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### TECHNICAL MEMORANDUM RESULTS OF OFF-SITE CESIUM-137 INVESTIGATION

at the

LABORATORY FOR ENERGY-RELATED HEALTH  
RESEARCH (LEHR)  
UNIVERSITY OF CALIFORNIA AT DAVIS,  
CALIFORNIA

*prepared for*

**United States Department of Energy**  
Oakland Operations Office  
1301 Clay Street  
Oakland, California 95612-5208

*prepared by*

**Weiss Associates**  
5500 Shellmound Street  
Emeryville, CA 94608-2411

January 18, 1999  
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

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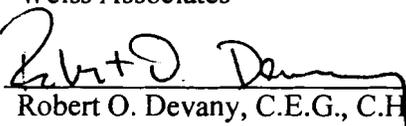
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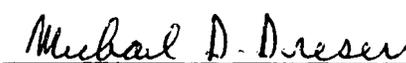
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## ACRONYMS

cpm	counts per minute
Cs-137	Cesium-137
GEL	General Engineering Laboratories
HPGe	high-purity germanium
LEHR	Laboratory for Energy-Related Health Research
PNNL	Pacific Northwest National Laboratory
PRG	Preliminary Remediation Goal
RBAS	Risk-Based Action Standard
WRS	Wilcoxon Rank Sum

## 1. TECHNICAL MEMORANDUM

### 1.1 Introduction

This Technical Memorandum presents the results of the July 1998 Off-Site Cesium-137 (Cs-137) Investigation conducted at the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California. Surface soil sampling was performed in July 1998 along the Old Davis Road drainage ditch in the vicinity of the former Radium Treatment System. This investigation was conducted because Cs-137 was detected at levels that equal or exceed 0.1 pCi/g, the  $10^{-6}$  Risk-Based Action Standard (RBAS), in eight of the nine surface samples collected during the November 1997 investigation in Areas 1 and 4 (Figures 1 and 2) of this drainage ditch; Cs-137 results are presented in Table 1. The highest Cs-137 activity detected in these samples was 0.32 pCi/g in a sample collected in Area 1 (Sample ID LEHR-SS-RA-0001) near the pipe under Old Davis Road (Figure 1). The November 1997 data also indicated that Cs-137 attenuates rapidly with depth. Details of the previous investigation in this area are presented in the *Final Technical Report: Results of Western Dog Pens, Background and Off-Site Investigations* (Weiss Associates [WA], 1998a). The July 1998 investigation was performed in accordance with the *Final Off-Site Cesium-137 Investigation Addendum to Work Plan for Western Dog Pens, Background, and Off-Site Investigations* (WA, 1998b).

### 1.2 Sampling Program

On June 1, 1998, a surface gamma radiation survey was conducted in the storm water drainage ditch along Old Davis Road using a hand-held scalar instrument (Ludlum 2221) equipped with a 2 inch by 2 inch sodium-iodide gamma scintillation detector (see Appendix A). This survey was conducted along the lowest point of the ditch in the four areas shown on Figure 2. These four areas were defined based on surface water drainage patterns:

- Area 1 collects run-off from the southwestern part of the LEHR site, and the flow direction in the ditch is to the north towards the pipe under Old Davis Road;
- Area 2 collects run-off from the northwest part of the LEHR site and from UC Davis facilities north of LEHR, and the flow direction in the ditch is to the south;
- Area 3 collects run-off from UC Davis facilities west and northwest of that area, and the flow direction in the ditch is to the south; and,
- Area 4 receives run-off from Areas 1, 2, and 3, as well as from UC Davis facilities to the west, and the flow direction is south to Putah Creek.

Continuous readings were taken along the entire lengths of these areas, and one-minute integrated readings were taken at least every 10 lateral ft. In addition, one-minute integrated readings were taken at five of the previous surface soil sampling locations in Area 1, and at locations 5 ft north and south of each of these previous sampling locations. Gamma readings from this surface survey ranged from 370 counts per minute (cpm) to 617 cpm, with no apparent pattern to the distribution of the readings. Readings at the previous sampling locations and at 5 ft from the previous sampling locations were within this same range. Readings for each of the four areas shown on Figure 2 were similar, with averages for the four areas ranging from 501 cpm for Area 1 to 552 cpm for Area 4. Based on the results of this survey, it appears likely that surface soil Cs-137 activities in the four areas surveyed are similar to each other and to the Cs-137 results already obtained for surface soils in Area 1. Given the relatively small range of readings throughout these areas, it also appears unlikely that any areas of significantly higher Cs-137 activities are present in these four areas.

Based on the gamma survey results, surface soil sampling was focused on comparing Cs-137 levels in Areas 1, 2 and 3. Area 1 is the area most likely to have been impacted by LEHR activities, Area 2 may have been impacted by both LEHR and upstream activities, and Area 3 should not have been impacted by LEHR activities. Cs-137 levels in Area 3 may reflect global fallout accumulation only. Therefore, comparing the Cs-137 levels in these three areas should help determine whether the slightly elevated level (with respect to background) previously detected in Areas 1 and 4 are the result of impacts from the LEHR site, other local sources, or global fall-out accumulation. Area 4 was not to be included in this round of surface soil sampling because it receives run-off from Areas 1, 2 and 3, so the significance of data from this area may be difficult to interpret.

The Wilcoxon Rank Sum (WRS) Test (EPA, 1992) was used to estimate the number of samples needed from each area so that statistically valid comparisons can be made. Assumptions and parameters used in the WRS Test are presented in the *Final Off-Site Cesium-137 Investigation Addendum to the Work Plan for Western Dog Pens, Background, and Off-Site Investigations* (WA, 1998b).

Surface soil samples from a depth of 0 to 6 inches were collected in July 1998. Vegetation and surface debris were removed prior to sampling. Eight samples were collected from Area 1, and 12 samples each were collected from Areas 2 and 3. In addition, 3 samples were collected from Area 1 at previous sampling locations B-1, A-5 and A-11, 5 ft, 43 ft and 103 ft, respectively, south of storm water pipe (Figure 2). Sample locations in each of these three areas were determined by stretching a measuring tape along the deepest part of the trench and sampling at locations along the tape determined by a random number generator (Table 2). Field duplicate samples from 7 of the 35 sample locations were also collected and analyzed.

