стан навколишнього середовища в якості підґрунтя про прийняття рішень щодо режиму роботи малої ГЕС. Дані повинні включати виміри рівнів витрат річкового стоку у верхньому і нижньому б'єфах, параметри якості води для підтримання прийнятного стану гідроекосистеми в умовах меженного стоку, забезпечення інтересів рибного господарства, контролю рівнів забруднення, планування екологічних та інших видів попусків.

Висновки. В результаті впровадження проектів малих ГЕС в Карпатському регіоні очікуються як позитивні, так і негативні впливи на навколишнє середовище. Останні не можна вважати значимими. Мінімізація або уникнення встановлених негативних впливів можлива шляхом повної відповідності запланованих дій до діючого чинного природоохоронного законодавства та проектованих техніко-технологічних рішень і застосування комплексу заходів, спрямованих на охорону навколишнього середовища. Запропоновано інженерно-технічні рішення для реалізації їх на практиці при будівництві малих ГЕС, які мінімізують техногенний вплив до приведення стану природно-техногенних гідроекосистем в оптимальний – безпечний.

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ЕКОЛОГІЯ ПЕДОСФЕРИ

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TECHNICAL AND FINANCIAL SOLUTIONS OF THE SOIL REMEDIATION - A CASE STUDY

This paper will present the technical and financial solutions of the soil remediation in case of a historical pollution with hydrocarbon. The study is a continuation of the already published paper by Oros, Coman and Gusat in [1], where the polluted area was described regarding the surface, pollution contain and some results of the modeling.

Here, the authors will present parts of the technical project which have been analyzed and proposed to the private company as the best solutions to rehabilitate the soil. Four stages will be presented with four treatment methods of the soil. The financial aspects will be described also, regarding the demolition cost for example or the cost of the selected technology.

This case study is a good opportunity for other private companies which are in same situation (historical polluted area) to analyze their financial options of the soil's rehabilitation.

Keywords: technical project, rehabilitation costs, soil pollution, financial schemes

An area bigger than 3,500 m² was historical contaminated with hydrocarbon (fuel oil source), whereby to enclose the area in the future development plan of the private owner company, the soil must be decontaminated firstly. According to the chemical analysis presented already in [1], the normal values for total hydrocarbons (THP) should be <100 mg / kg dry weight (mg/kg d.w.), the alert limit is between 101 and 1,000 (mg/kg d.w.) and the intervention limit is > 2,000 (mg/kg d.w.) after [2] for less sensitive land. In our case study a maximum of 469,325.88 mg / kg d.w. was founded.

Figure 1 shows the area of 3,500 m² which include the old construction with 505 m^2 to be demolished and the proposed decanter to be used with a volume of 1,277.5 m^3, whereby the effective used volume will reach only 1,124.2 m^3 (88%). In the following, four stages and four treatments methods of the soil will be discussed.

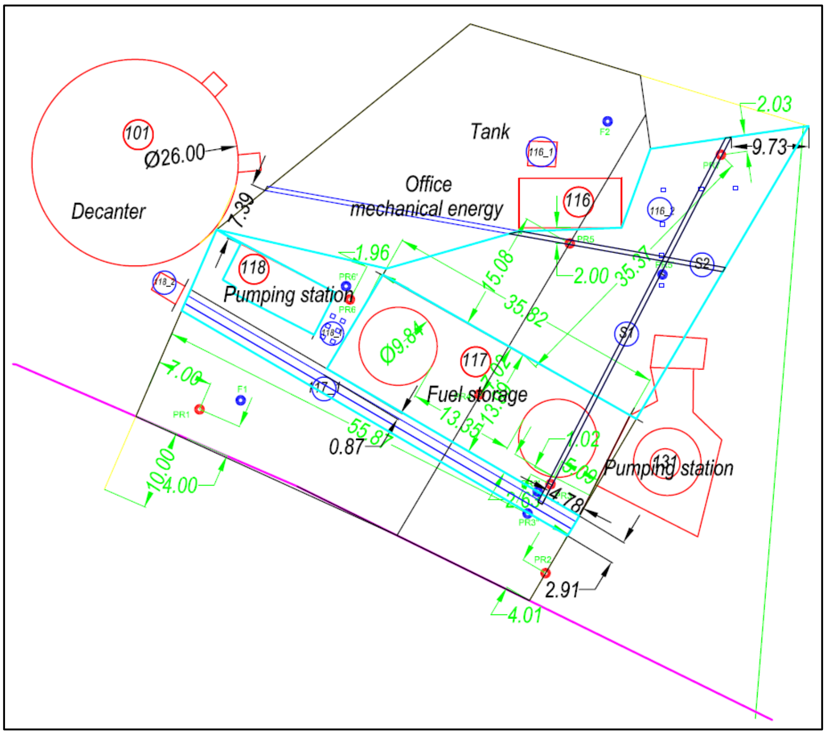

Figure 1. Site to be decontaminated, with the old constructions and Decanter with a volume of 1,277.5 m^3

