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WORLD ENVIRONMENT CENTER

EVALUATION OF GROUNDWATER CONTAMINATION BY

PETROLEUM PRODUCTS

CITY OF PLOIESTI - PRAHOVA COUNTY

ROMANIA

FEBRUARY 6 - 10, 1995

**WORLD ENVIRONMENT CENTER
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DISCLAIMER

The opinions expressed in this report are the professional opinions of the authors and does not represent the official position of the Government of United States or the World Environment Center.

TABLE OF CONTENTS

	Page
I. Introduction	1-2
II. Evaluation of Groundwater Contamination by Petroleum Products Report	3-8

INTRODUCTION

The World Environment Center (WEC) is conducting a waste minimization (WM) program in Romania. As part of that program, a waste minimization workshop was held June 13-16, 1994 in Valea cu Pisti for eight major chemical and petrochemical companies.

During the workshop, the WEC experts offered to provide answers to environmental questions that the company representatives may have, either as a group, or by individual company. The participants chose to meet with the WEC experts on an individual basis.

Two of the refinery representatives sought WEC assistance in helping them prepare a remediation program for the groundwater contamination caused by refinery operations, the transport of crude oil and hydrocarbon products by pipeline and other modes of transportation. The degree of the contamination has been increased due to causes beyond the control of the petroleum sector enterprises; such causes were World War II bombings and earthquakes.

WEC recommended that the refineries work together and form an ad-hoc committee of involved companies.

10 companies met under the aegis of Rafirom, the Institute which represents the refinery sector. The meetings produced positive results. The participants provided WEC with a report of its meeting and agreed that funding for initiating a remediation project would be provided by them.

USAID agreed with the approach that WEC was proposing. WEC obtained the pro bono services of three consulting firms who met with the interested Romanian companies during the week of February 6-10, 1995.

The following report jointly prepared by the three consulting companies contains their findings, and in compliance with the request of the petroleum companies, their recommendations to initiate a clean-up program.

The preliminary investigation and the experts' many years of experience indicate to them that the groundwater contamination is very severe and poses a serious threat to the drinking water in the region. Further information gathering is needed to better define the contamination.

It is very difficult to estimate the volume of free-phase petroleum product present on the groundwater system. However, it's reasonable to assume that the possibility exists for pumping 100,000 barrels of oil from the groundwater system. At the current price of approximately \$16 per barrel, the potential value of that oil

would be \$1,600,000. The results of additional work could indicate the possibility of higher levels of recoverable oil.

This report is submitted with the understanding that any future effort cannot be funded by USAID or WEC. The involved companies will have to assess themselves on an agreed upon basis to generate funds needed to initiate any project.

After a sufficient amount of information has been obtained which will indicate the severity of the contamination and the amount of recoverable oil, WEC will make its best effort to investigate sources of funding.

It is further understood that should a project be started, that formal contracts will be prepared for the three parties; Romanian petroleum industry enterprises, U.S.A. consulting companies, and WEC. WEC will act as the facilitator between the Committee and the Consultants collectively or individually.

WEC expresses its appreciation to USAID, the Romanian petroleum enterprises, the Romanian government and the pro bono experts for their fine cooperation in bringing the potential project to this stage of development.

EVALUATION OF GROUNDWATER CONTAMINATION BY PETROLEUM PRODUCTS

Romanian Refineries and Pipelines

- 1. Astra Romana, S.A**
- 2. Petrobrazi, S.A**
- 3. Petrotel, S.A**
- 4. Vega, S.A**
- 5. Conpet, S.A**
- 6. Petrotran, S.A**

City of Ploiesti, - Prahova County Romania

Prepared for

**World Environmental Center
Mr. Thomas J. McGrath, Vice President**

Prepared by

**Volunteer Specialists
Dr. John B. Malouf, P.E. - GeoMonitoring Services, Inc.
Mr. Dan C. Buzeu, CPG - Leggett, Brashears & Graham, Inc.
Mr. William Beck - Beck Consulting**

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In accordance with the agreement for services between the World Environment Center (WEC), and the volunteer specialists Mr. Dan Buzea, Mr. William Beck and Dr. John Malouf, P.E., the field trip to Romania was conducted between February 3 through February 11, 1995.

The purpose of the field visit was to evaluate the sources and the extent of groundwater contamination by petroleum products at refineries and pipelines located in the vicinity of Ploiesti City, Prahova County, Romania.

During the site visits, the volunteer specialists met with the following representatives of the Romanian Government and Industries:

- Ministry of Industry
- Ministry of Waters, Forest and Environmental Protection
- Governor of Prahova County
- Environmental Protection Agency, Ploiesti
- Petrobrazi, S.A. (refinery)
- Compet, S.A. (pipeline)
- ICERP, S.A. (research institute)
- Rafirom, S.A.
- Petrotrans, S.A. (pipeline)
- Petrotel, S.A. (refinery)
- Vega, S.A. (refinery)
- Astra, S.A. (refinery)

A more detailed list of the meeting attendees is shown in the attached Table I.

