FIELD TEST PROTOCOL
FOR IN-SITU PCB DESTRUCTION
AT THE BENGART & MEMEL SITE

November 1984
Revised June 1985
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1.0 INTRODUCTION

1.1 Background

During the summer of 1983 the first field testing of "APEG" reagents was conducted at the Bengart and Memel site by the Franklin Research Center and Galson Research Corporation in conjunction with EPA Research in Cincinnati. APEG is the generic term for the family of reagents which are based upon the reaction of alkali metals or their hydroxides with polyethylene glycols or their derivatives. The results of this field testing are summarized in a letter from EPA Project Officer, Charles Rogers to James Reidy, Chief of Permits, Solid Waste Branch (see Attachment #1). In addition to the field testing, considerable laboratory testing was subsequently performed to evaluate specific variables which were encountered during the field testing.

The results of this first round of testing of Bengart and Memel soil, and soil from other test sites, lead to the following conclusions:

- PCB's are more easily removed by APEG reagents in sandy soils than in soils containing clay or humic substances (such as those found at the Bengart and Memel site).

- "Processing" the soils (e.g. air drying, pulverizing and/or sifting) prior to reagent application significantly increases the degree of decontamination that may be achieved with a given soil.

- Soil moisture significantly affects the performance of APEG reagents.

Based on these initial testing results[1] the following areas of study have been recommended:

- Methods to enhance the mixing of soil and reagents to provide complete contact.
- Methods to reduce the soil moisture.

1.2 Purpose and Scope

Laboratory testing has been performed to evaluate both the most effective reagent formulations and the most appropriate reagent application method with which to overcome the problems encountered in field applications. Testing was conducted simultaneously by Franklin Research, Galson Research and by the ITT Corporation, in conjunction with the USEPA. The most effective reactions, based on available data, appear to be obtained with the alkali metal hydroxide reagents. Of the application methods evaluated, the slurry process should provide the greatest degree of contact between the soil and reagent. The in-situ process can be equally effective if sufficient amounts of reagent are used. Both these application methods using an APEG reagent will be field-tested side-by-side by the Galson Research Corporation at the Bengart and Memel site.

2.0 TEST AREA DESCRIPTION

Area "A" which was previously utilized as the test area for KPEG/NaPEG testing on the Bengart and Memel site has been paved in accordance with the sites' New York State Department of Environmental Conservation Consent Decree.

(1) USEPA, Industrial Environmental Research Laboratory, "Preliminary Report: Treatment/Detoxification Alternatives of PCB's and Chlorinated Organics", Cincinatti, Ohio, September 1984.

In the original hydrogeologic investigation of the site numerous test pits were utilized to obtain soil samples to assess the extent of surface soil contamination at the site. Based on the results of the hydrogeologic investigation those test pits determined to contain between 50 and 500 ppm of PCB's were scheduled to be removed from the site and disposed of in a secure burial facility. As shown on Figure 1, soils within a ten foot radius of Test Pits 4, 5, 6 and 8, 9, and 10 were identified to be excavated. The analytical results for these six test pits are summarized in Table 1.

The soils located at any of the six test pits should be suitable for field testing. The appropriate volume of soil for each test pit, in accordance with the site's NYSDEC Consent Order, will be excavated and drummed. Prior to testing, approximately two cubic yards of this drummed contaminated soil will be selected and well-mixed in preparation for reagent application.

