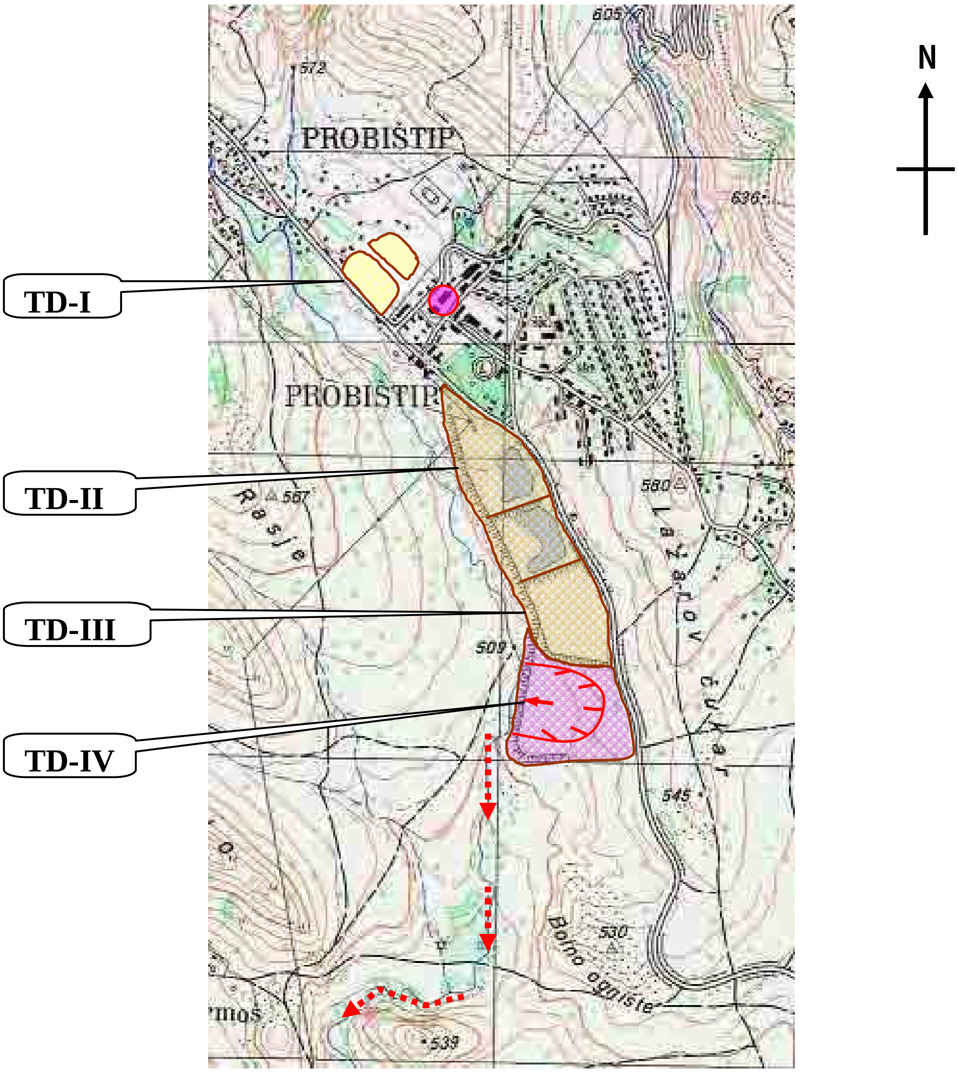
At present, TD-II and TD-III areas are covered by soil and surplus soils of construction in thickness of 2 to 2.5m conducted by Probistip City and MAFWE. In particular, TD-II area is reused by electric sub-station, garage, etc., and TD-III area is also re-planted by trees managed by Probistip City and MAFWE. However, a part of surface soil in TD-II and TD-III areas are confirmed to have high concentration of heavy metals due to affection from the bear surface of tailings dams such as TD-IV and TD-V.

After renovation (1971 to 1972) of mining facilities and equipment for increasing production, the tailings also were increased and newly piled at the south part of TD-IV as shown in Figure 4.6.

