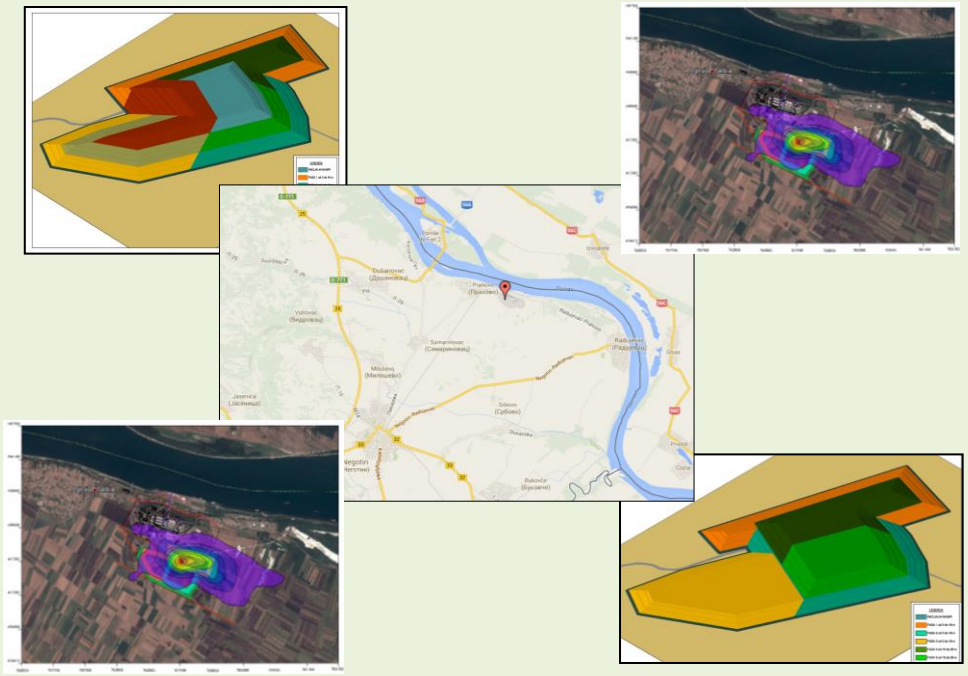
ELIXIR PRAHOVO, INDUSTRIJA HEMIJSKIH PROIZVODA DOO, PRAHOVO

SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY ON THE PHOSPHOGYPSUM STORAGE



Beograd, Mart 2015

University of Belgrade, Faculty of Mining and Geology

ELIXIR PRAHOVO INDUSTRIJA
HEMIJSKIH PROIZVODA DOO PRAHOVO

SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY ON THE PHOSPHOGYPSUM STORAGE

Study prepared by:

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Belgrade, March 2015

ELIXIR PRAHOVO INDUSTRIJA HEMIJSKIH PROIZVODA DOO PRAHOVO

Elixir Prahovo
Industrija hemijskih proizvoda
Delovodni broj: 189
Datum: 12.03.2015
Elixir Prahovo
Prahovo 19330, Radujevački put bb

SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY ON THE PHOSPHOGYPSUM STORAGE

Date: March, *2015.*

Manager

Strahinja Golubović

Elixir Prahovo
Industrija hemijskih proizvoda
Elixir Prahovo DOO Prahovo
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SUMMARY OF THE ENVIRONMENTAL IMPACT ASSESSMENT STUDY ON THE PHOSPHOGYPSUM STORAGE

1. INTRODUCTION

ELIXIR PRAHOVO INDUSTRY OF CHEMICAL PRODUCTS LTD PRAHOVO is a large chemical complex which used to be well-known for production and processing of phosphorous components, manufacturing of washing and cleaning products, fluorine chemistry, manufacturing of water purification agents, plant protection products, production of fodder additives and phosphorous salts. However, this company had always been recognized for production of mineral fertilizers and phosphoric acid.

The consortium formed by University of Belgrade Faculty of Mining and Geology and University of Belgrade Faculty of Civil Engineering developed the conceptual design of the phosphogypsum storage for ELIXIR PRAHOVO INDUSTRY OF CHEMICAL PRODUCTS LTD Prahovo.

The subject of this document is the Environmental Impact Assessment Study on the Phosphogypsum Storage, for which Ministry of Energy, Development and Environmental Protection of the Republic of Serbia prescribed scope and content of the study with Decision No. 353-02-511/2014-05 of 10.04.2014.

2. PROPONENT DETAILS

Organisation	Elixir Prahovo Industrija hemijskih proizvoda **ELIXIR PRAHOVO INDUSTRIJA HEMIJSKIH PROIZVODA DOOPRAHOVO**
Name of individual	Manager Strahinja Golubović
Address	Radujevački put bb, 19330 Prahovo, Serbia
Phone	+381 19 543 991
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E-mail	office@elixirprahovo.rs
Company identification number	07309783
Tax Identification Number	100777129
Description of activity code	Production of fertilizers and nitrogen compounds

3. DESCRIPTION OF THE LOCATION PLANNED FOR PROJECT IMPLEMENTATION

Physical characteristics and geographic location

Prahovo is located in Negotinska Krajina in the peripheral northeastern part of Serbia. It is a village in Municipality of Negotin, County of Bor. The geographic location of Negotinska Krajina and, consequently, of Prahovo is important because of proximity of the Danube River. The fundamental regional attribute is its location on the banks of the Danube, the border region toward the Republic of Romania and proximity of the state border toward the Republic of Bulgaria. The local attribute of Prahovo is defined with its central position in relation to villages: Radujevac, Samarinovac and Dušanovac. Prahovo is an industrial settlement of a compact type located 9 km from Negotin. It is situated, approximately, at +60 masl, on the right bank of the Danube River. The railway and modern road connects it with larger towns. It occupies an area of 1,957 ha.

The company "Elixir Prahovo Industry of Chemical Products Ltd Prahovo" is situated near the bank of the Danube River, by the Prahovo port, in Cadastral Municipality Prahovo. Apart from road and rail transport the proximity of the port also provides, inland waterway transport for the complex.

The chemical complex in Prahovo occupies around 135 ha, i.e. 95 parcels, of which 13 is partially occupied, while the remaining number is fully occupied. The largest part of the area occupies the industrial complex Elixir Prahovo Ltd. Prahovo, which is located at the Cadastral parcel No. 2300. The remaining occupied parcels are for the purpose of accessory facilities of the complex Elixir Prahovo Ltd. Prahovo.

The location of the complex Elixir Prahovo Ltd. Prahovo (Fig.1) can be positioned in relation to the following benchmarks:

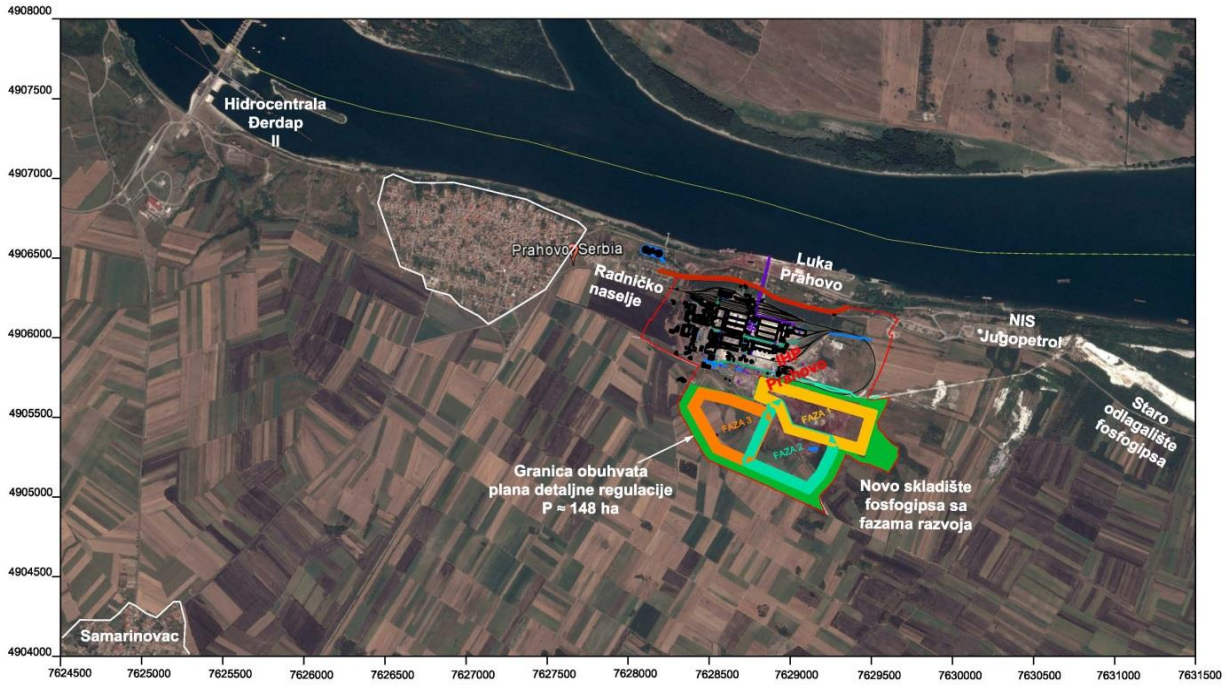

Fig.1 Industrial complex Elixir Prahovo Ltd. Prahovo with the location of the new phosphogypsum storage

- workers settlement (a small group of residential facilities) adjacent to the complex boundary in the western direction;

- The Prahovo port, at the distance of around 200 m in the northern direction;
- NIS Jugopetrol – the fuel and oil warehouse, at the distance of around 1 km in the eastern direction;
- the Prahovo village, at the distance of around 1 km in the western direction;
- HPP Djerdap II, at the distance of around 3 km in the western direction;
- the phosphogypsum disposal site, on the river bank, at the distance of around 2 km in the eastern direction, with around 8 million tons of phosphogypsum from the period before privatization;
- the village Radujevac, at the distance of around 5 km in the southeastern direction and the village Samarinovac, at the distance of around 10 km in the southwestern direction;
- the capital Belgrade, at the distance of around 260 km.

As a part of this Study the environmental impact assessment of the new phosphogypsum storage has been conducted at the entire location which the investor plans to purchase and assign for the new storage. Fig.1 shows the designed location of the new phosphogypsum storage. The total area which occupy the cassettes of the new phosphogypsum storage is 46.5 ha.

Soil characteristics

Pedological characteristics, i.e. soil types which are formed in the certain area are one of the most important factors for origination of vegetation (autochthonous or grown species). With a mutual impact of natural factors in the process of paedogenesis in the certain area occurs formation of various soil types and subtypes. Landscape, geological structure of the foundation and climate conditions crucially influence their spatial distribution. Such soils formed from lithosphere differentiate for their fertility, i.e. their potential for successful growth of plants which use water and nutrients. The following types of soil occur in Negotinska Krajina: alluvial soils (fluvisol), vertisols, chernozem (marsh dark soil; meadow black land).

Geomorphological characteristics of the terrain

One of the specific characteristics of each facility is the morphology of terrain in which the facility is located. Morphologically, the terrain is plain with elevation differences of up to 20 m. The highest elevations in the wider area of the industrial complex Elixir Prahovo Ltd. Prahovo are located in the village Prahovo (64 masl). The lowest elevation of the analyzed terrain is located on the bank of the Danube River (34 masl). The lowest elevation of the phosphogypsum storage will be the elevation of the lower level of disposal site, which is planned at +46 m.

Geological characteristics

From the aspect of regional geology, Prahovo is located within a wide valley called "Negotinska Krajina", which represents the part of the so-called area Carpatho-Balcanica**.** The company Elixir Prahovo Ltd. Prahovo was built on the Quaternary sediments of the river terrace of Pleistocene age, formed under impact of the Danube River. The observed area is virtually levelled (medium elevation ≈ 51 masl). The data on geological characteristics at the location of Elixir Prahovo Ltd. Prahovo are obtained on the basis of the Serbian basic geological map, as well as on the basis of data obtained by the previous conducted shallow exploration works at the location of the company.

Geological characteristics at the location of Elixir Prahovo Ltd. Prahovo are:

- Terrain surface – humified clay, of thickness 0.5-1.5 m;
- Loess and loess dust and clay with $CaCO_3$ concretions of average thickness which range 3.0-5.0 m;

- Clayey sand of average thickness of 1.0-3.5 m;
- Gravel which thickness is up to 4.0 m;
- Lacustrine gravel, sand and marls of thickness from 20 to 60 m;
- Pliocene (PI) sand and clays with sandstone partings of thickness over 150 m.

The shallow aquifer is directly affected and hydraulically connected with the Danube River. The level of groundwater in the Prahovo area is most frequently located deeper than 10 m, below the surface level. These waters are not scooped for water supply. The direction of groundwater flow is conditioned with the Danube River, i.e. toward the river during the regime of low waters or toward the hinterland during period of high water. The aquifer is fed with infiltration of surface water of the Danube River and from the hinterland as well as with discharges and seeping from production processes at the location. The shallow aquifer is drained into the Danube River (during the period of low water) as well as with seepage into the deeper aquifer.

Water supply sources

Deeper aquifer is used for the water supply of the wider area.

It has been planned to provide the supply of drinking water for the location of Elixir Prahovo Ltd from the water source "Barbaroš". The water source "Barbaroš" provides one third of the water requirements of the town Negotin. 1,400,000 cubic meters of water was pumped out from the water source "Barbaroš" during 2002. The minimal yield of the water source "Barbaroš" was around 30 l/s. The positive effects have been achieved with the regulated lowering of the level by averages of vertical drilled wells so that the minimal yield has been increased to around 75 l/s.

The technical conditions for connection to the PVC Ø 225 mm piping system exist at the location. The existing installations for sanitary water are in poor condition and its reconstruction and replacement with the pipes of suitable material resistant to environmental impacts is required. It has been planned a full reconstruction of the pipeline system and its construction to the required locations in the complex.

Seismologic characteristics

According to the seismic map of Serbia for the return period of 100 years, in the area of Prahovo can be expected the maximum earthquake of 8 degrees of Mercalli intensity scale.

Climate characteristics

Microclimatic peculiarities of the observed area are most frequently defined with dominant northwest and south winds, lower average temperatures (≈10 ^{o}C) and proximity of aquatorium which conditions higher air humidity.