In addition, 5 surface soil samples (4 primary and 1 field duplicate) were collected from the storm water run-off ditch along Old Davis Road north of the railroad tracks and south of Interstate 80 (Figure 3). Based on visual inspection and input from UC Davis, samples were collected from locations within the storm water run-off ditch that 1) appear to be in similar condition (i.e., similar surface soil types and vegetation with no evidence of recent reworking), and 2) receive similar volumes of storm water run-off (i.e., similar run-off area with a similar proportion of pavement) as

Area 1. These samples should provide additional data on Cs-137 levels in storm water ditch soil impacted only by global fall-out accumulation.

All 47 soil samples were analyzed for Cs-137 at the LEHR site by Pacific Northwest National Laboratory (PNNL) using high-resolution gamma-ray spectrometry to obtain a nondestructive radiological analysis of a soil sample by passively measuring radioisotope emissions of associated gamma rays. The surface soil samples were collected in the same manner as those previously collected from the drainage trench; i.e., a hand auger and drive sampler were used to collect the first six inches of soil beneath any loose vegetation/debris.

Seventeen (approximately 30%) of the 47 samples were sent to General Engineering Laboratories (GEL) in Charleston, South Carolina, for confirmation analysis. These samples were analyzed for Cs-137 by Gamma Spectrometry, EPA Method 901.1. Comparison of the PNNL and GEL results shows very good correlation (Figure 4).

### 1.3 Summary of Results

The results of all sampling described above are presented in Table 3 and are summarized below.

- Area 1 (east side of Old Davis Road, 0 to 121 ft south of the culvert crossing, i.e., area adjacent to Ra/Sr area) – Activities ranged from 0.0602 to 0.1795 pCi/g, with a mean value of 0.116 pCi/g. The results for samples from previous sampling locations B-1, A-5 and A-11 differ by 12% to 53%.
- Area 2 (east of Old Davis Road, 8 to 288 ft north of the culvert crossing) – Activities ranged from 0.0229 to 0.1563 pCi/g with a mean value of 0.086 pCi/g.
- Area 3 (west of Old Davis Road, 5 to 220 ft north of the culvert crossing) – Activities ranged from 0.0628 to 0.2394 pCi/g with a mean value of 0.138.
- Background Area (storm water run-off ditch along west side of Old Davis Road, north of railroad tracks) – Activities ranged from 0.0490 to 0.1280 pCi/g with a mean value of 0.082 pCi/g.

Eight sets of field duplicate samples (SSRA0020, 0026, 0031, 0037, 0042, 0046, 0052 and 0061) were collected. “Duplicate” samples were two 1.5-liter samples collected from 0 to 6 inches depth adjacent to each other. With one exception, the difference between duplicate results ranged from 0.6% to 21%. The exception (SSRA0019 and 0020) differed by 63%.

## 1.4 Risk Considerations

Table 4 presents the comparison of Cs-137 results with the LEHR's Risk-Based Action Standards (RBAS). The mean Cs-137 values are less than three times the background concentration of 0.046 pCi/g; higher values are expected in the areas that concentrate storm water runoff. Cs-137 results are slightly higher than the RBAS value of 0.10 pCi/g for Scenario 1 at  $10^{-6}$  Risk but less than the  $10^{-5}$  Risk value of 1.0 pCi/g. All sample results exceed the 1998 Residential  $10^{-6}$  Preliminary Remediation Goal (PRG) of 0.02 pCi/g. This information suggests that the measured Cs-137 levels will fall within the  $10^{-4}$  to  $10^{-6}$  NCP-defined Acceptable Exposure Level for residential land use.

Definitive comparison of the sample results to background is not possible since detailed information on the shallow vertical distribution of background Cs-137 (global fallout accumulation) is not available. Establishing depth-specific background levels for Cs-137 and other sorptive fission products may not be practical due to uncertainty in surface modifications/grade changes after fallout activities peaked in the early 1960s.

## 1.5 Findings and Recommendations

Results from this investigation indicate that:

- There is no significant difference between Cs-137 activities measured in Areas 1, 2 and 3;
- Cs-137 activities measured in Areas 1, 2 and 3 are comparable to those measured in the distant storm water run-off ditch;
- Cs-137 activities measured in these four areas are within the range reported by others for activities associated with global fallout from atmospheric nuclear testing for this area (Livermore Valley = 0.18 – 0.22 pCi/g and San Francisco/Oakland are two to three times higher [Gallegos, 1995]); and,
- Potential human health risks from the Cs-137 found in the ditch appear to fall within the NCP-defined Acceptable Exposure Levels (i.e.,  $10^{-4}$  to  $10^{-6}$  excess upper bound lifetime risk to an individual).

Based on these findings, we conclude that no significant environmental releases of Cs-137 resulting from activities at the LEHR site have occurred in the offsite ditch area, and recommend no further action at this time.

## 2. REFERENCES

- Gallegos, Gretchen, Surveillance Monitoring of Soils for Radioactivity, Lawrence Livermore National Laboratory 1976 to 1992, Health Physics Society, October 1995, Volume 69, Number 4.
- U.S. Environmental Protection Agency (EPA), 1992, Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3: Reference-Based Standards for Soil and Solid Media, EPA 230-R-94-004, December.
- Weiss Associates, 1998a, Final Technical Report: Results of Western Dog Pens, Background and Off-Site Investigations at the Laboratory for Energy-Related Health Research (LEHR), University of California, Davis, California, June.
- Weiss Associates, 1998b, Final Off-Site Cesium-137 Investigation Addendum to Work Plan for Western Dog Pens, Background, and Off-Site Investigations at the Laboratory for Energy-Related Health Research (LEHR), University of California, Davis, California, June.