The tailings were piled in the shape like a trapezium, being 300m to 400m wide, 300m to 400m long and about 22m high in maximum, as shown in Figure 4.8. TD-IV dam was also constructed by inter piling method of flat type. The volume of the tailings in TD-VI is thought to be approximately 900,000m^3 (Table 4.4).

In 1976, the collapse of the tailings dam occurred in TD-IV as shown in Figures 4.6 and 4.8, and tailings of about 290,000m^3 were spilled away to the lower stream areas of Kiselica and Zletovska Rivers. However, the tailings spill-out was re-calculated to about 290,000m^3 according the "Report on Zletovo Tailings Dam Spill Accident" (Zletovo Mine, 1979).

Although the cause of collapse of TD-IV was not clarified at that time, the main possible causes are assumed to be 1) the retaining dike of TD-IV was too weak against unstable tailings materials due to loose piling of materials and/or poor design of dams, 2) pore water pressure in the dam had increased due to inadequate drainage of including water of tailings, seepage water and groundwater, 3) foot of the retaining dike of TD-IV was in a location where it could be easily eroded by the Kiselica River and 4) others.



(Taken from Topographic map produced by Cardinal Authority, 1971)

0 0.5 km

Tailings dam (TD-I) constructed between 1928 and 1944

Tailings dam (TD-II & III) constructed between 1945 and 1970s

Tailings dam (TD-IV) constructed between 1970 (?) and 1976

Collapse and spill of tailings

Processing plant

Figure 4.6 Construction of Tailings Dams between 1928 and 1973

Table 4.4 Tailings Dams in Probistip

Tailings Dam (TD)	Location	Type	Volume (m^3)	Remarks
TD-I	Northwest of processing plant	Flat*1/IP*2	150,000	Used as succor pitches
TD-II	Left river side along Kiselica River	Flat/IP	100,000	
TD-III	Left river side along Kiselica River	Flat/IP	750,000	
TD-IV	Left river side along Kiselica River	Flat/IP	900,000	Collapsed
TD-V	Left river side along Kiselica River	Flat/IP	1,100,000	
New TD	Lower part of Kiselica River	Valley*3/IP	-	Re-started to operate

*1: Flat type tailings dam: Retaining dikes of tailing dam has 2 ~ 4 faces as shown in Figure 4.7 (1).

*2: Internal piling method of tailings: as shown in Figure 4.7 (3).

*3: Valley type tailings dam: Constructing in the valley as shown in Figure 4.7..