The area of Negotin is characterized with typical continental climate with average annual temperature between 11 and 12 ^{o}C, the lowest temperatures in January and the highest in the period July-August. The annual temperature amplitude is ≤ 23.0 ^{o}C, and over 50% of annual total precipitation occur in half of the year with summer. Duration of the drought periods is significantly longer than duration of rainy periods.

Flora and fauna and protected natural assets

Negotinska Krajina is located in the utmost eastern part of the country. It occupies the area of over 100,000 ha, of which forests and forest soil occupy 32,200 ha, meadows 22,800 ha and cultivated fields 41,000 ha. The landscape consists of three separate entireties: Negotin's

lowland, hilly plateaus and highland relief which consists of mountain ranges Deli Jovan and Miroč. The elevations range from 32 to 546 masl. Those natural and ecological characteristics, as well as rich and diverse flora and fauna created ideal conditions for breeding and development of all kinds of quarry.

The Municipality of Negotin is characterized with fertile soils suitable for agricultural production. The agricultural soils occupy around 65% of the municipal territory, while dominate cultivated fields, and then pastures and surfaces under vineyards and orchards.

There are several hunting grounds in the territory of the Municipality of Negotin in which are represented the following animal species: wild boar, deer, mouflon, doe, rabbit, pheasant, field partridge, wild duck, turtle dove, quail, wild pigeon, wolf, jackal, fox, wild cat and marten which can also be encountered in this area.

The bird fauna is rich and diverse. It has been recorded presence of numerous species: auks, grebes, pelicans, waterfowls, cranes, marsh hens, woodcocks and gulls. Furthermore, in the vicinity of Djerdap there is the colony of small cormorants and of great cormorants, and there is also present little egret, gray heron, white and black stork. It has also been recorded the presence of a large number of ducks (mallards, widgeons, common teals, common pochards) and ten thousands of coots. Raptors are also well represented, but some of them are very rare such as: black kite, white-tailed eagle, Great Nicobar serpent eagle, lesser spotted eagle, golden eagle, etc.

In the area of the village Prahovo and its surrounding a diverse flora of autochthons or introduced character is formed and it is a result of corresponding natural conditions. Plant species characteristic for settlements are represented in Prahovo itself, while agricultural land is in the surrounding. That is understandable considering a traditional character of this region.

Coastal vegetation grows near the Danube River since there is plenty of moisture in soil. In the immediate surrounding fragmented forests (groves) can be also observed.

Landscape

From a topographic aspect, the terrain is plain with elevation differences of up to 20 m. The highest elevations in the wider area of the industrial complex Elixir Prahovo Ltd. Prahovo is located in the village Prahovo (64 masl). The lowest elevation of the analyzed terrain in located on the bank of the Danube River (34 masl). The lowest elevation of the phosphogypsum storage will be the elevation of the lower level of disposal site, which is planned at +46 m.

Cultural property

Cultural and historical monuments with a special protection from the Republic Institute for Protection of Cultural Monuments are not recorded in the wider area of the investigated deposit.

Population, concentration of residents and demographic characteristics

According to the results of 2011 census in the Municipality of Negotin, in 39 populated settlements and 13,906 households lives slightly more than 37,000 residents, i.e. 17,826 men and 19,230 women. Out of that number, 16,882 residents live in the town of Negotin , while other settlements have from 150 to 1500 residents. The larger villages are Bukovača, Vidrovac, Dušanovac, Jabukovac, Kobišnica, Plavna, Prahovo, Urovica and Štubik.

Prahovo is an industrial settlement of a compact type. It occupies the area of 1,957 ha. According to the census of 2011, the number of residents was 1,197, i.e. 577 men and 619

women. The total number of households is 434, while the average number of residents per household is 2.76. Mainly Serbs (93.29%) live in Prahovo, while the minority includes Vlachs, Romanians, Montenegrins, Gypsies and Croats. The average age of residents is 47.7.

Prahovo is the industrial settlement located 9 km from Negotin, i.e. 260 km southeast from Belgrade.

Existing infrastructure

The fundamental regional attribute is its location on the banks of the Danube, the border region toward the Republic of Romania and proximity of the state border toward the Republic of Bulgaria. The local attribute of Prahovo is defined with its central position in relation to villages: Radujevac, Samarinovac and Dušanovac.

A single-track railway Niš-Zaječar-Prahovo passes along the periphery of the area. The Port of Prahovo is located on the right bank of the Danube River and represents the last port in the territory of the Republic of Serbia. It is connected with roads and railways with other parts of the Republic of Serbia.

The local and regional road network connects Prahovo via Negotin with Bor, Majdanpek, Kladovo and the border crossings Vidin toward the Republic of Bulgaria and Djerdap toward the Republic of Romania.

The infrastructural facilities also include a certain number of electric power and telecommunication facilities of a broader socio-economic importance, among which stand out, first of all, a substantial number of 110/10 kV and 10/0.4 kV substations as well as optical fiber cables.

4. PROJECT DESCRIPTION

Phosphogypsum is separated as a by-product during production of phosphoric acid. The quantities of phosphogypsum are 3-6 times higher than quantities of acid which is produced as a main product. According to its properties phosphogypsum is similar to other gypsums industrially produced (ODG-gypsum from desulphurization of exhaust gases, citro gypsum from production of citric acid, etc.), with minor differences in relation to natural gypsum. Its applicability in industry and construction trade is well known. The issue related to the application is connected with produced quantities since they exceed by manifold quantities which can be applied in industry during the same period.

At present, Elixir Group Ltd uses the old phosphogypsum storage (Fig. 2), formed almost 50 years ago at the site located around 2.4 km from the factory. The old storage is formed on the terrace above the Danube River and occupies around 54 hectares, whilst the level of hydrotechnical regulation of the area corresponds to standards applied in 1960s. Its regulation and upgrading to the currently required legal and technical level is complicated and unprofitable. Because of that Elixir Group Ltd has started works on the establishment of a new storage at the more favorable location. The new site is more favorable since it is closer to the factory.

Description of previous works on the project implementation

The first step in the storage formation is cleaning of the humus layer. After that leveling of the terrain to the elevation of storage's bottom planned at 46 masl is to be performed. The next

anticipated stage is the cassettes development, including construction of: embankment, access road and perimeter canal. After levelling and regulation of the cassette's bottom at 46.5 masl it is anticipated regulation of the cassette's bottom, what implies development of the mineral barrier of 0.5 m thickness, for the cassette's bottom stabilization. High density polyethylene liner (HDPE 1.5 mm) is placed on this layer in order to prevent percolation from the storage into groundwater. It is anticipated construction of drainage system on the cassette's bottom for reception of water percolated through the storage.

Fig.2 The location of the old phosphogypsum storage

Description of facilities and technology of the phosphogypsum storage development

The phosphogypsum storage will be developed in stages. From the aspect of the occupied surface, utilization will unfold in 3 stages, and in relation to the occupied volume in 8 stages. The first three stages implies occupation of the entire planned surface and overbuilding to elevation +18 m, while the following three stages include overbuilding to height of 36 m. The seventh and eighth stage include overbuilding to the final height of 50 m. Within the each stage operation is organized in several cassettes, 2 or 3. 15 cassettes will be formed.

The cassettes are formed in order to establish operational regime in which: one cassette is operational (there is performed storage of phosphogypsum); one cassette serves as a backup (it is prepared for reception of phosphogypsum and from there it dispatches phosphogypsum for the market), while one cassette is out of use (it is drained in order to enable overbuilding or extraction of phosphogypsum for the market). Table 1 shows the schedule of combined cassettes utilization.

The formation and utilization dynamics is developed for the most disadvantageous scenario when all quantities have to be stored since phosphogypsum cannot be sold on the market. If the investor provides sale of phosphogypsum developed dynamic is being changed and after "cleaning" of one cassette stockpiling is being done again in that empty space instead of activation of new cassettes. Figure 3 shows the facilities locations with stage development of the phosphogypsum storage.

Table 1: Schedule of combined cassettes utilization

Cassette	Overbuilding height, m													
1/1	3	3	3	6	6	6	9	9	9	12	12	12	15	15
1/2	0	3	3	3	6	6	6	9	9	9	12	12	12	15
1/3	0	0	3	3	3	6	6	6	9	9	9	12	12	12
2/1	-	-	-	-	-	-	-	-	-	-	-	-	0	0

Cassette	Overbuilding height, m												
1/1	15	15	15	15	15	18	18	18	18	18	18	18	18
1/2	12	15	15	15	15	15	15	15	18	18	18	18	18
1/3	12	12	15	15	15	15	15	15	15	15	15	18	18
2/1	0	0	0	3	3	3	6	6	6	9	9	9	12
2/2	-	0	0	0	3	3	3	6	6	6	9	9	9
3/1	-	-	-	-	-	-	-	-	-	-	-	-	0

Cassette	Overbuilding height, m												
1/1	18	18	18	18	18	18	18	18	18	18	18	18	18
1/2	18	18	18	18	18	18	18	18	18	18	18	18	18
1/3	18	18	18	18	18	18	18	18	18	18	18	18	18
2/1	12	12	12	15	15	15	15	18	18	18	18	18	18
2/2	9	12	12	12	15	15	15	15	15	15	18	18	18
3/1	0	0	3	3	3	3	6	6	6	9	9	9	12
3/2	-	-	-	-	0	3	3	3	6	6	6	9	9
4/1	-	-	-	-	-	-	-	-	-	-	-	-	18

Cassette	Overbuilding height, m																
3/1	12	12	12	15	15	15	18	18	18	18	18	18	18	18	18	18	18
3/2	9	12	12	12	15	15	15	18	18	18	18	18	18	18	18	18	18
4/1	18	18	21	21	21	24	24	24	24	24	24	24	27	27	27	27	30
4/2	-	-	-	-	-	-	18	18	21	24	24	24	24	27	27	27	27
5/1	-	-	-	-	-	-	-	-	18	18	21	21	21	21	24	24	24
6/1	-	-	-	-	-	-	-	-	-	18	18	21	21	21	21	24	24

Cassette	Overbuilding height, m																
4/1	30	30	30	33	36	36	36	36	36	36	36	36	36	36	36	36	36
4/2	30	30	30	30	33	33	33	36	36	36	36	36	36	36	36	36	36
5/1	24	27	27	27	27	30	30	30	33	33	33	36	36	36	36	36	36
6/1	24	24	27	27	27	27	30	30	30	33	33	33	36	36	36	36	36
7/1									36	36	39	39	39	42	42	42	45
7/2														36	39	39	39
8/1															36	39	39

Cassette	Overbuilding height, m														
7/1	45	45	45	48	48	48	50	50	50	50	50	50	50	50	Recultivation
7/2	42	42	42	42	45	45	45	48	48	48	50	50	50	50	
8/1	39	42	42	42	42	45	45	45	48	48	48	50	50	50	
8/2	21	21	24	24	24	24	27	27	27	30	30	30	33	33	Back-up

Note: Active cassette is marked with green color the, the back-up cassette with yellow cassette that is drained, with red, while with blue color the stage which is completed. The back-up cassette implies construction of peripheral embankments after drainage, but its elevation is not provided in this table.

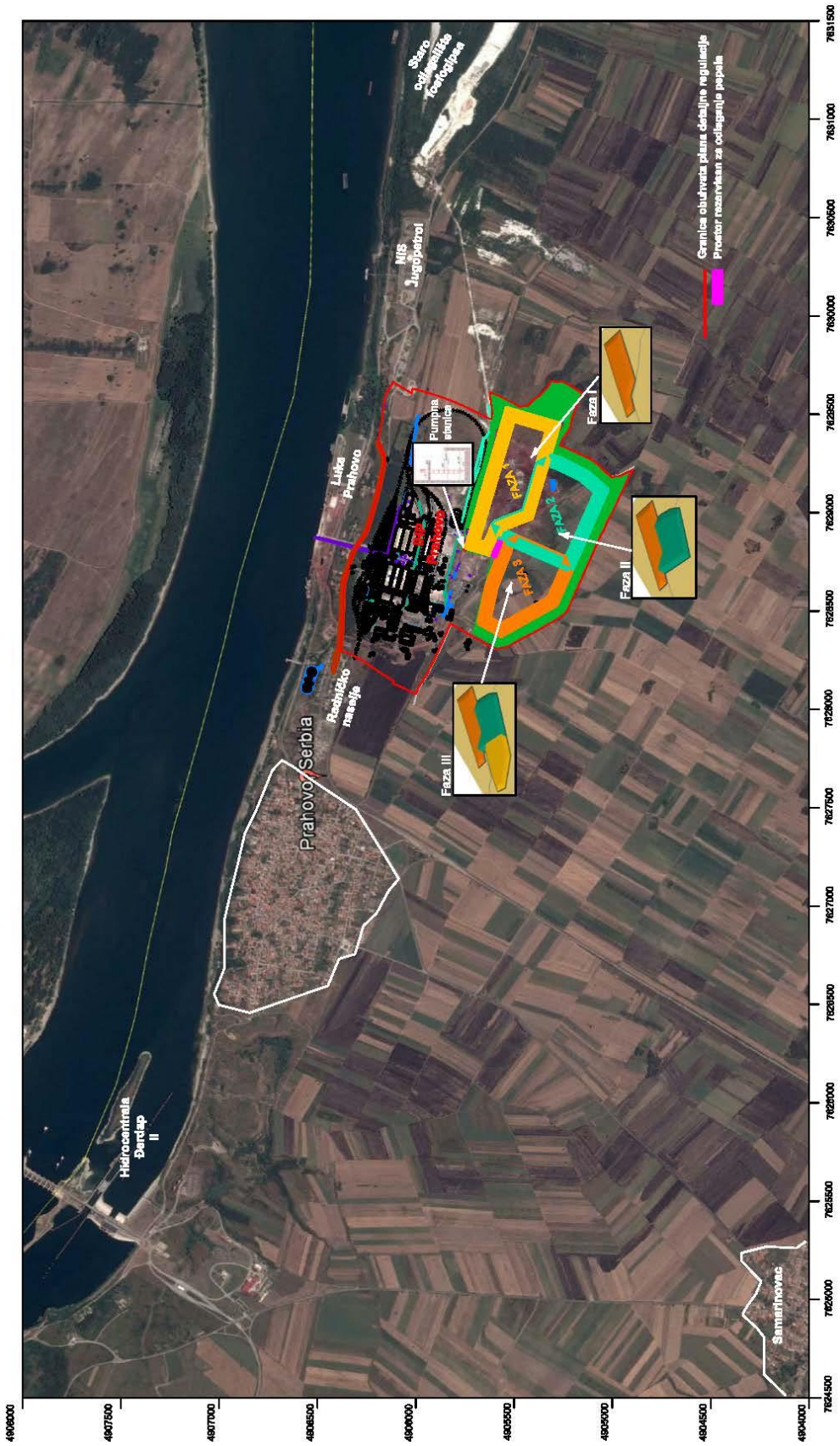

Fig.3 The facilities locations with stage development of the phosphogypsum storage

The estimate is provided for the annual production of phosphogypsum of 350,000 t and the required storage space of 485.000 m^3. Thus, considering per stages they last from 1.6 years to 5.4 years, i.e. in the entire occupied area the storage in which can be stored the entire quantity of phosphogypsum can be developed, without sale or increase of capacity in the period of 24-29 years. Figure 4 shows the final outline of the stage development of the phosphogypsum storage (8 stages).

