ADDENDUM TO VERIFICATION OF TREATMENT SAMPLING PLAN

Area 2 Phase I

Firing Range Stabilization Project

Prepared For:

Fluor Daniel Fernald

Cincinnati, Ohio

Prepared By:

Sevenson Environmental Services, Inc.

Midwest Division

June 1999

TABLE OF CONTENTS

1.0 INTRODUCTION

Sevenson Environmental Services, Inc. (Sevenson) presents this Addendum to the approved Verification of Treatment Sampling Plan (VTSP) for the Area 1 Phase II Trap Range Stabilization project at the Fernald Environmental Management Project (FEMP) site in Fernald, Ohio. This plan has been prepared in accordance with the requirements of Section 02211 of the technical specifications.

Sevenson has been subcontracted to stabilize approximately 45 cubic yards of above-RCRA lead-impacted soils at the Firing Range site. Sevenson will use its patented MAECTITE® process to stabilize the soils in-situ.

The area and depth requiring soil stabilization is as shown on the Construction Drawings, specifically Drawing No. 92X-5900-G-01031. The soils will be stabilized to a typical depth of 2 feet, except for one area where the soils will be stabilized to a depth of 4.5 feet. Depth tolerances shall be minus 0 to plus 2 inches. Surveying to confirm the limits of stabilization will be performed by Fluor Daniel Fernald (FDF).

MAECTITE® liquid reagent will be sprayed onto the ground surface and mixed into the soils with a flat-edged backhoe bucket. The mixing may be described as a back-and-forth folding motion, which will create a homogeneous mix. Water will be added as a carrier medium to enhance the dispersion of the reagent.

As part of its scope of work, Sevenson will collect and analyze stabilized soil samples to verify that the treatment objectives have been achieved. The treated soils must meet the following criterion:

- Meet or exceed the requirements of the Toxicity Characteristic Leaching Procedure (TCLP) test for lead (5.0 mg/L).

This Addendum to VTSP has been developed to present a sampling and analysis program to demonstrate that the treatment process was successful in treating all of the contaminated soils at the Firing Range site to the project requirements.

1.1 Purpose

The purpose of the Addendum to the VTSP is to present a sampling and analysis program for the treated soils at the Firing Range site. The sampling and analysis program must provide statistically defensible data, confirming all of the site soils have been stabilized in accordance with the project requirements.

1.2 Area Description

The Area 2 Phase I Firing Range site is located in the southern quadrant of the FEMP in the Southern Waste Units. FEMP security employees used the range for training purposes from the mid-1950's until 1988. This activity resulted in the surface deposition of lead fragments into the side of a hill.

Site characterization studies have identified the presence of lead-impacted soils above the RCRA standard of 5.0 mg/L at the Firing Range site. Pre-design investigation was performed by FDF to delineate the limits of the area to be stabilized.

1.3 Scope and Objectives

The primary objectives of the soil sampling and analysis program are to collect samples that are representative of the mixing and stabilization process. Further, the program must provide a 95% confidence level that more than 99% of the treated soil is below the TCLP criteria limits.

2.0 SOIL SAMPLING AND ANALYSIS PROGRAM

The soils treated by Sevenson's MAECTITE® process will be sampled and analyzed for treatment verification after pH readings below 6 have been documented to verify proper application and mixing. The following sections present a description of the soil sampling and analysis strategy, sampling and analysis requirements, location and number of samples (including statistical basis), quality assurance/quality control (QA/QC) requirements, equipment decontamination, health and safety, and disposition of wastes for this portion of the work.

2.1 Soil Sampling and Analysis Strategy

Sevenson will utilize a random sampling strategy for verification of treatment sampling and analysis. Sample locations, identified with survey coordinates, will be randomly generated for each of three (3) treatment areas. A computer program will be used to generate the locations. This strategy is based on the assumption that each area, after treatment, is uniform and homogeneous with respect to leachable lead.

2.2 Sampling and Analysis Requirements

Sevenson will collect samples from each of the three (3) treatment areas by advancing the sampling device to the stabilization depths identified on the Construction Drawings. The samples will be composited from the entire full depth of stabilization. Sampling devices to be utilized may include a stainless steel soil trier, stainless steel bucket auger, or trowel. Sevenson will collect approximately 350 grams of treated soil for each sample. The samples will be homogenized in the field, using a stainless steel trowel and mixing basin, prior to being labeled, packaged, cooled to 4°C, and shipped to the offsite laboratory for analysis.