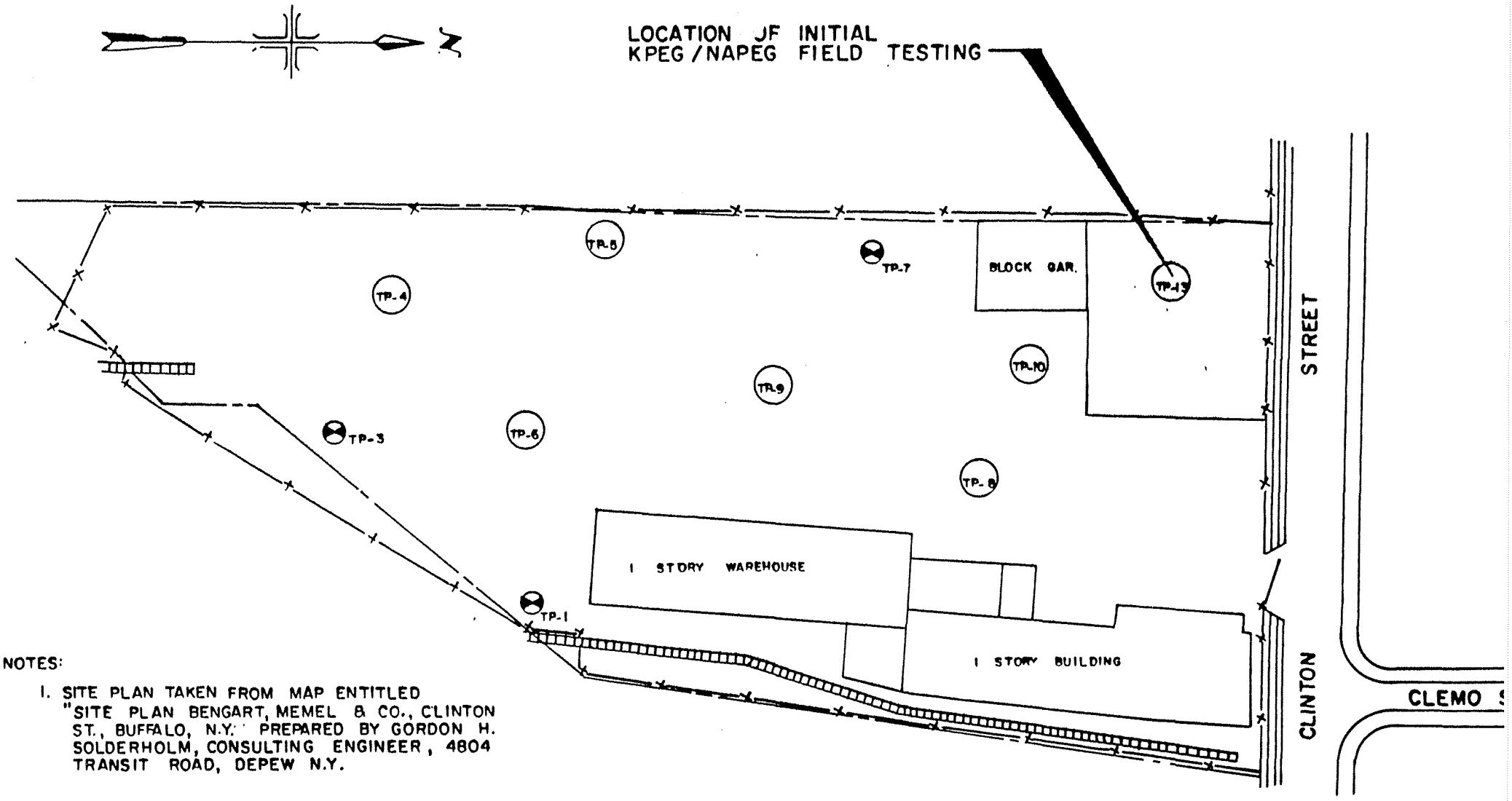
3.0 FIELD TESTING

3.1 Reagent Application Methods

Initial laboratory screening has identified two promising areas for further field testing; heated in-situ treatment and slurry processing. The two cubic yards of soil to be tested will be equally divided and placed into twelve separate specially modified 55-gallon steel drums. Six drums will be used to test in-situ treatment, six will be tested using the slurry process. A description of each application method is given below.

3.1.1 In-Situ Application

As stated previously, a major obstacle to satisfactory decontamination results in the initial field testing of



NOTES:

1. SITE PLAN TAKEN FROM MAP ENTITLED "SITE PLAN BENGART, MEMEL & CO., CLINTON ST., BUFFALO, N.Y." PREPARED BY GORDON H. SOLDERHOLM, CONSULTING ENGINEER, 4804 TRANSIT ROAD, DEPEW N.Y.