At the storage phosphogypsum is disposed in form of suspension, mixture of water and phosphogypsum. Natural deposition of phosphogypsum particles under gravity force occurs after discharge. Due to particle`s small density and size deposition will be slow and it will be performed in the regime of congested deposition. The settling pond will be simultaneously formed. It will serve as a temporary retention area for clarification of water before it is returned to the factory.

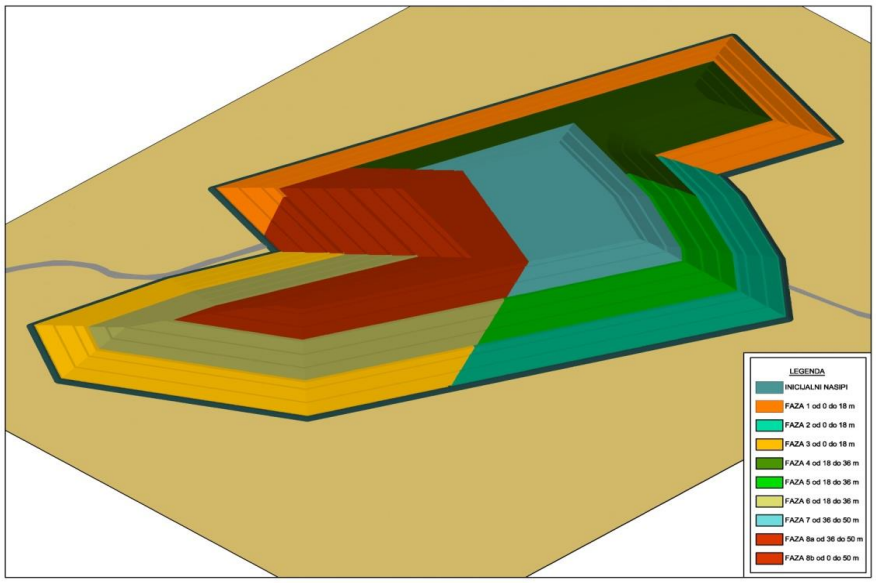

Fig.4 The development scheme of phosphogypsum storage in Stage 8

5. MAIN ALTERNATIVES TAKEN INTO CONSIDERATION

There is no dilemma during the storage planning and designing connected with existence or non-existence of the storage since domestic and foreign practice shown that sale of phosphogypsum, as a secondary raw material, is seasonal and, therefore, the storage is necessary.

The alternatives which are taken into considerations are issues related to:

- the form in which phosphogypsum will be delivered to the storage (dry or wet); and
- the location of the future phosphogypsum storage.

6. REVIEW OF ENVIRONMENTAL CONDITIONS AT THE LOCATION

Residents

When speaking of the residents and project impact on them it is first of all thought about socioeconomic aspect of that impact. The former experiences indicated that the only socioeconomic aspect was the one which always has, to certain extent and conditions, some benefits form the project development. It is another issue whether this benefit is always in accordance with the expectations of the community members, but nevertheless it is evident. In this case, a subjective character of realized benefit is far more pronounced than with other environmental aspects. Therefore it is difficult to achieve consensus regarding the issue of the project impact on residents, concerning the scope but also disadvantage of its impact.

As for the village Prahovo, according to the data obtained from the previous censuses it is evident that during the period 1961-2011 trend of decreasing population is permanently present. The other issue of this small community is ageing population. The average age of residents is 47.4 years, while the group of people aged 60-64 is the most numerous.

Flora and fauna

As for flora and fauna it is of utmost importance from the aspect of each project the fact that in the particular location are not recorded rare or protected species of flora and fauna, which could have a significant impact on scope and realization of the project.

Furthermore, regarding possibility and scope of a potential impact of the project on flora and fauna it ought to be underlined that this project mainly occupies devastated area, i.e. devastated agricultural land. The chemical industrial complex in Prahovo covers the area of around 135 ha, i.e. 95 parcels, of which 13 is partially occupied, while the remaining number is fully occupied. The largest part of the area occupies the industrial complex Elixir Prahovo Ltd. Prahovo. The remaining occupied parcels are in the function of accessory facilities of the complex Elixir Prahovo Ltd. Prahovo. The utilization of new agricultural land is anticipated only for a smaller part.

Scope and type of degradation depend on the source of degradation, i.e. whether it is plant itself, accessory facilities, pyrite burns dump and likewise. However, the fact is that the existing flora and fauna in the immediate surrounding is adjusted to great extent to the conditions of changed natural habitat.

Soil

The company INTERGEO Environmental Technology conducted, among other things, detailed soil investigation for requirements of the definition of existing environmental conditions. The results of those investigations demonstrated that there is contamination at several locations due to exceeding of normal values. On the basis of the analysis of the results related to the soil quality it has been ascertained that remedial values are exceed for a certain number of parameters and it is also ascertained low pH value for soil with one sample, while with 13 samples is detected increased natural radioactivity, and at several locations are detected high values of fluorides, sulphates, nitrates and phosphates (they are not standardized).

The similar investigations, with the objective to define the existing environmental conditions in the chemical complex Prahovo, were conducted during 2012 by City Institute for Public

Health, Belgrade. Works on installing 3 piezometers were performed for requirements of the investigation of the existing environmental conditions.

The laboratory analysis was used to test soil samples for most significant parameters of possible soil contamination in accordance with the represented technological processes and activity in this complex. The following parameters related to soil quality are investigated: pH value, moisture content (%), incineration loss, total phosphorous, sulphate, total nitrogen, fluorine, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls **(**PCB)**,** total hydrocarbons (C10-C40), nitrophen and metals (Hg, Cd, As, Pb, Zn, Cu, Ni, total Cr, Mo and V).

On the basis of the expert processing of the results obtained by the soil investigation from the surface layer it has been ascertained the following:

- In the large number of soil samples it have been ascertained that limits are exceeded by some of the investigated parameters, according to the Regulation;
- The most frequently, deviation is related to existence of the content of some of heavy metals and total hydrocarbons (C10-C40), which are exceeded the remedial value at several locations;
- the presence of pesticide in increased concentrations (location No.4 in front of the nitrophen storehouse) has been ascertained in one soil sample. The nitrophen content in that sample is over 100 mg/kg, which is very high value;
- Concentrations of total nitrogen, total phosphates and sulphates reached very high values at some locations, albeit those values are not standardized;
- Soil`s pH value is mostly compromised at the location behind the sulphuric acid reservoir, where it is 2.1 pH;
- The significant concentrations of polycyclic aromatic hydrocarbons (PAH) are recorded only at two locations, i.e. the locations 4 and 8;
- In the investigated samples presence of polychlorinated biphenyls **(**PCB) and mercury has not been recorded, and generally observing the most significant contamination of the surface layer within the complex is recorded at the location No.4 To be more specific in front of the nitrophen storehouse between the concrete plateau and the railway, where have been ascertained the highest concentrations (in comparison to the all investigated samples) of a larger number of parameters: cadmium, zinc, arsenic, fluorine, polycyclic aromatic hydrocarbons (PAH), total hydrocarbons (C10-C40) and nitrophen. Besides, it is also recorded high content of lead, copper, chrome and phosphate (the second place in comparison to the values from the other locations).

On the basis of the results of soil investigations from the drilled material it has been ascertained the following:

- In a certain number of soil samples, limit values are exceeded for some of investigated parameters prescribed by the Regulation on the programme of the systematic monitoring of soil quality, indicators for risk estimate for soil degradation and methodology of development of remedial programme;
- Most frequently, the deviation is related to the increase of content of some heavy metals (nickel and vanadium in 8 samples, copper and cadmium in 2 samples) and total hydrocarbons (C10-C40 in 7 samples), which concentration at no locations have exceeded the remedial value;
- The concentration of total nitrogen, total phosphates and sulphates reached high concentrations, albeit they are not standardized;
- Soil pH value ranges from 6.6 to 6.9, which are characteristics for a normal soil composition.

Water

Physical and chemical analyses of groundwaters, surface waters and waste waters were conducted during the period 2008-2013 in order to define the quality of water within the holding of IHP Prahovo. They are presented in:

- The Study "Extended Environmental Investigations at Holding IHP AD Prahovo, Fertilizer Factory, Serbia" (INTERGEO Environmental Technology, 2008);
- The Study of Existing Environmental at Holding IHP AD Prahovo (Institute of Public Health, Beograd, 2012);
- The Draft "Strategic Estimate of Environmental Impact – the Plan of detailed regulation for the holding of chemical industry in Prahovo" (Company for Engineering, Consulting, Designing and Construction "SET" Ltd. Šabac, 2013).

As a part of investigation of environmental factors, the company INTERGEO Environmental Technology conducted physical, chemical analyses of 16 groundwater samples during 2008. On the basis of those analyses it has been ascertained that remedial values or limit values are exceeded with some samples for the certain number of parameters. The groundwater samples have pH values between 5.6 and 7.6, and only 3 samples had pH value below the limit pH value of 6.5. It has also been ascertained an increased concentration of fluorides, sulphates and nitrates in some samples, while the concentration of total phosphorous ranged from 1-500 mg/l.

According to the obtained results those groundwater samples do not exceed remedial values standardized by the Regulation on the pollutant limit values in surface waters and groundwater and sediments and deadlines for their reaching (OJ of the RoS, No. 50/2012).
City Institute of Public Health, Beograd also conducted the investigations of groundwater during 2012. It was performed sampling of groundwater from the installed piezometers in order to define water quality. The physical, chemical analysis of three obtained samples included the following parameters: temperatures, oxygen saturation, dissolved oxygen, pH value, electrical conductivity, dried remains, biochemical oxygen demand (BOD), ammonium, nitrates, chlorides, orthophosphates, total phosphate, sulphates, fluorides, suspended materials, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), total hydrocarbons (C10-C40), pesticides, phenols and metals (Hg, Cd, As, Pb, Zn, Cu, Ni, Cr, Al, B Mo, V, Na, K, Mg, Ca, Fe and Mn).

On the basis of the obtained results of investigation of the three groundwater samples from the piezometers the following has been ascertained in the Study:

- "in no investigated sample concentrations of the investigated parameters have exceeded limit or remedial values of pollutant materials in groundwater as prescribed by the Regulation;
- the only recorded deviation is related to exceeding of ammonium concentration at the 2 locations in relation to the values for III and IV class of water, according to the Rulebook on the dangerous materials in water (OJ of SRoS, No.31/82)"

The general conclusion of the Study on Existing Environmental Conditions at the Holding of IHP Prahovo which was prepared during 2012 by City Institute for Public Health Belgrade states that contamination at some locations within the Holding of IHP Prahovo is not substantially impacted the groundwater quality.

Generally, it can be said on the basis of results of the groundwater analysis in the surrounding of the phosphogypsum storage from 2008 and groundwater from the piezometer No.3, that are not exceeded remedial values standardized by Regulation on the pollutant limit

values in surface waters and groundwater and sediments and deadlines for their reaching (OJ of the RoS, No. 50/2012).

The company INTERGEO Environmental Technology was conducted physical, chemical analyses of 12 water samples which are named "surface waters" during 2008, but, in fact, those were samples of wastewater: the drain canal (Sw4), in proximity of the new pipeline (Sw5-Sw10), the drain canal in proximity of the sulphuric acid reservoir (Sw15) and the wastewaters which can have a direct impact on the quality of water in the Danube River, as its recipient - wastewater from the factory's drain network (total wastewater from the factory grounds – waste water collector, Sw11) and spillway of the present phosphogypsum storage (Sw13). Furthermore, the analysis of water from the Danube River was performed (Sw3), below the discharging location of the spillway of the phosphogypsum storage into the Danube River. It has been concluded that in the majority of the investigated 12 wastewater samples, has low pH value (below pH 6.5), it is detected an increased content of sulphates and heavy metals (As, Cu, Ni, Cd, Cr), and in a smaller number of samples the increased total petroleum hydrocarbon (TPH) content is detected.

On the basis of the obtained results, considering the valid legislation it can be concluded that water from the storage's existing spillway (Sw13) is in accordance with the defined parameters for the class I and II (Table 5.10). The water is only in relation to nitrate of the III class, and for phosphates and electrical conductivity of the IV class. When the values of those parameters are compared the parameters in samples Sw11 (PO_4 560 mg/l; NO_3 140 mg/l) and Sw3 (PO_4 3.2 mg/l; NO_3 8 mg/l) with the values for samples Sw13 (PO_4 0.35 mg/l; NO_3 6 mg/l) and Sw1 (PO_4 0.45 mg/l; NO_3 7 mg/l) it can be said that, according to the stream standards methodology, water from the spillway of the present phosphogypsum storage does not have impact on the water quality in the recipient, i.e. the Danube River, for these parameters.

As for pH value of the water from the spillway of the phosphogypsum storage it is somewhat lower than the emission limit value, or limit value of 6.5, and according to that parameter it would be classified in the class V. However, the analysis of water from the Danube River, downstream from the discharge locations of this effluent indicated that pH value of water from the Danube River is 7.4 (Sw1, Table 5.8). Furthermore, if pH value of the wastewater from the collector, pH=2.3 (S211) and pH=7.4 of the water from the Danube River below the discharging of the collector's wastewater (Sw3)are compared, what is above the location of the phosphogypsum storage's spillway, and aforementioned pH values for Sw13 and Sw1, it is concluded that the storage's spillway does not have impact on the quality of water in the recipient for this parameter.

