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Soil Sampling Plan in Support of the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory

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Soil Sampling Plan Revision History

First revision in response to DTSC comments on the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility* March 2006. Comments by Michael J. Anderson, Ph.D.

Second revision in response to DTSC comments on the Ecological Risk Assessment (only). DTSC Cover Letter Date September 4, 2007, DTSC Memorandum Date August 23, 2007.October 2007 in response to DTSC comments. Comments by Michael J. Anderson, Ph.D. and Al Batakji, Hazardous Substance Engineer.

Third revision in response to DTSC comments received by email regarding additional statistical analysis on the soil sampling results. Comments from Michael J. Anderson, Ph.D., included in an email dated November 1, 2007, from Al Batakji, Hazardous Substance Engineer to Stan Terusaki, LLNL.

Fourth revision in response to DTSC comments to formalize and reference the Soil Sampling Plan in the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory*, UCRL-TR-216940 Vol 1 Rev.4.

Soil Sampling Plan in Support of the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory

LLNL proposes to obtain soil samples from the following areas:

1. Four areas downwind of the Explosives Waste Treatment Facility (EWTF) Burn Units (i.e., Thermal Treatment Unit and Burn Pan)

2. One area upwind of the Burn Units and Detonation Pad

3. Two areas downwind of the EWTF Detonation Pad

4. Three areas unaffected (representing ambient conditions) by EWTF operations approximately 7000–8000 feet upwind of the facility

The purpose of the sampling in areas 1, 2, and 3 is to detect if operations cause increases in concentrations of materials downwind of the Burn Units or downwind of the Detonation Pad. The purpose of the sampling in area 4 is to determine if previously developed background screening levels can be applied to EWTF operations.

A 20 foot diameter circle will define each sample area. Soil samples will be obtained from four random locations inside each 20 foot circle. The samples will be obtained immediately below the surface, free of any organic matter (e.g., roots) and other surface and subsurface material (e.g., rocks) that is not conducive to analysis. The random identification of four discrete sample locations in each circle will allow the variability between sample locations and areas, if present, to be evaluated statistically. At a minimum, data will be evaluated by the Wilcoxon Rank Sum test.

All future sampling will occur in the same 20 foot diameter circle; however, only one randomly located sample (instead of four) will be obtained. Future samples will be analyzed for the same chemicals of potential ecological concern (CPECs) as the initial sample. Sample areas and locations will be recorded by Global Positioning System coordinates.

Summary of Sample Areas and Locations

Initial sampling: The total number of sample areas will be 10 (listed above). Each sample area will be sampled from four random locations; therefore, soil samples will be obtained from 40 locations.

Future sampling: Samples will be obtained from the same areas downwind of the Burn Units (#1 above), area upwind of EWTF (#2 above), and areas downwind of the Detonation Pad (#3 above). Soil samples will be

obtained at each area from one random location inside the 20 foot circle.

Burn Units Sample Plan

The first three proposed sample areas are in the valley downgradient and east of the Burn Units. The downgradient direction also coincides with the predominantly easterly wind direction during treatment operations. Therefore, CPECs, if present, would most likely be carried downwind and downgradient by wind and erosional processes.

The fourth and last downwind sample area is near a ridge before crossing into another small valley. This would be the last area where CPECs would be deposited before airborne CPECs would be diluted by dispersion effects of the ridge east of the Burn Units.

The upwind sample will be obtained approximately 850 feet west of the Burn Units, near the top of a ridge surrounding EWTF. This sample will also be the upwind sample for the Detonation Pad. **Table A** summarizes the sampling plan for the Burn Units.

Downwind and upwind samples will be compared using the Wilcoxon Rank Sum test (at a significance level of 5%) to determine if a statistically significant difference exists.