In addition, the three specialists completed site visits at four refineries; Petrobrazi, Petrotel, Vega and Astra and two pipeline companies; Compet and Petrotrans. During these visits, several possible sources of groundwater contamination were evaluated, including some of site waste disposal ponds that will have to be immediately remediated, to discontinue the release of hydrocarbon products into the ground.

Site Assessment and Project Phase Approach:

The limited evaluation conducted by the U.S. consulting team concluded that the existing contamination by petroleum products south and southeast of Ploiesti City presents a very serious threat to the water supply in the region. Based on the limited information that was received on each of the facilities that were visited during the month of February 1995, it is recommended that a remediation project be initiated as soon as possible and to divide the project into five phases, as shown in Figure 1. All five phases should be completed by a joint U.S. consultants and Romanian team, to be selected by the committee. The

successful accomplishment of the proposed work is dependent upon the committee for its arrangements for local assistance, guidance and support from organizations such as the Ministry of Industry, Ministry of Environmental Protection, RAFIROM SA, ICEP SA (Institute of Research of Research for Petroleum Processing and Petrochemistry), IPI SA (Design Institute for Petrochemistry) and the Environmental Protection Agency in the city of Ploiesti.

PHASE I.

Phase I of this project should be divided into three tasks. The main purpose of these three tasks is to properly understand the problem and to be well prepared for evaluating the potentials for product recovery and for initiating the Plume Interception Design.

Task 1. Evaluation of available data:

This task will include the following scope of work:

- ◆ site visits by the U.S. consulting team
- ◆ meetings and coordination between the U.S. and Romanian teams
- ◆ collect all available existing data
- ◆ evaluate the data; and
- ◆ prepare a summary report.

Task 2. Preliminary field investigation:

- ◆ inventory of all monitor/observation and production wells
- ◆ groundwater and petroleum product level measurements and product thickness evaluation
- ◆ monitor/observation and production wells evaluation and location survey
- ◆ collection and analysis of groundwater samples from observation wells, domestic wells and the water supply wells without free-phase petroleum product
- ◆ collection and analysis of water samples from local streams and rivers

- ◆ provide equipment and training to the Romanian team for groundwater and product level measurements and groundwater analysis for petroleum products
- ◆ prepare a groundwater monitor program
- ◆ conduct a preliminary groundwater computer model to define the extent of the plumes
- ◆ evaluate the feasibility of in-situ treatment and bioremediation of contaminated sites of waste disposal facilities and sites with spill contamination along the pipelines
- ◆ evaluate and analyze data and prepare a report

The Task 2 report will include recommendations for additional subsurface investigations to obtain the following data:

- define the extent of free-phase and dissolved petroleum product plumes
- collect data on groundwater elevations and groundwater flow direction
- develop estimates on approximate volumes of free-phase petroleum products below the ground
- locate additional wells or other systems for dissolved plume interception and free-phase petroleum product recovery

Based on the preliminary evaluation of the data provided by the refineries and our team experience at U.S. refineries under similar geologic and hydrogeologic conditions, it is apparent that significant volumes of free-phase petroleum product is present on top of the groundwater in the region. At the present time, it is difficult to estimate the volume of free-phase petroleum product; however, depending on the depth and thickness of the product, it is expected that fifty percent of the existing petroleum product can be recovered for reprocessing.

Task 3 Limited petroleum product recovery:

Following task 2 and evaluation of the free-phase petroleum product, floating on top of the groundwater, will be conducted inside each refinery. Based on this evaluation, the following tasks will be implemented at each refinery:

- select observation/monitor or production well, which can be used for product recovery
- select and supply state of the art equipment for groundwater pumping and product recovery
- conduct pumping tests and determine the rate of petroleum product recovery
- install and operate a minimum of four recovery systems (one per refinery); and
- start recovery of petroleum product which can provide additional funding for the project by reprocessing the product

PETROLEUM PRODUCT SOURCES FOR GROUNDWATER CONTAMINATION

As part of Phase I investigations, the possible sources of petroleum products that could be potentially contaminating the groundwater will be investigated at each of the sites. However, detail design information to eliminate such sources will only be addressed in Phase II of this project. It is possible, however, that some obvious solutions can be addressed in Phase I to reduce the impact of the releases of hydrocarbon within the refinery area.

Based on our observations, during the brief visits to the four refinery sites, we have summarized the possible major sources of leaking hydrocarbon products/hydrocarbon wastes to the groundwater. The following is a summary list of such sources that will be evaluated during this project to reduce the limit of this problem on the groundwater.

