

**TECHNICAL MEMORANDUM #5 - PILOT STUDY
TECHNICAL MEMORANDUM #8 - ESI**

POST-PILOT STUDY EXPANDED SOIL SAMPLING

**FOR THE
EXPANDED SITE INVESTIGATION - FORMER FIRE TRAINING AREA
MARSHALL ARMY AIRFIELD, FORT RILEY, KANSAS
AND NEARBY OFF-POST PROPERTIES**

22 December 1995

Prepared for
United States Army Engineer District, Kansas City
CEMRK-ED-TP
601 East 12th Street
Kansas City, Missouri 64106-2896

Prepared by
Louis Berger & Associates, Inc.
1819 H Street, N.W., Suite 900
Washington, D.C. 20006



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**TECHNICAL MEMORANDUM #5 - PILOT TEST STUDY/
TECHNICAL MEMORANDUM #8 - ESI
POST-PILOT STUDY EXPANDED SOIL SAMPLING**

I. Summary

This technical memorandum outlines soil sampling to be conducted at the Former Fire Training Area - Marshall Army Airfield (FFTA-MAAF) at Fort Riley, Kansas, to support multiple CERCLA activities associated with the site, including the following:

(1) Evaluate Pilot Test Study

- a. collect samples comparable to the baseline soil samples to evaluate effectiveness of the bioventing and soil vapor extraction (SVE) systems tested at the site.
- b. collect samples for geotechnical analyses at locations in AOC-1 and AOC-2 with highest rates of air flow to determine whether any physical changes occurred to the subsurface geologic media due to implementation of the bioventing and SVE systems.

(2) Evaluate Need for Further Cleanup of Soils

- a. identify specific compounds at the site for use in development of Soil Screening Levels (SSLs), which may be used to determine whether cleanup of soils is warranted.
- b. generate data on mass of contaminants at the site so that duration of bioventing and SVE systems operation to achieve SSLs, if necessary, can be predicted.

(3) Characterize Soils

- a. determine which contaminants are elevated above background concentrations.
- b. identify areas of contamination with highest concentrations as well as define the horizontal and vertical boundaries of contamination.
- c. generate data to support characterization of migration of contaminants from soils to underlying groundwater.
- d. develop mean concentrations for specific contaminants at the FFTA-MAAF within areas of high concentrations (if any exist) as well as within the boundaries of the horizontal and vertical extent of soil contamination.

Other activities are currently underway to collect additional data on groundwater contamination at the site (see Technical Memorandum #7 for the Expanded Site Investigation). Therefore, this technical memorandum focuses only on soils data. Further, it examines the previous soil data collected at the site as part of the Site Investigation (September 1993) and the baseline soil sampling conducted as part of the Pilot Test Study (July 1994). The majority of additional data being

collected to support CERCLA activities are chemical data to evaluate contaminant distribution at the site. Some limited geotechnical data are also being collected.

This soil sampling builds upon the data available from previous investigations of the site. Procedures for collection of soil samples will adhere to procedures and protocols previously established for environmental investigations at Fort Riley and FFTA-MAAF. The soil sampling data collection activities have been designed to collect data to fulfill requirements of CERCLA. The relevant documents are as follows:

Existing Supporting Documents

- *Draft Site Investigation for Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas, and Nearby Off-Post Properties*, 1 August 1995. [The draft SI report included data collected during the SI, the Pilot Test Study and the Expanded Site Investigation (ESI) through January 1995.]
- *Draft Final Work Plan - Pilot Test Study, Soil Vapor Extraction and Bioventing Systems, Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas*, August 1994.
- *Quality Assurance Project Plan for Site Investigations at Fort Riley, Kansas*, 9 January 1995. (Hereafter referred to as the QAPP.)
- *Draft Final Basic Monitoring Well Installation Plan for Site Investigations at Fort Riley, Kansas*, 8 August 1994. [This contains the procedures for drilling and sampling of soil borings.]

Relevant EPA Guidance

- *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*, EPA 540/R-93-057, August 1993, USEPA.
- *Soil Screening Guidance - Quick Reference Fact Sheet*, EPA/540/R-94/101, OSWER Directive 9355.4-14FS, December 1994, USEPA
- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA - Interim Final*, EPA/540/G-89/004, October 1988, USEPA.
- *Risk Assessment Guidance for Superfund Volume I - Human Health Evaluation Manual (Part A) Interim Final* - EPA/540/1-89/002, December 1989, USEPA.

Section II presents the soil sampling plan. Section III identifies changes from the post pilot study sampling plan found in the Work Plan.

II. Sampling Plan

Soil samples will be collected from a total of 49 borings. Samples for chemical analyses will be collected from 47 borings and samples for geotechnical analyses will be collected from 2 borings.