Table A. Sample Plan for the Burn Units

Burn Units Sample Area ID #	Distance from Burn Units (feet)	Number of soil sample locations per sample area	Constituents	EPA Method
Burn Units DW[1] #1	Adjacent to facility	4 random	Table B-8 CPECs[2]	Explosives EPA Method 8330, Furans EPA Method 8290, Total Metals EPA Method 6010B, Semi-volatiles EPA Method 8270, + grain size, pH, %organic matter
Burn Units DW #2	250	4 random	Table B-8 CPECs	Explosives EPA Method 8330, Furans EPA 8290, Total Metals EPA Method 6010B, Semi-volatiles EPA Method 8270, + grain size, pH, %organic matter
Burn Units DW #3	500	4 random	Table B-8 CPECs	Explosives EPA Method 8330, Furans EPA Method 8290, Total Metals EPA Method 6010B, Semi-volatiles EPA Method 8270, + grain size, pH, %organic matter
Burn Units DW #4	650	4 random	Table B-8 CPECs	Explosives EPA Method 8330, Furans EPA Method 8290, Total Metals EPA Method 6010B, Semi-volatiles EPA Method 8270, + grain size, pH, %organic matter

continued

Burn Units Sample Area ID #	Distance from Burn Units (feet)	Number of soil sample locations per sample area	Constituents	EPA Method
Burn Units and Detonation Pad UW[3] #1	850	4 random	Table B-8 CPECs	Explosives EPA Method 8330, Furans EPA Method 8290, Total Metals) EPA Method 6010B, Semi-volatiles EPA Method 8270, + grain size, pH, %organic matter

1 DW = Downwind

2 CPECs = Chemicals of Potential Ecological Concern, Attachment 1 (Table B-8, from the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory*, Volume 1: Report of Results, UCRL-TR-216940 Vol 1 Rev.4)

3 UW = Upwind

Detonation Pad Sampling Plan

The proposed sampling strategy for the Detonation Pad will not differ from the burn units sampling plan except for the following:

- The distance from the Detonation Pad to the top of the downwind ridge is approximately 180 feet. Therefore, the shorter distance from the unit to the ridge only allows two sample areas.

Table B summarizes the sampling plan for the Detonation Pad.

Downwind and upwind samples will be compared using the Wilcoxon Rank Sum test (at a significance level of 5%) to determine if a statistically significant difference exists.

Table B. Sample Plan for the Detonation Pad

Detonation Pad Sample Area ID #	Distance from Detonation Pad (feet)	Number of soil sample locations per sample area	Constituents	EPA Method
Detonation Pad DW[1] #1	Adjacent to facility	4 random	Table B-8 CPECs[2]	Furans EPA Method 8290, Total Metals EPA Method 6010B, Semivolatiles EPA Method 8270, Explosives EPA Method 8330, + grain size, pH, %orgnic matter
Detonation Pad DW #2	120	4 random	Table B-8 CPECs	Furans EPA Method 8290, Total Metals EPA Method 6010B, Semivolatiles EPA Method 8270, Explosives EPA Method 8330, + grain size, pH, %orgnic matter

continued

Detonation Pad Sample Area ID #	Distance from Detonation Pad (feet)	Number of soil sample locations per sample area	Constituents	EPA Method
Detonation Pad UW[3] #3	Same sample as the Burn Units upwind sample	4 random	Table B-8 CPECs	Furans EPA Method 8290, Total Metals EPA Method 6010B, Semi-volatiles EPA Method 8270, Explosives EPA Method 8330, + grain size, pH, %orgnic matter

1 DW = Downwind

2 CPECs = Chemicals of Potential Ecological Concern, Attachment 1 (Table B-8, from the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory*, Volume 1: Report of Results, UCRL-TR-216940 Vol 1 Rev.4)

3 UW = Upwind

Ambient Location Sampling Plan

Three sampling locations are proposed to evaluate ambient levels, if present, of the CPECs. The location of the three areas is in the west to northwest corner of Site 300, approximately 7000 - 8000 feet upwind of EWTF. The location of EWTF and the three sample areas (NPS, WOBS, and DSW) are shown in **Figure 1.** Soil samples will be obtained from the "GAF" soil type in order to minimize the effects of potentially different chemical, mechanical weathering processes and source terrain influences on the sample results. **Figure 2** identifies the "GAF" soil type distribution across Site 300.

The same sampling strategy described above for the Burn Units and will be implemented for the ambient sample areas. **Table C** summarizes the sampling plan for the ambient locations.