Finally, on the basis of the results it could be generally said that the wastewater from the collector Sw11 has the main impact on the quality of the water in the Danube River since at the measuring location Sw3 and Sw1 the water is classified in the V class for phosphate. However, it is observed that the Danube water significantly dilute the collector's wastewater, considering that the phosphate concentration is around 175 times lesser in the Danube's water (Sw3) than in the collector's water (Sw11) or in Sw1's water (below the inflow of water from the phosphogypsum storage).

The accredited organization, i.e. Institute for Quality of Work Environment and Surroundings "1st May" the joint-stock company Niš, was performed analysis of water during the zero state in order to investigate the quality of environmental factors. The similar investigations of water quality are performed by the accredited laboratory – Anahem from Belgrade. The sampling was conducted on 21.12.2012.

Institute for Quality of Work Environment and Surroundings "1st May" the joint-stock company Niš, was performed analysis of wastewater samples from the collector (0467 WW) and the water samples from the Danube River upstream (0468 WW) and downstream (0469 WW) from the wastewater discharge location (0467 WW). In the report compiled by Institute for Quality of Work Environment and Surroundings it is written: "The estimate of quality is made with comparison of the obtained results on the downstream sample from the Danube River, after inflow wastewater from the collector and its complete mixing and maximum allowable concentrations, indicators of the quality of II class river, to which the quoted water course belongs and which is the recipient of wastewater."

On the basis of the given analysis, the conclusion is that the quality of wastewater satisfies the provision from the Rulebook and regulations regarding the content of pollution parameters and therefore, the wastewaters can be discharged in the quoted recipient.

We are of an opinion that the wastewater from the collector is not of the II class for the following parameters: suspended materials, biochemical oxygen demand (BOD), chemical oxygen consumed, concentration of ammonium ions, detergents. However, the quality of the Danube's water upstream and downstream from the wastewater discharge location is, according to the results, of the II class except for suspended materials. Thus, it can be said that wastewater does not influence the quality of the recipient.

The authorized and accredited laboratory Anhem from Belgrade also performed analyses of wastewater samples, water from the Danube River upstream and downstream from the discharge location (sampling as of 21.12.2012). The results of investigations indicate that concentrations of the all parameters, except suspended materials, BOD, and nitrates in the samples from the Danube River 100 m upstream and downstream from the inflow of waste water, are below maximal allowable concentrations prescribed by the Regulation. The difference in concentrations of the quoted parameters is insignificant and indicate that the wastewater from the factory does not substantially influence the quality of the River Danube.

However, our conclusion is that the results indicate that biochemical oxygen demand (BOD) values for the all three samples are above the maximum allowable concentration for the II class, and for this parameter the analyzed water belongs to the III class ($5>BOD\leq7$). In fact, the Danube River has somewhat higher value than the maximum allowable value for the II class (5.1 mg O_2/l).

Those samples neither belongs to the II class for suspended materials, and it ought to be underlined that the Danube's water 100 m upstream from the wastewater discharge location was not of the II class (56 mg/l), and that the wastewater (180 mg/l) increased the concentration of suspended materials in the Danube's water downstream from the discharge location (88 mg/l).

Finally, if the wastewater samples from the collector are compared which are analyzed during the period 2008-2012 it is noticed that the values of some parameters are substantially different (for example, pH), what can be explained with the fact that all production facilities in the complex worked or not worked in certain periods. Consequently, it had impact on the quality of wastewater which was discharged in the recipient, i.e. the Danube River. It has already been mentioned that the wastewater from the collector can influence the quality of the Danube's water. However, most frequently the Danube's water upstream from the wastewater discharge location for the collector was not, of the required II class, and the quantity of the Danube's water has impact on a great dilution of wastewater and as a result, the quality of the Danube's water downstream in relation to the water quality upstream from the inflow location is not substantially changed.

Air

With deposition of air impurities first of all of particles pollution onto the soil surface and their dissolution and rinsing into the deeper soil parts which can be brought into a direct connection to the quality of air and soil. Depending on chemical properties of deposited dust and its capability of dissolution the indirect connection between the deposited materials and surface waters, i.e. groundwaters can be realized. From that aspect, the knowledge of air quality represents a significant step in the process of protection of soil and water quality.

Institute for Technology of Nuclear and Other Raw Materials (ITNMS) was conducted during 2010 (May-September) investigations of the total deposited materials. The settlers were situated in the surrounding of storage area, at 14 locations on the distances from 500-2500 m.

During the measuring period, the deposited materials only exceeded limit values of 300 $mg/m^2/24h$ in two days. The quantity of dissolved and undissolved part varied, depending on the quantities of total deposited materials and the represented dissolved part was somewhat bigger with it.

During 2012, City Institute for Public Health, Belgrade was conducting sampling of ambient air for requirements of the definition of zero-state at the location of the primary school in Prahovo and in no case occurred exceeding of the limit values.

7. DESCRIPTION OF POSSIBLE ENVIRONMENTAL IMPACTS OF THE PROJECT

The construction of the new phosphogypsum storage in the holding of Elixir Prahovo, Industry of Chemical Products Ltd., with all its characteristics, can influence on the quality of environment. The successfulness of each solution in the domain of environmental protection and improvement of environment implies comprehensive consideration and definition of all possible impacts. Accordingly, it is always set as a priority the obligation of definition of possible impacts in relation to the basic environmental media such as: air, water, soil, climate, flora, fauna, landscape, etc.

The analysis of environmental impacts is connected for the requirements of this project takes into consideration potential environmental effects which are anticipated on the basis of implementation of the Best Available Technologies (BAT) in the designing stage and project development and the Best Management Practices (BMP) which are applied during construction and operation of the new phosphogypsum storage.

The environmental effects are classified in the following way:

- Physical surrounding – soil (physiography, geology and soil), water (surface and underground resources), air (climate, air quality and noise);
- Natural environment – aqueous and earth habitats;
- Socio-economic environment – the existing and planned utilization of land and resources and economic activities related to it.

Cultural environment – archeological, cultural characteristics and inheritance which includes any locations or cultural asset of historical importance which could be physically exposed to the project impact. This potential type of impact is not expected, on the basis of available information and will not be further taken into consideration.

Analysis of impacts on air quality

Suspended particles which concentrations, under certain conditions can be above limit values prescribed for populated areas represent a significant, potential danger for air. The creation of a dispersive phase in air in the working environment is connected to a greater or lesser extent with the all designing technological process's phases.

The characteristics sources of air pollution with suspended particles are: a point source pollution (loaders, bulldozers), an air pollution line source (the roads in the industrial complex), surface (the surfaces on which are performed activities in the storage and disposal site). The primary sources include mining and construction equipment in operation, while the secondary sources include all active surfaces which under impact of wind emit in air a floating fraction from the deposited dust.

The total intensity of air pollution with suspended particles greatly depend on meteorological conditions, which averages that occasionally, in dry periods during the year it can represent a potential polluter of air in the environment where activities are performed.

In the Study on the environmental impacts of the project of development of the phosphogypsum storage in the industrial complex of the company ELIXIR PRAHOVO INDUSTRY OF CHEMICAL PRODUCTS LTD. PRAHOVO, for analysis and estimate of impacts of the technology of development of the new storage on air pollution was used the standard EPA model (US Environmental Protection Agency) AERMOD.

The quantification of PM10 particulate matter emissions, i.e. of the factors of dust emissions for various activities in the process of stockpiling phosphogypsum in the industrial complex of ELIXIR PRAHOVO INDUSTRY OF CHEMICAL PRODUCTS LTD. PRAHOVO was conducted in accordance with the EPA documents (US EPA AP-42, Compilation of Air Pollution Emission Factors) and National Pollutant Inventory (Emission Estimation Technique Manual for Mining and Processing of Metallic Minerals, 2011).

The AERMOD model (US Environmental Protection Agency) was used for estimation of the air quality for the purpose of distribution of concentration of particles PM10. The obtained results represent average daily values of concentration of particles PM10 (μg/m^3) for defined sources of separation, defined period and receptors. It ought to be emphasized that in the reviewed models has been taken into consideration the terrain elevation. Data from the period 2010-2013 were used for meteorological conditions.

Figure 5 shows the distribution of daily average concentration of suspended particles PM10 (μg/m^3) around the industrial complex of the stage 1 of the development of the phosphogypsum storage in the complex of Elixir Prahovo Ltd. Prahovo for analyzed meteorological conditions. The analysis was conducted for conditions in which exist 5 dust sources: the two surface sources (the phosphogypsum storage, the ash dump) and the three volume sources (loader, hydraulic excavator and unloading from a truck) under conditions in which are not applied dedusting measures.

The contour lines of dust particles PM10 concentrations presented in Figure 5 clearly indicate that can be expected impact of dust in the area around implementation of works on storage of phosphogypsum, because of the overall activities. In the broader area around industrial complex dust particles PM10 concentrations substantially decrease from 267 μg/m^3 (the phosphogypsum storage) to 50 μg/m^3 in the industrial border area zone.

The distribution of daily average concentration of suspended particles PM10 (μg/m^3) around the industrial complex of the stage 2 of the development of the phosphogypsum storage in

the complex of Elixir Prahovo Ltd. Prahovo for analyzed meteorological conditions is presented in Figure 6. The analysis was conducted for conditions in which 6 dust sources exist: the three surface sources (the phosphogypsum storage of stage 1 and 2, the ash dump) and the three volume sources (loader, hydraulic excavator and unloading from a truck) under conditions in which are not applied dedusting measures.

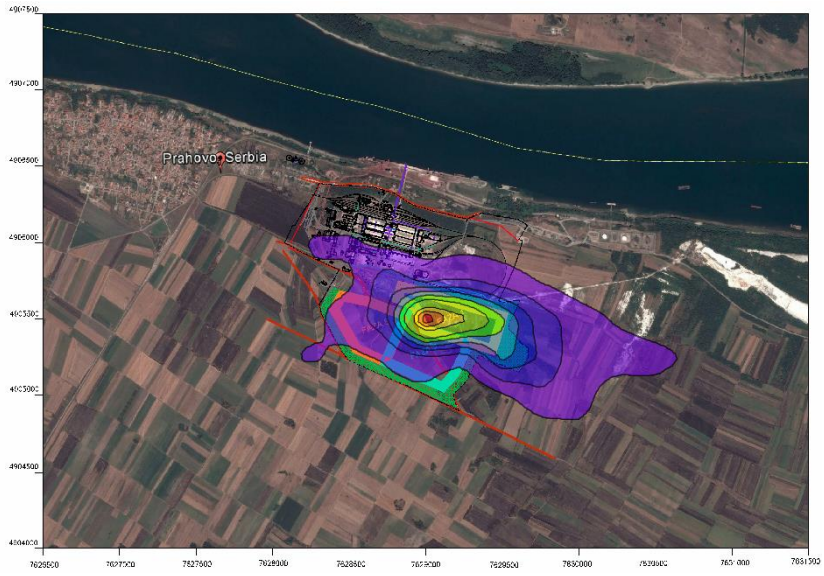

Fig.5 The distribution of daily average concentration of particles PM10 (μg/m^3) around the phosphogypsum storage in the development stage 1 without application of methods and procedures for dust protection

The contour lines of dust particles PM10 concentrations presented in Figure 6 clearly indicate that can be expected impact of dust in the area around implementation of works on storage of phosphogypsum, because of the overall activities. In the broader area around industrial complex dust particles PM10 concentrations substantially decrease from 277 μg/m^3 (the phosphogypsum storage) to 50 μg/m^3 in the industrial border area zone.

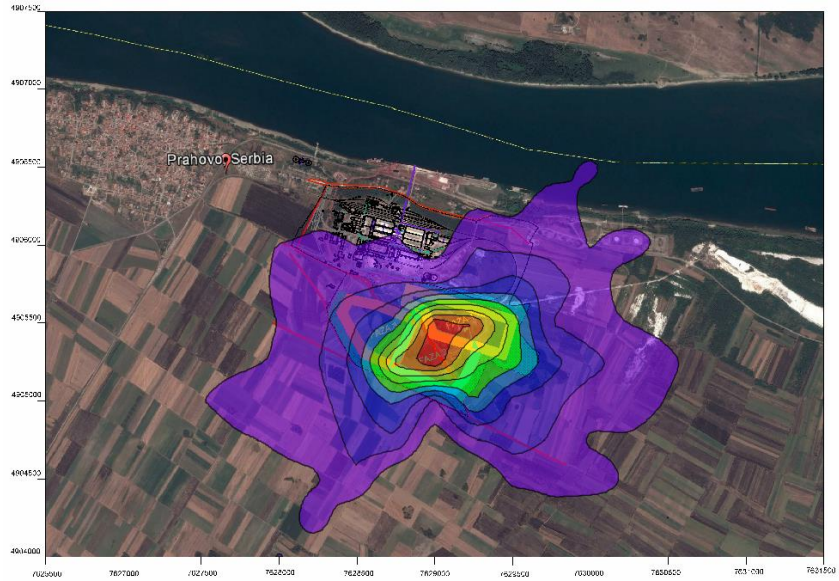

Fig.6 The distribution of daily average concentration of particles PM10 (μg/m^3) around the phosphogypsum storage in the development stage 2 without application of methods and procedures for dust protection

In order to better estimate air quality for the purpose of distribution of concentration of particles PM10 for various activities in the process of phosphogypsum disposal in the industrial complex of the company Elixir Prahovo Ltd. Prahovo was conducted the analysis of the development stage 3 of the phosphogypsum storage. The distribution of daily average concentration of suspended particles PM10 (μg/m^3) around the industrial complex of the stage 3 of the development of the phosphogypsum storage in the complex of Elixir Prahovo Ltd. Prahovo for analyzed meteorological conditions is presented in Figure 7. The analysis was conducted for conditions in which 7 dust sources exist: the three surface sources (the phosphogypsum storage of stage 1, 2 and 3, the ash dump) and the three volume sources (loader, hydraulic excavator and unloading from a truck) under conditions in which are not applied protection dedusting measures.