## **FIGURES**

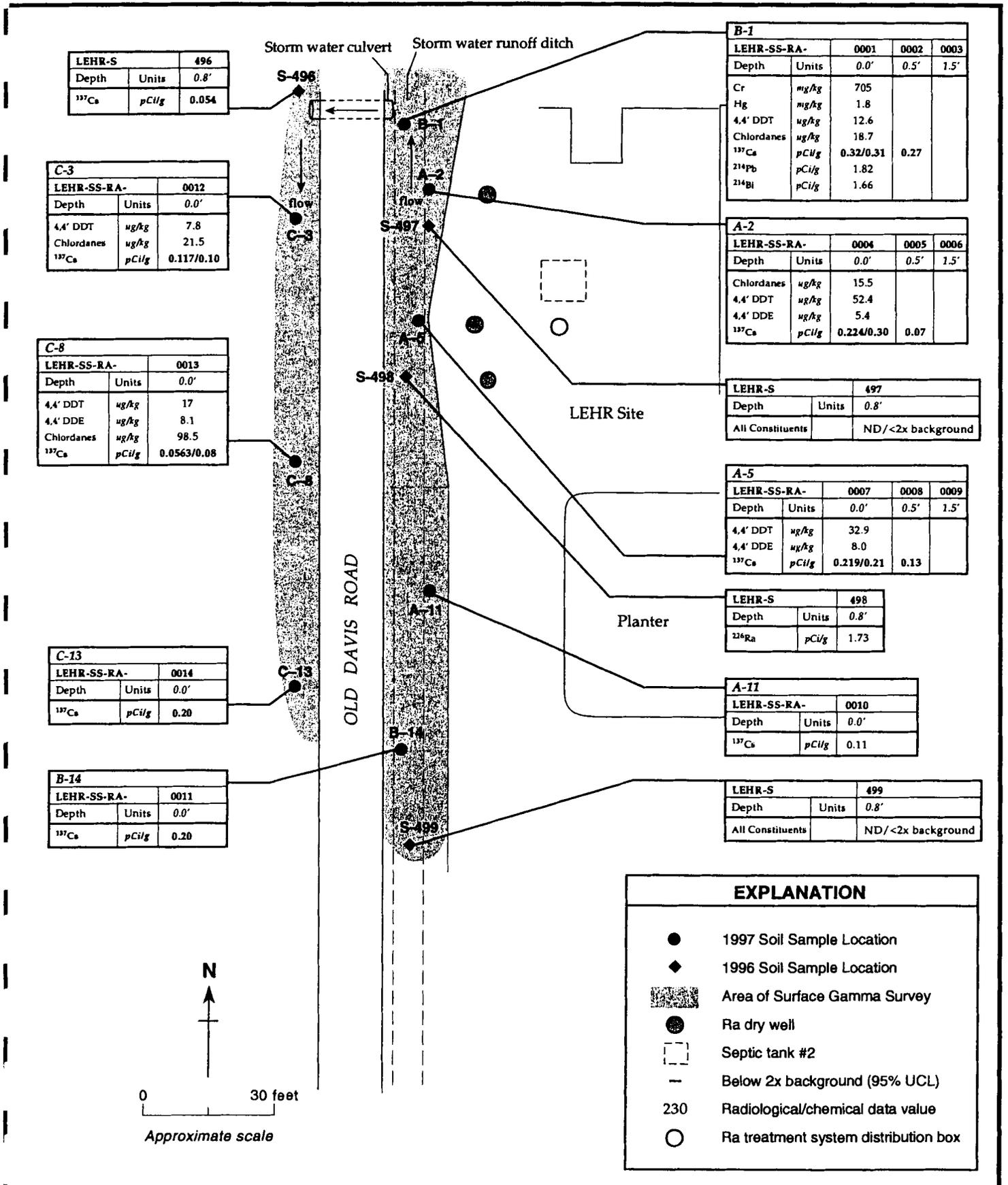


Figure 1. Off-Site Soil Sampling Locations and Summary of Significant Findings, November 1997, LEHR Site, UC Davis, California