LEGEND

(TP) TEST PITS TO BE EXCAVATED

TEST PITS TO BE COVERED WITH 6" FILL

SITE MAP OF THE
BENGART, MEMEL & CO.
PROPERTY

BENGART, MEMEL & CO. NOVEMBER 19(

TABLE 1

ANALYTICAL RESULTS - TEST PIT SAMPLES[2]

TEST PIT NO.	DEPTH FROM SURFACE (inches)	PCB AS AROCLOR (ug/g - dry) 1016	1221	1232	1242	1248	1254	1260	1268
4	0	<0.130	<0.130	<0.130	≤0.130	≤0.130	45.6	79.1	<0.130
	6	<0.052	<0.052	<0.052	≤0.052	≤0.052	21.1	6.67	<0.052
	12	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052	<0.052
	18	<0.071	<0.071	<0.071	<0.071	<0.071	<0.071	<0.071	<0.071
5	0	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.02	<0.001
	6	<0.051	<0.051	<0.051	<0.051	<0.051	25.4	<0.051	<0.051
	18	<0.063	<0.063	<0.063	<0.063	<0.063	45.1	19.6	<0.063
	24	<0.625	<0.625	<0.625	<0.625	<0.625	45.9	<0.625	<0.625
	36	<0.043	<0.043	<0.043	<0.043	<0.043	2.62	<0.043	<0.043
6	0	<0.07	≤0.07	<0.07	<0.07	<0.07	97.7	670	<0.07
	6	<0.088	<0.088	<0.088	<0.088	<0.088	63.5	<0.088	<0.088
	12	<0.049	<0.049	<0.049	<0.049	<0.049	9.54	<0.049	<0.049
	24	<0.027	<0.027	<0.027	<0.027	<0.027	19.0	<0.027	<0.027
8	0	<0.066	<0.066	<0.066	<0.066	<0.066	38.3	115	<0.066
	12	<0.097	<0.097	<0.097	<0.097	<0.097	≤0.097	22.4	<0.097
	18	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060
9	0	<0.110	<0.110	<0.110	<0.110	<0.110	79.5	≤0.110	<0.110
	12	<0.241	<0.241	<0.241	<0.241	<0.241	<0.241	<0.241	<0.241
	18	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049
10	0	≤0.006	≤0.006	<0.006	1.15	≤0.006	0.79	0.90	<0.006
	6	<0.114	<0.114	<0.114	<0.114	<0.114	101.00	13.7	<0.114
	12	<0.052	<0.052	<0.052	<0.052	<0.052	7.48	17.5	<0.052
	24	<0.061	<0.061	<0.061	<0.061	<0.061	≤0.061	<0.061	<0.061

APEG reagents was the presence of in-situ soil moisture. There are a number of methods being evaluated to add heat to the in-situ reagent/soil mixture in order to enhance the reactivity of the reagent, and drive off soil moisture including solar heating; energy from radio frequency heating; and electrical heating. Electrical heating will be tested at the Bengart and Memel site. Figure 2 illustrates the drum configuration utilized to simulate in-situ heating.