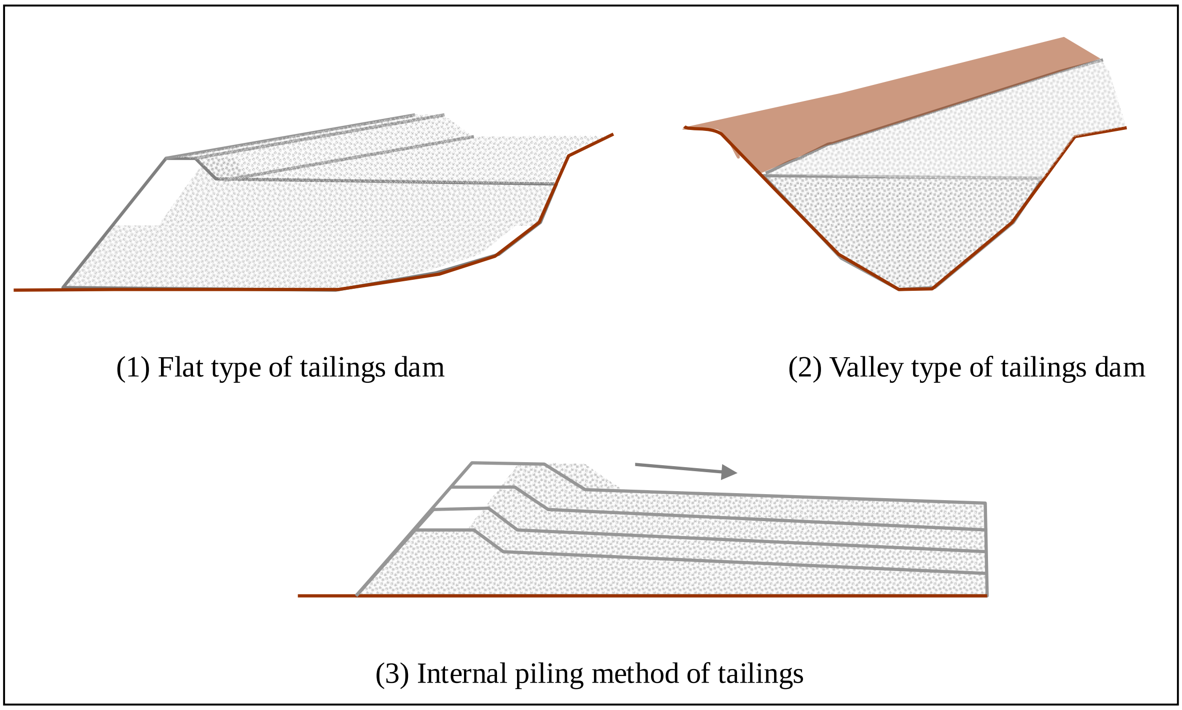


Figure 4.7 Piling Type of Tailings Dams

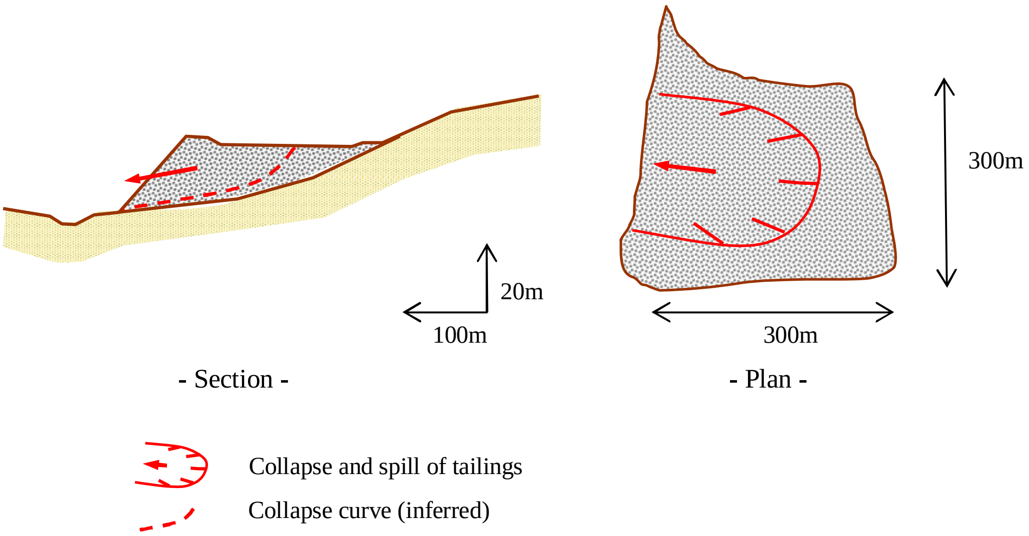


Figure 4.8 TD-IV Tailings Dam and Collapse of Tailings

The restoration of collapsed dam (TD-IV) was enforced using new tailings generated after the incident as well as piling tailings in TD-V as shown in Figure 4.9. However, no measures have been taken against the soil and water contamination in the lower stream of the Kiselica and Zletovska Rivers.