Soil samples will be collected for chemical analysis from 47 locations at three to five depths at each location. Samples will be collected via split-spoon samples through hollow-stem augers. Samples will be collected near the surface (either at 1 to 3 foot depths or 6 to 12 inch depths, as outlined within this memorandum), at depths of 4 to 7 feet, at depths of 10 to 12 feet, at depths of 14 to 16 feet, and at depths directly overlying the zone of groundwater saturation. Where either the 10 to 12 foot samples or the 14 to 16 samples are within one foot of the top of groundwater at the time of sampling, deeper samples will not be collected. Thus, samples will vary from three to five per boring location, depending on depth to groundwater at the time of sampling. [Three samples will be collected if the depth to groundwater is 13 feet or less, four samples will be collected if depth to groundwater is 13 to 17 feet, and five samples will be collected if depth to groundwater is greater than 18 feet.] Each of the soil samples will be analyzed for the following:

- Volatile organic compounds (VOCs) using EPA Method 8260;
- Semi-volatile organic compounds (SVOCs) using EPA Method 8270;
- Total petroleum hydrocarbons (TPH) - gasoline (GRO) and diesel (DRO) fractions using EPA Method 8015 modified;
- Thirteen priority pollutant metals using the following EPA Methods: arsenic - 7060A, beryllium - 6010A, cadmium - 6010A, chromium - 6010A, copper - 6010A, lead - 7421, mercury - 7470/7471, nickel - 6010A, selenium - 7740, silver - 6010A, thallium - 7841, tin - 7041, and zinc - 6010A; and
- Geotechnical analyses including moisture content, grain size, specific gravity, Atterberg limits and cation exchange capacity.

As noted above, the soil sampling presented in this memorandum will support multiple data requirements. For purposes of determining whether further cleanup is necessary, the soil sampling must identify and characterize areas of highest concentrations. To support site characterization, it is necessary to define the vertical and horizontal boundaries of contamination. For risk assessment purposes, it is necessary to define the mean concentrations of contaminants throughout the volume

of contaminated soils. Because of the differing data needs, the study area was divided into three zones, as described below. Each of the zones has a different level of sampling intensity performed within its boundaries.

- Zone I - This zone consists of areas of potential high contaminant concentrations, based on previous soil sampling data. Two areas of potential high contaminant concentrations at the site have been previously identified as AOC-1 and AOC-2. Thus, these two areas are designated as Zone I. An examination of the SI soil and soil gas data and the baseline soil sampling data show that the areas of high VOC and TPH detections in AOC-1 correspond closely with the boundaries of the former fire training pit. Therefore, the boundaries of the former pit are established as Zone I. For AOC-2, the areas of detections of VOCs correspond with the approximate boundaries of AOC-2 established for the pilot test study. Therefore, the boundaries of AOC-2 established for the pilot test study are established as a second Zone I area at the site.
- Zone II consists of areas where soil contamination is considered to have the potential to be present. The boundaries of Zone II are based on the results of the soil gas surveys conducted as part of the SI. Zone II is established based on areas where there were soil gas detections of VOCs in excess of 10 ug/L during the SI, indicating that contaminants may be present in soils. [Note that soil gas detections will also reflect contaminants in underlying groundwater and may not correlate directly with soil contamination.]
- Zone III represents a buffer zone around Zone II. Contamination of soil in Zone III is not anticipated; however, it is an area to be investigated to ensure that soil contamination does not exist.

The horizontal boundaries of Zones I, II and III are depicted in Figure 1. The vertical boundaries of the study area are defined as the soil surface down to the top of the zone of saturation. The top 6 inches of soil are excluded because collection of representative samples within the root zone of grasses covering the area may be difficult. The soils beneath the zone of saturation are not included because the samples will not be entirely representative of soil contamination. Depth to groundwater varies due to seasonal and climatic influences. In general, it ranges from approximately 12 to 17 feet beneath the ground surface. During the baseline soil sampling at twelve locations, soil samples were collected from depths of approximately 12 to 15 feet at each location. Of these 12 locations, VOCs were detected below a depth of 12 feet at only four boring locations. Thus, if soil samples are not collected below a depth of 12 feet due to high groundwater elevations at the time of sampling, the loss of the soil sampling data is *not* considered critical to determining the vertical extent of soil contamination at the site.

Methodology for Selecting Soil Sample Locations - Three general strategies exist for selecting sampling locations: purposive sampling, random sampling and systematic sampling.

- Purposive sampling consists of placing samples in specific locations to collect data for characterizing the site. To support the needs of the Pilot Test Study, purposive sampling was conducted at the FFTA-MAAF at specific locations within, between and near the areas undergoing treatment.
- Random sampling involves selecting sample locations in an unbiased manner to define average concentrations throughout a site.
- Systematic sampling is performed by establishing a grid of sample locations using a regular pattern. Systematic sampling is also used to define average concentrations throughout a site, for identifying small areas of higher concentrations, and for generating data for statistical evaluations.

Both random and systematic sampling can be used to define average concentrations of contaminants at the site. However, as noted above, systematic sampling provides additional capabilities for identifying areas of higher concentrations. Therefore, a systematic sampling approach will be used instead of random sampling for characterizing the site.