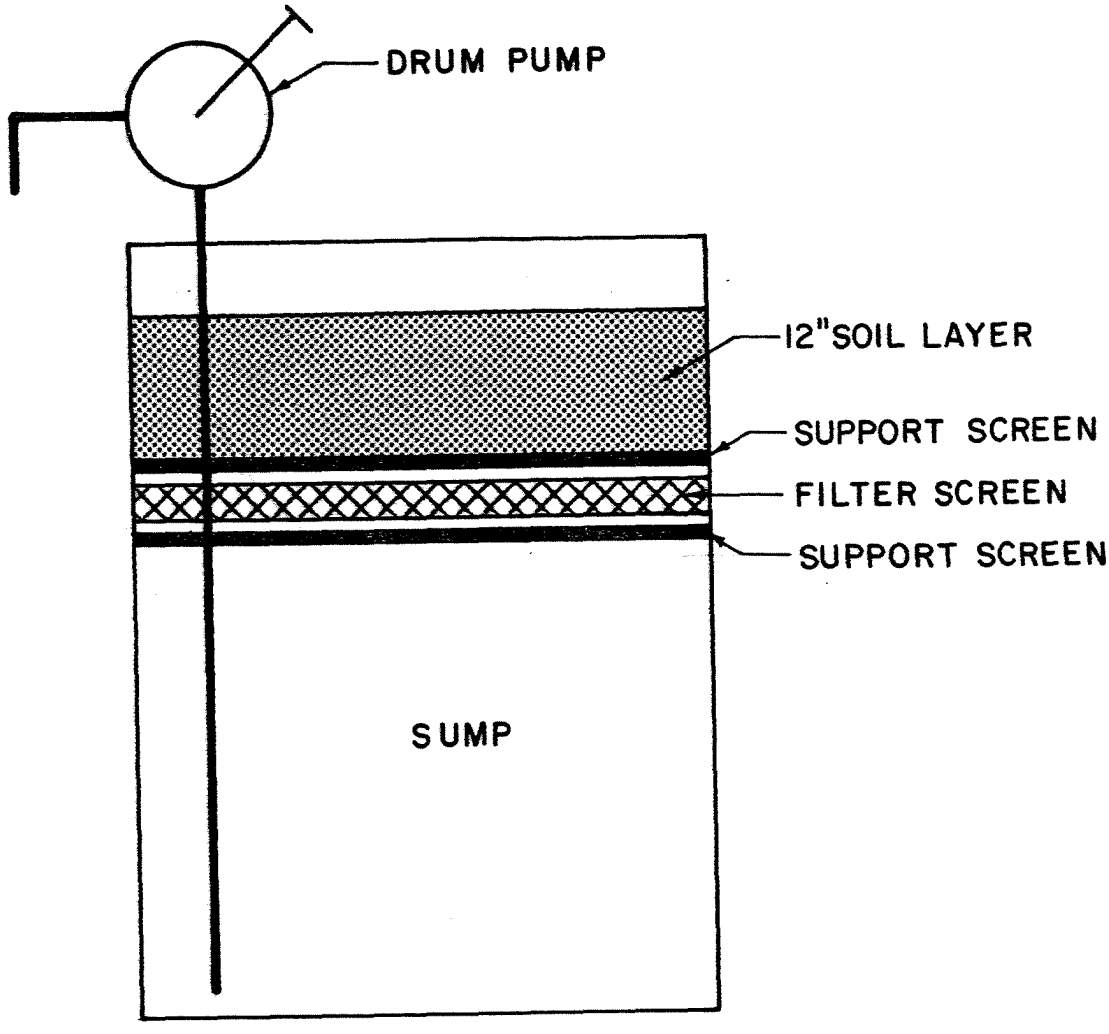
The contents of the drums will first be individually characterized to determine the soils' PCB content. Ten to thirty percent by volume of reagent will then be added to the soil and the mixture will be heated to 70°C via heat tape surrounding the drum. The mixture will remain, heated in the drum, for five to ten days depending on the composition of the soil in the drums. The soils will be sampled and analyzed for PCB content once a day to determine the rate of reaction and reagent effectiveness.

3.1.2 Slurry Process

The slurry process is different from in-situ heating in that the soil is excavated and placed in a large mixer/-reactor (similar to a cement mixer) and contacted with a greater volume of reagent for a shorter period of time. The contents are mixed and the reagent is recovered and reused. A block diagram of the slurry process is shown in Figure 3.