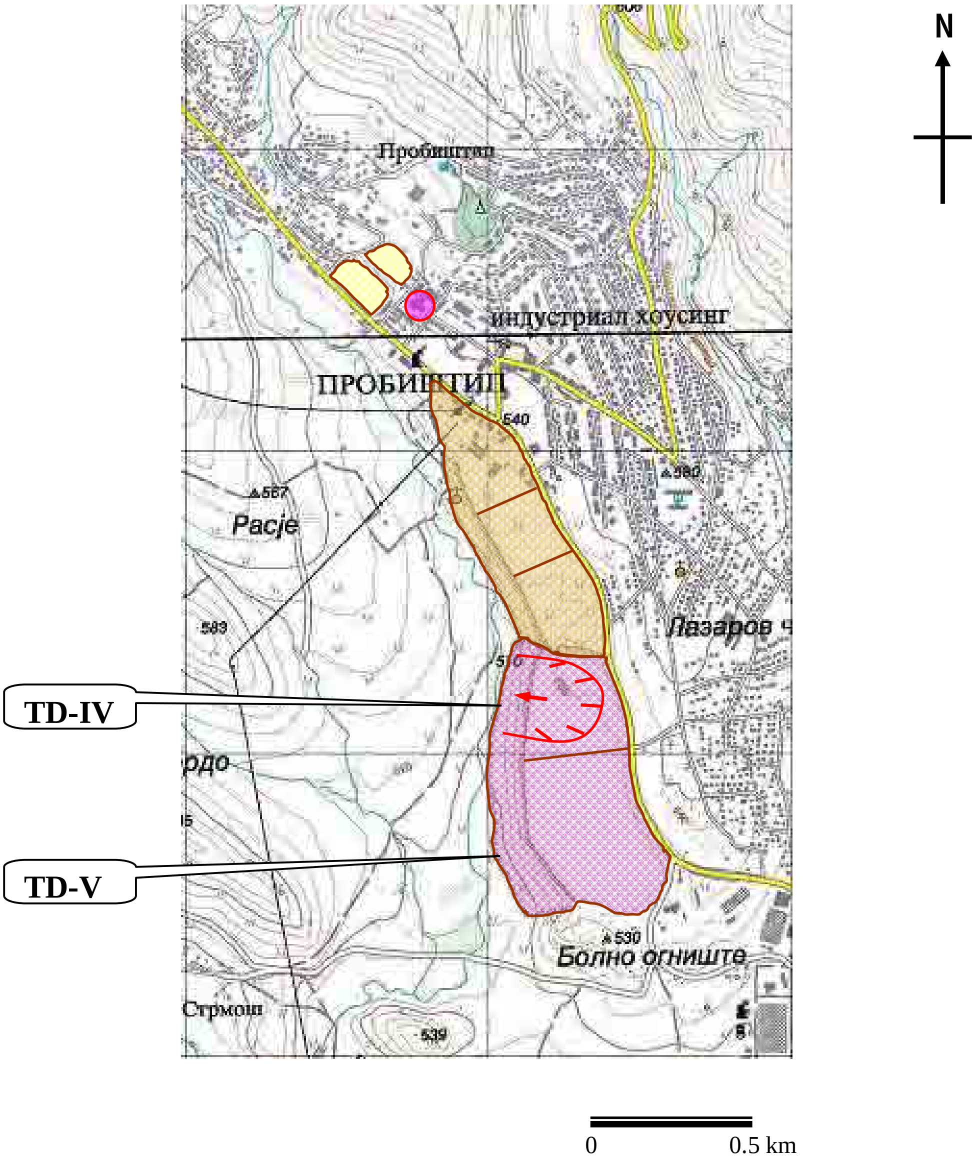
c. Old Tailings Dams (TD-V) between 1976 and 1986

The restoration of collapsed dam (TD-IV) and piling tailings in TD-V were conducted between 1976 and 1986. The annual production of crude ore of the mine had reached to 470,000t in 1978.

TD-V dam were also constructed by inter piling method of flat type, and the volume of the tailings of TD-V is thought to be approximately 1,100,000m^3 as shown in Table 4.4.

Presently, the TD-IV and V areas remain with bare tailings surface except along the road of the eastern side of the area, which is locally covered by surplus soils of construction and demolition wastes in thickness of 1 to 2.5m.