Weiss Associates

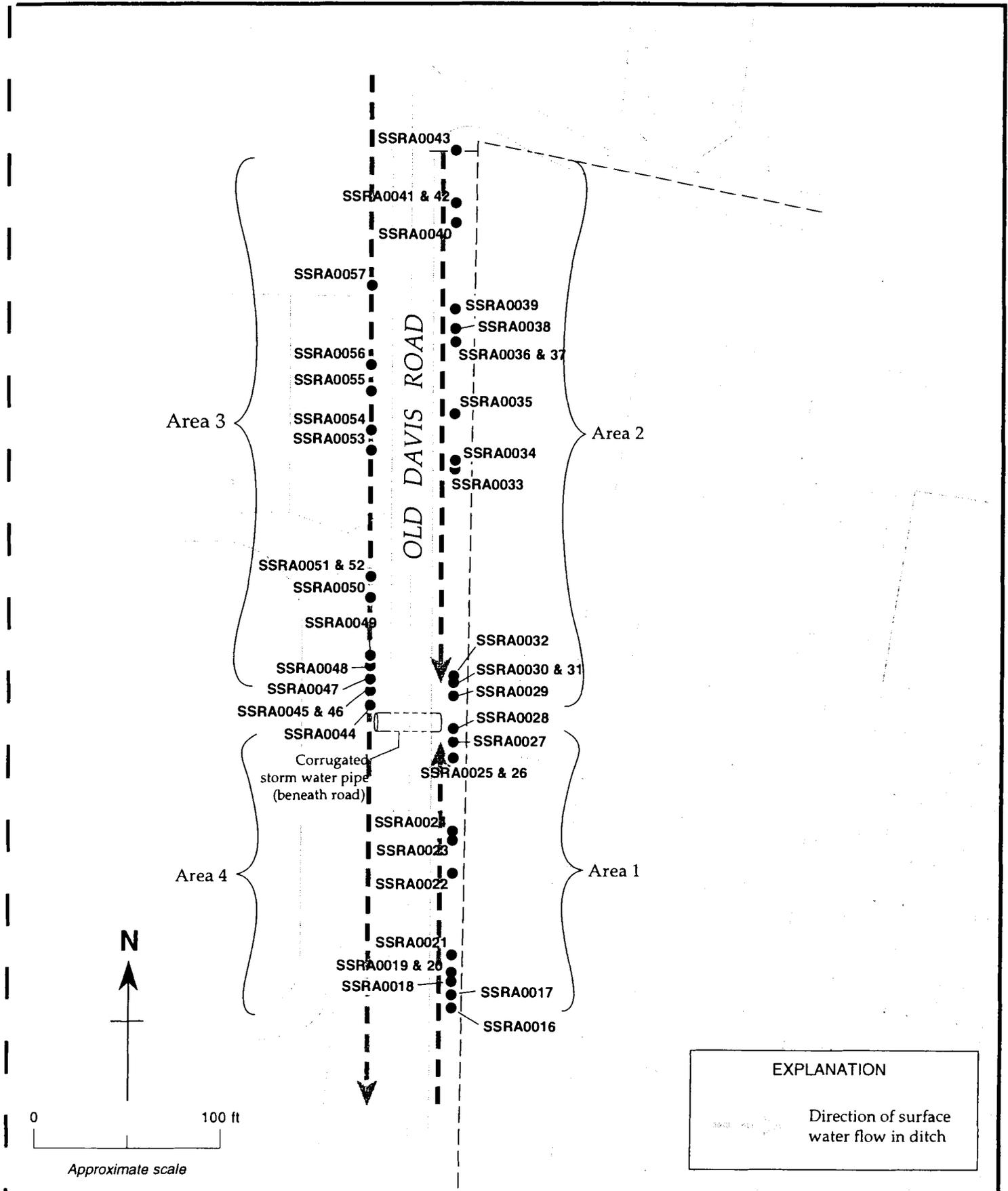


Figure 2. Off-Site Cesium -137 Sampling Locations, July 1998, LEHR Site, UC Davis, California

Weiss Associates

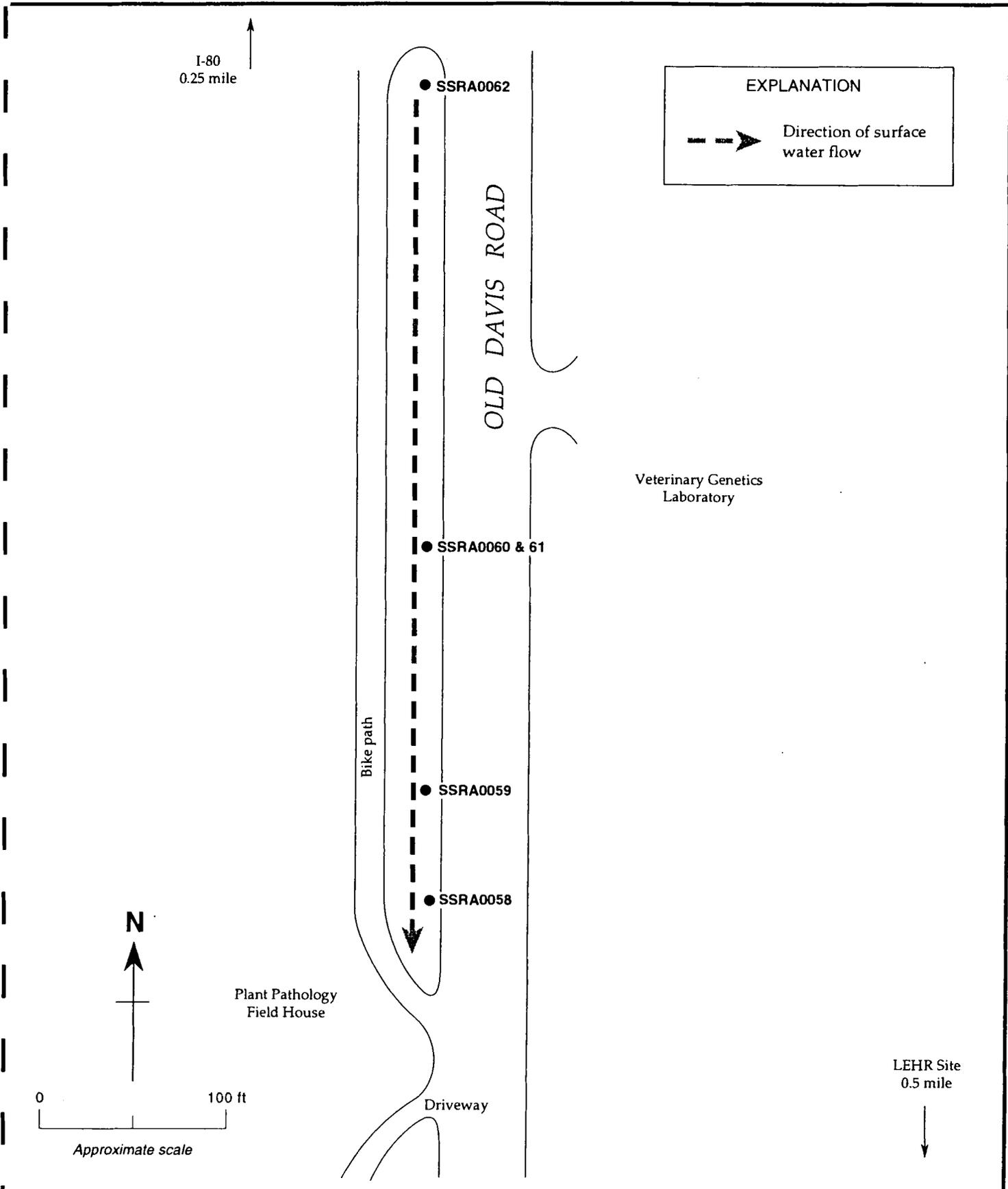
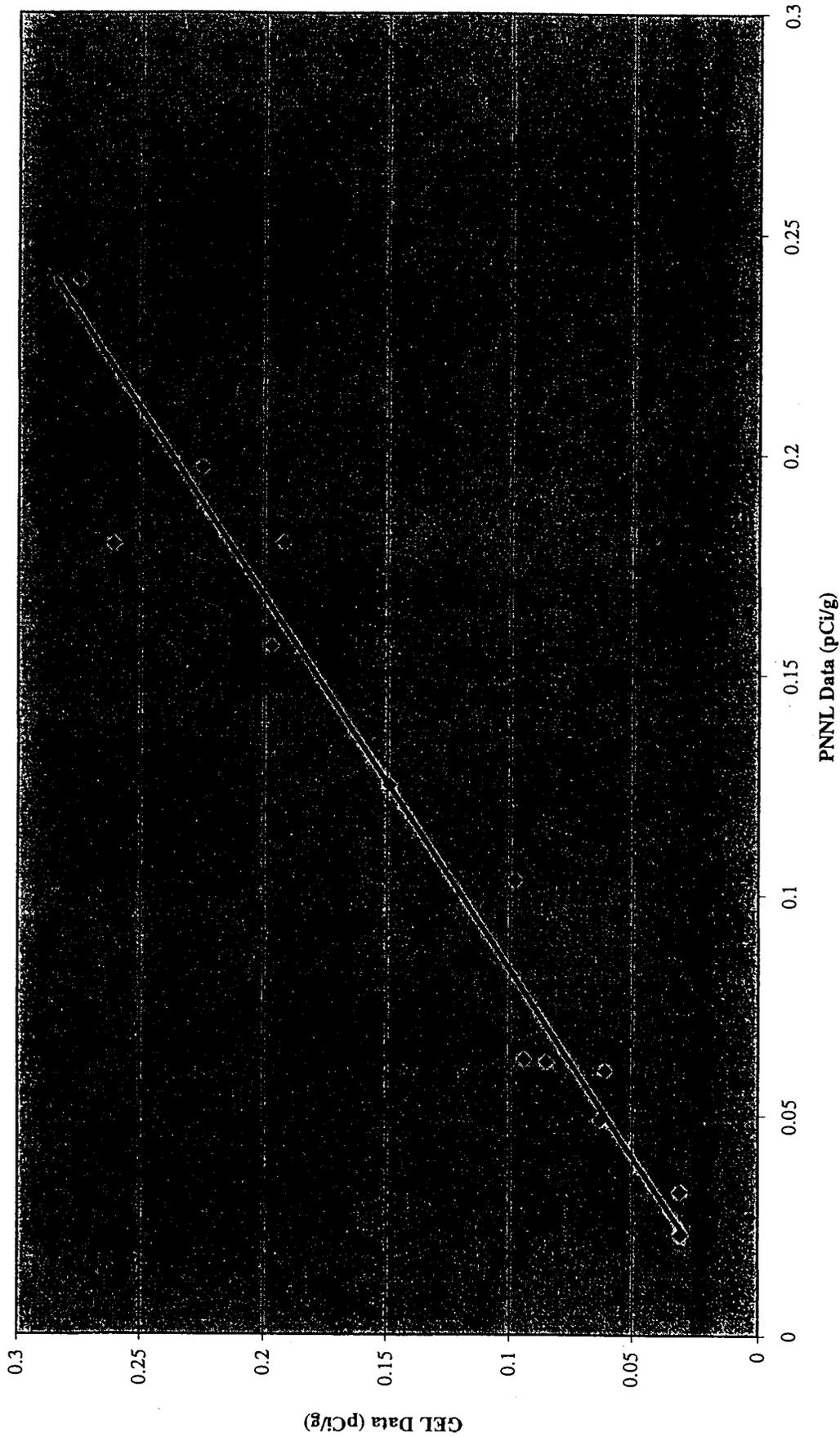


