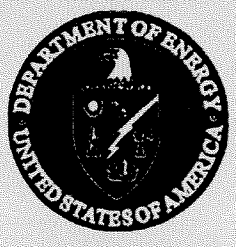
RD00-198
DOE/CD-ETEC-17th Street

RDOO-198

DRAFT DOCKET

FOR THE RELEASE OF THE 17th STREET DRAINAGE AREA AS PART OF THE ENERGY TECHNOLOGY ENGINEERING CENTER CLOSURE

August 2000



U.S. DEPARTMENT OF ENERGY
OAKLAND OPERATIONS OFFICE
ENVIRONMENTAL RESTORATION

FORWARD

The purpose of this Docket is to document the successful decontamination of the 17th Street Drainage Area operated by the former Energy Technology Engineering Center (ETEC) at the Santa Susana Field Laboratory (SSFL), Area IV; and that the facility is suitable for release for unrestricted use. The material in this Draft Docket consists of documents supporting the status that conditions at the former drainage area are in compliance with applicable DOE and proposed Environmental Protection Agency and Nuclear Regulatory Commission standards and criteria established to protect human health, safety, and the environment.

CONTENTS

EXHIBIT I

DOCUMENTS SUPPORTING THE CERTIFICATION FOR THE UNRESTRICTED USE OF THE 17th STREET DRAINAGE AREA IN AREA IV AT SANTA SUSANA FIELD LABORATORY (SSFL)

NOTE: This exhibit is normally a DOE-OAK summary letter to EM-44 requesting release of the area or facility. Since all of the documents normally contained in a draft docket package have not been received from ORISE (because of funding limitations) and State of California DHS (concurrence because of funding limitations and other factors), issuing this letter is premature at this stage.

EXHIBIT II

SITEWIDE RELEASE CRITERIA FOR REMEDIATION OF FACILITIES AT THE SANTA SUSANA FIELD LABORATORY (INCLUDES ENERGY TECHNOLOGY ENGINEERING CENTER) AND ASSOCIATED DOCUMENTATION

BOEING

Supporting Document

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ABSTRACT

This document supersedes revision A of N001SRR140127, "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL" issued August 22, 1996. N001SRR140127 was submitted to the Department of Energy (DOE) and the California Department of Health Services (DHS) who subsequently approved the use of these criteria for release of radiological facilities at Rocketdyne for unrestricted use.

A complete set of release criteria for facilities at the SSFL has been developed, and are presented in this report. The various categories of release guidelines include; 1) annual expected dose, 2) soil and water concentration guidelines, 3) surface contamination guidelines, and 4) ambient gamma exposure rate. The guidelines were obtained from regulatory values where available. Where not available, for example for soil, guidelines were calculated by use of the DOE computer code, RESRAD. For these calculations, the annual dose limit is 15 mrem/year, which is consistent with proposed EPA and NRC guidelines and ALARA principles.

* COMPLETE DOCUMENT
NO ASTERISK, TITLE PAGE/SUMMARY OF CHANGE PAGE ONLY.

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FORM 734-C REV. 7-97

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1. INTRODUCTION

This document supersedes revision A of N001SRR140127, "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL" issued August 22, 1996. N001SRR140127 was submitted to the Department of Energy (DOE) and the California Department of Health Services (DHS) who subsequently approved the use of these criteria for release of radiological facilities at Rocketdyne for unrestricted use. Copies of approval letters from DOE and DHS are included in Appendix B.

At several locations at the Santa Susana Field Laboratory (SSFL), low levels of radiological contamination in buildings and in soil have occurred and have been or will be cleaned up for eventual release for use without radiological restrictions. The DOE requirements for allowable residual radioactivity in sites suitable for release without radiological restrictions ("unrestricted release") are established in DOE Order 5400.5 (Ref. 1). Specific guidelines are given in 5400.5 for surface contamination and for direct gamma exposure. However, except for radium and thorium in soil, no specific guidelines are provided for residual contamination in soil or water. It became clear that a set of DOE-authorized limits for the SSFL would greatly facilitate the process of determining that a facility is acceptably clean, and verifying this with a confirmatory survey. Approval of such a set of authorized limits is provided for in DOE Order 5400.5, Chapter IV, Section 5, and in draft 10 CFR 834.301(c).