Needed stages for remediation works

Four stages have been proposed here as following:

Stage 1: Removal of all remaining technological waste from the old site, a cleaning action of a total of 94 barrels tanks with waste sludge (Figure 2).

Figure 2. Barrels with a capacity of 200 l

Stage 2: Collection and disposal of fuel oil from storage, pumping station, oil separator, oil collecting groove. Cleaning of reservoirs, pumping stations, underground concrete channels (Figure 3).

Figure 3. Liquid and solid asphalt fractions to be removed in Stage 2

Stage 3: Demolition and waste management from former buildings (see also Figure 1)

Stage 4: Soil remediation

For this stage, the authors have proposed four methods to decontaminate the soil:

- 1st Method – Soil excavation of 1/3 and its burning and soil bioremediation other 2/3 of the site
- 2nd Method – Excavation of the whole soil and its bioremediation
- 3rd Method – Excavation of the whole soil, transportation and disposal or burning
- 4th Method – Selective excavation of the soil and its bioremediation

Technical aspects

Stage 1: Here 94 barrels have been filled in a cleaning action of the area and as result, an amount of 17.35 t of waste was transportated by an aproved company to be proper disposed/or burned.

Stage 2: The collection of solid asphalt fractions will be done mechanically and manually and temporarily should be stored in metal barrels with a volume of 200 liters on the existing platform on site. The liquid fractions existing in the pump house and the oil separator will be collected by pumping with whirlpool and will be temporarily stored in the barrels as well. The concrete cleaning of the stored fuel (117), channel capture leaks (117_1), pumping station (118) is made by mechanical brushing and washing with biodegradable detergent. After our estimation an amount of 36.9t of waste will be collected in additionall 200 barrels on this stage and transported for a proper disposal/or burning.

Stage 3: This stage involves the following steps: Weakening the buildings by cutting the main pillars. The operation is done with an excavator equipped with a multifunctional hydraulically powered scissors that cut progressively the pillars and the roof. Crumbling the concrete. The primary division is performed using hydraulic scissors and hammer to obtain manageable sized pieces.

Harnessing the resulting material. The resulting material is used as filler by the company and any excess will be used as a coating material at different landfills of the area.

At this stage the estimated waste amount is showed in Table 1.

To execute the demolition operations were provided with autonomous machines powered with diesel engines, using the following equipment:

- Multifunction excavator with hammer attachment possibilities: 1 pc.
- Backhoe with hammer: 1 pc.
- Backhoe without hammer: 1 pc.
- Loader: 1 pc.
- Loader with telescopic arm: 1 pc.
- Crane TELEMAC 12.5 tons: 1 pc.
- Dumpers (16 m^3): 2 pcs.

Table 1

Estimated waste construction

Nr. crt.	Construction accord to Figure 1	Material	UM	Amount
1.	Offices mechanical energy (116)	Beton&Bricks	m^3	18.23
2.	Basin (116_1)	beton	m^3	1.1
3.	Six big pillars (116_2)	beton	m^3	13.6
4.	Fuel storage (117)	beton	m^3	67.5
5.	Capture channel of leakage (117_1)	beton	m^3	7.3
6.	Pumping station (118)	Beton&Bricks	m^3	32.8
7.	Six small pillars (118_1)	beton	m^3	2.5
8.	Pumping station (118_2)	beton	m^3	0.5
9.	Pumping station (131)	Beton&Bricks	m^3	75.6
	TOTAL		m^3	**241.09**

The stages from 1 to 3 will be the same, whereby in the stage 4, the authors propos four methods to be chosen.

Stage 4: 1st Method – Soil excavation of 1/3 and its burning and soil bioremediation other 2/3 of the site. This method has been presented already in [1]. Additionally we can include here the specific bioremediation method to be discussed. The determination of nutrients is very important because in the process of bioremediation the nutrients including bacteria and bacterial culture will get in contact with contaminants. The surfactants and nutrient consumption relates to the content of pollutants, in this case oil, with an average amount of THP of 4.350,24 mg/kg d.w.