The drum configuration for the slurry process testing at the Bengart and Memel site is similar to that for the in-situ testing except that the drums will be placed on rockers and agitated during the testing period. The soils in each of the six drums will be characterized initially to

FIGURE 2

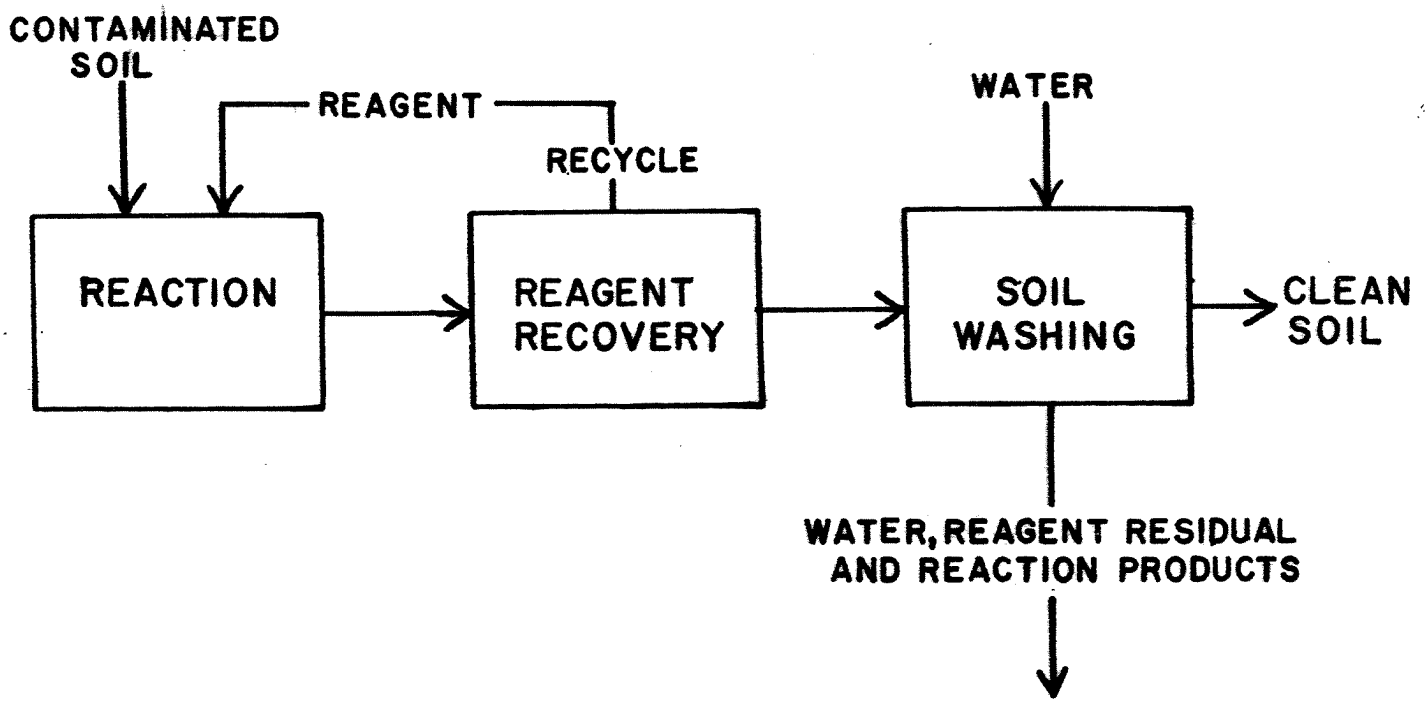


MALCOLM PIRNIE

IN SITU TEST DRUM CONFIGURATION

BENGART & MEMEL, INC. JUNE 1985

FIGURE 3



* AS IDENTIFIED BY THE GALSON RESEARCH CORPORATION

MALCOLM PIRNIE

BLOCK DIAGRAM OF SLURRY PROCESS *

BENGART & MEMEL, INC. JUNE 1985

determine PCB content. Reagent will then be added in a one-to-one ratio. The soil/reagent mixture will be heated and reacted for one to two hours depending on the characteristics of the soil, the reagent will be drained and held for reuse and the soil will be flushed with water to recover additional reagent in the soil. The slurry process testing will be performed as a batch process. At the end of the processing period the soils will be tested again for PCB content to evaluate treatment effectiveness.