The following presents the rationale for sample locations and depths:

- (1) Purposive soil sampling will be performed at the twelve (12) locations and four (4) depths sampled as part of the pilot test study - baseline soil sampling to fulfill the needs of the pilot test study. Sampling at a fifth depth will occur if depth to groundwater is greater than 17 feet.
- (2) Purposive soil sampling will be performed at two (2) locations -- adjacent to pilot study vapor wells IW-1 and SVE-1 -- to collect geotechnical data in areas of highest air flow during the pilot test study.
- (3) Systematic soil sampling will be performed throughout the potential area of contamination to delineate the vertical and horizontal boundaries of contamination, including identification of potential areas of high contaminant concentrations.
 - (a) systematic sampling will be performed on a triangular grid since this pattern has a greater probability of detecting areas of high concentrations than square or rectangular grids with the same grid spacing (Statistical Methods for Environmental Monitoring, Van Nostrand Reinhold, New York, 1987, Chapter 10.)
 - (b) different grid spacings will be used within each zone as follows: Zone I - 35 feet, Zone II - 55 feet and Zone III - 75 feet. [The grid spacings were determined through application of ELIPGRID-PC by J.R. Davidson of Oak Ridge National Laboratories (version 12 September 1995), which uses statistical nomographs and probabilistic approaches to select grid spacings for collection of environmental samples for purposes of identifying areas of contamination.]

- (4) Sufficient samples are being collected to develop a statistically reliable mean concentrations for contaminants in soils.
- (5) Soil samples will be collected from depths of 6 to 12 inches to support risk assessment evaluation of direct contact threats.
- (6) Soil samples will not be collected beneath the zone of saturation (as discussed earlier).
- (7) Soil samples will be collected outside of areas affected by the site to establish site-specific background concentrations; sufficient numbers of samples are being collected to apply statistical techniques for determining whether detected concentrations are elevated above background (e.g., for naturally-occurring metals).

The locations of the forty-seven soil borings are shown on Figure 2. A summary of the sample locations and chemical analyses are provided in Table 1. Prior to the pilot test study, twelve soil borings were drilled and identified as SB-1 through SB-12. As noted in the pilot test study workplan, borings following the completion of the pilot test were to be identified with the prefix "PSB." Therefore, the soil boring locations to be sampled in accordance with this technical memorandum are identified as PSB-1 through PSB-47.

The purposive samples are shown as sample locations PSB-1 through PSB-12. These are at the same locations as SB-1 through SB-12 used to establish baseline soil concentrations prior to the pilot test study. The systematic sample locations are identified by the triangular grid intersections. An examination of the locations of the purposive sampling locations and some of the systematic sampling locations shows that some of the purposive sampling locations are sufficiently close to grid intersections such that they can also fulfill the needs of the systematic sampling. As a result, the number of systematic sampling locations can be reduced without impacting the results of the investigation. As described below, the 47 borings at which samples for chemical analyses will be collected include the 12 purposive samples PSB1 through PSB-12, 4 additional systematic samples in Zone I - AOC-1 (PSB-13 through PSB-16), 6 additional systematic samples in Zone I - AOC-2 (PSB-17 through PSB-22), 10 additional systematic samples in Zone II (PSB-23 through PSB-32), and 15 additional systematic samples in Zone III (PSB-33 through PSB-47):

- (1) Zone I - AOC-1 - Data from PSB-3, PSB-4 and PSB-5 can be used to meet the needs of the nearest systematic, grid-based sampling locations. Thus, a total of seven samples in this zone can be achieved by using the three purposive sample locations and adding four additional sampling locations.
- (2) Zone I - AOC-2 - Data from PSB-9, PSB-10, and PSB-11 can be used to meet the needs of the nearest systematic, grid-based sampling locations. Thus, a total of nine systematic sampling locations can be achieved by using three purposive sampling locations and adding six additional

sampling locations. Purposive samples PSB-8 and PSB-12 are located closer to PSB-9 and PSB-11, respectively, than they are to other systematic sampling locations. Thus, they will not be able to replace systematic sampling locations.

- (3) Zone II - Data from PSB-2, PSB-6 and PSB-7 can be used to meet the needs of the nearest systematic, grid-based sampling locations. Thus, a total of thirteen systematic sampling locations can be achieved by using three purposive sampling locations and adding ten additional sampling locations. Purposive sample PSB-1 is located closer to PSB-6 than to other systematic sampling locations and will not serve to replace a systematic sampling location.
- (4) There are no purposive samples in Zone III. Thus, samples will be collected at all fifteen systematic sampling locations.

The depths of samples at the purposive sampling locations will be identical to the sampling depths at those locations during the baseline soil sampling. Samples at each location were collected at depths of 1 to 3 feet, 4 to 7 feet, 10 to 12 feet, and directly above the water table (typically from 13 to 15 feet). If depth to groundwater is greater than 17 feet at the time of sampling, the fourth sample will be collected at the depth of groundwater saturation during the baseline sampling and a fifth sample will be collected from immediately above the zone of saturation at the time of sampling. In contrast, if higher groundwater conditions are encountered, only those samples from above the zone of saturation will be collected since soils from below the zone of saturation at the time of sampling are not considered representative of only soil contamination.