In our case an amount of 3,222.20 t of polluted soil should be remediated. In the suitable lliterature for biological decontamination processes the proportion of carbon, nitrogen and phosphorus will be 100:10: 1. [3]. Because by THP (chemical formula C_nH_{2n}) the carbon content is around 86%, the average content of C resulting reminded will be 3,741.2 mg / kg contaminated soil. Respecting the proportions set, the requirement will be 374 mg / kg nitrogen (N) and 37 mg / kg phosphorus (P).

Choosing to N the ammonium nitrate (NH_4NO_3) and taking into account the proportion of nitrogen in the salt, resulting specific fuel consumption of ammonium nitrate will be 900 mg / kg of contaminated soil.

For P is chosen trisodium phosphate (Na_3PO_4), resulting in specific consumption of Na_3PO_4 of 185 mg / kg of contaminated soil. For the entire mass of contaminated soil

3,222,207.72 kilograms the requirement is 2,900 kg ammonium nitrate and 112 kg of trisodium phosphate.

To speed up the process of soil's decontamination, it is proposed to use a biodegradable surfactant containing trisodium phosphate at a rate of up to 30%, among other surfactants and enzymes. Under these conditions the phosphate source is the detergent. Dosage is as a solution of 25 g / l for which purpose detergent dissolve 5 kg in 200 liters of water contained in a 200 liter barrel fitted with a drain valve.

The ammonium nitrate will be sprayed on the soil during of soil loosening measure. Respecting the proportion of 10:1 with phosphate in a volume of 200 l barrel dissolve 15 kilograms of nitrogen, which is dosed under the same conditions.

- 2nd Method – Excavation of the whole soil and its bioremediation

As well as the 1st Method, this method has been presented already in [1]. By this Method, an amount of 5,281.41 t of polluted soil should be remediated with an average amount of THP of 111.998,90 mg/kg d.w.

- 3rd Method – Excavation of the whole soil, transportation and disposal or burning

By this Method, an amount of 3,520.94 t of polluted soil should be remediated with an average amount of THP of 111.998,90 mg/kg d.w.

- 4th Method – Selective excavation of the soil and its bioremediation

This method involves a selective excavation of soil heavily polluted and unpolluted or poor polluted soil. Taking into account the results of simulations in soil of THP concentrations described in [1], an execution is proposed with two grooves remediation sampling S1 (52 m length) and S2 (59m) with the width and depth of 0.6 m (see Figure 1). The volume of excavated soil from S1 and S2 will be 29.97m³.

This soil is proposed to be decontaminated by bioremediation (up to 60 cm depth = 965.52 m³ and a mass of 1,581.83 t) will be stored and decontaminated in Decanter (101 in Figure 1) right in the vicinity of the contaminated site.

Figure 4. Decanter (101) used in Method 4 for bioremediation

The decanter will be cleared and provided at the base with 2 to 3 perforated PVC pipe and connected to the surface to feed air from the bottom up to the surface. Circulated air will support the growth of bacteria used for decontamination.

The difference in settling volume of about 150m³ will be useful to capture the rain water. It is very important to avoid the compaction of decontaminated soil to keep the bacterial growth rate.

Financial aspects. By the soil remediation not only the technology but largely the financial aspects (investments funds) could indicate the best method to be used. Here we will present the prices (in EUR by a rate of 1 □ to 4.55 RON), to show how different can be one method to another.