- Product and intermediate storage tanks
- Process piping system
- Abandoned equipment and pipelines
- API oil water separator
- Rail hydrocarbon loading area
- Waste water trenches/sumps/transfer systems

PHASE II

Phase II of the project can not be discussed in detail at this point because the scope of work for this Phase is dependent on the results obtained from Phase I. However, some information on Phase II are obvious at this time and will involve extensive field operation for plume delineation utilizing a drilling rig. The plume delineation will characterize the extent of the soluble and the floating hydrocarbon plumes as it relates to the four refineries and the pipeline networks in the area. In addition, aquifer information will be gathered to determine if the plumes from various facilities are interconnected or separated by a naturally occurring divider between the aquifer formations. Further, information regarding the groundwater interconnection with the two adjacent rivers will also be part of this field investigation. The outcome of Phase II is a design document for plume interception and for an efficient hydrocarbon recovery system.

Phase II will begin first by shipping an all terrain drilling rig to Romania and then mobilizing the staff required to conduct the field operation within the region of the four refineries. The most critical information to be obtained from this task is the extent of the plume and the formation characteristics. This operation could last about four months and if needed the field operation can be extended until all essential data has been obtained. After completing this field task, the equipment will be stored at a safe place in Romania and the staff will return to the U.S. to analyze the data and to prepare a design document for Plume Interception and Hydrocarbon Recovery for this specific region.

The type of recovery system that will be utilized is very much unknown at this time, and therefore, we cannot discuss any details about the system implementation requirements. However, depending on the funds availability, we recommend that the recovery system implementation should be completed within two years from the start of the project. In addition, depending on our analysis of the existing recovery system, certain modifications could be implemented that would allow us to begin partial recovery of product and plume interception in less than one year from the start of this project.

Included in the report in Figure One as part of phase II is a recommendation for waste minimization and pollution prevention training. This will be a crucial part of the entire project. There will be no lasting improvement if all employees of the enterprises are not trained in pollution prevention.