Figure 3. Off-Site Cesium-137 Sampling Locations, Storm Water Run-Off Ditch, LEHR Site, UC Davis, California

Weiss Associates

Figure 4. Off-Site Cesium-137 Investigation: PNNL vs. GEL Data, LEHR Site, UC Davis, California



## **TABLES**

Table 1. November 1997 Off-Site Cesium-137 Results, LEHR Site, UC Davis, California

Sample ID	Location	Depth (ft)	<-----Result-----> (pCi/g)		Accuracy <sup>1</sup> (±pCi/g)	Detection <sup>1</sup> Limit (pCi/g)	Field Gamma <sup>2</sup> (cpm)
			Initial	Confirmation			
SS-RA-0001	B-1	0	0.32	0.31	0.04	0.02	7300
SS-RA-0002	B-1	0.5		0.27	0.03	0.01	NA
SS-RA-0003	B-1	1.5		0.02	0.01	0.02	NA
SS-RA-0004	A-2	0	0.224	0.30	0.04	0.02	7200
SS-RA-0005	A-2	0.5		0.07	0.02	0.02	NA
SS-RA-0006	A-2	1.5		0.01	0.01	0.02	NA
SS-RA-0007	A-5	0	0.219	0.21	0.03	0.02	7400
SS-RA-0008	A-5	0.5		0.13	0.02	0.02	NA
SS-RA-0009	A-5	1.5		0.00	0.01	0.02	NA
SS-RA-0010	A-11	0		0.11	0.02	0.02	6700
SS-RA-0011	B-14	0		0.20	0.03	0.02	7100
SS-RA-0012	C-3	0	0.117	0.10	0.02	0.01	6900-7200
SS-RA-0013	C-8	0	0.0563	0.08	0.02	0.02	6900-7200
SS-RA-0014	C-13	0		0.20	0.03	0.02	6900-7200
SS-RA-0015 <sup>3</sup>	A-5	0		0.20	0.03	0.02	7400

Notes:

<sup>1</sup>For confirmation results only.

<sup>2</sup>Counts per minute (cpm) using 2" x 2" NaI gamma scintillator (Ludlum Model 44-10).

<sup>3</sup>Field duplicate of sample SS-RA-0007.