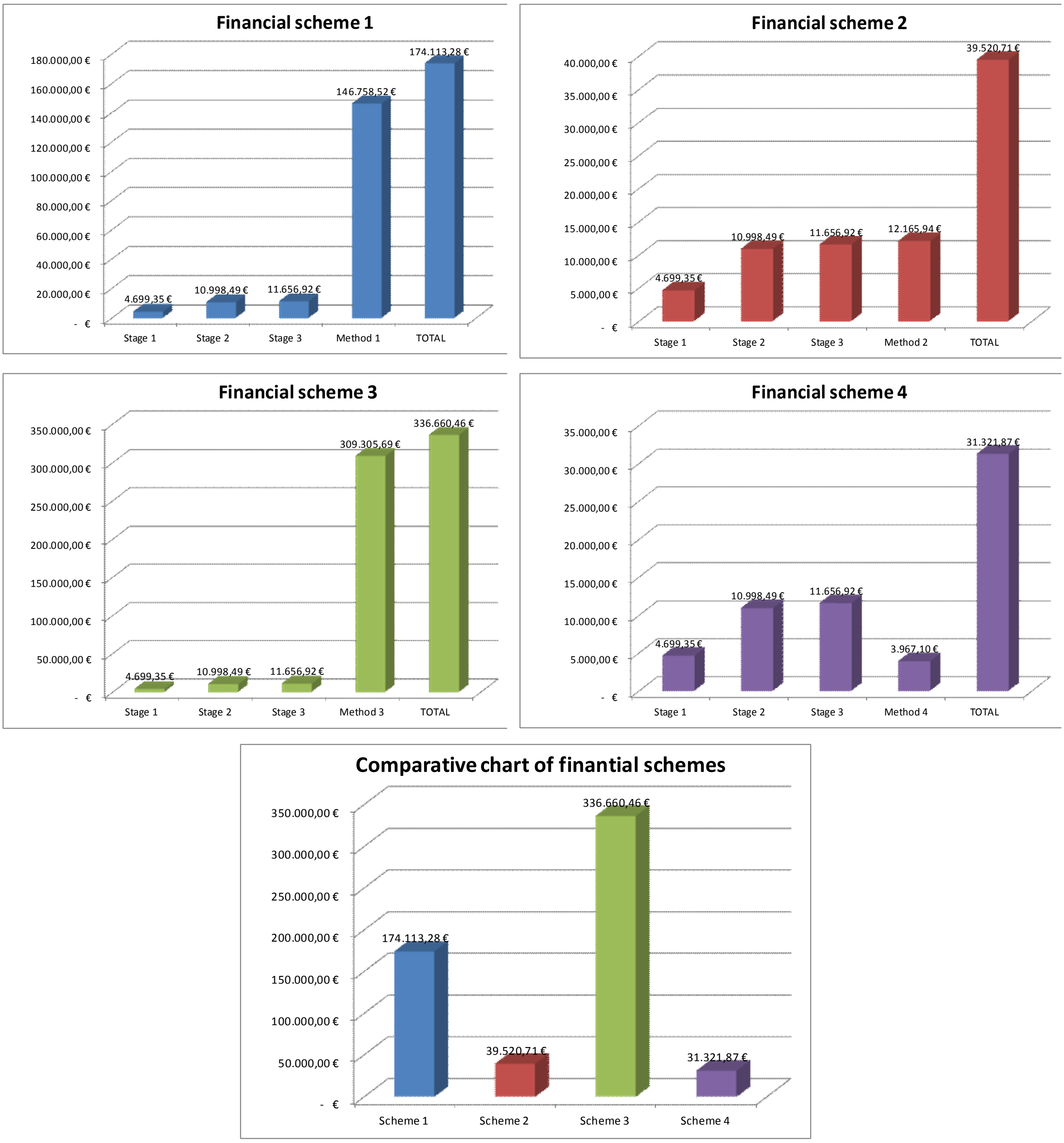

Figure 5: Charts of Financial schemes for 4 Stages

It can be observed, that the financial scheme 4 with an amount of 31,321.87□ is the best financial solution with the advantage that the bioremediation will be done in situ!

Monitoring aspects. The specifics of the remediation work that will be conducted in a short period and aimed at achieving complete cleanup of the site, does not require that systematic emission of pollutants to be monitored after remediation phase.

Real situation of soil pollution monitoring will be carried out at all stages of excavation work by direct observation and by sampling and laboratory analysis. Where observations indicate the existence of intense pollution as less polluted areas or depths, will be readjustments of the planned work. Table 2 indicates the monitoring time and samples to be conducted.

Table 2

Monitoring program. Duration 5 years.

Nr. cr.	Stage of the project	Samples	Nr. of samples	Timing	Analyze	Responsible
1	Stage of bioremediation	Soil	10	During the stage	TPH	Company
		Water from drilling shaft	2	At the beginning and during the stage	TPH	Company
2	Bioremediation	Soil from Decanter	3	6 months	TPH	Company
		Water from drilling shaft	1	3 months	TPH	Company
		Soil from site	1	Yearly	TPH	Company

Conclusions. In such cases, a historical polluted areas could be a big problem for a private company. Such sites occur in many zones in Romania. The problem in many cases is that the new owner of these areas (e.g. a private company as showed in [1]) doesn't have an idea if that soil is polluted or not, so it is very important for the private company to have a financial support from the state for reducing the rehabilitation costs.

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