The sample homogenization technique will be as follows:

1. Divide sample into quarters and thoroughly mix each quarter.
2. Combine two opposite quarters into halves and thoroughly mix each half.
3. Combine halves into one and thoroughly mix.
4. Return to Step 1 until sample has been mixed twice.
5. Place sample into applicable sample container for shipment to lab.

The treatment areas have been designated as Areas A, B, and C (Figure 1). The numbering system will assist in tracking the samples and facilitate the retrieval of analytical results. The samples will be numbered sequentially, beginning with FR-A-01 (Firing Range-Treatment Area A, Sample Number 1).

The verification samples will be shipped to General Engineering Laboratory (GEL) in Charleston, South Carolina for offsite analysis (2-week turnaround time). GEL is an FDF-approved lab and is NRC licensed. The analytical parameters and applicable test methods are listed in Table 1.

Table 1
Verification of Treatment Testing
Area 2 Phase I Firing Range

Parameter	Method
Soil Digestion	USEPA SW-846 Method 3051
TCLP Extraction	USEPA SW-846 Method 1311
Metals in TCLP Extraction Fluid (Pb)	USEPA SW-846 Method 6000/7000

If a sample does not meet the treatment criteria, a 10 ft. by 10 ft. area from which the sample was taken will be re-treated. The area will then be re-sampled and analyzed for verification purposes.

Ten percent (10%) of the samples will be split with the FDF Construction Manager and analyzed at their on-site laboratory. U.S. EPA and Ohio EPA may also wish to obtain split samples, in which case Sevenson will make additional soil available.

2.3 Location and Number of Samples

The sampling program involves collecting a total of eight (8) samples from the three treatment areas. Four (4) samples will be taken from Area A, three (3) samples will be taken from Area B, and one (1) sample will be obtained from Area C. The material from the 4.5 foot stabilization area will be spread over Area A for treatment and at least one sample will be taken from the spread material. As discussed previously, the sample locations will be randomly generated for each treatment area.

Upon completion of the sampling and analysis program, a statistical analysis of the sample size will be performed. This analysis will be used to confirm that eight (8) samples which pass TCLP was sufficient to verify that all of the soils were treated to the project requirements. Areas that need to be retreated will be re-sampled to generate new TCLP results. Failed TCLP results will not be included in the final statistical test.

2.3.1 Statistical Basis

In order to verify the effectiveness of the MAECTITE® treatment to reduce leachable lead to levels below the TCLP limit of 5000 parts per billion (ppb) in the former firing range, eight (8) initial samples will be selected at random locations within the contaminated areas. Lead contaminated soil in the Firing Range is estimated to be 45 cubic yards, equating to approximately one sample per 5.6 cubic yards. By comparison, the verification of treatment plan devised for the Trap Range Stabilization project will collect approximately 1 sample per 50.7 cubic yards (72 samples from approximately 3,650 cubic yards). The proposed treatment methodology will be to add a four (4%) percent MAECTITE® to the contaminated soil and allow to cure for seven days.

Based on the Addendum to Treatability Study Report, the expected mean residual leachable lead levels after the proposed treatment plan should be approximately 800 ppb with minimal variability; well below the 5000 ppb TCLP threshold. The two tests performed using the proposed treatment methodology resulted in final leachable levels of lead at 762 ppb and 780 ppb. Both results are well below the TCLP limit of 5000 ppb. Based on this information, it is determined that the proposed 8 samples should be sufficient to verify the effectiveness of treatment. To test this assumption, the equation for the estimation of the Upper Tolerance Limit (UTL) was utilized. The comparison of the UTL (calculated from a sample population) against a threshold value is often used as a "not to be exceeded" test. The UTL is defined as the (1-α)% upper confidence limit on the estimated p^{th} percentile of the population. The p^{th} percentile is chosen from the upper end of the distribution. The percentile used is the reasonably allowable portion of the population that could exceed the threshold without significant impact. Usually the 95^{th} or 99^{th} percentile is used, depending on the severity of the consequences of an exceedance of the threshold level. If the consequences of exceeding the threshold are very severe or catastrophic then a higher percentile my be chosen. The 99^{th} percentile has been selected for this project. To establish confidence that the actual population percentile does not exceed the threshold a confidence bound (or limit) is placed on the percentile based on the sample data. It is most common to use a α = 5% (1 - α = 95%) confidence limit on the selected percentile.