NA = not available

pCi/g = picoCuries per gram

Table 2. July 1998 Off-Site Cesium-137 Sampling Locations for Three Areas of Investigation, LEHR Site, UC Davis, California

Investigation Area	Distance from Pipe Under Old Davis Road	Investigation Area	Distance from Pipe Under Old Davis Road
Area 1	0 ft S	Area 2	217 ft N
	14 ft S		258 ft N
	45 ft S		268 ft N
	62 ft S		288 ft N
	94 ft S	Area 3	5 ft N
	100 ft S		17 ft N
	116 ft S		22 ft N
	121 ft S		23 ft N
Area 2	8 ft N		27 ft N
	17 ft N		67 ft N
	19 ft N	72 ft N	
	128 ft N	136 ft N	
	130 ft N	149 ft N	
	159 ft N	162 ft N	
	190 ft N	178 ft N	
195 ft N	220 ft N		

Table 3. July 1998 Results of Off-Site Cesium-137 Investigation, LEHR Site, UC Davis, California

Sample ID	Location	Depth	Notes	Lithology	Cs-137 Result (pCi/g)			
					On-Site Lab (PNNL)		Off-Site Lab (GEL)	
<i>Area 1 - East side of Old Davis Road, south of storm water pipe</i>								
SSRA0016	121 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1211	+/- 0.0095		
SSRA0017	116 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0656	+/- 0.0038		
SSRA0018	103 S	surface, 0-6"	A-11	Clayey Silt (ML), Soft, Dry, LP	0.0972	+/- 0.0087		
SSRA0019	100 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0602	+/- 0.0096	0.060	± 0.046
SSRA0021	94 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0961	+/- 0.0091		
SSRA0022	62 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1297	+/- 0.0092		
SSRA0023	45 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0622	+/- 0.0076	0.085	± 0.024
SSRA0024	43 S	surface, 0-6"	A-5	Clayey Silt (ML), Soft, Dry, LP	0.1407	+/- 0.0117		
SSRA0025	14 S	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1555	+/- 0.0111		
SSRA0027	5 S	surface, 0-6"	B-1	Clayey Silt (ML), Soft, Damp, LP	0.1795	+/- 0.0120	0.261	± 0.073
SSRA0028	0	surface, 0-6"	at storm pipe	Clayey Silt (ML), Soft, Damp, LP	0.1645	+/- 0.0114		
					Mean = 0.116		0.135	
<i>Area 2 - East side of Old Davis Road, north of storm water pipe</i>								
SSRA0029	8 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1189	+/- 0.0054		
SSRA0030	17 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1249	+/- 0.0100	0.149	± 0.047
SSRA0032	19 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1563	+/- 0.0117	0.197	± 0.036
SSRA0033	128 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP, 5-10% gravel	0.0732	+/- 0.0052		
SSRA0034	130 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP, 5-10% gravel	0.0616	+/- 0.0088		
SSRA0035	159 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0327	+/- 0.0062	0.031	± 0.021
SSRA0036	190 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1082	+/- 0.0100		
SSRA0038	195 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0900	+/- 0.0082		
SSRA0039	217 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0371	+/- 0.0074		
SSRA0040	258 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1231	+/- 0.0054		
SSRA0041	268 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0886	+/- 0.0048		
SSRA0043	288 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0229	+/- 0.0060	0.031	± 0.016
					Mean = 0.086		0.102	

Sample ID	Location	Depth	Notes	Lithology	Cs-137 Result (pCi/g)		
					On-Site Lab (PNNL)	Off-Site Lab (GEL)	
<i>Area 3 – West side of Old Davis Road, north of storm water pipe</i>							
SSRA0044	5 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1543	+/- 0.0113	
SSRA0045	17 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1968	+/- 0.0121	0.225 ± 0.040
SSRA0047	22 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1686	+/- 0.0116	
SSRA0048	23 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1798	+/- 0.0239	0.192 ± 0.039
SSRA0049	27 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1748	+/- 0.0124	
SSRA0050	67 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1425	+/- 0.0124	
SSRA0051	72 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.2394	+/- 0.0137	0.275 ± 0.046
SSRA0053	136 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0992	+/- 0.0107	
SSRA0054	149 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0628	+/- 0.0103	0.094 ± 0.035
SSRA0055	162 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0686	+/- 0.0088	
SSRA0056	178 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0636	+/- 0.0077	
SSRA0057	220 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1000	+/- 0.0097	
					Mean = 0.138		0.197
<i>Storm Water Run-Off Ditch - West side of Old Davis Road, north of railroad tracks</i>							
SSRA0058	85 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.1032	+/- 0.0105	0.099 ± 0.035
SSRA0059	175 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0868	+/- 0.0089	
SSRA0060	370 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0556	+/- 0.0102	
SSRA0061	370 N	surface, 0-6"	Field dup	Clayey Silt (ML), Soft, Dry, LP	0.0490	+/- 0.0038	0.063 ± 0.020
SSRA0062	736 N	surface, 0-6"		Clayey Silt (ML), Soft, Dry, LP	0.0705	+/- 0.0041	
Storm Drain Composite					0.1280	+/- 0.0096	
					Mean = 0.082		0.081

Notes:

pCi/g = picoCuries per gram

LP = low plasticity

PNNL = Pacific Northwest National Laboratory

GEL = General Engineering Laboratories

Table 4. Comparison of Cesium-137 Results with Risk-Based Action Standards

Cs-137 Results, pCi/g			Risk-Based Action Standards, pCi/g				
Study Area	Range	Mean	Background Concentration	Scenario 1 10 <sup>-6</sup> Risk	Scenario 2 10 <sup>-6</sup> Risk	Scenario 3 10 <sup>-6</sup> Risk	1998 10 <sup>-6</sup> Residential PRG
Area 1	0.0602 - 0.1795	0.116	0.046 (0' - 4' depth)	0.10	200,000	25,000	0.020
Area 2	0.0229 - 0.1563	0.086					
Area 3	0.0628 - 0.2394	0.138					
Background Area	0.0490 - 0.1280	0.082					

Notes:

Scenario 1 = On-Site Research; Scenario 2 = East-Side Residential Farmer; Scenario 3 = South-Side Residential Farmer.