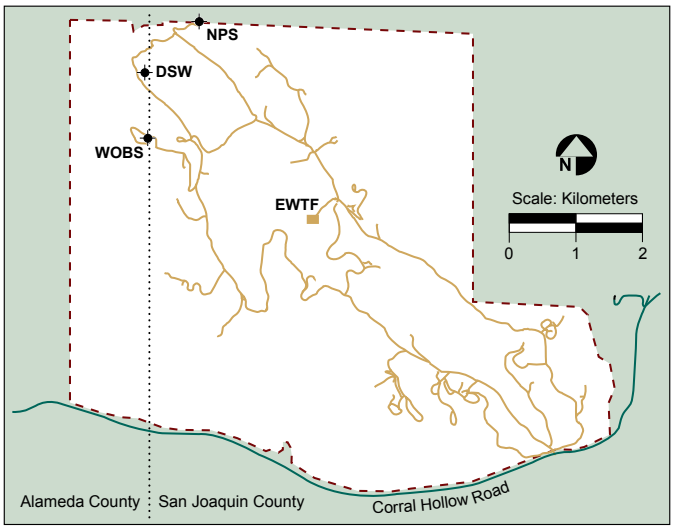
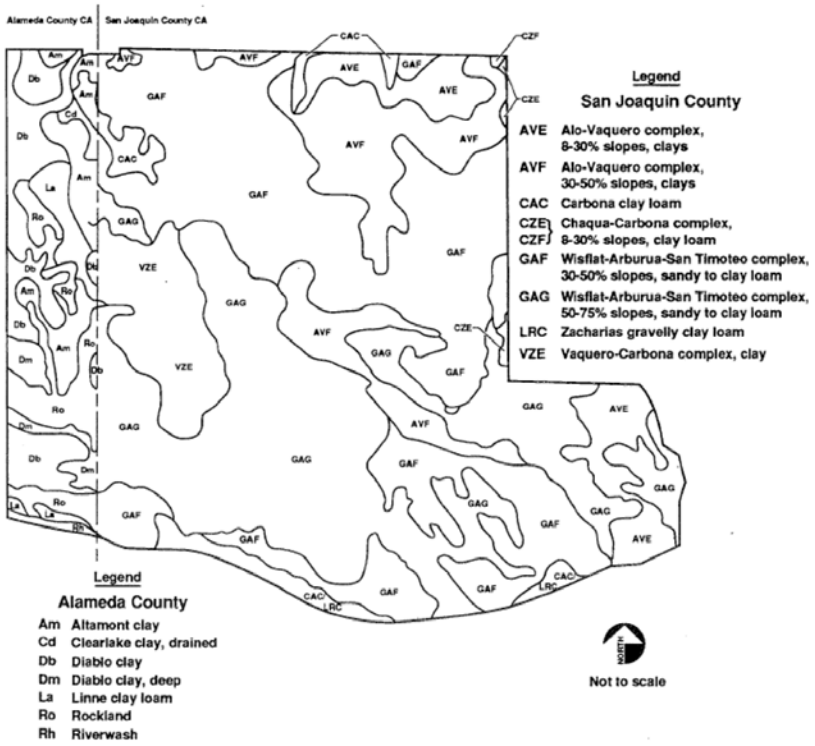


Figure 1. NPS, DSW, WOBS, EWTF locations.



Source: Soil Survey of San Joaquin County, California. Conducted in 1990; Soil Survey of the Alameda County, California, 1966.

Figure 2. Soil map of LLNL Site 300 (soils of the two counties are the same, only nomenclature is different).

Table C. Sample Plan for the Ambient Locations

Sample Area ID #	Approximate Distance from EWTF (feet)	Number of soil sample locations per sample area	Constituents	EPA Method
WOBS	7000	4 random	Table B-8 CPECs[1, 2]	Explosives EPA Method 8330, Furans EPA Method 8290, Semi-volatiles EPA Method 8270, Total Metals EPA Method 6060B, + grain size, pH, %organic matter
DSW	7500	4 random	Table B-8 CPECs[1, 2]	Explosives EPA Method 8330, Furans EPA Method 8290, Semi-volatiles EPA Method 8270, Total Metals EPA Method 6010B, + grain size, pH, %organic matter

continued

Sample Area ID #	Approximate Distance from EWTF (feet)	Number of soil sample locations per sample area	Constituents	EPA Method
NPS	8000	4 random	Table B-8 CPECs[1, 2]	Explosives EPA Method 8330, Furans EPA Method 8290, Semi-volatiles EPA Method 8270, Total Metals EPA Method 6010B, + grain size, pH, %organic matter

1 CPECs = Chemicals of Potential Ecological Concern, Attachment 2 (Table B-8, from the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Volume 1: Report of Results, UCRL-TR-216940 Vol 1 Rev. 4)

2 Samples for total metals analysis by EPA Method 6010B will be obtained if warranted by statistical analysis.

Background Metals Concentrations in Site 300 Soils

Table D provides background screening level concentrations for metals (except aluminum) at Site 300. The concentrations were calculated based on the statistical probability that only 1 in 200 samples from background will exceed that value. All of the soil samples used to create the database were obtained at Site 300 and were not sampled from any known source of anthropogenic contamination.