To test the assumption that eight samples will be sufficient to determine if the treatment is effective the estimated UTL could be compared to the threshold limit. In actuality, ALL sample results will be required to be less than the TCLP threshold before the treatment is complete, but for sample size determination the following UTL equation will be utilized:

$$UTL = \hat{\bar{x}} + \hat{s}K$$

where

$\hat{\bar{x}}$ = estimated sample mean residual level = $\frac{1}{n}\sum_{i=1}^{n} TCLP_i$,

$\hat{s}$ = estimated sample standard deviation = $\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(TCLP_i - \hat{\bar{x}})^2}$, and

K = factors for estimating the upper limit on the p^{th} percentile from a normal distribution (Owen, 1962).

The K factors depend on the α level and the percentile. Appendix A3 from Statistical Methods for Environmental Pollution Monitoring (Gilbert, 1987) provides tables for $1 - \alpha = .90$ (90%) and $1 - \alpha = .95$ (95%) for the 90^{th} (.900), 95^{th}, 97.5^{th}, 99^{th}, and 99.9^{th} percentiles for sample sizes (n) from 2 to ∞. Table 3 at the end of this section is an abbreviated version of this table.

If we start with a UTL, the not to be exceeded threshold of a sample size and the percentile of interest and the desired confidence level, we can 'back' calculate the required sample mean over a range of coefficients of variation (CV) The CV is simply, the standard deviation divided by the mean. Reversing the equation above, the required sample mean to meet the threshold can be expressed as:

$$\hat{\bar{x}} = UTL - \hat{s}K$$
$$= \frac{UTL}{1 + CV \times K}$$

where

$\hat{s}$ = estimated sample standard deviation, and

CV = coefficient of variation $= \frac{\hat{s}}{\hat{\bar{x}}}$.

Table 2 below provides the estimated post-treatment mean lead level that would be needed to statistically meet the TCLP limit for the entire volume of treated soil, given that the confidence level is fixed at 95%, varying the CVs from 0.25 (small variability) to 1.5 (moderately high variability) for the 95th, 99th and 99.9th percentiles and given that the sample size is 8.

Table 2

Estimate Sample Mean TCLP Lead Concentration to Realize a UTL = 5000 ppb for Given Percentile and CV (Coefficient of Variation) for a Sample Size of 8 at the 95% Confidence Level

CV	95th percentile	99th percentile	99.9th percentile
0.25	2782	2589	2394
0.50	1928	1747	1574
0.67	1600	1436	1281
0.75	1474	1318	1172
1.00	1194	1058	934
1.25	1003	884	776
1.50	865	759	664

Note: Estimated means are expressed as parts per billion (ppb).

It can be seen from Table 2 that, assuming that the 99th percentile is the percentile of interest, that even at moderately high variability levels and the expected post treatment TCLP lead level of 800 ppb that 8 samples is more than sufficient to assess compliance with TCLP limits of the entire treated volume of soil. Assuming that the CV is smaller, as is expected based on the treatability tests and previous experience, the sample average could be even twice the expected and still pass the statistical test. Clearly, using the proposed 4% MAECTITE® and a curing time of 7 days, 8 samples is sufficient to assess compliance.

2.3.2 a posteriori Sample Size Test

After all samples have been collected and analyzed and all the results shown to be below the TCLP limit an *a posteriori* sample size determination will be performed using the same equation above to determine if the sample size was sufficient to assess compliance with the TCLP limit even though all sample results were shown to be below the limit. But, in this case, we turn the equation around and solve for the *K* factor using the sample mean and standard deviation of the eight samples and then look up this factor in the table of factors for estimating the upper

confidence limit on the p^{th} percentile from a normal distribution (Table 2). The sample size, n, associated with the largest tabled *K* factor less than the calculated *K* would be the required sample size to demonstrate that the UTL of the population is less than the TCLP limit. If this sample size is less than or equal to eight, we would conclude that the sample size was sufficient. Otherwise, additional samples will be collected and analyzed.