## **APPENDIX A**

### **JUNE 1998 FIELD SURVEY RESULTS**

**SURFACE GAMMA SURVEY OF STORM WATER RUN-OFF DITCH ALONG OLD DAVIS ROAD**  
1 day effort on June 1, 1998

- Calibrate 2x2 NaI probe
- Establish local background using 3 borehole locations used last time a NaI probe was used to survey Old Davis Road area.
- Lay measuring tape on ground within drainage ditch on East side of road. Place beginning of tape at corrugated pipe beneath road. Survey north to within 50 feet of UCD sewage pumping station, but no more than 300 ft. Run instrument on single pass through deepest part of drainage ditch.
- Make one minute counts on 5 foot intervals for 1st 20 feet. Record results.
- Make one minute counts on 10 foot intervals for remainder of northward run and additional locations where readings are 2 times background.
- Lay measuring tape on ground starting within drainage ditch on East side of road to south of corrugated pipe beneath road. Do not extend tape more than 150 feet in south direction. Run instrument on single pass through deepest part of drainage ditch.
- Make one minute counts at sample locations B-1, A-2, A-5, A-11, and B-14. Make one minute counts 5 feet north and south of location B-1, A-2, and A-5.
- If there is discernable difference in readings 5 foot from specified locations, then repeat at locations A-11 and B-14. Make all other one minute readings at 10 foot intervals and additional locations where readings are 2 times background.
- Record results.
- Repeat process on west side of road, going only 50 ft north and 50 ft south from corrugated pipe. Steps for north run are same as on east side of road. Steps on south run are same using borehole locations C-3, C-8, and C-13.
- Give data to WA. Minimum number of one minute survey locations: 64

### INSTRUMENT EFFICIENCY

Project: LEHA Date/Time: 6-1-98 / 1650  
 Instrument: L-222 Serial #: 148479  
 Source Ser.#: 03920502 / Cs-137 Activity: ~1uc1  
 Performed By: D. Bina / J

#### Background Determination

DETERMINE AVERAGE BACKGROUND COUNT RATE

Background Count Time: 1.0 min

Background:

2 counts:

WA-1	WA-2	WA-3	WA-4		
544	484	534	479		
532	533	529	516		
547	499	522	440		
540	477	461	491		
479	505	482	460		

$$\bar{c}_b = \frac{1}{30} \sum c_b \quad \dot{c}_b = \frac{\bar{c}_b}{t}$$

$\bar{c}_b = 502.9$

$\dot{c}_b = 503$

#### Source Determination

DETERMINE AVERAGE SOURCE COUNT RATE

Source Count Time: \_\_\_\_\_

Source Counts:

$$\bar{c}_s = \frac{1}{30} \sum c_s \quad \dot{c}_s = \frac{\bar{c}_s}{t}$$


$\bar{c}_s =$  \_\_\_\_\_  $\dot{c}_s =$  \_\_\_\_\_  $\dot{c}_n =$  \_\_\_\_\_

$$\dot{c}_n = \dot{c}_s - \dot{c}_b$$

#### Efficiency Determination

DETERMINE INSTRUMENT EFFICIENCY

$E_{ff} =$  \_\_\_\_\_  $CF =$  \_\_\_\_\_

$$E_{ff} = \frac{\dot{c}_n}{A_c} \quad CF = \frac{1}{E_{ff}}$$

# IT Corporation

## SCALER SETUP SHEET

Project Name/# LEHR 774079  
 Instrument/# Ludlum 2221/148438  
 Probe Type/# 44-10-1/152101  
 Technician D. Williams

Date/Time 6-1-98 / 0800  
 Date Calibrated 5-8-98  
 Source Activity 1998000.00 dpm  
 Source Type Cs-137  
 HV Check/Setting Sat/820

### 1. Total Background Counts observed: record counts in 1 - 10

Count Time 1.00 minutes

1	816	25.30	640.09
2	749	-41.70	1738.89
3	768	-22.70	515.29
4	777	-13.70	187.69
5	817	26.30	691.69
6	770	-20.70	428.49
7	782	-8.70	75.69
8	821	30.30	918.09
9	809	18.30	334.89
10	798	7.30	53.29

Average Counts = 790.70 counts

Average count rate = 790.70 cpm

Standard Deviation Bkg 24.91 counts

Sum of Squares = 5584.10

### 2. Total Source Counts observed: record in 1 - 10

1	113408	1444.70	2087158.09
2	104786	-7177.30	51513635.29
3	112567	603.70	364453.69
4	113081	1117.70	1249253.29
5	113043	1079.70	1165752.09
6	112575	611.70	374176.89
7	112676	712.70	507941.29
8	112810	846.70	716900.89
9	112443	479.70	230112.09
10	112244	280.70	78792.49

Average source count = 111963.30 counts

Avg Source Ct Rate = 111963.30 cpm

Std Dev Source cts = 2544.89 counts

Sum of Squares = 58288176.10

Net source cts = 111172.60 counts

Efficiency = 0.06 cpm/dpm

Std. Dev. Net = 2545.01 counts

Corr. Factor 17.97 dpm/cpm

Net Ct. Rate = 111172.60 cpm

LLD = 133.47 counts

MDA = 2398.64 dpm/498-*cm*

RSO REVIEW



Date 6-1-98

RADIATION/CONTAMINATION SURVEY COVER SHEET

Survey Number: 060198-001	Survey Location: DRAINAGE DITCH By OLD DAMS 2
Survey By: D. Brown / Jh	Job Scope: "CHEATER" SURVEY
Date: 06/01/98	PRELIMINARY
Time: 0930	

INSTRUMENT DATA							Source Check				
Model #	Serial #	Cal Due	BKG	EFF	MDA	Time	Source #	Isotope	Activity	CPM	NCPM
L-2221	148438	5/8/99	791	0.06	2399	0800	0392007	CS-137	~1401	11963	10405

SURVEY RESULTS

#	Location	Alpha Equiv.		B-G Equiv.		Rad Level	Comments
		Loose dpm/ 100cm <sup>2</sup>	Fixed dpm/ 100cm <sup>2</sup>	Loose dpm/ 100cm <sup>2</sup>	Fixed dpm/ 100cm <sup>2</sup>	<input type="checkbox"/> m/hr <input type="checkbox"/> μr/hr  CPM	
1	NE-1					569	DRAINAGE DITCH
2	2					564	
3	3					510	
4	4					540	
5	5					565	
6	6					542	
7	7					531	
8	8					484	
9	9				A	541	
10	10					548	
11	11					566	
12	12					524	
13	13					514	
14	14					605	
15	15					474	
16	16					402	
17	17					407	
18	18					375	