The purpose of this report is to document the set of approved guideline values for the release without radiological restriction of DOE facilities at the SSFL. The various categories of release guidelines include; 1) annual expected dose, 2) soil and water concentration guidelines, 3) surface contamination guidelines, and 4) ambient gamma exposure rate. The guidelines presented in this report are for residual radioactivity above background. When feasible, the local background activity of the suspect radionuclides should be determined and these background values subtracted from the measured release survey data.

The goal for these limits is to provide assurance that reasonable future uses of the property will not result in individual doses exceeding 15 millirem per year. This is consistent with current EPA and NRC guidance, and is supported by a generic cost-benefit analysis presented in Reference 2.

2. ANNUAL DOSE LIMITATION

DOE Order 5400.5 specifies a base Total Effective Dose Equivalent (TEDE) limit of 100 millirem per year for any potential future occupant of a remediated site. The Order also requires the use of the As Low As Reasonably Achievable (ALARA) principle to establish Authorized Limits at a level that is below the base limit. Rocketdyne will apply a value of 15 millirem per year for the calculation of derived limits for the cleanup of DOE sites at the SSFL, consistent with EPA and NRC guidance. A limit of 15 millirem per year (mrem/year) is adopted to assure that future uses will contribute small doses compared to natural background doses, which are in the range of 250-400 mrem/year (Ref. 3). This limit is considered to be as low as reasonably achievable below the basic DOE dose limit of 100 mrem/year. The 15 mrem/year value corresponds to a calculated increased lifetime cancer risk to a potential future user of the site of 3×10^{-4}.

For any reasonable assigned cost per person-rem, further reduction of anticipated dose due to exposure to residual radioactivity at the site is difficult to justify. For example, the EPA proposed TEDE of 15 mrem/year was arrived at after extensive ALARA analysis of cleanup costs and benefits at sixteen "Reference Sites" representing a wide range of conditions found at contaminated sites throughout the United States. Their analyses assumed a residential use of the decontaminated sites, and their conclusions were that the 15 mrem/year limit represented the most effective value considering all the technical and socio-political issues involved.

Furthermore, at the SSFL, conservative choices in the development, measurement, and interpretation of limits and final surveys provide a firm bias towards overestimation of the remaining risk. These include, 1) a conservative residential scenario for the pathway analyses, 2) use of calibration sources that tend to underestimate the detector efficiency for the likely contaminants, and 3) both qualitative and quantitative tests that provide assurance that the decommissioned facility is suitable for release without radiological restrictions.

3. SOIL AND WATER GUIDELINES

Since there are no federal or state regulatory limits for soil contamination for many of the potential or actual radionuclides of concern at SSFL, site-specific guidelines must be developed. This development is done, as required by the DOE Order, by use of a "pathways" analysis program, which estimates the radiological dose (total effective dose equivalent) that a future user of the property might receive, considering the residual radioactivity and various conditions of use. An effort is made to make these use conditions as reasonable for the use and the local area as can be achieved, without greatly over-estimating or under-estimating potential doses.

To establish these guidelines for cleanup operations at SSFL, the pathways analysis program RESRAD (Ref. 4), developed at Argonne National Laboratory (ANL) for use by DOE, has been used to calculate single radionuclide guidelines for the radionuclides of potential concern at SSFL.

For soil, a dose limit of 15 millirem per year is used. For consideration of radiological contamination in water, which may be collected from wells, sumps, below-grade seepage, or surface water, concentration guidelines were calculated from the Dose Conversion Factors (DCFs) in RESRAD, using the EPA limit of 4 millirem per year for ingested drinking water (Ref. 5), and the EPA assumed intake of water, 2 liters per day. These limits are more restrictive than those imposed on releases from operating facilities, as provided by DOE Order 5400.5 (Ref. 1), NRC (Ref. 6), the State of California (Ref. 7), and EPA for uranium mines and mills (Ref. 8).

3.1 Pathway Analysis

Pathways analysis involves calculating the doses received by a person through several pathways: direct radiation exposure; inhalation of airborne radioactivity; drinking water containing radioactivity; eating foods that have accumulated radioactivity, through uptake of water with radioactivity from the soil, or with airborne radioactivity deposited on the foliage; and ingestion of small amounts of contaminated soil.