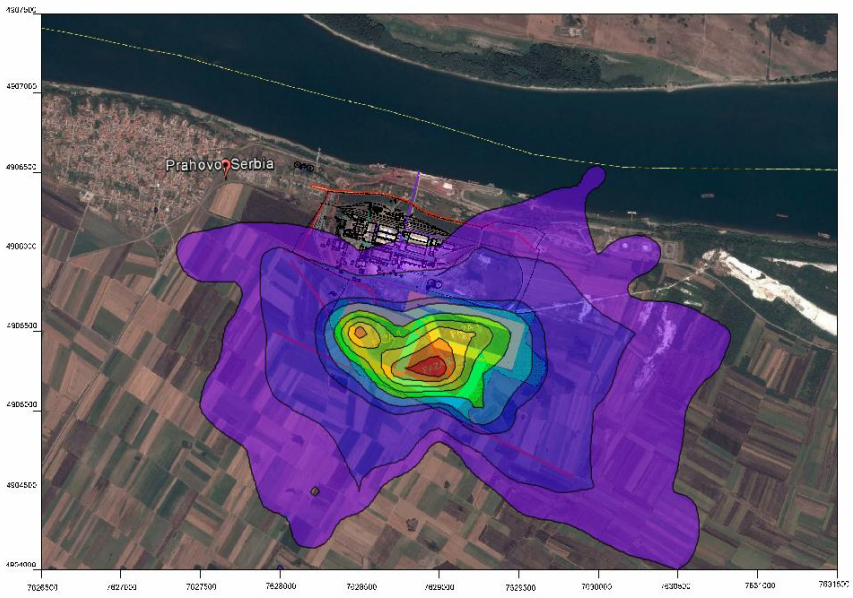

Fig.7 The distribution of average daily concentration of particles PM10 (μg/m^3) around the phosphogypsum storage in the development stage 3 without application of methods and procedures for dust protection

The contour lines of dust particles PM10 concentrations presented in Figure 7 clearly indicate that can be expected impact of dust in the area around implementation of works on storage of phosphogypsum, because of the overall activities. In the broader area around industrial complex dust particles PM10 concentrations substantially decrease from 347 μg/m^3 (the phosphogypsum storage) to 50 μg/m^3 in the industrial border area zone.

On the basis of the analysis of distribution of suspended particles PM10 emitted from the technological process of phosphogypsum storage in the complex of Elixir Prahovo Ltd. Prahovo can be concluded that is a reliable estimate that in the area of the nearest receptors (residential buildings in the village Prahovo) emissions of suspended particles will not exceed prescribed limits of 50 μg/m^3.

During operation of motor with internal combustion will be emitted the following pollutants: carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur dioxide (SO_2), volatile organic compounds (VOCs), aldehydes, soot, etc. Having in mind that it is about a relatively small pollution emission, determination of gas concentration fields does not have practical importance. The impact zones are of local character, i.e. they are related to a small area immediately around the pollution source and, most frequently, are spread within the working environment.

Analysis of impacts of noise and vibrations

Possible occurrences of unfavorable impacts of excessive noise in working environments exist in the all phases of operation on the disposal and storage of mineral raw materials and other materials. The sources of noise are construction machines for excavation, transport and ancillary works: drilling machines with compressors, loaders, bulldozers, trucks, tanker trucks, as well as crushers, mills, classifying screens, etc.

The danger from noxious impacts of vibration only exist in some phases during operation of construction machines and it is only connected with the working environment.

A certain number of methods has been developed for prediction of noise which occurs at large, open sites. The British standard Noise Control on Construction and Open Sites Part 1 (1997) contains the method for estimation of an equivalent continual level of noise in decibels (Leq – A-ponderation).

The estimation of noise level which originates from activities on phosphogypsum storage was implemented with the application of NoiseMap-SiteNoise model. The model is based on the British standard 5228, Part 1, 1984, Noise Control on Construction and Open Sites. The model includes the following sources of noise:

1. Floating pump – 65 dB(A), situated in the middle of the cassette, on a pontoon, it transfers water from the cassette into the peripheral canal;
2. Hydraulic excavator 75 dB(A), it operates on formation of the embankment in the stage of cassette immuring;
3. Pumping station 60 dB(A) - it returns collected water in the peripheral canal to the factory –the water cycle.

It has been modelled the development stage 3 of the phosphogypsum storage), when the works on phosphogypsum storage are at elevation +64 m. According to topography, elevations of the village Prahovo ranges from 60 to 62 masl. Stages 1 and 3 have not been modelled since in those cases works are further from the residential buildings. Considering that the sources of noise in those stages are the same as in the stage 3, it is realistic to expect the same noise levels in their surroundings, and the obtained outlines of noise would be moved toward the east for the moved operations. A excavator is situated in the side which faces the settlement, i.e. the all sources are in the modelled moment nearest to the residential buildings in the immediate surroundings of the industrial complex.

Since the phosphogypsum storage is situated within the industrial zone, the allowable noise level at the border of this zone is not allowed to exceed the limit value of the zone with which is bordered. In the concrete case, the industrial zone borders with the zone 3, the residential settlement, so that the adopted limits for day and evening are 55 dB, i.e. 45 dB during night. As it can be seen in Figure 8, a reliable estimate is that the noise connected with activities on phosphogypsum storage will not have impact on the nearest residential buildings in the village Prahovo.

The estimate of noise level, presented in Figure 8, indicates that in the area of phosphogypsum storage the noise levels above 70 dB(A) can be expected. The fact is that noise in this part of the industrial complex will have first of all, impact on the workers at the location of implementation of works – workers and operators. Because of that, corresponding protection measures have to be undertaken (construction or personal protection measures) in order to prevent unfavorable impact of noise on the employees.

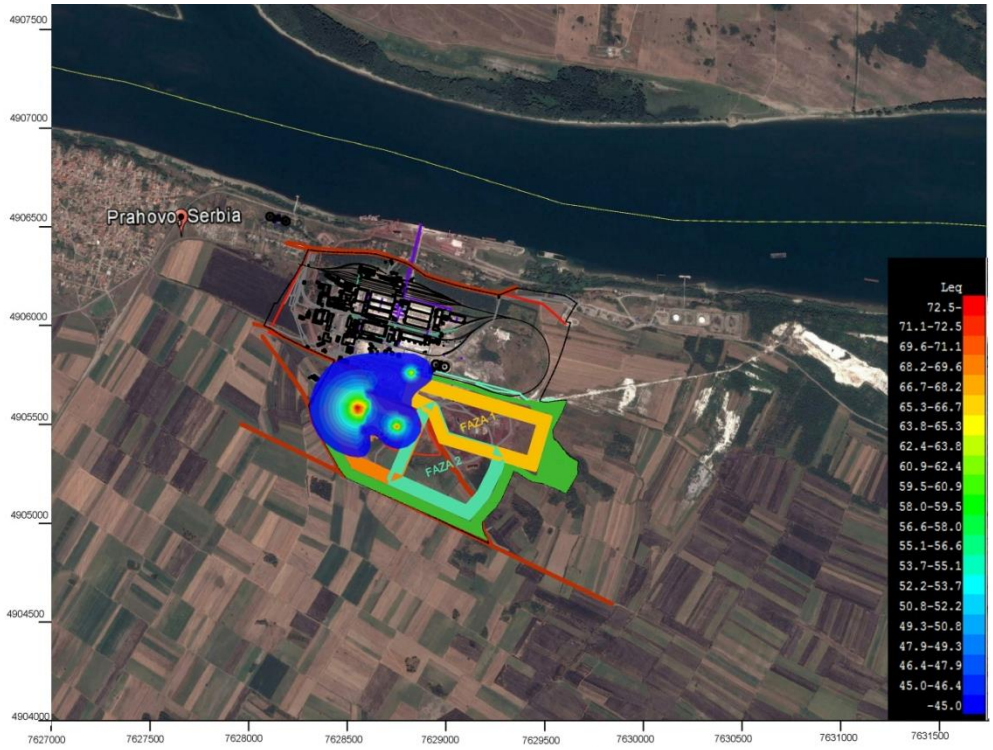

Fig.8 The estimate of noise levels around the phosphogypsum storage

The danger of noxious impacts of vibration exists only in some phases of construction machines operations and is only connected with the working environment. In that sense, it is required to regularly conduct measurements of vibration level during operation of equipment and implement required protection measures for operators as required.

Analysis of impacts on the quality of surface waters and groundwaters

The estimation of wastewaters impact from the complex Elixir Prahovo Ltd. Prahovo, on the quality of surface waters and groundwaters, the Danube River, which is classified according to the Rulebook on benchmark conditions for types of surface waters (OJ of RoS, No. 67/2011) in the large lowland rivers, domination of a fine deposit (Type 1), and according to the Rulebook on the parameters of chemical and quantitative status of groundwaters (OJ of RoS, No. 74/2011) in the class II for limit values (limit value and maximal allowable value) of pollutants defined by the Regulation on the pollutant limits in surface waters and groundwater and sediments and deadlines for their reaching (OJ of the RoS, No. 50/2012), is based on the results of physical and chemical analyses of water presented in Section 5.4 of this Study, with a combined approach of stream and effluent standards.

In order to estimate the impact of the future phosphogypsum storage, first of all, on groundwaters (and soil), herein is underlined that the solutions anticipated in the conceptual design provide protection of soil and groundwater. The new storage will have hydro insulation on the bottom and internal sides, while water will be used in the production process as return water. On the basis of the data from terms of reference and the data from the Report on investigation of technical and geotechnical characteristics of phosphogypsum (Faculty of Mining and Geology, University of Belgrade, July 2013), it has been adopted that in the process of continual operation, 70 t of deposited gypsum will bond 50 t (m^3) of water and, according to the mass balance from around 210 m^3 of water from the storage around 160 m^3 will be return water. It virtually averages that on the new storage will not be any surplus of water.

On the basis of the presented it can be estimated that the future phosphogypsum storage will not have any impact on the groundwater of the complex Elixir Prahovo Ltd. Prahovo. Only in cases of some industrial accidents, bursting of the pipeline or damage of the liner used for hydro insulation of the future phosphogypsum storage, it is possible that the quality of groundwaters would correspond to the quality of groundwater from the piezometer 3 (2012) or to those qualities detected during 2008 around the present phosphogypsum storage, if there is free water in the new storage. For those groundwaters it is ascertained that there were not exceeded remedial values standardized with the Regulation on the pollutant limit values in surface waters and groundwater and sediments and deadlines for their reaching (OJ of the RoS, No. 50/2012). As for the water from the pipeline, it could correspond to the quality of water from the spillway of the present phosphogypsum storage, for which it can be said according to the stream standards methodology that does not influence the quality of water in the recipient, i.e. the Danube River nor groundwaters.

Analysis of impacts on the soil quality

Considering that it belongs to limited natural resources which are hardly renewable, occupation and disturbance of soil represents the most important conflict of the industry with the surrounding. The stage development of the new phosphogypsum storage has been planned at the location of the industrial complex. Thus, the stage 1 includes the degraded area around the existing pyrite burns dump, the area which is the company's property while the stages 2 and 3 imply utilization of the area which Elixir Prahovo Ltd. Prahovo will purchase from the present owners.

AERMOD model (US Environmental Protection Agency) was used for evaluation of dust deposition in function of distribution of deposition matter at area the phosphogypsum storage. Obtained results are average daily deposition values (mg/m^2 day) for defined emission sources and receptors. It should be mentioned that these models included terrain elevation. Data from the period 2010-2013 are used for meteorological conditions.

Figure 9 shows the distribution of deposition particles (mg/m^2 dan) around the industrial complex of the development stage 1 of the phosphogypsum storage in the complex of Elixir Prahovo, Industry of Chemical Products Ltd. for analyzed conditions.

The deposition particles at the level of maximal allowable value of 450 mg/m^2 per day are located in the area of the phosphogypsum storage, i.e. within the boundaries of the industrial complex, so that it can be concluded that the deposition particles due to activities on the phosphogypsum storage will not exceed limit values in the area of residential buildings in the village Prahovo.

The distributions of deposition particles (mg/m^2 per day) around the industrial complex of the developmental stages 2 and 3 of the phosphogypsum storage in the complex of Elixir Prahovo Ltd. Prahovo for analyzed meteorological conditions are presented in Figures 10 and 11.

The deposition particles at the level of maximal allowable value of 450mg/m^2 per day are located in the area of the phosphogypsum storage, i.e. within the boundaries of the industrial complex, in case of the stages 2 and 3 of the storage development, so that it can be concluded that the deposition particles due to activities on the phosphogypsum storage will not exceed limit values in the area of residential buildings in the village Prahovo.

The soil quality in the area of the industrial complex of Elixir Prahovo Ltd. Prahovo presented in Section 6 herein, to great extent support the conducted estimate of impact of deposition particles and the statement that impact can be expected in the area of the phosphogypsum storage, i.e.

within the boundaries of the industrial complex. It is required to perform detailed soil investigations outside the industrial complex for more comprehensive analysis and realization of impacts.