The Wilcoxon Rank Sum test will be conducted on the ambient and the upwind metals results. If the metals at the ambient locations are not present at elevated concentrations relative to the upwind locations, this will suggest the background screening metals concentrations in **Table D** may be used for future comparisons.

The Wilcoxon Rank Sum (WRS) Test is a non-parametric test which can be used to examine whether measurements from one population tend to be consistently larger (or smaller) than those from another population. LLNL Site 300 will use this test to determine whether inorganic sampling data (background versus site) represent similar or different statistical populations. In addition to visual inspection of the distribution plots and in order to identify potential outliers, LLNL Site 300 will perform a quantile test complementary to the WRS test. The quantile test will be used to detect differences which are not detected by the WRS, and to evaluate and compare the upper tails of two distributions. LLNL Site 300 will use appropriate references including the Navy guidance document found at https://portal.navfac.navy.mil/pls/portal/docs/PAGE/NAVFAC/NAVFAC_WW_PP/NAVFAC_NFESC_PP/ENVIRONMENTAL/ERB/LAB/PROCGUID.PDF for determining inorganic constituent background concentrations in addition to other, appropriate statistical tests. LLNL will submit to DTSC a report including a discussion of the statistical tests (i.e. Wilcoxon Rank Sum test), distribution of data, outliers and complete summary of results.

LLNL proposes to not sample for aluminum based on the fact that aluminum is a ubiquitous and abundant element found in soil in Livermore and Tracy. At Site 300, aluminum is found in clay-bearing source rocks (e.g., graywacke, metagraywacke,

shale, argillite) of the metamorphic Franciscan Assemblage and sedimentary rocks of the Great Valley Sequence. Erosion of the metamorphic and sedimentary rocks has produced a clay-rich soil (Vertisols) high in aluminum concentration that is typical of the Diablo Range, which encompasses Site 300 and the Livermore site.

Soil samples obtained from the Livermore site have an aluminum concentration that ranges from 1 to 2% (10,000 to 20,000 mg/kg). Based on this analytical data for Livermore and the common source terrain (i.e., Diablo Range) for Livermore and Site 300, aluminum soil concentrations at Site 300 should be similar to the Livermore site. Therefore, it may not be possible to discern aluminum from EWTF emissions, which is calculated at 86 mg/kg (Table B, page B-30) relative to 10,000 to 20,00 mg/kg natural background. For this reason, aluminum soil sampling is not proposed as part of this sampling plan.

Soil Sampling Tables

Table E lists each sample area, location, number of samples to be obtained in each location and analytical test. **Table F** provides duplicate sample quality assurance information for the initial effort. **Table G** provides the estimated sample plan five years after the initial effort. Subsequent sampling efforts may only include only one sample location in the Burn Units and Detonation Pad areas; however, additional samples and samples locations may be necessary if the variability exceeds 20% pursuant to DTSC comment 2B [DTSC letter dated September 4, 2007, enclosed HERD Comments].

This sampling plan will be implemented at five year intervals as requested in the DTSC comment letter dated June 8, 2006. The five year sampling plan will be submitted to DTSC for approval based of the statistical analysis of the first year sample results.

Quality Assurance/Quality Control

Table F lists the total number of field duplicates that will be obtained for each sample and duplicate sample locations. The duplicate sample will be collected at the same time from the two locations adjacent to each other, and will be submitted to the analytical laboratory as separate samples (i.e., "blind" duplicates). The duplicates will be used to assess the consistency of the overall sampling effort, including collection, shipping, analysis and consistency and precision of the laboratory's analytical system.