The following equation will be used to calculate the *K* factor:

$$K = \frac{UTL - \bar{x}}{s}$$

where

$\bar{x}$ = sample mean residual level = $\frac{1}{8}\sum_{i=1}^{8} TCLP_i$, and

s = sample standard deviation = $\sqrt{\frac{1}{8-1}\sum_{i=1}^{8}(TCLP_i - \bar{x})^2}$.

Table 3
Factors $K_{1-\alpha,p}$ for Estimating an Upper 100(1 — α)% Confidence Limit on the p^{th} Percentile of a Normal Distribution

1 - α = .95	Percentile		
n	95th	99th	99.9th
2	26.260	37.094	49.276
3	7.656	10.553	13.857
4	5.144	7.042	9.214
5	4.210	5.749	7.509
6	3.711	5.065	6.614
7	3.401	4.643	6.064
8	3.188	4.355	5.689
9	3.032	4.144	5.414
10	2.911	3.981	5.204
11	2.815	3.852	5.036
12	2.736	3.747	4.900
13	2.670	3.659	4.787
14	2.614	3.585	4.690
15	2.566	3.520	4.607
16	2.523	3.463	4.534
17	2.486	3.414	4.471
18	2.455	3.370	4.415
19	2.423	3.331	4.364
20	2.396	3.295	4.319
21	2.371	3.262	4.276
22	2.350	3.233	4.238
23	2.329	3.206	4.204
24	2.309	3.181	4.171
25	2.292	3.158	4.143
30	2.220	3.064	4.022
35	2.166	2.994	3.934
40	2.126	2.941	3.866
45	2.092	2.897	3.811
50	2.065	2.863	3.766
60	2.022	2.807	3.695
70	1.990	2.766	3.643
80	1.965	2.733	3.601
90	1.944	2.706	3.567
100	1.927	2.684	3.539
120	1.899	2.649	3.495
145	1.874	2.617	3.455
300	1.800	2.522	3.335
500	1.763	2.475	3.277
∞	1.645	2.326	3.090

2.4 QA/QC Requirements

QA/QC requirements for the Firing Range Stabilization project will follow the requirements described in the approved Verification of Treatment Sampling Plan.

2.5 Equipment Decontamination

Equipment decontamination for the Firing Range stabilization project will follow the requirements described in the approved Verification of Treatment Sampling Plan.

2.6 Data Management

GEL laboratory data is managed using the Laboratory Information Management System (LIMS) for in-house sample scheduling, tracking, and data transcription. The LIMS system allows real-time tracking of all samples in-house. After the data is complete for each treatment area, a copy will be faxed to the FDF Construction Manager for their information.

GEL will prepare data reports to be included in a Verification of Treatment Report. Data reports will include the following information:

- Project identification.
- Field sample number.
- Laboratory sample number.
- Sample matrix description.
- Date of sample collection.
- Date of sample receipt at laboratory.
- Analytical method description and reference citation.
- Individual parameter results.
- Date of analysis (extraction, first run, and subsequent runs).

- Quantitation limits achieved.
- Dilution or concentration factors.
- Corresponding QC report, which includes a QC data verification checklist (to include method blanks, blank/spikes, and continuing calibration checks).

2.7 Health and Safety

All work associated with this activity will be performed in accordance with the Project Specific Health and Safety Plan (to be provided by FDF) and Sevenson's Safe Work Plan. Potential hazards may include exposure to contaminants, heat stress, and radiological hazards. Safety controls will include use of air monitoring, the "buddy system", employee training, and a radiological program. It is anticipated that the work will be performed in Modified Level D (hardhat, steel-toed boots, safety glasses, and tyveks) personal protective equipment.

2.8 Disposition of Wastes

Upon completion of the analyses, the off-site laboratory will return all soil samples to the Fernald site for disposition. The samples will be transported in containers amenable for shipping.