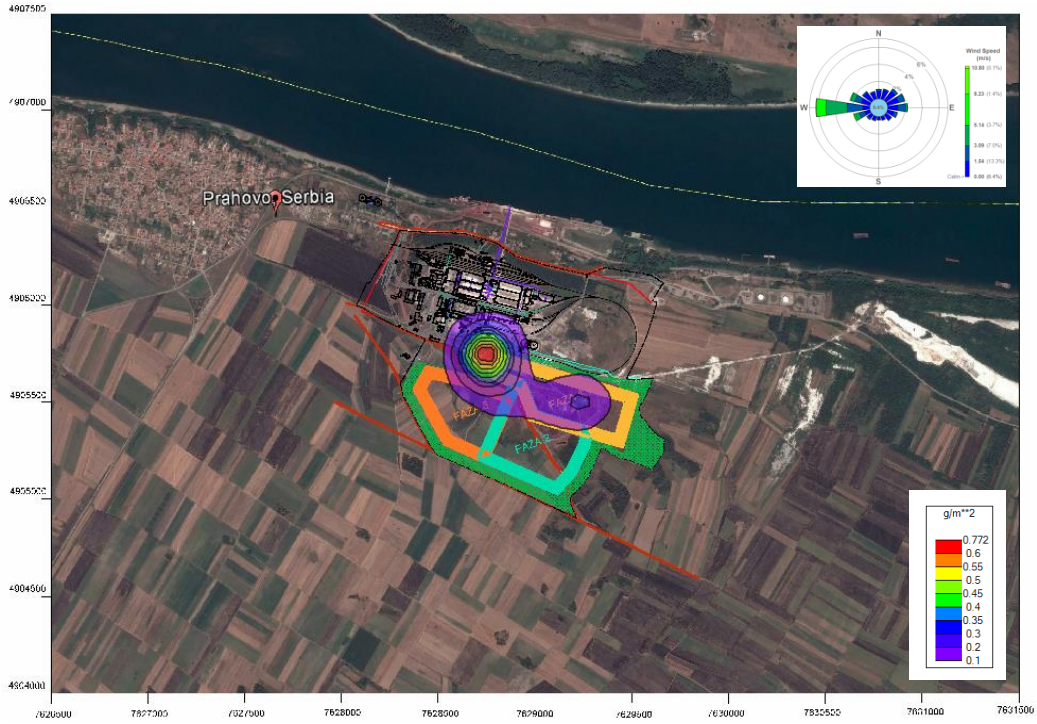

Fig.9 The distribution of deposition particles mg/m^2 per day) around the industrial complex of the development stage 1 of the phosphogypsum storage without application of methods and procedures for dust protection

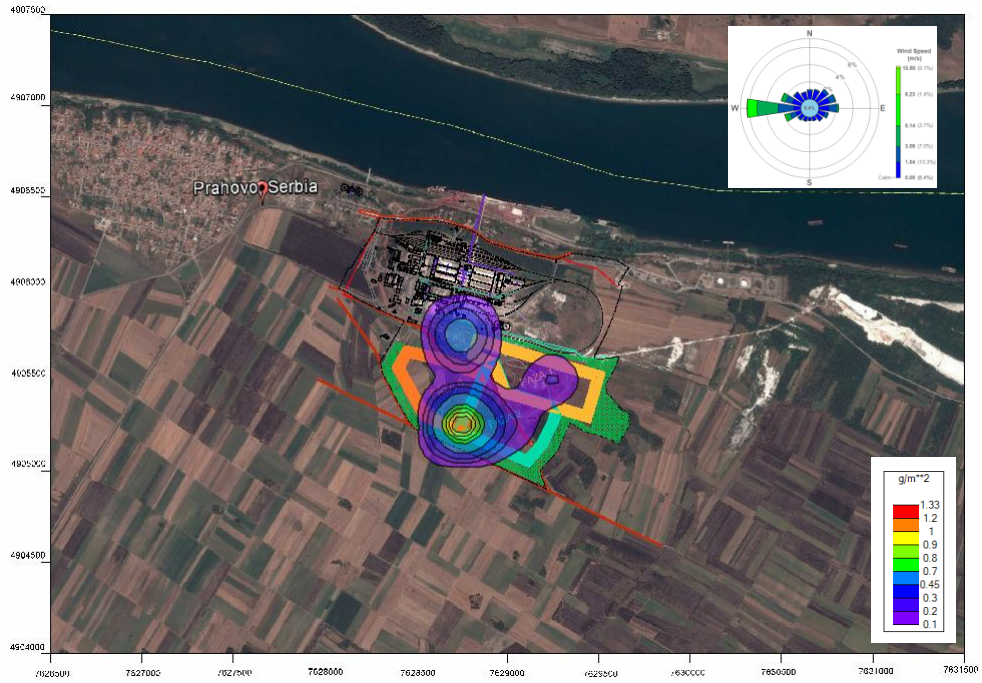

Fig.10 The distribution of deposition particles mg/m^2 per day) around the industrial complex of the development stage 2 of the phosphogypsum storage without application of methods and procedures for dust protection

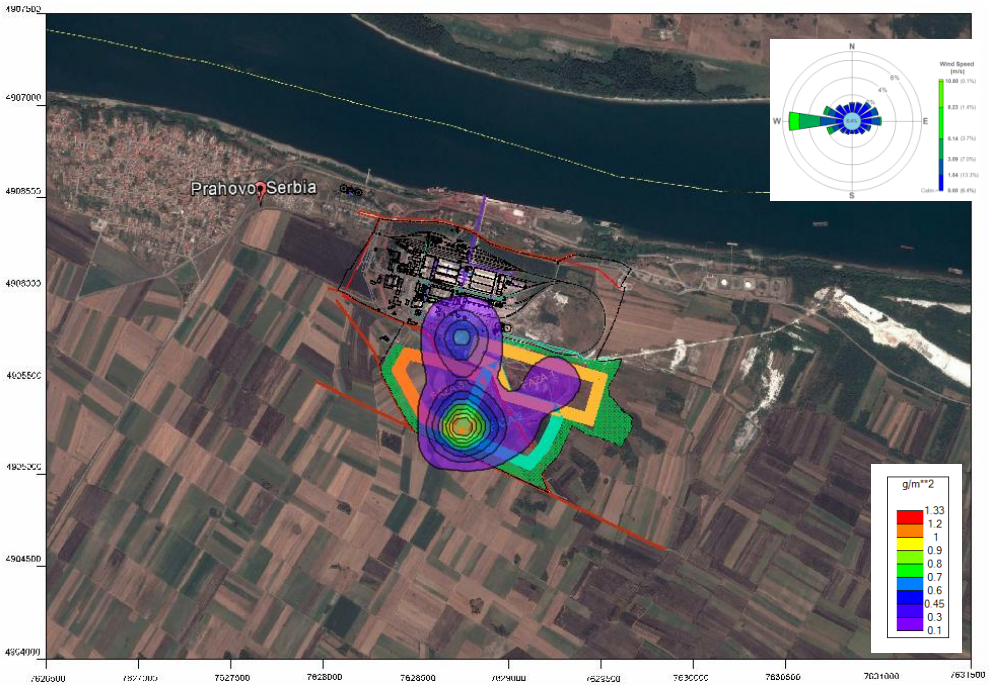

Fig.11 The distribution of deposition particles mg/m^2 per day) around the industrial complex of the development stage 3 of the phosphogypsum storage without application of methods and procedures for dust protection

The impact of process, i.e. phosphogypsum storage on change of the landscape characteristics, in a sense of morphological changes of the terrain, implies formation of the storage of certain size. During implementation of works on the phosphogypsum storage at the observed location will be unavoidably occupied the present surfaces, what will condition change and disturbance of morphological and esthetical characteristics of the existing natural ambient. Considering that the character and scope of the designed works is such that it is not possible to restore the original morphological appearance It is planner's obligation that with the technological process of storage, i.e. the activities on disposal of phosphogypsum and technical recultivation develop the storage's final geometrical outline in the way that newly formed space is adjusted in a functional and esthetical sense as much as possible to the existing natural ambient.

With the estimate of impact of the phosphogypsum storage on landscape characteristics in the domain of vegetation it is valued the vegetation's visual and biological quality, having in mind changes of appearance. For the disposal technology and formation of the phosphogypsum storage change of the landscape occurs due to unavoidable changes of vegetation in the surrounding area.

Analysis of impacts on residents' health

The estimate of impacts on residents' health can be performed with the implementation of the model compatible with the WHO procedures, which consists of the following steps:

- identification of issue;
- identification of danger;
- identification of dose and effects of negative impacts;
- estimate of exposition for the relevant population;
- characterization of the risk.

The fundamental dangers for residents' health as a consequence of activities on the phosphogypsum storage are mineral dust, noise and wastewaters. The causes of possible adverse impacts and occurrence of related health problems are, first of all, inadequate monitoring and control of air pollution and noise levels, absence or inadequate equipment and instrument maintenance as well as luck of awareness about possible dangers for people's health.

Within the study, for estimate of the risks of the project for health of local residents, will be singled out and analyzed possible impacts of dust, noise and discharge of wastewater. The identification of dangers and estimate of impact intensity is presented under items 6.2.3 and 6.3.3 herein. It is required to be underlined that the residents in the village Prahovo, northwest from the industrial complex of Elixir Prahovo Ltd. Prahovo (the total number of residents is 1,197) can be exposed to such impacts during implementation of mining works at the excavation site in case of the southeast wind.

The estimate of impacts of suspended particles and noise on local residents' health is performed with the application of the methodological concept developed within Pollution Prevention by Design in Pacific Northwest National Laboratory (2003, by US Department of Energy). According to the quoted methodological concept, the level risk (R) of individual impact criterion is defined as the product of impact scope of the applied technology (I) and probability category of impact occurrence (P), i.e. R = I x P.

Within the quoted methodological concept, the categories of impact occurrence (P) are valued through three categories: no impact (0), small impact (1) and great impact (2). The level of individual risk from certain activity from the analyzed technological process is determined through the following differentiated categories: negligible risk (0), small risk (2), moderate risk (2) and great risk (4).

In case of the emission of suspended particle during implementation of works on the phosphogypsum storage, the level of risk for local residents is R = 1 x 1 = 1. That estimate points out to the small risk. In case of noise level during operation of used equipment on the phosphogypsum storage, the level of risk for local residents is R = 1 x 1 = 1. The estimate also points out to the small risk from the increased noise level in the surrounding of the site. In case of the uncontrolled discharge of wastewater from the phosphogypsum storage's area the level of risk for local residents is R = 2 x 1 = 2. The estimate points out to a moderate risk.

Analysis of impacts on flora, fauna and ecosystems

At the site of phosphogypsum storage in the industrial complex of Elixir Prahovo Ltd. Prahovo there are no recorded rare plant communities, nor rare animal species and also, some susceptible ecosystems are not identified. In that sense, it does not occur any significant impacts on flora and fauna, except the ones already quoted in that section of the Study.

Social and economic impact

Approximately, 15 workers will be required for implementation of works on the phosphogypsum storage. The company Elixir Prahovo Ltd. Prahovo requires operators of heavy mechanizations, mechanics, process operators, administrators and others. The certain number of workers, for the quoted jobs, is recruited from the local community, while for the specific technological operations will be hired more experienced workers from the other areas. In this way, the requirements for workers will have impact on the infrastructure of local community.

8. ENVIRONMENTAL IMPACT ASSESSMENT IN THE CASE OF ACCIDENT

The EIA Study contains the presentation of dangerous materials, their quantities in the relation to the project for which is prepared the Environmental Impact Assessment Study. The subject of this Study is the storage, i.e. the process of phosphogypsum storage. In that sense, the question is raised whether phosphogypsum is a dangerous material, i.e. whether it ought to be observed as such in the process of definition of potential accidents.

The Law on Amendments of the Law on Environmental Protection, adopted in the National Assembly of the Republic of Serbia in May 2009, in accordance with recommendations of the Sevaso Directive (II), defined the Sevaso plant. It is the plant in which are performed activities in which is present or can be present a dangerous material in the equal or higher quantities of the prescribed ones. In accordance with it, Ministry of Environment and Spatial Planning of the Republic of Serbia identified the plants which are under obligations of the Sevaso Directive (II) and published the preliminary list of those plants (14 May 2009). In that list, under No.46 is IHP Prahovo – Fertilizers Ltd.

The fact that phosphogypsum ought not to be regarded as a dangerous material is supported with the content of the Rulebook on the list of dangerous materials and their quantities and criteria for definition of the document types which compile the operator of the Sevaso plant, i.e. the complex (OJ of RoS, No. 41/2010). With this Rulebook the list of dangerous material and their quantities and the list of danger classes and limit quantities of dangerous materials is prescribed, which are printed with this Rulebook and are its integral part. Phosphogypsum is not mentioned as a dangerous material in them.

Hazards Identification

The identification of hazards includes identification of critical points, i.e. locations in the process or the plant which represent the weakest points or possible sources of hazard from the aspect of possible accidents.

As a potential accident is imposed an eventual destruction of peripheral embankments which enables formation of the phosphogypsum storage. There are several possible reasons for unfolding of such scenario:

- Mistakes in the formation of peripheral embankments, as a consequence of non-compliance with the design solutions for formation of the storage;
- Failure of the pumps for return water, what would cause the occurrence of excessive water on the surface of some stages of the phosphogypsum storage and eventual decay and breach of peripheral embankments; and
- External sources of accidents, as potential dangerous ones can be singled out abundant precipitations, eventual flooding of the Danube River or earthquake.

Possible accident level and risk assessment

The possible level of accident is defined on the basis of the width of affected area and the analysis of vulnerability, and it is expressed as I, II, III, IV and V level of accident (the Rulebook on the content of policy of accident prevention and content and methodology for the compiling of reports on safety and the plan for accident prevention, (OJ of RoS, No. 41/2010). The analysis of vulnerability implies identification of vulnerable facilities in the surrounding, within the vulnerable areas.

From the aspect of phosphogypsum storage, and on the basis of the estimate of the width of the vulnerability zone and the analysis of vulnerability, it can be concluded that is only

realistic, in case of the quoted potential accident, to expect I and II level of accident. The consequences of accident would be, first of all, limited on the part of facility in which is performed storage, what consequently leads to the conclusion that it would not have any direct consequences for the entire complex.

On the basis of the low probability of an accident with consequences of little importance or without importance, can be concluded, from the aspect of assumed accidental situation, i.e. the failure of the peripheral embankments of the phosphogypsum storage, the risk is negligible.

Prevention measures and procedures in the case of an accident

The prevention of accident is the set of measures and procedures at the level of facility, the complex and the broader community which have for the objective prevention of the accident, reduction of probability of accident occurrence and minimization of consequences the Rulebook on the content of policy of accident prevention and content and methodology for the compiling of reports on safety and the plan for accident prevention, (OJ of RoS, No. 41/2010). On the basis of this, it is not difficult to conclude that prevention measures are those which in case of this project reduce a potential risk of accidental situation to the least possible measure.

In connection with this project, prevention of possible accidents as well as prevention and reduction of eventual consequences are boiled down to the following:

- The measures which are anticipated and realized with the designing and construction of the facility;
- The measures which are anticipated and realized with the selection of technological equipment, the equipment for process management and other technical equipment;
- The measures which are anticipated in the security system;
- The measures which are anticipated with the objective of staff training for management and responds to the accident, what presuppose educating people about potential accidental situations and measures for their prevention as well as for rehabilitation;
- Forces and technical averages planned and provided for preventive action and response to the accident.

9. DESCRIPTION OF MEASURES FOR PREVENTION, REDUCTION AND REMEDIATION OF ENVIRONMENTAL IMPACTS

A numerous measures for environmental protection have been undertaken for prevention of pollutions with the pollutants which originate from the phosphogypsum storage.

- **The storage location.** The selection of the storage location along the holding of IHP Prahovo, on partially degraded and agricultural land of inferior worthiness, without surface currents and water supply sources, at a sufficient distance from the Danube, far away from the zones with sanitary protection, and also from the residential areas, the terrain is plain and mildly sloped, virtually there is no catchment area from which water gravitates toward the storage.
- **Technical regulation.** The undertaken technical measures for provision of geotechnical and ecological stability implies a complete geotechnical and hydrotechnical regulation for the storage (starter dike, drainage system, hydro insulation of the storage internal area, the completion of the industrial water cycle with its collection and return to the phosphoric acid factory, perimeter canals for temporary

reception of all excessive water and insulation of the storage from the influx of water from the outside, etc.)