The pathways analysis program RESRAD, was developed in the late 1980's for DOE by Argonne National Laboratory for the purpose of performing pathways analysis for a broad range of applications. Considerable flexibility is provided in the program for representing the site-specific conditions of exposure, to permit making the calculation as reasonable for the application as is possible.

Four general types of use may be considered for land for the purpose of calculating dose, other than the obvious zero-dose case of non-use. These may be identified as the industrial scenario, the wilderness scenario (or recreational, such as a park or golf course), the residential scenario, and the family farm scenario. Within these general use scenarios, choices are made for occupancy time (indoors and outdoors), water use, and food sources. Further choices are made to represent the contamination situation, geology, and hydrology. The program comes with a

complete set of generally conservative default values, and these may be changed as appropriate to reflect local reality in terms of usage practices and physical conditions, to produce a realistic pathways analysis for the specific site. The default values and the values actually used by the program in the analysis are listed in the output for each calculation, so departures from the default set are well recorded. The printed results from the calculations described in this report are stored in the Radiation Safety library file.

The family farm, on which family members spend 100% of their time, drinking water from the surface or from wells, eating vegetables and fruit grown on the land and irrigated with the same water, raising their meat, milk, and fish on that land, is not a reasonable scenario for the site. Although commercial farming is practiced in low-lying valley and coastal areas west of the facility, the rugged nature and topography of the SSFL, combined with poor soil quality, would reasonably preclude a family farm activity on the site. Further, recent land use trends in the area have been to conversion of previous farming property to other non-farming uses. Thus, the industrial, wilderness, and residential scenarios are all perhaps equally probable for the future of the site, and should be the scenarios considered.

3.2 Property Usage Scenarios

The basic usage conditions (per year) modeled in these calculations, for each of the three realistic scenarios, are summarized in Table 1. A complete listing of all RESRAD input data, for the three scenarios, is given in Appendix A. Discussion on specific RESRAD input parameters is given below in Section 3.3

Table 1. Property Usage Conditions for Three Realistic Scenarios

	Industrial	Wilderness	Residential
Occupancy, indoors (hours/year)	1752	0	4380
Occupancy, outdoors (hours/year)	350	876	2190
Occupancy, off site (hours/year)	6664	7890	2190
Drinking water (liters/year)	0	0	510
Fruit, vegetables, grain (kg/year)	1.6	1.6	16
Leafy vegetables (kg/year)	0	0	1.4
Cover thickness (meters)	0	0	0
Contamination area (m^2)	10000	10000	10000
Contamination thickness (meters)	1	1	1
Depth to water table (meters)	5	5	5

3.3 RESRAD Input Parameters

Default values provided in RESRAD are considered to be conservative estimates intended for use when no site-specific information is available. Users of the program are encouraged, however, to use input data that most closely reflects actual conditions existing on their site. As

part of several earlier efforts at the SSFL, a number of screening evaluations were performed using the RESRAD code to determine which of the approximately 80 input parameters required by RESRAD were of significance to the general SSFL area. These screening evaluations also were useful in determining conservative site-specific values for input to the code, when the default values were not used. In general, changes to most of the parameters were found to have a negligible effect on the final results because certain dose pathways were either not applicable or negligible for the given scenarios.

Contaminated Zone Parameters: Default values for the area of contamination (10,000 m^2) and the length parallel to aquifer flow (100 m) were assumed. For the depth of contamination, a conservative value of 1 meter is assumed. Measurements conducted at the site have indicated historical maximum values ranging from about 0.4 to 0.6 m for this parameter.

Occupancy Parameters: The default RESRAD values for occupancy of a residence on an affected site are 50% of the time spent indoors and 25% of the time spent outdoors, on the site. Thus, 25% of the time the occupancy is assumed to be off site. For the residential scenario, assuming 8,760 hours in a year, this translates into 4,380 hours spent indoors, 2,190 hours spent outdoors on the site, and 2,190 hours spent off site. For the industrial scenario, the corresponding percentages are assumed to be 20%, 4%, and 76% respectively. For the wilderness scenario, the corresponding percentages are 0%, 10%, and 90%.