3.0 REFERENCES

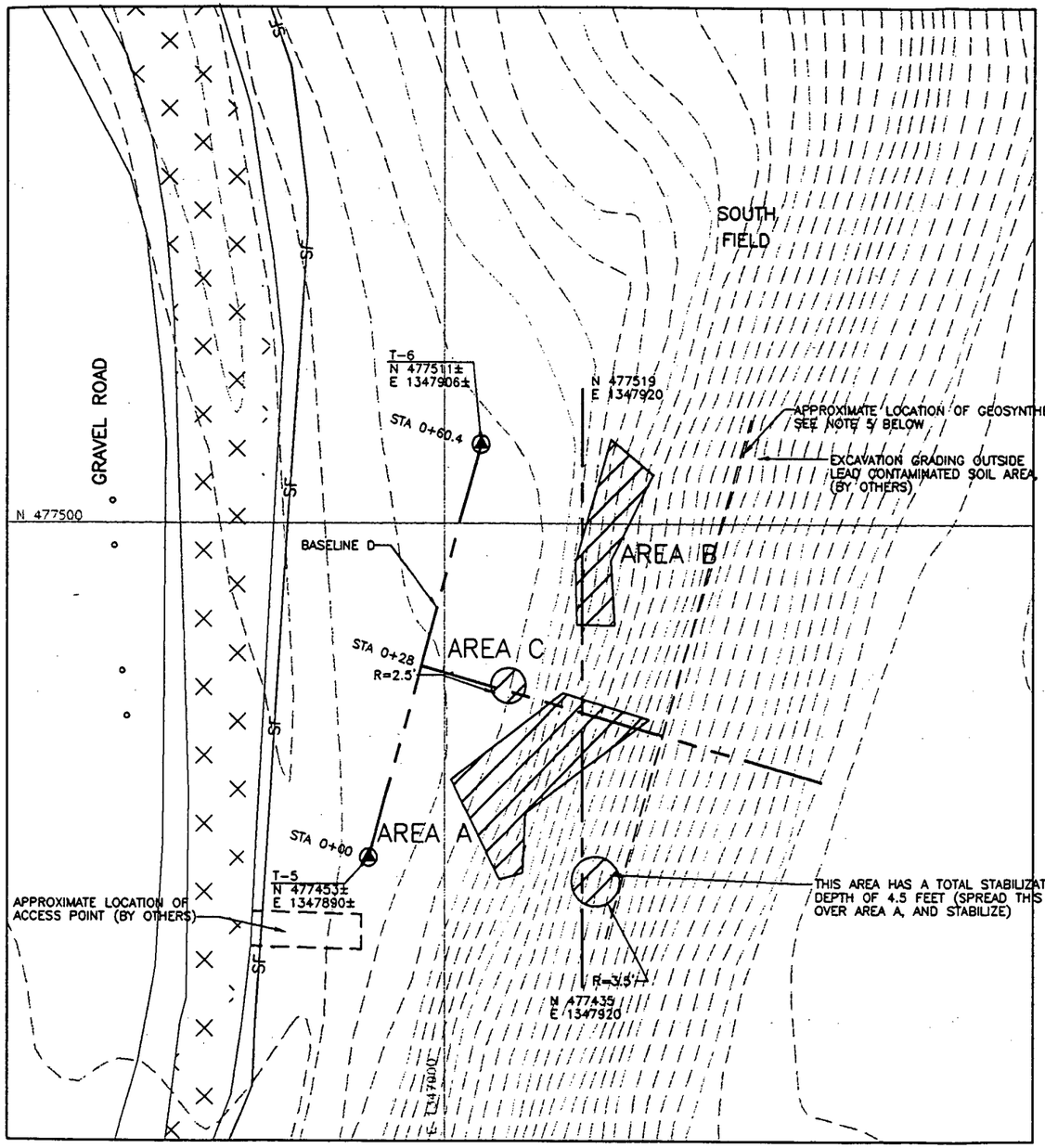
Gilbert, Richard O., 1987. *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold, New York.

Owen, D.B., 1962. *Handbook of Statistical Tables.* Addison-Wesley, Palo Alto, CA.

EPA/530-SW-89-026: "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance", April, 1989.

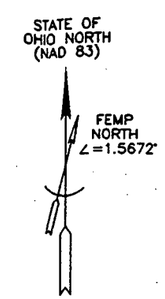
Sevenson Environmental Services, Inc. *Verification of Treatment Sampling Plan*, May, 1999.