3.2 Analytical Methods

Analytical method number 8080 as identified in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA Office of Solid Waste and Emergency Response, Washington D.C., July 1982 will be utilized for all soil samples. Any soils that have been contacted with reagent will be acidified prior to extraction.

4.0 SAFETY PROCEDURES

In order to reduce the possibility of direct skin contact with PCB's during sampling and soil handling activities, each person will be provided with disposable latex surgical gloves, rubber boots and Tyvek disposable coveralls. All protective clothing will remain at the site. To reduce the possibility of inhalation of PCB-contaminated dust particles each worker will also be provided with a fabric dust mask.

All protective gear which directly contacts potentially-contaminated soil will be either decontaminated or discarded in properly labelled drums for later disposal at an approved and permitted disposal facility.

ATTACHMENT 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
CINCINNATI, OHIO 45268

DATE: August 10, 1984

SUBJECT: Field Tests of KPEG at Bengart & Memel Site

FROM: Charles J. Rogers, Physical Scientist CJR
Hazardous Waste Treatment Group, EPCD

TO: James Reidy, Chief of Permits Section
Solid Waste Branch, USEPA Region II

Attached is a letter prepared at my request by Dr. Frank Iaconianni, Franklin Research Center, that describes the Franklin results from the KPEG field test conducted August 22, 1983, at the Bengart & Memel PCB-contaminated area in Buffalo, New York.

In addition to Franklin, Mr. Robert Peterson, Galson Research Corporation, Syracuse, New York, participated in the August 22 field test. The Galson reagent was applied in Test Area #1 and the Franklin reagent in Test Area #2 (see attachment). Soil samples were taken from treated areas on 9/1/83, 9/12/83 and 5/17/84. The measurements obtained on 9/1/83 and 9/12/83 (as well as baseline measurements taken on 8/2/83) are shown in the attachment. Dr. Iaconianni's letter discusses the measurements made by Franklin Research Center on 5/17/84. Clearly the data show many anomalies, and Dr. Iaconianni has suggested a number of possibilities that might explain these results.

Since the resources available to the study permitted only composite samples, there was no possibility of conducting any statistical analysis whatsoever. Furthermore, the late start of the study prevented us from evaluating multiple KPEG treatment which, in earlier laboratory studies, had produced a decided enhancement of the dechlorination action of KPEG.

In addition to multiple KPEG treatments we are currently evaluating radio frequency heating and soil extraction as a way to enhance KPEG destruction of toxic halogenated pollutants in soils. We are familiar with the Bengart & Memel site, believe it to be typical of many other PCB-contaminated sites throughout the country, and would like to test our improved PCB treatment system at this location in the spring/summer of 1985. Since our FY 1985 budget will permit us to make many more measurements, it will be possible to design the experiment in such a way as to permit a rigorous statistical analysis of the data.

If there are any questions, feel free to contact me at FTS 684-7757.

Attachments

cc: Garrett Smith, Region II
John Brogart, Region II
~~Ann-Marie McMannis, Malcolm Pirnie~~
David Stephan
Clyde Dial
Albert Klee

PRELIMINARY DATA SUMMARY OF KPEG APPLICATION TESTING

	Samples Collected 8/2/83 Untreated Soil			Samples Collected 9/1/83 Treated Soil-One Application			Samples Collected 9/12/83 Treated Soil-One Application		
	Control Area	Test Area I	Test Area II	Control Area	Test Area I	Test Area II	Control Area	Test Area I	Test Area II
Recra Research Results	220	193	320						
Galson Scientific Results				118	56		107	109	
Franklin Research Results				130		123	137		99

- All results reported as ppm of Aroclor 1260

- Note: The numbers in this table represent composites of from 3 to 5 samples per test/control area

Franklin Research Center
A Division of The Franklin Institute

August 1, 1984

U. S. Environmental Protection Agency
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

Attention: Mr. Charles J. Rogers, Project Officer

Reference: Grant Assistance ID No. CR810068-02-0;
Field Tests at the Bengart & Memel Site, Buffalo, NY