(Drainage system)
In the Old Tailings Dams of TD-II to TD-V, several culverts were installed in the dams for the drainage of internal water and seepage water consisting of rainfall water and groundwater derived from outside of the dams. Presently, however, it is thought that they are not functioning due to collapse, and some places of strong acidic seepage are found on the slopes of dikes, but they are a small quantity of discharge.



Tailings dam (TD-I) constructed between 1928 and 1944

Tailings dams (TD-II & III) constructed between 1945 and 1970s

Tailings dam (TD-IV & V) repaired and constructed between 1976 and 1986

Collapse and spill of tailings

Processing plant

Figure 4.9 Construction of Tailings Dams between 1974 and 1986

d. New Tailings Dam after 1987

The New Tailings Dam was constructed in the lower part of the Kiselica River and is located 1.5km south of the Old Tailings Dams as shown in Figure 4.10, and tailings started to pile from 1987.

The New Tailings Dam is also constructed by inter piling method of valley type as shown in Table 4.4 and Figure 4.10.

(4) Spill Incident and its Impacts

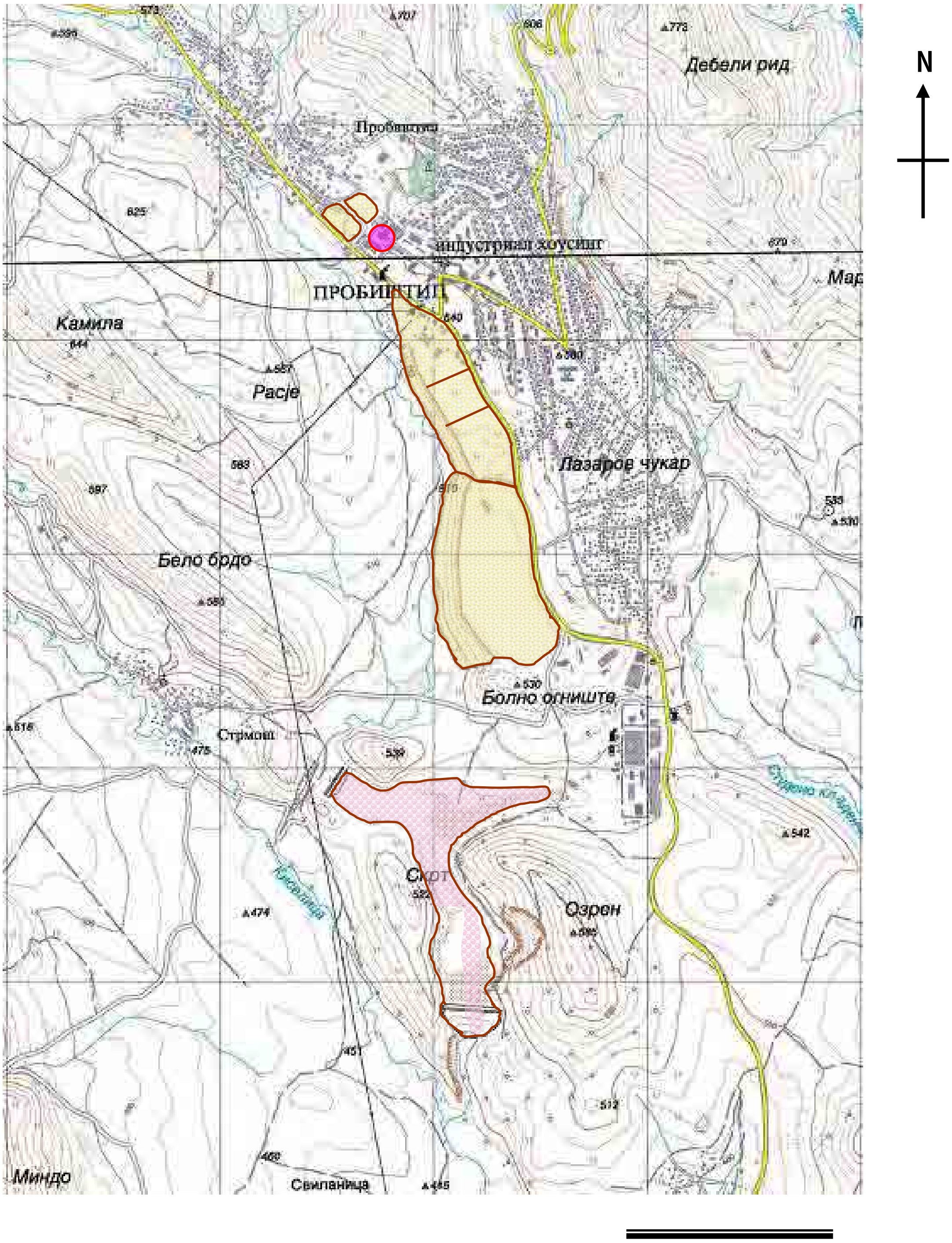
There are some reports from the local community about small tailings collapses occurring at different times in the last 40 years, and these small amounts of tailings were transported down the valley. However, the main tailings collapse occurred in 1976 and much tailings material was spilled downstream along the valley of Kiselica River.