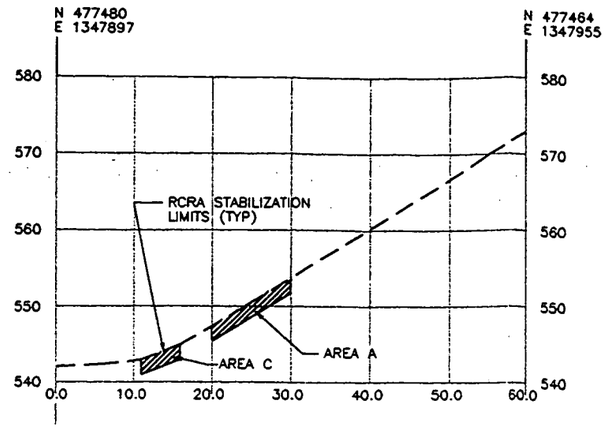
Sevenson Environmental Services, Inc. *Addendum to Treatability Study Report*, May, 1999.



AREA 2 PHASE II FIRING RANGE STABILIZATION AREA PLAN

20 0 20
SCALE IN FEET

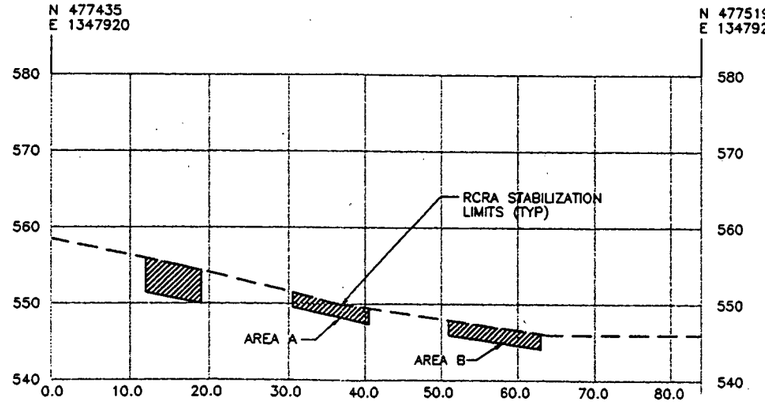




STATION 0+28
SCALE: HOR 1"=10'
VER 1"=10'

LIMITS OF RCRA EXCAVATION SOIL AREA (RLA)		
POINT	NORTHING	EASTING
1	477512	1347925
2	477507	1347931
3	477495	1347925
4	477486	1347925
5	477486	1347920
6	477495	1347920
7*	477477	1347910
8	477476	1347918
9	477473	1347930
10	477459	1347912
11	477451	1347912
12	477450	1347909
13	477464	1347902
14**	477450	1347923

* CENTER OF A 2.5' RADIUS CIRCLE
** CENTER OF A 3.5' RADIUS CIRCLE



E 1347920
SCALE: HOR 1"=10'
VER 1"=10'

RCRA (RLA) SOIL LIMITS

1. SURVEYING AND STAKING LIMITS OF RCRA SOIL AREA WILL BE PERFORMED BY OTHERS.
2. STABILIZE THE RCRA SOIL AREAS TO THE LIMITS AND DEPTHS SHOWN ON THIS SHEET AND AS SPECIFIED IN TECHNICAL SPECIFICATION 02211. DEPTH IS 2 FEET UNLESS SPECIFIED ON THIS SHEET.
3. THE CONTRACTOR HAS OPTION FOR THE CIRCULAR AREAS SHOWN ON THIS SHEET TO EITHER SPOT EXCAVATE AND SPREAD SOIL OVER THE LARGER TREATMENT AREAS OR STABLIZE IN-PLACE.
4. PERFORM CONFIRMATORY SAMPLING.
5. ANCHOR TRENCH AND GEOSYNTHETIC COVER WILL BE INSTALLED BY OTHERS. AFTER SAMPLES ARE COLLECTED THE CONTRACTOR SHALL UNROLL GEOSYNTHETIC COVER AND PLACE AS DIRECTED BY CONSTRUCTION MANAGER.

AREA 2 PHASE I FIRING RANGE TREATMENT AREAS

U.S. DEPARTMENT OF ENERGY

SEVENSON ENVIRONMENTAL SERVICES, INC. 000017

DRAWING 1		
	DATE:	6/3/99
	DRAWN BY:	MB
	CHECKED BY:	SS
	CAD FILE:	92g01031A
	SCALE:	SHOWN