Dear Charles:

The results of the recent field tests at the Bengart and Memel site, Buffalo, NY, conducted in conjunction with EPA and Malcolm Pirnie Inc. are presented and assessed. During this study, several technical problems were encountered which have led to the acquisition of inconclusive results in complete contrast to those obtained under laboratory-controlled conditions. The point that must be stressed is that these problems, which were unforeseen in the laboratory, are not impossible to overcome in the field. There is no reason to believe that a direct chemical treatment of PCB-contaminated soil shouldn't produce results at least as promising as those obtained in the laboratory studies. The Buffalo site study was, in fact, the first case in which an application of reagent to contaminated soil was successfully carried out on-site by FRC personnel.

On August 22, 1983, the direct, on-site application of one of FRC's NaPEG^{tm} reagents to the PCB-contaminated soil was made. The date originally scheduled for the treatment was postponed due to a brief delay caused by the shipping firm that transported the reagent from FRC's Elverson Test Site to Malcolm Pirnie, Inc., in Niagara Falls. In the meantime, a rainfall had saturated the soil with water - just in time for the application of the reagent. All parties involved in the study agreed to proceed with the application, despite the fact that excess water was known to reduce the rate of chemical decomposition of PCBs in soil. Additional delays could have sacrificed the higher ambient temperatures of summer that were known to accelerate PCB destruction. When considering this, and the costs, in time and money involved in another rescheduling, it was decided to treat the soil as planned. Although the exact water content and organic composition of the soil was not known, prior laboratory results with other soils suggested that some

Although it is possible that sizeable portions of the total PCB contamination may be effectively shielded from the extracting solvent, the uneven distribution of PCBs in the soil is also a very probable reason for unexpected and irreproducible analytical results. As an example, rocks and small metal scraps were found in the Bengart and Memel soil, accounting for up to 75% of the total mass in some samples. These impurities should be relatively free of PCBs, except on the surface, and yet may be included in the total sample weight if small enough to pass through the sieve. In addition, the presence of PCB "hot spots" in the soil cannot be ruled out. These irregularities alone could cause considerable errors in the determination of PCBs in soil. A separate study involving dioxin-contaminated soil performed at Wright State University[1] exemplifies the importance of thorough soil homogenization to assure reproducible analytical results. The process of homogenizing, and possibly pulverizing of soil before chemical treatment is, in retrospect, strongly recommended, especially if such a treatment is for evaluation or demonstration purposes.

The lack of evidence of significant dechlorination in the field-treated soil is of much greater immediate concern than the irreproducible results and the possibility of liberation of additional "trapped" PCBs by the reagent. PCB dechlorination occured to a considerable extent with Bengart and Memel soil in preliminary experiments conducted in FRC's laboratory[2]. KPEG 350, in particular, reduced the levels of PCBs from approximately 100 ppm to below 50 ppm. Subsequent laboratory experiments were conducted using soil which had been taken from the chemically treated plot at the Buffalo site. The composite soil sample which was removed in May 1984, nine months after the on-site treatment, was homogenized, divided into portions and subjected to additional reagent applications under various laboratory conditions. In each case, substantial dechlorination occurred, as evidenced by a considerable reduction in the total PCB concentration. As expected, the reduction was greatest for the more highly chlorinated PCBs[3].

By May 1984, several methods were proposed for heating the soil in order to accelerate the chemical decomposition of soil contaminants. Heating the soil has proved advantageous in laboratory experiments with PCB-contaminated soil, including our most recent tests using soil samples from the Bengart and Memel site. In addition, and perhaps more importantly, it was discovered by this time that pre-drying was essential for the reagent to be effective. Results using PCB-contaminated soil from another site showed that significant dechlorination is achieved by simply air drying the soil at room tempeature prior to the application of the reagent[4]. Without this pretreatment, insigificant decontamination was observed for the relatively wet soil, even when KPEG-350 was used.