Shielding Factors: The annual dose estimates calculated by RESRAD from either direct exposure or by inhalation (dust) are functions of two "structural" shielding parameters and the fraction of time an individual is assumed to spend inside a structure built on the site. Both shielding factors range from 0 to 1, and may be changed by the user to more appropriately match actual site conditions. For inhalation, the RESRAD default is 0.4, and this value is assumed for the present evaluations. For direct gamma exposure, the RESRAD default is 0.7, which is a rather conservative estimate of gamma shielding by a structure. For the present calculations, this latter value was adjusted from the default, for both the industrial and residential scenarios, to account for local construction practice which dictate a minimum 4-inch (0.1 m) concrete slab under the structure.

The gamma shielding factor used as input to RESRAD was calculated by modeling a typical two-story residential structure, and a single story industrial structure using the computer code MicroShield[1]. MicroShield is a point-kernel gamma shielding code developed for IBM-compatible personal computers, based on the mainframe code ISOSHLD. For the residential structure, a conservative lower bound footprint (area) value of 93 m^2 (1,000 ft^2) was assumed. For the industrial structure, a 186 m^2 (2,000 ft^2) area was assumed. A circular area was used with MicroShield to obtain maximum code accuracy with minimum computational time. Screening

[1] MicroShield, Version 4.0, Grove Engineering, Inc., 15215 Shady Grove Road, Suite 200, Rockville, MD 20850.

calculations indicated no significant differences between the results for circular and square areas of the same volume.

In all cases the contaminated soil was assumed to have a density of 1.5 g/cm^3, and a thickness of 1 meter. Dose calculations were performed for two vertical distances (1m for the ground floor and 3.6 m for the second story) and for three radial distances (center, midpoint, and edge of structure). The isotopic mix input to MicroShield was the same as that used for the present RESRAD calculations, with a concentration of 1 pCi/g for each isotope. Resulting gamma energy groups for this isotope mix ranged from 0.1 to 1.5 MeV. A factor of 0.89 was used to account for gamma shielding from a typical structural wall composed of approximately 1 inch of stucco and 5/8 inch of drywall, and a window area of approximately 10% of the wall area.

Effective gamma shielding factors obtained from the MicroShield calculations are given in Appendix A. For the residential scenario (the most credible), it is assumed that 12 hours are spent inside the structure per day. If it is further assumed that 8 of these hours are spent upstairs in a bedroom, 4 hours are spent downstairs in a family room, and that a person (on average) is located at the midpoint between the center and the edge of the structure, then the effective gamma shielding factor would be: (0.67)(0.61) + (0.33)(0.31) = 0.51. For the industrial scenario, the value is 0.25, which is the shielding value at the midpoint location for the single story structure.

Table 2. Gamma Shielding Factor Calculations for Typical SSFL Structure

	Gamma Shielding Factor	
Radial Location	**1st Floor**	**2nd Floor**
Residential Structure (93 m^2 footprint, two story)		
Center	0.27	0.57
Midpoint[a]	0.31	0.61
Perimeter[b]	0.57	0.71
Industrial Structure (186 m^2 footprint, single story)		
Center	0.22	-
Midpoint[a]	0.25	-
Perimeter[b]	0.58	-

[a]Midpoint between the center and the perimeter of the structure
[b]Edge of the structure.

It should be noted, that these values do not take into account any out-structures such as garages and patios, both of which would result in additional gamma shielding, and both of which would almost certainly be part of any residences built on the site.

Dietary Parameters: Default RESRAD input values for food and water consumption are based on the family farm scenario, where a significant portion of the diet is grown or raised on the site. For the three credible scenarios considered here, these parameters were adjusted as follows: for the residential scenario, it is conservatively assumed that a small fraction (10% of that grown on a family farm) of the fruit and leafy vegetables consumption would be from material grown on site. The values used are 16 kg/year per person and 1.4 kg/year per person, respectively. It was further assumed that water for the residence would be obtained from a well on the site (510 liters/year per person).

For the industrial and wilderness scenarios, it was assumed that no water would be used that was taken from the site; thus, all water pathways were suppressed with the exception of a secondary pathway via plant ingestion. In the industrial case, bottled drinking water is supplied. Since essentially all surface water at present is a result of the current industrial operations, no surface water would be available in the wilderness scenario. It is also assumed that perhaps 1% of the family farm fruit consumption value might be collected from wild sources, thus, 0.14 kg/year is used for these scenarios.