Vertical delineation of contaminants will be achieved throughout Zones I, II and III by collection of samples from multiple depths at each sampling location. The results of the baseline soil sampling showed that significant differences in concentrations were detected over the four sampling depths used in areas where contamination was present. For example, concentrations of PCE at SB-8 were as follows: 1 to 3 feet - 35 ug/kg; 4 to 6 feet - 260 ug/kg; 10 to 12 feet and 12.5 to 13 feet - less than 1.1 ug/kg. At other locations such as SB-5, concentrations were highest in the samples below 10 feet. For this reason, the four sampling depths used during the baseline soil sampling provide good vertical delineation of contaminant concentrations and will be used at all systematic sampling locations with the following provisions:

- (1) the uppermost samples will be collected within a depth interval of 6 to 12 inches (instead of 1 to 3 feet) to provide better characterization of near surface soils for evaluating potential on-site exposures during the risk assessment;
- (2) an additional sample will be collected at a depth of 14 to 16 feet if the depth to groundwater is greater than 17 feet at the time of sampling; and

- (3) the deepest samples will not be collected if they are below the zone of groundwater saturation.

QA/QC samples will be collected in accordance with the QAPP in addition to samples collected at the purposive and systematic sampling locations. An overview of these samples is as follows:

- Approximately 10% of the soil samples will be collected in duplicate and subjected to identical chemical analyses.
- A field blank will be collected once for every two days of sample collection or for approximately once every 20 samples, whichever is greater. Field blanks will be subjected to identical chemical analyses as record samples.
- Matrix spike and matrix spike duplicate samples will be submitted for approximately 5% of the samples.

Background sampling locations have been chosen to determine which contaminants (anthropogenic and naturally-occurring) are present at concentrations above background in areas of site-related contamination. The collection of background locations was incorporated into the establishment of the boundaries of Zone III, a buffer area around Zone II. Initially, all sample locations within Zone III in areas upgradient of the site (to the south) will be considered background locations. The soil sampling is expected to generate over 20 data points that can be used to calculate a mean background concentration for metals in soils. This data set will allow statistical evaluation of whether metals are associated with site contamination at concentrations above background.

Analyses for Tentatively Identified Compounds (TICs) are not warranted as described below. During the initial operation of the SVE and bioventing pilot test study, vapors drawn from the area of soil contamination at the FFTA-MAAF were collected for on-site analyses using a field screening chromatograph with FID detector (using EPA method 8020). Attempts to detect trichloroethylene (TCE) were thwarted by co-eluting interferences. Recognizing that the FID detector is sensitive to a wide range of hydrocarbon and other organic compounds, samples were submitted to an off-site laboratory for analyses by GC-mass spectroscopy (GC/MS) using a low-resolution chromatography column.

The total ion current chromatograms, which are similar to the FID in selectivity (i.e., the total ion chromatograms are not selective and all the compounds eluting are detected), had numerous peaks many of which were poorly resolved (i.e., at least partially overlapped). The total ion chromatogram was similar to total petroleum hydrocarbons (TPH) chromatograms obtained with FID detectors. The mass spectra corresponding to the highest point of the 10 most prominent peaks were compared against the computer library of known compounds to see if any close matches occurred. Computer matches between the unknown peaks and the known library were generally mediocre to poor (e.g.,

typically the scores were in the range 700 to 800 (out of 1000) and in most cases the top three matches for each unknown peak were not strongly distinguished.

For the largest peak in the total ion current chromatogram, the highest ranking scores were for heptane derivatives that fragment to the heptyl ion without leaving a characteristic fragment indicative of the functional group. Similar observations were made for several other peaks in the total ion chromatogram. That is, for all the mass spectra of all 10 chromatographic peaks examined, the ions that were present were characteristic of aliphatic hydrocarbons with no indication of other functional groups present. However, because they were the result of co-eluting compounds with overlapping chromatographic peaks, the mass spectra often best matched by bromo-alkyl, azido-alkyl or O-alkyl-hydroxylamines as well as by aliphatic hydrocarbons. The presence of bromo-alkyl compounds was quickly ruled out by running the sample on a gas chromatograph with a halogen-selective detector. No attempt was made to screen the sample using more costly nitrogen-selective detectors. The conclusion that was drawn was the chromatograms were indicative of aliphatic hydrocarbons, which were expected as residues from the petroleum hydrocarbons used as a combustion source at the FFTA-MAAF. For purposes of characterizing the site, the material that was detected can be identified as aliphatic total petroleum hydrocarbons. There is no need to further characterize the residue.

III. Modifications to the Post-Test Sampling Plan

Post-test sampling was specified in the workplan for the pilot test study. The soil sampling outlined above fulfills the needs of the pilot test study. However, the proposed sampling results in some modifications to the planned post-test sampling. Those modifications are identified and discussed below.