The movement of tailings down the valley has been described as a rolling flow of tailings material. There were no human deaths as a result of the collapse, but several agricultural livestock (e.g. cattle) were lost.

There are varying reports regarding the depth of the tailings residues that covered parts of the valley in the days after the collapse, and this would of course depend on the width of the valley. In Tripitanci (located in the valley 8km south of Probistip), the tailings in the valley reached 2 to 3m deep. Further south in Pisica (14km south of Probistip), the depth of tailings was 15cm.

At the bridge over the Kiselica River (in between Buciste and Neokazi), the tailings had blocked the channel under the bridge and built up against the bridge, so that the tailings were even pushed across the road. The tailings visibly remained around the bridge for 3 to 4 years.

In 2007, there are still a few visible signs of residues in the valley and there are also varying reports about the time taken for the majority of the tailings residues to be washed away. During the first year after the tailings collapse the mining company used bulldozers to remove tailings from the river and from private land. However, it is believed that most of these removed tailings were simply placed on nearby municipal land. Over the following years, much of the tailings residues were washed away by natural processes (e.g. rain water and surface run-off). It is apparent that the majority of the tailings residues were washed away within 1 to 4 years, although under the topsoil some tailings material can still be seen around Buciste, and the P/P survey had observed evidence of residual tailings in the area.



Old Tailings Dams constructed between 1928 and 1945

Old Tailings Dams constructed between 1945 and 1986

New Tailings Dam started to pile since 1987

Processing plant

Figure 4.10 Construction of Tailings Dams after 1987

In the Zletovica Valley, several areas have been affected in terms of agricultural production. Just to the south of the P/P area, the village of Pisica (14km south of Probistip) reportedly was not able to grow crops in several nearby areas for 3 years after the collapse, and even after 3 years, many crops had a poor yield. After the incident the local community was instructed to move livestock away from the area of contamination.

Further up the valley, the impacts on crop production were worse. For example, in Tripitanci (about 8km from Probistip), the local farmers tried to change the types of crops that they grow on the land that was affected, but even today some land does not yield agricultural crops in economical quantities, and there are a few concerns of the local community about the contamination of the crops.

In Strmos and Neokazi, which are villages nearer the tailings dams, the situation is even worse and the local community report that no plants or trees will grow on certain areas of land. Neokazi, in particular, has been impacted and continues to be affected (Strmos village is itself uphill from the tailings dam, but some areas of cultivated land down the valley near Strmos, which are farmed by people from Strmos, were greatly affected.).

Generally, there is an apparent lack of awareness of the farming community in the Zletovica River valley, in relation to the possible impacts of potentially contaminated soil. However, it is probable also, that the priority for these poorer members of the local community is to grow crops in order to gain an income or simply to have food for their families, and the fact that the crops could be contaminated is likely to be a low priority for them.

None of the people interviewed remembered any visible health impacts as a result of the tailings collapse.