Contaminated Zone Hydrology Data: The SSFL facility is located in the Simi Hills in eastern Ventura County, California. The Simi Hills are in the northern part of the Transverse Range geomorphic province, and are composed primarily of exposures of the Upper Cretaceous Chatsworth Formation. This formation is a marine turbidite sequence of sandstone with interbedded siltstone/mudstone and minor conglomeratic lenses. The Chatsworth Formation is at least 1,800 m thick in locations east and north of the Facility.

The principal geologic units at the SSFL are the Chatsworth Formation and the shallow alluvium which overlies the Chatsworth Formation in some parts of the Facility, notably in Area IV of the SSFL where the decommissioning and decontamination of nuclear sites is taking place. This layer is Quaternary alluvium consisting of mixtures of unconsolidated sand, silt, and clay, and would include the contaminated zone. Drill holes indicate that the layer may be as thick as 6 meters in some locations.

The density of this alluvium layer is approximately 1.5 g/cm^3. The total and effective porosity of the contaminated zone are assumed to be 0.43 and 0.20 based on the average of data for sand, silt, and clay as given in the RESRAD manual. Precipitation at the facility is measured annually by a rain gauge located in the northeastern portion of the SSFL (Ventura County Rain Gauge Number 249). Based on measured data since 1959, the mean annual precipitation at the SSFL is approximately 18.6 inch, or 0.47 meters. In general, the majority of the precipitation occurs during the months of January through March.

Saturated Zone Hydrology Data: There are two groundwater systems at the SSFL: 1) a shallow system in the surficial alluvium and the underlying zones of weathered sandstone and siltstone/claystone, and isolated shallow fracture systems; and 2) a deeper regional system in the fractured Chatsworth Formation. The shallow zone is discontinuous, with depths to groundwater ranging from land surface to over 9 m. For the present study, we assume that this shallow region most conservatively represents the saturated zone, with an average depth to the water table of about 5 m. Hydraulic conductivity in the saturated zone generally ranges from about 30 to 3,000 m/year. Here, the higher value has been assumed.

Typical pumping rates for deep wells in the Chatsworth Formation (rock) range from 60 to 70 m^3/year up to a maximum of about 300 m^3/year. For the shallow (alluvium) region, however, pumping rates are significantly lower, typically about 35 m^3/year. Further, in the shallow region, many wells would be dry for a good fraction of the year as the replenishment rate is generally low. Water table drop rates, therefore, would range up to 10 m as a result of on-site pumping. Without pumping, however, no data is available on any inherent lowering of the water table. For conservatism, therefore, the default value of 0.001 m/year has been assumed.

Radon Pathway: Two default values were modified for the radon pathway. The thickness of the foundation was set at 0.1 m (4 inches) to correspond to the gamma shielding calculations discussed above. Also, the depth below ground surface was also set at 0.1 m, as basement structures are not typical for the local area.

3.4 Calculated Soil and Water Guidelines from RESRAD

The guidelines calculated from the RESRAD code for various single radionuclides are listed in Table 3 for comparison of the three scenarios. Values for each of the scenarios were determined from separate RESRAD calculation runs using the input parameters given in Appendix A. Water guideline values in Table 3 were calculated from the dose conversion factors used in RESRAD for ingestion, using an EPA value of 2 liters/day total water consumption (per person) from the site, and an EPA dose limit of 4 mrem/year (Ref. 5).

For radionuclides specifically regulated by the EPA (and the State of California), the Safe Drinking Water Act (and CCR Title 22) limits were used. These are (in pCi/l):

H-3	20,000
Combined Ra-226 and Ra-228	5
Sr-90	8
Gross alpha (not including radon and uranium)	15
Gross beta	50
Uranium (U-234 + U-235 + U-238)	20

For U-234, U-235, and U-238, DOE imposes the EPA regulations in 40 CFR 192 (and parts 190 and 440). Similarly, for Ra-226, Th-228 and Th-232, DOE imposes the limits in DOE Order 5400.5.