- (1) The planned post-test sampling included grain size analyses at all locations. This data was collected during the baseline sampling, which provides sufficient data to support the pilot test study, the RI, and the risk assessment. Further, grain size is not subject to change over time. Therefore, these analyses are not required and are not included in this sampling plan.
- (2) The planned post-test sampling included analyses for Total Organic Carbon at locations PSB-1 through PSB-7. This data was collected during the baseline sampling, which provides sufficient data to support the current data needs. Further, total organic carbon is not expected to change significantly over time. Therefore, these analyses are not required and are not included in this sampling plan.
- (3) The planned post-test sampling included geotechnical analyses adjacent to each of the injection or extraction wells for both the bioventing and SVE systems (BVW-1 through BVW-4, IW-1, and SVE-1 through SVE-3). Four samples were to be collected at each of the locations; the

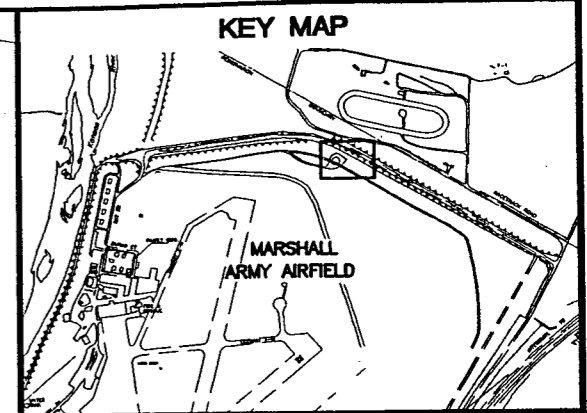
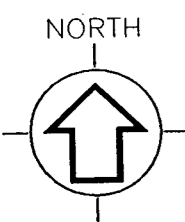
samples were to be analyzed for moisture content, grain size, specific gravity, Atterberg limits and cation exchange capacity. This same data was collected during installation of the bioventing and SVE systems. Recollection of these samples for geotechnical analyses will provide an assessment on any physical changes that occurred within the soil media as a result of the system operation. However, data to assess potential changes in these physical characteristics are not needed at all eight injection or extraction wells since the amount of variance, if any, between the pre- and post-test data is expected to be minimal. Therefore, the quantity of geotechnical analyses has been reduced without impacting on the quality of the evaluation of the treatment systems that will result. Specifically, geotechnical analyses will only be performed adjacent to IW-1 and SVE-1. Each of these were selected because they had the highest volume of air flow for AOC-1 and AOC-2, respectively, relative to the other wells.

- (4) Microbial testing was performed on the baseline soil samples to identify bacterial populations present in soils at the site and was planned as part of the post-test sampling. The microbial testing provides qualitative data regarding the types of compounds - volatile vs. semi-volatile - that the individual bacterial strains can biodegrade. A comparison of baseline microbial populations and post-test microbial populations was planned to qualitatively identify which bacterial strains increased in mass, indicating which types of compounds were undergoing increased rates of biodegradation. This data would provide insights into compound specific rates of biodegradation. However, the overall mass reductions of organic compounds due to biodegradation can be estimated from the pilot test study respiration test data. Further, comparisons of baseline and post-test concentrations will provide the required data to evaluate comparative reductions in organic compounds (e.g., VOCs relative to gasoline range TPH relative to diesel range TPH), without determining whether the reductions were necessarily due to SVE or biodegradation (or other factors, e.g., sample heterogeneity). While useful, the microbial sampling is not critical and has been deleted. Further, microbial populations are highly susceptible to changes over time. The time elapsed between the shutdown of the system in September 1995 and the sampling planned in this memorandum would render the microbial population data non-representative of conditions at the end of the test.
- (5) During the baseline soil sampling, VOC analyses in AOC-1 was performed using EPA method 8240. Soil samples collected in accordance with this technical memorandum will be analyzed using EPA Method 8260. Both methods are used to analyze VOCs of EPA's Target Compound List, the difference lies in the type of chromatography column employed and the internal standards (IS) used to quantify the target compounds. The resolution offered by the capillary column used in Method 8260 is superior to that of the packed column used in Method 8240. The laboratory has used capillary chromatography columns as specified in Method 8260 along with the IS recommended for Method 8240 throughout the SI/ESI to maintain analytical comparability.

- (6) For AOC-2, the VOC analyses in the baseline sampling were conducted for chlorinated VOCs only using EPA Method 8010. Use of the same method was planned in the workplan. However, the sampling outlined in this Technical Memorandum uses EPA Method 8260 for VOC analyses, including the sample locations in AOC-2 that will be used for direct comparison with the baseline soil concentrations. EPA Method 8260 is selected for the broader range of compound analyzed by this technique compared with EPA Method 8010 and is the analytical method specified in the QAPP. Method 8260 captures the halogenated compounds of concern analyzed by 8010 as well as non-halogenated compounds of concern, such as hydrocarbons associated with petroleum products. Both techniques employ gas chromatography for analyte separation, while method 8260 uses a mass selective detector (compared to a halogen-specific detector for method 8010) for analyte quantitation and identification. The difference in practical quantitation limits (1 ug/kg for 8010; 5 ug/kg for 8260) does not impact the calculations of the mass of contaminants present in the soils as the difference in detection limits is well within variability in concentrations due to sample heterogeneity.