- **Monitoring and control**. The anticipated complex and encompassing measures of technical monitoring of conditions at the storage, facilities at the storage, utilization dynamics and storage development with which is established geotechnical and technological control of conditions at the storage and in the surrounding. Those measures are accompanied with the environmental monitoring program in order to dully detect disturbances or conditions which might impact the environment.

The individual effects of anticipated measures for water, air and soil protection from the negative effects of pollutants are specifically analyzed.

Air protection

The project provides air protection in several steps:

- It has been selected the site for storage in which is such wind rose that each eventual air pollution does not affect the populated settlements;
- Around the storage is anticipated formation of a powerful wind protection belt, of 25 m width up to over 50 m, in which will be planted suitable trees;
- The initial peripheral embankment will be made from coarse-grained and properly rolled material from the borrowing source so that elevation of dust is not expected regardless of the intensity and wind direction;
- A small size of retention area of the storage conditions that the discharge locations ought to be frequently changed in order to provide balanced filling of the space.

Water protection

For water protection the following measures are undertaken:

- It has been selected the site near the factory, i.e. there are no surface water courses in the area;
- The bottom and internal slopes of the storage are hydro insulated with installation of a geomembrane (liner) made of high-density polyethylene (HDPE) (Fig.12);

Fig. 12 Liner spreading along the storage cassette's bottom

- It is closed a cycle of industrial water in the way that the entire water from the storage, drainage water as well as water from the settling pond is collected in the specially designed pumping station and from there is delivered to the phosphoric acid factory for reuse;
- Considering that there is virtually no catchment area from which water would be collected into the tack it is relatively easy to close the water balance between the storage and the factory, since there is always basic technological water those water

which return from the storage as return water, and the quantity of that water is always lesser than the quantity of the required water;
- Around the storage are constructed the peripheral protection canals which ought to prevent entrance of water from the surrounding into the storage and its mixture with waters from the storage.

Soil protection

The soil protection is specific since the development of storage has to permanently change the purpose of the existing land. The fact is that it is difficult to find a favorable location in the wider location of the factory, without impact on the soil.

The investor was desirous to avoid jeopardizing agricultural land with grown crops and, therefore, opted out for the development of the new storage at already degraded soil used for storage of pyrite, pyrite burns and other waste, but in one part will be included agricultural land immediately along the factory which quality is significantly reduced, due to activities in the chemical complex in the previous period.

At the same time, the storage height was elevated to the maximum possible 50 m in order to increase in that way volume and reduce surface required to be occupied for the industrial storage.

The protection of soil is performed also indirectly, with protection of soil and air from pollution. Namely, water and air are main pollution transporters around the surrounding, and precipitation and other meteorological events condition that air pollutions are deposited onto the soil, there are scooped with water and further distribute around the surrounding.

Noise protection

An adverse impact of excessive noise in the working environments exists in the all stages of formation and utilization of the phosphogypsum storage.

In that sense, preventive measures from the aspect of environmental protection include:
- the control of noise level within the chemical complex, i.e. the phosphogypsum storage and eventual surrounding residential buildings;
- the reduction of noise at individual plants and machines;
- application of the acoustic protection with installation of a greenbelt for protection, physical barriers and fences, if required; Formation of a greenbelt for requirements of protection of surrounding air and soil will greatly influence the quality of environment from the aspect of noise.

The employee education is very important in the context of awareness of workers about the need for reduction of noise levels to the values defined by the regulations and about noxious effects for people's health due to exposure to an excessive noise. It is also important staff training in the field of equipment maintenance, i.e. in proper operating condition, as well as requirements and methods of use of personal protection equipment (PPE) for protection from noise.

Phosphogypsum storage closure

After completion of disposal of phosphogypsum, will be performed sealing of the stored mass which cannot be sold on the market in the foreseeable future. The sealing is successive since it can be only sealed those parts which are not physically connected with the activities from the following stages. The closure implies a complete hydro insulation of the deposited

mass, i.e. cover liners are joined with the line installed on the storage's bottom and internal slope of the peripheral embankment and protection of the cover liner from damage with application of the drainage layer from the gravel and coarse-grained inert material layers.

After completion of each stage will be performed closure of that part of the storage which overbuilding is not planned, in the way as designed on the drawing in the design's graphic section.

Firstly, it is performed covering of that storage surface with the 1.5 mm HDPE liner, Fig. 13. This liner on its lower part will be connected with the bottom' liner and internal slope liner on the starter dike, in the way which firstly anticipates partial excavation of this liner from the trench for its anchoring and welding with the liner used for storage covering. With this step it is provided that the entire storage external surface is covered with a watertight liner and protected from the contact with atmospheric waters which reach on the storage surface.

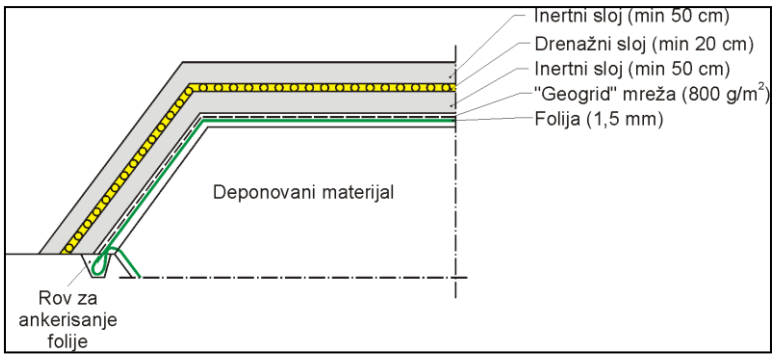

Fig. 13 Layers arrangement with phosphate storage closure

(inter layer – minimum 50 cm; drainage layer – minimum 20 cm; inert layer – minimum 50 cm; geogrid net – 800 g/m2; liner – 1,5 mm; deposited material; trench for liner anchoring)

For the covering of storage slopes will be used the liner with coarse surfaces on the both sides, while horizontal safety zones will be covered with a fine liner.

The design anticipates installation of the protective geogrid net, minimum weigh 800 g/m^2 over HDPE water tight liner. Geogrid net receives loads from a cover layer and protect the liner from tearing or damage.

It is further anticipated to apply the 50 cm inert material layer as a minimum, and then the 20 cm gravel layer. The used gravel will have the same grain-size as a protection layer. As the final layer is anticipated a 50 cm coarse-grained inert material as a minimum.

Measures to be undertaken in case of industrial accident

The potential industrial accident implies possibility of:

- origination of fires and explosions;
- discharge of dangerous materials in water and soil, due to damage on perimeter dikes;
- release of uncontrolled emissions in atmosphere;
- occurrence of natural disasters (lightening, earthquakes, floods, landfalls, etc.)

As for the entire process of phosphogypsum storage development and utilization, from the quoted accident categories it is possible to occur: fires, of a local character (mechanization and facilities in the storage area), discharge of dangerous materials, which originates from the phosphogypsum storage, (in waters or soil) due to damage and natural disasters (lightening and earthquakes).

A potential danger from fire is manifested through the possibility of origination: exogenous fires of class A, B and D (Standard SRPS ISO 3941:1994). In this concrete case a potential danger from fire is connected with the origination of smaller fires, and as such can be estimated as objectively small. The fire which eventually originates at the storage due to ignition under action of external factors (open flame, sparks, electric arch, etc.) for its proportions would be oriented to the location where originated, with a relatively small possibility of further spreading outside the complex, and that only in case of spreading of fire to the surrounding plant vegetation, when it is formed protection greenbelt.

It exists the possibility of spreading of fire gases at larger distances and outside the complex, under the impact of air currents, but their emission is of such a scope that environment would not be endangered. The experiences with fires from larger complexes point out to that. However, the size of a potential fire and the scope of damage caused on such an occasion condition application of corresponding technical and organization measures which are used to prevent the possibility of their origination.

Generally, a potential danger from fire is connected with the facilities' fire loading values and equipment at the storage and with origination of an exogenous fire of limited proportions. On the basis of the aforementioned, it can be concluded that a potential danger from exogenous fire at the phosphogypsum storage can be categorized as a low degree danger. The quoted potential danger conditions applications of corresponding technical and organization measures which will prevent the occurrence of fire as well as provide facilities protection, first of all, with a definition of locations equipped with fire extinguishers and their number. In the function of protection from exogenous fires of smaller proportions in the area of the phosphogypsum storage, it is required to place on machines fire extinguishers, types S-6, S-9 and CO_2 which are allocated depending on fire load and fire types.

On the basis of the previously stated it can be concluded that the likelihood of an industrial accident due to fire in the storage formation process is small and, accordingly, the possible consequences for the lives and health of people and environment are estimated and negligible, on the basis of data obtained with the analysis.

Since the risk of an accident is estimated on the basis of accident origination as well as on the scope of possible consequences, it can be concluded that the risk from accident due to possible fire occurrence is low, in case of the phosphogypsum storage.

As one of possible accidental situations is mentioned at the beginning of this section discharge of phosphogypsum into surrounding land or eventually into water streams due to damage, i.e. accident. The cause of manifestation of such accidental situation would be damaged or complete failure of perimeter dikes.

Because of this, within the said design a great attention is directed toward the estimate of phosphogypsum storage stability. For that purpose it is formed phosphogypsum storage model and with assistance of software programs were conducted the all necessary testing of the formed storage model and, first of all, the estimate of stability of storage slopes, i.e. perimeter dikes.

The estimate of slope stability is first determined for the cylindrical slip plane. It has been calculated a satisfactory safety coefficient (1.814). Then, the same estimate is repeated for case of maximum expected seismic activity of 8^0MMS. It has also been calculated a satisfactory safety coefficient 1.052>1.

Afterwards, it was performed control in the process of tension and deformation analysis, with the finite element method (FEM), with calculation of safety coefficients with the method of reduction of

tangential dilations. It has been calculated a satisfactory safety coefficient 1.69, but with a different shape of sliding body. Namely, the location of the zone of maximum tangential dilations, points out that failure will occur, dominantly due to sliding of the deposited material along the foundation.

Because of that the estimate was repeated with the method of **limit** equilibrium for the **predisposed** sliding plane. It has been also calculated a satisfactory safety coefficient 1.773. Then, the same estimate is repeated from the maximum expected seismic activities of 8^0MMS. It has been calculated a satisfactory safety coefficient 1.61>1.

The stability estimate has been performed for balanced conditions in the storage and with parameters which are obtained in a very short period after suspension discharge at the storage. It is expected a real situation will be somewhat changed since with the time will occur solidification of the phosphogypsum storage. With it will also change of values of elements of internal resistance (cohesion, angle of internal friction) and filtration coefficient. It is expected that the estimate results will be more favorable than the presented herein.

In order to preserve stability under control it is recommended to perform drilling on the established cassettes during stage of preparation of main designs and define values for the quoted parameters in order to perform the estimate with taking into account impacts generated with the storage time.

10. ENVIRONMENTAL IMPACTS MONITORING PROGRAMME

For an early detection of adverse environmental impacts it is required to develop the monitoring system for the storage and the surrounding area. This monitoring system ought to enable estimate of the scope and intensity of pollution and possible damages in order to undertake measures in a due time to prevent pollution, i.e. prevention of a wider pollution or a successful rehabilitation of the observed and recorded pollution.

The control of large industrial storage in open space, as well as the facilities assigned for specific purposes is performed through the two groups of activities:

- monitoring of facilities for control of its geotechnical stability; and
- monitoring of occurrences on and around the facilities in order to define ecological stability.

Monitoring, as a technical control, is performed by means of:

- visual observation of occurrences and events at the storage and its surrounding;
- individual parameter measurements for the estimate of condition;
- periodical preparation of studies, statements, expertise and reports which study conditions, and in a professional way solve the problem detected by visual observation and individual measurements.

The all monitoring elements are defined in the JUS U.C5.020 standard “Designing of Earth Dam and Hydrotechnical Embankments, “Technical Conditions” (the Rulebook No. 31-7303/1 as of 1980-04-17, Official Gazette of SFRJ No. 25/80). The details connected with storage monitoring are worked out in the Conceptual Design of the Phosphogypsum Storage, while herein has provided details important for monitoring organization for the control of ecological stability of the facility and its surrounding.

Monitoring system configuration

A reliable environmental monitoring system in the area of the phosphogypsum storage consists of the following steps:

- the identification of pollution sources and parameters (type and dimensions);
- the selection of environmental parameters for which are conducted measurements (in space and time);
- determination of critical areas;
- collection of data, analysis and estimate.

With the proposed environmental monitoring system will be monitored pollutant emissions from the area where will be stored phosphogypsum and immissions from the several locations in the surrounding in order to define the impacts of activities in the stalk with covering of the following environmental entities:

- the quality of surface waters and groundwaters and occurrence of potential toxic materials:
- air quality;
- soil quality.

The environmental monitoring system proposed by this Study will be capable of conducted analysis of pollution sources in accordance with its contribution to the total environmental pollution with the realization of efficiency of applied environmental protection measures. The monitoring process will take into account the valid legal and institutional framework in the Republic of Serbia. In cases of non-existence of legislation in the Republic of Serbia will be followed international regulations and recommendations (EU, the World Bank, EPA, WHO).

The proposed environmental monitoring system needs to provide establishment of the procedure for estimating of environmental impact caused by activities at the storage, as well as environmental protection status. It has been estimated that the establishment of such system is realistic and that system development will provide an efficient monitoring in the area of the phosphogypsum storage and its surrounding.

Parameters for determination of environmental impacts

The environmental impact needs to be monitored on the basis of measurements of air, water and soil. The pollutions which might occur will have mainly diffusive character. Hence, the monitoring program was done as a combination of emission monitoring, what is the legal obligation of each business entity, and immissions monitoring what is not an explicit obligation of a business entity, but in practice is applied when emission cannot be exactly measured and defined.

Because of possible jeopardy of water in accidental and pre-accidental situations in the wider location around the storage as a central issue is imposed the monitoring of groundwater quality, downstream and around the storage.

For soil it is anticipated monitoring of heavy metals spreading, while for air the impact of air pollution on residents which are located nearest to the storage and the industrial grounds.

Considering that storage will be formed by construction mechanization, and that the largest operations will be before the commencement of stage 1, it is of importance to monitor environmental conditions in the periods of the storage formation and utilization.

Table 1 shows the parameters which are required to be monitored through these periods.