3.5 Soil and Water Guidelines

Based on the data in Table 3, conservative guidelines, consistent with the several applicable regulations governing residual radioactivity discussed above, are listed in Table 4. With the exception of uranium, radium, and thorium, the soil guidelines are those calculated from RESRAD for the residential use scenario. For uranium, the guidelines are those adopted by the NRC (30, 30, and 35 pCi/g for U-234, U-235, and U-238, respectively, see Ref. 9). For

Table 3. RESRAD-Calculated Single Isotope Guideline Values

	Soil Guidelines (pCi/g)			
Radionuclide	**Industrial**	**Wilderness**	**Residential**	**Water (pCi/l)[a]**
Am-241	120	162	5.44	1.50
Co-60	10.9	9.83	1.94	204
Cs-134	18.7	16.9	3.33	74.7
Cs-137	51.9	46.7	9.20	110
Eu-152	25.3	22.8	4.51	845
Eu-154	23.0	20.7	4.11	573
Fe-55	2,370,000	4,780,000	629,000	9,020
H-3	129,000	129,000	31,900	85,600[b]
K-40	162	147	27.6	294
Mn-54	34.4	30.9	6.11	1,980
Na-22	13.0	11.7	2.31	476
Ni-59	1,390,000	1,560,000	151,000	26,100
Ni-63	511,000	572,000	55,300	9,490
Pu-238	140	192	37.2	1.71
Pu-239	127	175	33.9	1.55
Pu-240	127	175	33.9	1.55
Pu-241	4,740	6,430	230	79.9
Pu-242	133	183	35.5	1.63
Ra-226	0.520	13.6	0.199	4.12[b]
Sr-90	370	376	36.0	35.8[b]
Th-228	14.8	14.7	2.81	6.78
Th-232	7.94	7.98	1.53	2.01
U-234	519	647	106	19.3[b]
U-235	163	160	32.1	20.5[b]
U-238	399	445	90.9	20.4[b]

[a]Water guidelines calculated from RESRAD ingestion dose conversion factors, assuming the EPA dose limit of 4 mrem/year (see text).

[b]For these radionuclides, the EPA Safe Drinking Water Act or the State of California CCR Title 22 limits should be used (see Table 4).

Table 4. Soil and Water Guidelines for SSFL Facilities

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Am-241	5.44	1.5
Co-60	1.94	200
Cs-134	3.33	75
Cs-137	9.20	110
Eu-152	4.51	840
Eu-154	4.11	570
Fe-55	629,000	9,000
H-3	31,900	20,000[a]
K-40	27.6	290
Mn-54	6.11	2,000
Na-22	2.31	480
Ni-59	151,000	26,000
Ni-63	55,300	9,500
Pu-238	37.2	1.7
Pu-239	33.9	1.6
Pu-240	33.9	1.6
Pu-241	230	80
Pu-242	35.5	1.6
Ra-226	5[c] and 15[c]	4.1
Sr-90	36.0	8[a]
Th-228	5[c] and 15[c]	6.8
Th-232	5[c] and 15[c]	2.0
U-234	30[b]	
U-235	30[b]	total uranium 20[a]
U-238	35[b]	
Gross alpha (not including radon and uranium)		15[a]
Gross beta		50[a]

[a]State of California Maximum Contaminant Levels, CCR Title 22
[b]Generally more conservative NRC limits for uranium isotopes are used.
[c]DOE Order 5400.5 limits are used (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm).

radium and thorium, DOE Order 5400.5 limits are used (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm, see Ref. 1). Guidelines established from the residential use scenario are the most restrictive of the three scenarios considered.

The choice of a basic dose limit of 15 mrem/year for all pathways combined leads to lower limits than would result from the use of the dose limits established by the EPA for the uranium fuel cycle (Ref. 10) and by DOE for unrestricted release of contaminated property (Ref. 1). The water guidelines are those calculated from the RESRAD dose conversion factors, using the EPA values for the basic dose limit and daily water intake, with the Maximum Contaminant Levels (MCL) specified for certain radionuclides by the State of California (Ref. 11).

4. SURFACE CONTAMINATION GUIDELINES

Surface contamination limits are specified in Figure IV-1 of Chapter IV in DOE Order 5400.5. For SSFL facilities, these limits have been modified by specifying the potential contaminants present in the Rocketdyne facilities, and eliminating those that are not pertinent. The proposed guidelines are given in Table 5. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

Table 5. Surface Contamination Guidelines for SSFL Facilities

Radionuclide	Average over 1 m^2 (dpm/100 cm^2)	Maximum in 100 cm^2 (dpm/100 cm^2)	Removable (dpm/100 cm^2)
Plutonium, Radium	100	300	20
Thorium	1,000	3,000	200
Uranium	5,000	15,000	1,000
Mixed fission products	5,000	15,000	1,000
Activation products	5,000	15,000	1,000
Tritium	-	-	10,000

As included in Table 5, Pu, Ra, U, Th, mixed fission products, and activation products, refer to those forms of radioactive material that comprise the residual activity at the SSFL. Plutonium is predominately Pu-239; Radium is Ra-226. It is assumed that thorium is sufficiently aged that all daughters are in equilibrium, Th-natural. Uranium will occur in depleted, normal, or enriched forms; U-233 is not present. Mixed fission products include Sr-90 and Cs-137 as components of the mixture. Possible activation products include Co-60, Fe-55, Mn-54, Eu-152, Eu-154, Al-26, and similar radionuclides.