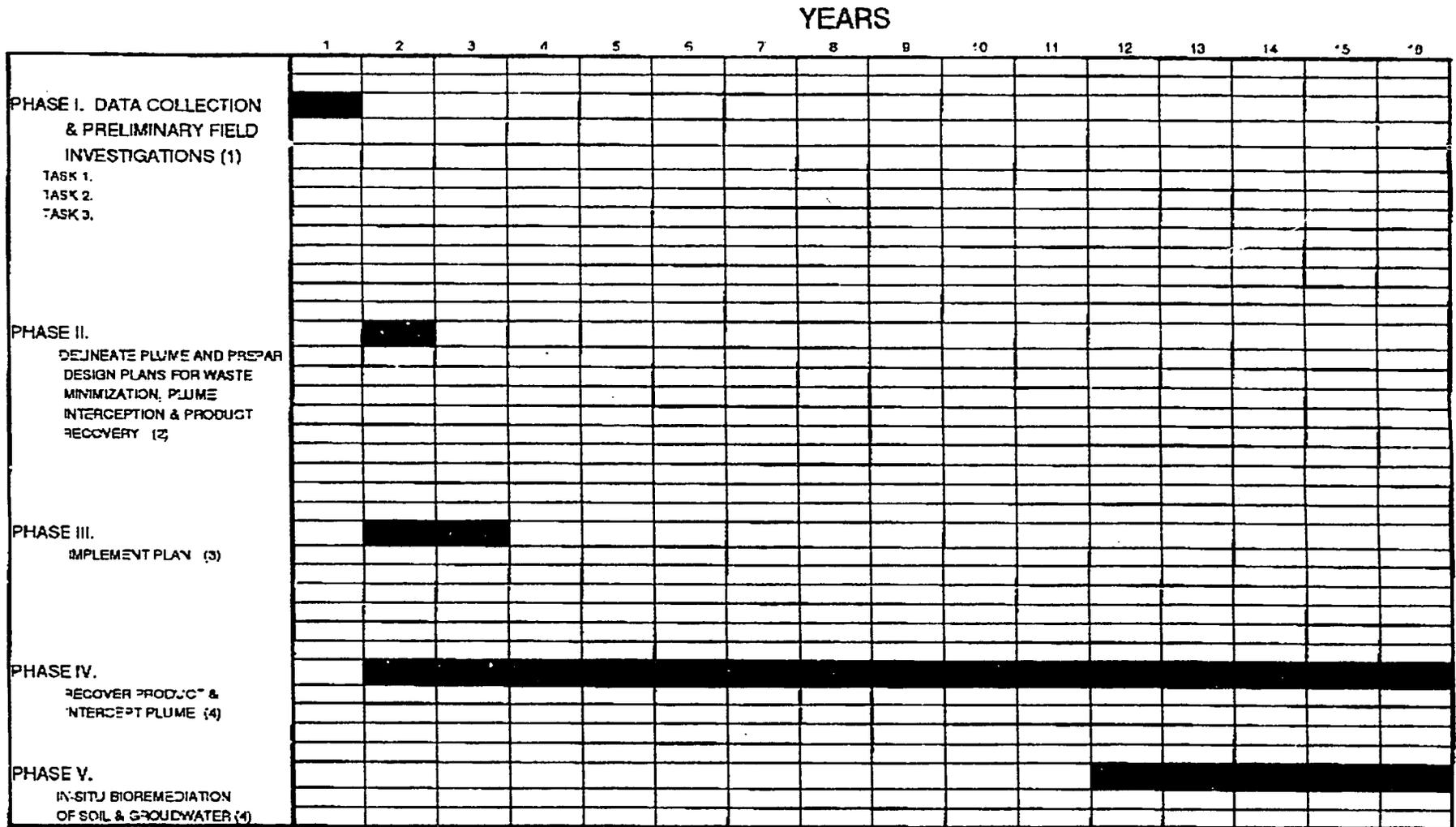
Future Actions

The U.S. consultants, via WEC, will send Rafirom, the refineries and pipeline enterprises cost estimates for Phase I.

WEC expresses its appreciation to all for the excellent cooperation received during its visit.

FIGURE 1.

WASTE MINIMIZATION, PLUME INTERCEPTION AND RECOVERY SCHEDULE



(1) SEE REPORT FOR THE DETAILS OF TASKS 1 THROUGH 3.

(2) INSTALL BORINGS TO DEFINE STRATIGRAPHY AND TO DELINEATE THE PLUME LOCATION OBTAIN INFORMATION ON GROUNDWATER GRADIENT AND FORMATION CHARACTERISTICS & WASTE MINIMIZATION DATA.

(3) CONSTRUCT ALL THE RECOMMENDED FACILITIES TO BE USED TO STOP PLUME FROM MIGRATING ANY FURTHER, AND TO RECOVER THE FREE FLOATING HYDROCARBON ON TOP OF THE GROUNDWATER.

(4) IT IS DIFFICULT AT THIS TIME TO ESTIMATE THE DURATION OF TASKS III & IV. HOWEVER, IN THE FOURTH YEAR OF THIS OPERATION NEW DURATION ESTIMATES WILL BE FIRMED UP.

TABLE 1

**LIST OF ROMANIAN REPRESENTATIVES THAT
MET WITH WEC SPECIALISTS**

No.	Agency or Industry	Name	Title	Telephone
1	Ministry of Industry	Alexandru Georgescu Mircea Turtureanu	dr.ing. expert Manager Technical Division	659 41 91 650 38 80
2	Ministry of Waters, Forests and Environmental Protection	Ioan Jeleu	State Secretary	401 631 60 44
3	Prohova County	Nicolae Balanoli	Governor	40 44 116003
4	Environmental Protection Agency	Marilena Patrascu	Ph.d., P.Eng.	40 44 158068
5	Petrobrazi S.A.	Gheorghe Pop Cristian Georgescu Gheorghe Brankste G. Constantinescu	Chief of Ecology Dept. Utilities Manager Technical Director Refinery Manager	40 7 144621 40 0 44 143121 1044 40 0 44 121620 40 0 44 126773
6	Compel S.A.	Gheorghe Ionescu Andrei Cristache	Chief of Environmental Protection Department Mechanical-Energetic Chief Engineer	044 1212 26 118 971 21226
7	ICERP S.A.	Sorin Hant Cristina Motol Adrian Georgescu	Dipl. Engineer Dipl. Engineer Head of Department	044 13511/ext 117 044 13511/ext 184 40 44 164738
8	RAFIROM S.A.	Liviu Jivan Gheorghe Ionita Luchian Matel	Resch & Development Director Head of Office	401 638 43 20 401 638 61 15 401 638 45 44
9	Petrotrans, S.A.	Sorin Vijoll Petre Petrescu	General Manager Deputy General Mgr.	044 11 51 38 044 11 51 38
10	Petrotel, S.A.	Eugen Iavolschi Vladimir Dragoman	Technical Director Petrochemistry Managing Director	40 044 11 38 31 40 97 14 66 71
11	Vega S.A. Ploiesti	Olaru Ilie	Technical Manager	4-044 121 773
12	Astra Romana	Ghisela Gheorghe Tudor Emil Gheorghita Jolta	Dipl. eng. sing. Dipl. eng.	040-97 147421/233,326 040-97 123379 040-97 147421/233

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