Table D. Background screening levels for metals in soils at Site 300

Metal	Number of Analyses	Number of Detections	Background Screening Level (mg/kg)
Antimony	53	0	1.0
Arsenic	53	50	9.24
Barium	53	53	331
Beryllium	53	24	1.01
Cadmium	53	3	2.6
Chromium	53	53	45.6
Cobalt	53	51	16.2
Copper	53	53	34
Lead	53	16	70.3
Mercury	53	1	0.05
Molybdenum	53	3	12
Nickel	53	50	66
Selenium	53	11	2.87
Silver	53	0	2.5
Thallium	53	0	1.0
Vanadium	53	53	97.5
Zinc	53	53	78

Table E. Soil Sampling Area/Location

Area	Location	# Samples/Analysis	
Burn Units DW #1	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x metals	4 x % organic matter
		4x semi-volatiles	
Burn Unit DW #2	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x metals	4 x % organic matter
		4x semi-volatiles	
Burn Unit DW #3	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x metals	4 x % organic matter
		4x semi-volatiles	
Burn Unit DW #4	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x metals	4 x % organic matter
		4x semi-volatiles	
Burn Unit Detonation Pad UW #1	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x metals	4 x % organic matter
		4x semi-volatiles	
Detonation Pad DW #1	4 random locations	4x semi-volatiles	4x soil grain size
		4x explosives	4 x soil pH
		4x furans	4 x % organic matter
		4x metals	
Detonation Pad DW #2	4 random locations	4x semi-volatiles	4x soil grain size
		4x explosives	4 x soil pH
		4x furans	4 x % organic matter
		4x metals	
WOBS	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x semi-volatiles	4 x % organic matter
DSW	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x semi-volatiles	4 x % organic matter
NPS	4 random locations	4x explosives	4x soil grain size
		4x furans	4 x soil pH
		4x semi-volatiles	4 x % organic matter

Metals may be added to ambient locations (WOBS, DSW, NPS) based on statistical results.

Table F. EPA Method/Total Number of Samples/Number of Duplicates

EPA Method	Total Number of Samples	Number of Duplicate Samples	Duplicate Sample Locations
Explosives EPA Method 8330	40	4	Burn Unit DW #1
			Detonation Pad DW #1
			Burn Units/Detonation Pad UW #1
			NPS
Furans EPA Method 8290	40	4	Burn Unit DW #2
			Detonation Pad DW #2
			Burn Units/Detonation Pad DW #1
			DSW
Total Metals EPA Method 6010B	28 (minimum) 40 (maximum)	3 (minimum) 4 (maximum)	Burn Unit DW #3
			Detonation Pad DW #1
			Burn Units/Detonation Pad UW #1
			WOBS
Semi-volatiles EPA Method 8270	40	4	Burn Units DW #1
			Burn Units DW #4
			Detonation Pad DW #1
			NPS
Grain Size	40	4	Burn Unit DW #2
			Detonation Pad DW #2
			Burn Units/Detonation Pad DW #1
			DSW
pH	40	4	Burn Unit DW #2
			Detonation Pad DW #2
			Burn Units/Detonation Pad DW #1
			WOBS
% Organic Matter	40	4	Burn Unit DW #2
			Detonation Pad DW #2
			Burn Units/Detonation Pad DW #1
			NPS
Total	268-280	27-28	

Table G. Estimated Sampling 5 Years After Initial Sampling Effort

Area	Location[1]	# Samples/Analysis[1]
Burn Units DW #1	1-4 random location(s)	1-4x explosives
		1-4x furans
		1-4x metals
		1-4x semi-volatiles
Burn Unit DW #2	1-4 random location(s)	1-4x explosives
		1-4x furans
		1-4x metals
		1-4x semi-volatiles
Burn Unit DW #3	1-4 random location(s)	1-4x explosives
		1-4x furans
		1-4x metals
		1-4x semi-volatiles
Burn Unit DW #4	1-4 random location(s)	1-4x explosives
		1-4x furans
		1-4x metals
		1-4x semi-volatiles
Burn Unit/Detonation Pad UW #1	1-4 random location(s)	1-4x explosives
		1-4x furans
		1-4x metals
		1-4x semi-volatiles
Detonation Pad DW #1	1-4 random location(s)	1-4x explosives
		1-4x furans
		1-4x metals
		1-4x semi-volatiles
Detonation Pad DW #2	1-4 random location(s)	1-4x furans
		1-4x metals

1 Additional sample locations and samples per location may be required based on statistical tests from the first year sampling and DTSC comment 2B. Duplicate samples will be determined after DTSC approval of the total number of sample locations and samples.