-- End Text --

Includes Figure 1, Figure 2 and Table 1



LEGEND

- AREA OF CONCERN (AOC-1 & AOC-2)
- STUDY AREA BOUNDARIES (ZONES I, II, III)
- FORMER PIT BOUNDARY
- EXISTING ROAD
- EXISTING FENCE
- PILOT STUDY AREA-TEMPORARY FENCING
- PCE CONCENTRATIONS IN 4' SOIL GAS SAMPLE (Data from 9/93)
- TOTAL FID IN 4' SOIL GAS SAMPLE (Data from 9/93)
- FOC - FIBER OPTIC CABLE
- EXISTING GROUNDWATER MONITORING WELL
- POST-TEST SOIL BORINGS (PSB)-PURPOSIVE SOIL SAMPLE LOCATIONS

ZONE I
 AREAS OF HIGHEST RELATIVE SOIL CONCENTRATIONS DEFINED AS BOUNDARIES OF AOC-1 (BOUNDARIES OF FORMER FIRE TRAINING PIT) AND AOC-2 (AS DEFINED FOR PILOT TEST STUDY).

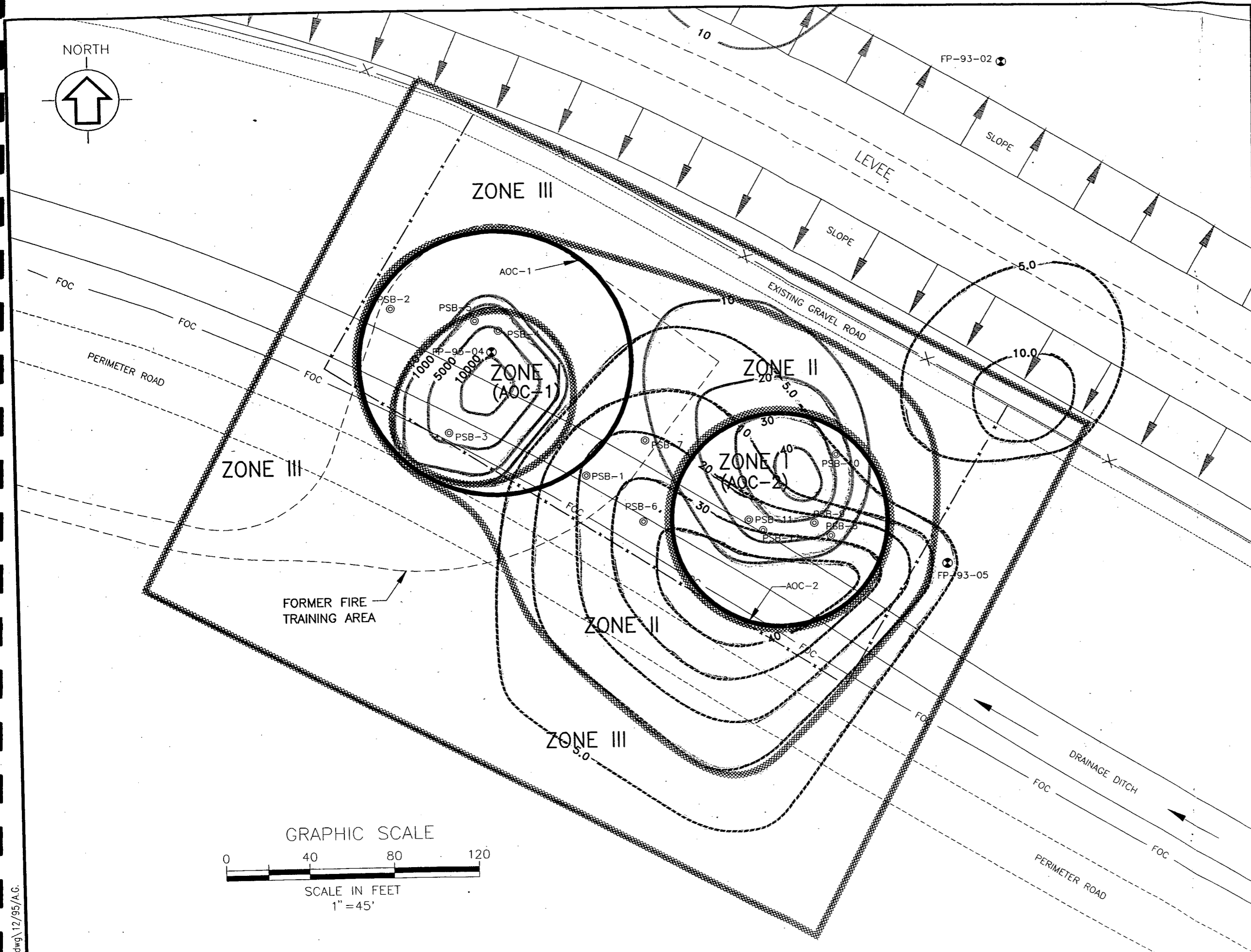
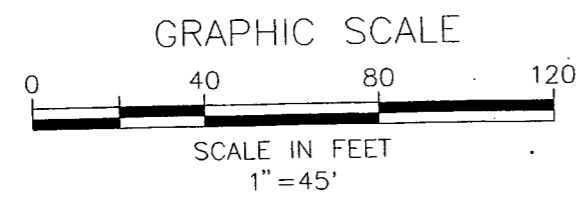
ZONE II
 AREAS OF POTENTIAL SOIL CONTAMINATION BASED ON RESULTS OF SOIL GAS SURVEY CONDUCTED DURING THE SI AND BASELINE SOIL SAMPLING CONDUCTED AS PART OF THE PILOT TEST STUDY.