Table 1: Parameters for determination of environmental impacts in the periods of storage development and utilization

<table>
<tr><td colspan="5">WATER EMISSIONS (POLLUTION) from the phosphogypsum storage</td></tr>
<tr><td colspan="5">IN THE STAGE OF STORAGE FORMATION AND FACILITIES CONSTRUCTION AT THE STORAGE</td></tr>
<tr><td colspan="2">Noise</td><td colspan="3">Monitoring of noise emissions in the period of storage formation (terrain levelling, excavation of perimeter canal, road construction, mineral barrier formation, liner installation, drainage system construction) needs to be performed within the factory grounds, immediately along the industrial facilities with a permanent crew, which are nearest to the storage</td></tr>
<tr><td colspan="5">IN THE STAGE OF STORAGE UTILIZATION</td></tr>
<tr><td colspan="2">Emission in water</td><td colspan="3">Considering that water is not discharged in the surrounding there is no locations at which can be measured emissions</td></tr>
<tr><td colspan="2">Emission in air</td><td colspan="3">Considering that is prevented dust formation during utilization with technical measures there is no location at which can be measured emission</td></tr>
<tr><td colspan="2">Noise</td><td colspan="3">Considering that technological process does not required particular involvement as a source of industrial noise, the measurement of noise emission does not make sense in the period of storage utilization</td></tr>
<tr><td colspan="5">IMMISSIONS (POLLUTIONS) in the phosphogypsum storage's surrounding</td></tr>
<tr><td colspan="5">IN THE STAGE OF STORAGE FORMATION AND FACILITIES CONSTRUCTION AT THE STORAGE</td></tr>
<tr><td rowspan="2">Air</td><td rowspan="2">Measurement locations within holding of IHP, nearest to the storage</td><td colspan="2">Quantity of pollutants in air</td><td>Soot, PM_{10}, $PM_{2,5}$</td></tr>
<tr><td colspan="2">Total deposited materials</td><td>Quantity of deposited material, heavy metals content (arsenic, cadmium, nickel, mercury, zinc, lead) and phosphorous content</td></tr>
<tr><td rowspan="2">Waters</td><td rowspan="2">Available piezometers in the industrial grounds and around the storage</td><td>Water quality</td><td colspan="2">Parameters which are controlled and average (limit) annual concentrations prescribed by the Regulation on limit values for pollutants in surface waters and ground waters and sediments and deadline for their reaching (Official Gazette RS, No. 50/12):
• nitrates; and
• active substances in pesticides, including their relevant metabolites, products of degradation and reactions
From the pollutant list are to be monitored content of:
• organophosphorus compounds
• inorganic phosphorous compound and elementary phosphorous,
• mineral oil and hydrocarbons
• metals, metalloids and their compounds: Zn, Cu, Ni, Cr, Pb, Se, As, Sb, Mo, Ti, Sn, Ba, Be, B, U, V, Co, Tl, Te and Ag</td></tr>
<tr><td>Water level</td><td colspan="2"></td></tr>
<tr><td>Soil</td><td colspan="2">Arable land in the surrounding</td><td colspan="2">pH, cadmium, lead, mercury, arsenic, chrome, nickel, fluorine, copper, zinc, boracium, cobalt, molybdenum, phosphor</td></tr>
<tr><td colspan="5">IN THE STAGE OF STORAGE UTILIZATION</td></tr>
<tr><td rowspan="3">Air</td><td rowspan="3">Measurement locations within holding of IHP, nearest to the storage</td><td colspan="2">Quantity of pollutants in air</td><td>Soot, PM_{10}, $PM_{2,5}$</td></tr>
<tr><td colspan="2">Total deposited materials</td><td>Quantity of deposited material, heavy metals content (arsenic, cadmium, nickel, mercury, zinc, lead) and phosphorous content</td></tr>
<tr><td colspan="3">Radionuclides content</td></tr>
<tr><td rowspan="3">Waters</td><td rowspan="3">Available piezometers around the storage</td><td>Water quality</td><td colspan="2">Parameters which are controlled and average (limit) annual concentrations prescribed by the Regulation on limit values for pollutants in surface waters and ground waters and sediments and deadline for their reaching (Official Gazette RS, No. 50/12):
• nitrates; and
• active substances in pesticides, including their relevant metabolites, products of degradation and reactions
From the pollutant list are to be monitored content of:
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• inorganic phosphorous compound and elementary phosphorous
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<tr><td>Level</td><td colspan="2"></td></tr>
<tr><td>Radionuclides content</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Soil</td><td rowspan="2" colspan="2">Arable land in the surrounding</td><td colspan="2">pH, cadmium, lead, mercury, arsenic, chrome, nickel, fluorine, copper, zinc, boracium, cobalt, molybdenum, phosphor</td></tr>
<tr><td colspan="2">Radionuclides content</td></tr>
</table>

Monitoring of air quality

The proposed system for air monitoring will provide a recording of air quality in the phosphogypsum storage, in order to estimate risk for people's health which are potentially exposed to air pollutions. The all works on monitoring need to be conducted in accordance with the Regulation on monitoring conditions and requests for air quality (Official Gazette RS, No. 11/2010) and the Regulation on amendment of the Regulation on monitoring conditions and requests for air quality (Official Gazette RS, No. 75/2010 and 63/2013).

The zones for air quality measurements are selected at locations where the risk of exceeding the limit values is high. The zones proposed for the implementation of monitoring are the holding of IHP Prahovo and the nearest residential buildings outside the industrial grounds. Those measurement zones have been selected since they are locations in the in the wider surroundings in which in continuity stay people.

Fig.14 shows sampling zones at the location immediately along the storage.

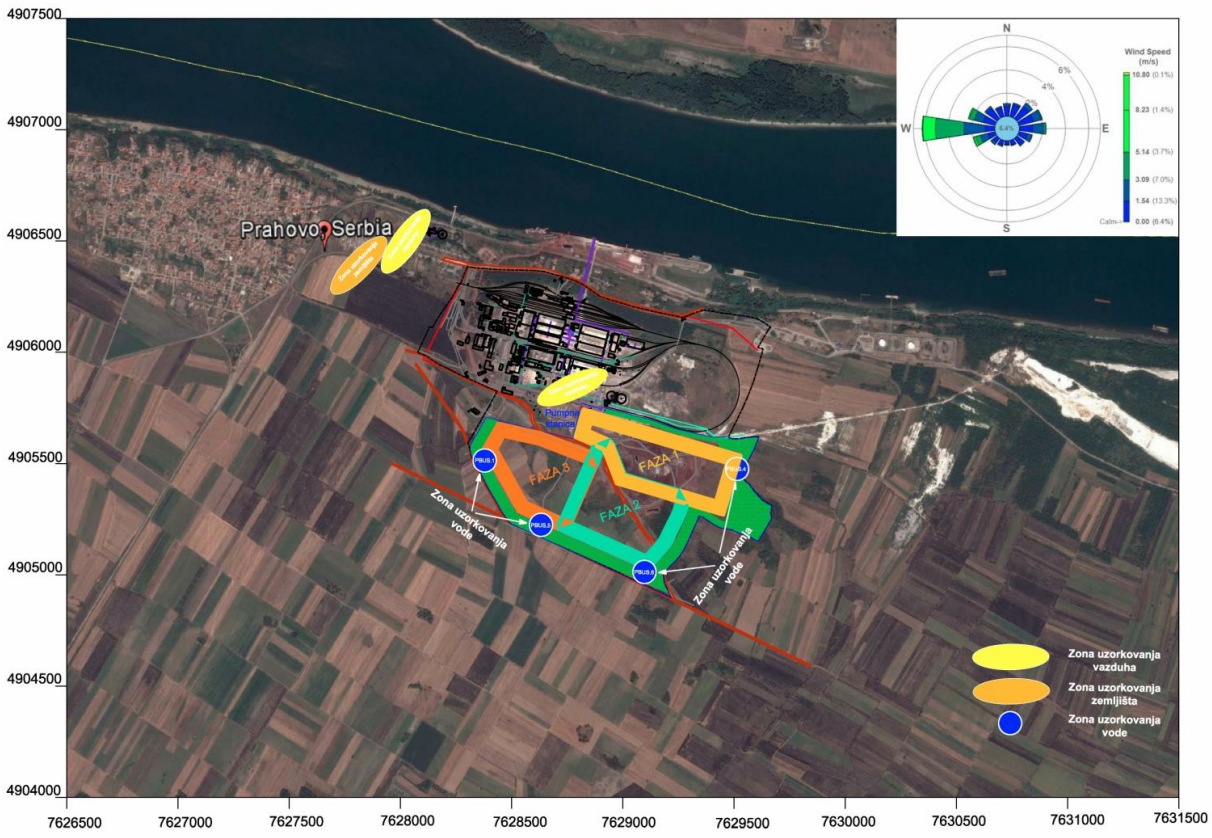

Fig.14 Sampling zones

The monitoring of air pollution will be conducted in the mobile laboratory, which can be dispatched to the target points in order to conduct measurements during temporary air pollutions. The data which are collected by the mobile laboratory are entered into the central database.

The dust sampling will be conducted occasionally, once a year in accordance with the Regulation on monitoring conditions and requests for air quality (Official Gazette RS, No. 11/2010) and the Regulation on amendment of the Regulation on monitoring conditions and requests for air quality (Official Gazette RS, No. 75/2010 and 63/2013) and the Rulebook on limit values, immissions measurements methods, criteria for establishment of measurement

locations and data recording (Official Gazette RS, No 54/92, 30/99 and 19/2006), which regulate this type of monitoring. Depending on concrete circumstances and the auditor report's results, sampling frequency can be increased or decreased, all in accordance of the adaptive monitoring which implementation is proposed.

The measuring instrument and equipment have to be attested. The sampling and analyses need to be conducted according to the valid standards, while on the all occasions when monitoring, measurement or analysis are not covered by the Serbian standards, ISO and EU standards are applied.

Concurrently with the air monitoring it needs to be determined radionuclides content in the air. The measurements need to be conducted once a year, in accordance with the technical standards prescribed in the Rulebook on definition of program for systematic investigations of environmental radioactivity (Official Gazette RS No. 100/10).

Water monitoring

The primary recipient for waters from the site of industrial grounds and the new storage from where they are discharged, on surface or underground, is the Danube.

Water quality monitoring includes monitoring of levels and quality of water in piezometers which encircle the site of the future phosphogypsum storage, 4 piezometers were formed during March 2014, Fig. 15. It is requited that sampling, sample storage are harmonized with standards, and in the all cases when it is not covered with Serbian standard ought to be applied ISO and EU standards (sampling, sample storage, preservation of samples are covered by ISO Standards from Group 5667).

The quality of a surface water course, i.e. the Danube River, is monitored by Republic Hydrometeorological Service of Serbia and, therefore, it is not anticipated to monitor its quality as a part of the monitoring of the area around the storage.

The list of physical and chemical parameters, i.e. indicators which need to be monitored is provided in Table 1.

Map with piezometers location			
			
PBUS.1 x: 7628378.91 y: 4905514.27 z: 47.82 water PPv 10.50	PBUS.4 x: 7629513.65 y: 4905476.49 z: 47.69 water PPv 12.30	PBUS.5 x: 7628632.57 y: 4905225.13 z: 46.50 water PPv 11.00	PBUS.6 x: 7629097.43 y: 4905013.41 z: 46.70 water PPv 11.80

Fig.15 Piezometers around the phosphogypsum storage (P1-P4)

Concurrently with the water monitoring it needs to be determined radionuclides content in water. The measurements need to be conducted once a year, in accordance with the

technical standards prescribed in the Rulebook on definition of program for systematic investigations of environmental radioactivity (Official Gazette RS No. 100/10).

Soil monitoring

The location of the storage is surrounded with the industrial complex from the north side and agricultural land from the other sides.

The sampling ought to be performed outside the grounds, up to 500 m from the site of the storage in direction toward a populated settlement. Samples ought to be taken from arable and cultivated land. Composite samples which consist of a greater number of subsamples ought to be taken.

The objective of investigation is monitoring of changes and eventual increase or reduction of concentrations of the analyzed elements in relation to the state before opening of the phosphogypsum storage. The all works need to be harmonized and obtained results are compared with provisions from the valid Regulation on systematic soil quality monitoring program**,** indicators for assessment of risk **of** soil degradation, and methodology for development of remediation programs (Official Gazette of RS, No. 88/2010).

The radionuclides content need to be determined on collected samples. The measurements are to be performed at least once a year, and in accordance with the technical standards prescribed in the Rulebook on definition of program for systematic investigations of environmental radioactivity (Official Gazette RS No. 100/10).

The list of physical and chemical parameters, i.e. indicators which need to be monitored is proved in Table 1.

Accidental situations

From the accidental situations which may have negative implications on environment the following are possible:

- the damage on the closed return water supply system, which supplies the plant with return water from the phosphogypsum storage;
- the damage on the transport system for phosphogypsum suspension, on the pipeline between the factory and the phosphogypsum storage;
- the damage on the storage.

If there is a damage on the return water supply system from the phosphogypsum storage it is possible to occur increased pollutants concentration in groundwaters. If this accident occurs it is required to immediately conduct unscheduled sampling from the all piezometers in order to realize a negative impact caused by the damage. Depending on the damage intensity it is required to conduct water sampling and determination of the relevant parameters (Table 1) several times during the first day, and at least once a day during several following days. The unscheduled sampling is stopped as soon as water quality becomes usual.

The similar effects and procedures are in case of the damage on the pipeline for the transport of suspension from the factory to the phosphogypsum storage.

If there is some damage at the storage (failure, sliding, overflow) it is possible pollution of the surrounding soil and groundwaters, in case of a larger damage the consequences can be detected on the Danube. In that case it is required to act in the same way with the water monitoring as with the damage on the system for return water supply. In the part of the

terrain affected with phosphogypsum spillage it is required to collect at least 3 soil samples and investigate pollution.

It has been proposed the adaptive monitoring system in order to achieve an efficient environmental monitoring.

Monitoring ought to be established with trucking down at least those parameters provided in this Study. After monitoring is established and parameters are monitored for several years it is required, through the auditing process, to perform harmonization, i.e. adaptation of parameters which ought to be monitored in the next period. With that will be stopped monitoring of the parameters which are not characteristic for the technological process, but it will be put emphasis on importance and change of monitoring dynamics of the parameters selected like potentially dangerous. In conceptualization of proposals for adoption of corrected monitoring programme which would include monitoring of harmonized parameters it is important to conduct the auditing programme.