Tritium contamination limits are based on interim guidelines for removable surface contamination (Ref. 12). This level of removable contamination insures that any non-removable or volumetric contamination will not cause unacceptable exposures.

These guidelines will be imposed for accessible (or potentially accessible) surfaces and structures.

5. AMBIENT GAMMA EXPOSURE RATE

A guideline of 5 μR/hr above natural background, measured at 1 meter above the surface, is used. This value has been imposed by the NRC for decommissioning research reactors (Ref. 13). It is as low as reasonably measurable, due to variations in background, and is significantly lower than the guideline of 20 μR/hr stated in DOE Order 5400.5, Chapter IV, Section 4.c. This guideline is imposed for accessible (or potentially accessible) structures and land. Our experience has been that this level can be achieved and verified in facilities that would be suitable for continued use.

6. APPLICATION OF GUIDELINES

Note: The survey protocols described below were those employed at the time of issue of N001SRR140127 and have been in use up until the end of 1998. As of the beginning of 1999, MARSSIM protocols will be employed (Reference 19) utilizing the guidelines developed in this report as the DCGLWs (derived concentration guideline limits).

The guidelines presented above should be used in planning any decontamination effort at the SSFL. Analytical capability for detection of each radionuclide should be, if possible, less than one-tenth of the guideline values. That is, the Minimum Detectable Activity (MDA, our LLD) should be less than 0.1 x guideline. Field measurements used to direct removal of contaminated soil should be capable of practical measurements below the guideline value. Survey measurements and sample analyses should be corrected for the local background activity of each radionuclide.

6.1 Soil Guidelines

Sample analysis is necessary to demonstrate the successful decontamination of soil areas. A qualitative scan will be performed using gamma-sensitive and/or beta-sensitive detectors to identify any significant areas of residual contamination. Soil samples will be taken from locations based on a 3x3 meter master grid. One sample will be taken from within a 1x1 meter grid location in each 3x3-meter section, based either on the qualitative scan survey indications at the area of maximum readings or, if no noticeable readings were found, at the location most likely to have residual contamination, by the surveyor's judgment. This selection assures a reasonably uniform sampling of the ground areas, at a sample density of approximately 11 samples per 100 m^2.

Results from individual samples will be compared with the limit for hotspots of 9-m^2 area, that is, 3.3 x the adopted concentration limit. Averages of adjacent samples, covering 100 m^2, will be compared with the average limit. The overall average, assuming that the individual and 100-m^2 area averages satisfy the applicable limits, will be used for a RESRAD confirmatory calculation. This calculation will be performed to demonstrate that the maximum expected annual dose for the indicated reasonable use scenario for the facility *does not exceed* the proposed 15 mrem/year guideline value.

For mixtures of radionuclides in soil, the "Sum of Fractions" rule is used. The sum of the ratios of concentration of each radionuclide to the corresponding guideline must not exceed 1. This value must be satisfied when samples are averaged over each 100-m^2 region. For cases in which the relative concentrations are known or assumed, this method is used to generate combined radionuclide guidelines for each radionuclide in the mixture.

The guidelines are not intended to be spot limits, and should not be applied to individual measurements. If the specific sampling provides only (or fewer than) one measurement per 100-

m^2 area, each measurement becomes, by default, the "average" for that 100-m^2 area, and the guidelines have the effect of acting as spot limits. In cases where an individual sample exceeds the guideline value, additional samples should be taken from within the same 100-m^2 area, and used to define the average contamination in this area.

The maximum concentrations remaining as "hot spots" must have contamination less than that calculated by the hot-spot rule presented in DOE Order 5400.5, Chapter IV, page 4. The average contamination within any area not exceeding 25 m^2 shall not be greater than $\sqrt{100/A}$ guideline, where A is the area in m^2. Reasonable efforts shall be made to remove any soil with contamination that exceeds 30 x guideline (Ref. 4).