SMEAR RESULTS							
#	Location	Alpha Equiv.		B-G Equiv.		Rad Level	Comments
		Loose dpm/100 cm	Fixed dpm/100cm	Loose dpm/100 cm	Fixed dpm/100 cm	m/hr CPM	
19	NE - 19					450	DRAINAGE DITCH
20	20					510	
21	21					524	
22	22					518	
23	23					526	
24	24					546	
25	25					533	
26	26					535	
27	27					605	
28	28					560	
29	29					539	
30	30					560	
31	31					559	
32	32					453	
33	33					572	
34	34					493	
35	35					461	
36	36					455	
37	37					447	
38	NW - 1					577	
39	2					614	
40	3					587	
41	4					564	
42	5					589	
43	6					422	
44	7					388	
45	8					370	
46	9					617	
47	10					510	
48	11					497	
49	12					474	
50	13					475	
51	14					520	
52	15					485	
53	16					528	
54	17					562	
55	18					523	
56	19					496	
57	20					533	

SMEAR RESULTS							
#	Location	Alpha Equiv.		B-G Equiv.		Rad Level	Comments
		Loose dpm/100 cm'	Fixed dpm/100cm	Loose dpm/100 cm'	Fixed dpm/100 cm'	mr/hr cpm	
58	NW- 21					503	DRAINAGE DITCH
59	22					547	
60	23					484	
61	24					419	
62	25					526	
63	26					533	
64	27					522	
65	28					486	
66	29					466	
67	30					518	
68	31					548	
69	32					582	
70	33					565	
71	34					599	
72	35					561	
73	36					614	
74	37					577	
75	SE- 1					521	
76	2					463	
77	3					470	
78	4					478	
79	5					477	
80	6					468	
81	7					527	
82	8					513	
83	9					466	
84	10					427	
85	11					513	
86	12					466	
87	13					427	
88	14					430	
89	15					488	
90	16					567	
91	B-1a					581	Previous Bonedile
92	B-1b					454	5' SOUTH
93	B-1c					517	5' NORTH
94	A-2a					441	Previous Bonedile
95	A-2b					430	5' SOUTH
96	A-2c					502	5' NORTH

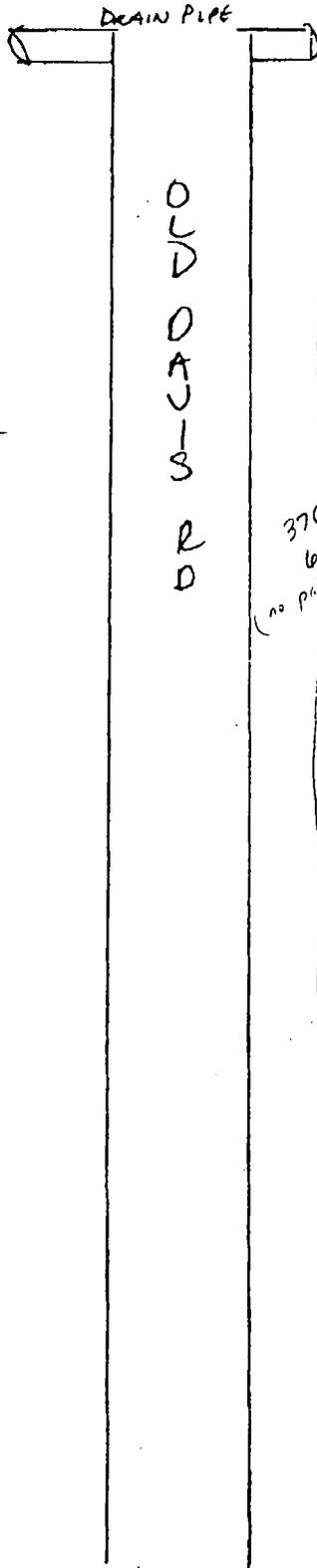
Page \_\_\_\_\_ of \_\_\_\_\_ Revised By: \_\_\_\_\_ Date: \_\_\_\_\_





By \_\_\_\_\_ Date \_\_\_\_\_ Subject \_\_\_\_\_ Sheet No. \_\_\_\_\_ of \_\_\_\_\_  
Chkd. By \_\_\_\_\_ Date \_\_\_\_\_ Proj. No. \_\_\_\_\_

0.5cm. X 0.5cm.



- NE-1
- NE-2
- NE-3
- NE-4
- NE-5
- NE-6
- NE-7
- NE-8
- NE-9
- NE-10
- NE-11
- NE-12
- NE-13
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- NE-15
- NE-16
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- NE-23
- NE-24
- NE-25
- NE-26
- NE-27
- NE-28
- NE-29
- NE-30
- NE-31
- NE-32
- NE-33

484-605

375-474

510-605

447-572

- 34
- 35
- 36
- 37

- NW-1
- NW-2
- NW-3
- NW-4
- NW-5
- NW-6
- NW-7
- NW-8
- NW-9
- NW-10
- NW-11
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- NW-23
- NW-24
- NW-25
- NW-26
- NW-27
- NW-28
- NW-29
- NW-30
- NW-31
- NW-32
- NW-33

5' apart

10' apart

370-617  
(no picture)

- 34
- 35
- 36
- 37

Background = 503





By \_\_\_\_\_ Date \_\_\_\_\_ Subject \_\_\_\_\_ Sheet No. \_\_\_\_\_ of \_\_\_\_\_  
Chkd. By \_\_\_\_\_ Date \_\_\_\_\_ Proj. No. \_\_\_\_\_

0.5cm. X 0.5cm.

A95-591

- Sw-1 \*
- Sw-2 \*
- Sw-3 \*
- Sw-4 \*
- Sw-5 \*
- Sw-6 \*
- Sw-7 \*
- Sw-8 \*
- Sw-9 \*
- Sw-10 \*
- Sw-11 \*
- Sw-12 \*
- Sw-13 \*
- Sw-14 \*
- Sw-15 \*
- Sw-16 \*

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