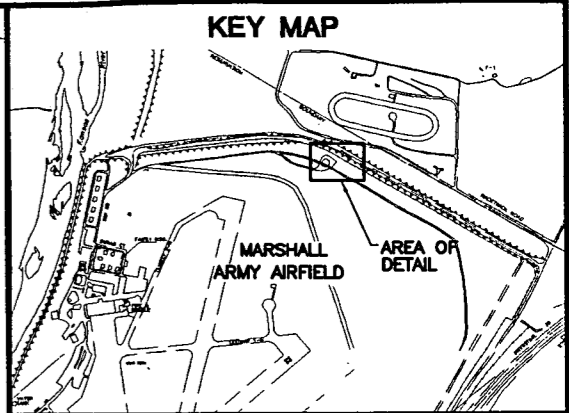
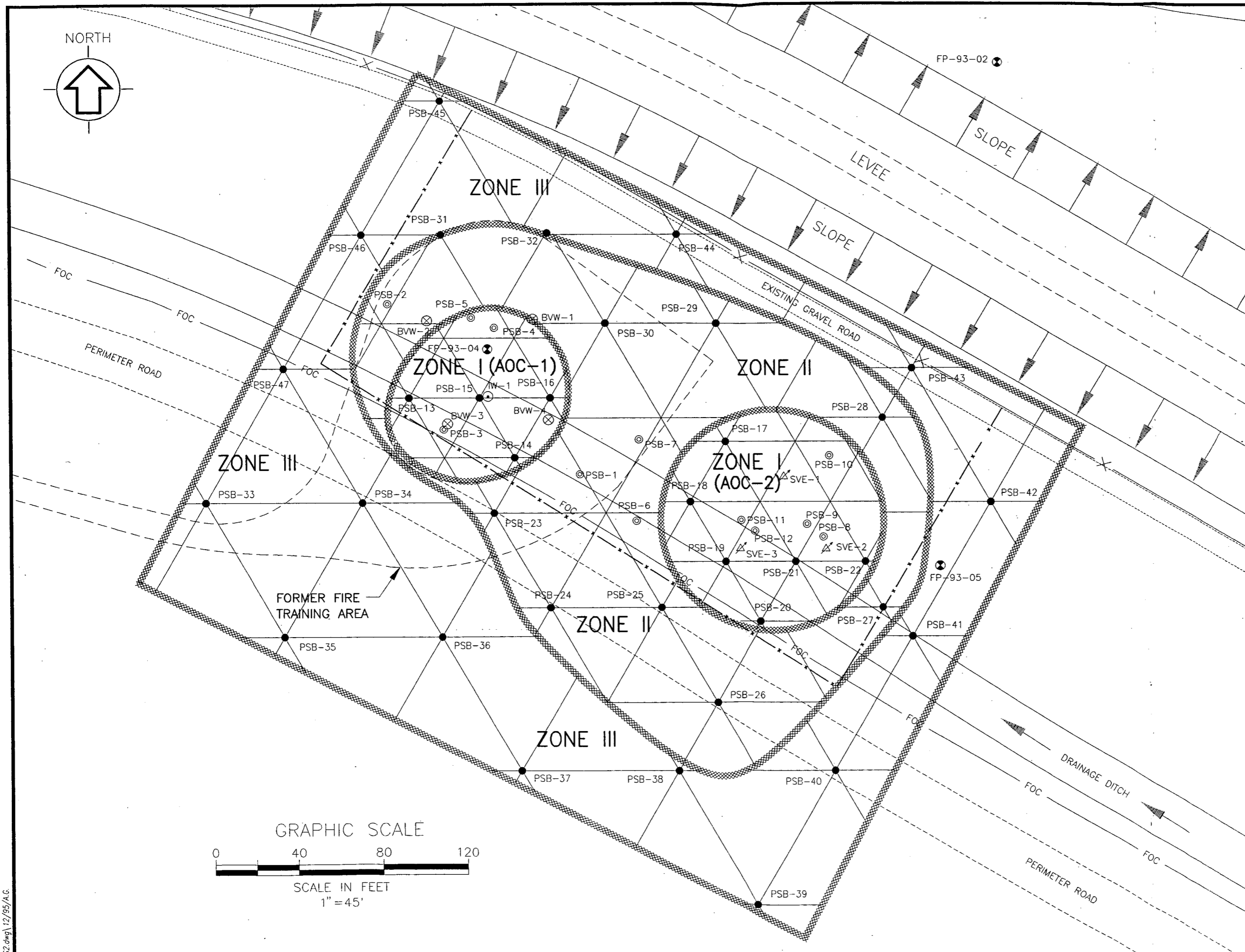
ZONE III
 BUFFER ZONE TO IDENTIFY BOUNDARIES OF CONTAMINATION; INCLUDES UPGRADIENT, BACKGROUND AREAS TO THE SOUTH.

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 FFTA-MAAF

Figure: 1
ZONES OF POST-EXTRACTION SOIL SAMPLING

DRAWN: SO SCALE: AS SHOWN DATE: OCTOBER 1995

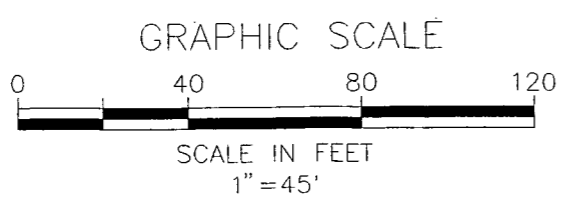




LEGEND

- STUDY AREA BOUNDARIES (ZONES I, II, III)
- FORMER PIT BOUNDARY
- EXISTING ROAD
- EXISTING FENCE
- PILOT STUDY AREA-TEMPORARY FENCING
- FOC FIBER OPTIC CABLE
- EXISTING GROUNDWATER MONITORING WELL
- POST-TEST SOIL BORINGS (PSB)-PURPOSIVE SOIL SAMPLE LOCATIONS
- POST-TEST SOIL BORINGS (PSB)-SYSTEMATIC SOIL SAMPLE LOCATIONS
- SOIL VAPOR EXTRACTION WELL (SVE)
- AIR INJECTION WELL (IW)
- BIO-VENTING WELL (BVW)

GRID DISTANCE OFFSET	
ZONE 1	10.17 METERS
ZONE 2	16.09 METERS
ZONE 3	22.74 METERS



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FORT RILEY MILITARY RESERVATION
FFTA-MAAF

**Figure 2:
POST-EXTRACTION
SOIL SAMPLING PLAN**

DRAWN: SO SCALE: AS SHOWN DATE: OCTOBER 1995

ALLSET2.dwg 12/95/A.G.

Table 1: Overview of Expanded Post-Pilot Study Test Soil Sampling at FFTA-MAAF

Background Information on Soil Samples					Data Usage (c)				
Sample Name	Zone(e)	Sample Type	Tests	Sample Depths (feet)	Pilot Study	Soil Cleanup	Remedial Inves.	Risk Assessment	
PGT-IW-1	Ia	Purposive	Geotechnical (a)	1-3, 4-7, 10-12, 13-15 (b)	1b	NA	NA	NA	
PGT-SVE-1	Ib	Purposive	Geotechnical (a)		1-3, 4-7, 10-12, 13-15 (b)	1a	2a, 2b	3a, 3b, 3c	4a, 4b
PSB-1	II	Purposive	VOCs (EPA Method 8260) SVOCs (EPA Method 8270) RCRA metals (EPA Methods 6010 and 7000 Series) TPH-GRO/ TPH-DRO (EPA Methods 8015 Modified)						
PSB-2	II	Purposive/Systematic							
PSB-3	Ia	Purposive/Systematic							
PSB-4	Ia	Purposive/Systematic							
PSB-5	Ia	Purposive/Systematic							
PSB-6	II	Purposive/Systematic							
PSB-7	II	Purposive/Systematic							
PSB-8	Ib	Purposive							
PSB-9	Ib	Purposive/Systematic							
PSB-10	Ib	Purposive/Systematic							
PSB-11	Ib	Purposive/Systematic							
PSB-12	Ib	Purposive							
PSB-13 through PSB-16	Ia	Systematic		0.5-1, 4-7, 10-12, 13-15 (d)	NA	2a, 2b	3a, 3b, 3c	4a, 4b	
PSB-17 through PSB-22	Ib								
PSB-23 through PSB-32	II								
PSB-33 through PSB-47	III								

NA: Not Applicable

(a): Geotechnical tests include moisture content, grain size, specific gravity, Atterberg limits and cation exchange capacity.

(b): The 13 - 15 foot sample will not be collected if below the zone of groundwater saturation.

(c): Data will be utilized for one of the four studies listed below. The numbers in the table correspond to the following tasks within the four main studies:

1. Pilot Test Study

1a. Collect samples comparable to the baseline soil samples to evaluate effectiveness of the bioventing and soil vapor extraction (SVE) systems tested at the site.

1b. Collect samples for geotechnical analyses at locations in AOC-1 and AOC-2 with highest rates of air flow to determine whether any physical changes occurred to the subsurface media during bioventing/SVE test.

2. Evaluate need for further soil cleanup (as part of Pilot Test Study or Feasibility Study)

2a. Identify specific compounds at the site for using in development of Soil Screening Levels (SSLs).

2b. Generate data on mass of contaminants at the site so that duration of bioventing and SVE system operation to achieve SSLs, if necessary, can be predicted.

3. Remedial Investigation (RI)

3a. Determine which contaminants at the site are elevated above background concentrations.

3b. Identify hot spots of contamination as well as the horizontal and vertical boundaries of contamination.

3c. Generate data to support characterization of migration of contaminants from soils to underlying groundwater.

4. Risk Assessment

4a. Develop mean concentrations for specific contaminants at the site within potential hot spots, as well as the horizontal and vertical extent of contamination

4b. Provides data on Tentatively Identified Compounds.

(d): The 13 - 15 foot sample will not be collected if below the zone of groundwater saturation.

Also, an additional sample will be collected above the groundwater table if depth to groundwater is greater than 17 feet.

(e): Zone Ia is AOC-1 (the area of the former fire training pit) and Zone Ib is AOC-2 (in the adjacent drum storage area).