6.2 Surface Contamination Guidelines

The proposed surface contamination guidelines would be applied to all accessible surfaces and structures. This would include ceilings, floors, and walls, and other potentially accessible locations such as attics. Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the guidelines established for alpha- and beta-gamma-emitting radionuclides should apply independently. Measurements of average contamination are averaged over an area of 1 m^2. For objects of less surface area, the average should be derived for each such object. The maximum contamination level applies to an area of not more than 100 cm^2. Surfaces of facilities which are likely to be contaminated, but are inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the applicable limits.

Following a complete qualitative scan of the facility, quantitative surface contamination measurements will be made over a fraction of the structural surfaces, as determined by the designation of the area as affected or unaffected. Affected areas will be surveyed at a nominal fraction of 11%. Unaffected areas will be surveyed at lesser fractions. Locations for the quantitative survey measurements will be based on a 3x3 meter master grid. One sample will be taken from within a 1x1 meter grid location in each 3x3-meter section, based either on the qualitative scan survey indications at the area of maximum readings or, if no noticeable readings were found, at the location most likely to have residual contamination, by the surveyor's judgment. Results from individual locations will be compared with the applicable limits.

Total surface contamination is measured by use of detectors primarily or exclusively sensitive to alpha or beta-gamma radiation. After a qualitative survey of the surfaces of the entire subject area, quantitative measurements are made on 1-m^2 areas selected uniformly throughout the area. These measurements are made with the detectors connected to a scaler set to accumulate counts for a 5-minute period. The detector is slowly scanned over the 1-m^2 grid location and the numerical result, after correction for background, count time, and detector efficiency, yields the 1-m^2 average surface activity. These detectors are calibrated against Th-230 for alpha activity and Tc-99 for beta activity. The emission energies of these radionuclides is generally less than those radionuclides found as contamination at SSFL. This results in an

underestimate of the efficiency of the detectors for the actual contaminant radioactivity and hence an overestimate of the actual measurement.

The amount of removable activity per 100 cm^2 of surface area is determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. Typically at Rocketdyne, a low background gas flow proportional counter is used. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the guidelines for removable contamination.

Smear methods for tritium detection are similar to that described above, with the exception that a wet swipe or piece of Styrofoam should be used. If the property has been recently decontaminated, a follow-up measurement (smears) should be conducted to ensure that there is no build-up of contamination with time.

6.3 Ambient Gamma Exposure

Measurements of the ambient gamma exposure rate provides a useful determination of residual volumetric radioactivity that may not be as easily detected by surface measurements or sampling and analysis. For the purpose of demonstrating suitability for release, this measurement provides an additional test.

The DOE established a limit of 20 μR/hr above natural background for screening radium-contaminated property. The NRC has imposed a 10μR/hr limit on the decommissioning of radioactive materials licensees, and a 5μR/hr limit on the decommissioning of research reactors. The 5 μR/hr limit above natural background is proposed for use at Rocketdyne. Because of the variability and differences in natural background, the limit of 5 μR/hr is about as low as can be reasonably implemented.

Quantitative measurements of the ambient gamma exposure rate will be made over a fraction of the structural surfaces, as determined by the designation of the area as affected or unaffected. Affected areas will be surveyed at a nominal fraction of 11%. Unaffected areas will be surveyed at lesser fractions. Locations for the quantitative survey measurements will be based on a 3x3-meter master grid. One measurement, covering one 1-m^2 grid location, will be made at each grid location chosen for the surface contamination measurements. Results from individual locations will be compared with the applicable limits.

At Rocketdyne, gamma exposure rate is generally measured by use of a 1x1 inch NaI(Tl) detector/photomultiplier probe, connected to a scaler to provide objective numerical values. The

detector is placed 1 meter above the local (ground or floor) surface. This instrument is calibrated by reference to a High Pressure Ion Chamber (HPIC) in a background area.

6.4 Statistical Validation of Survey Data

The statistical approach employed at Rocketdyne/ETEC for establishing that survey data meets guideline values is a method referred to as Sampling Inspection by Variables (Ref. 14). This method has been widely applied in industry and the military and is essential where the lot size is impractically large. Application of this method to the remediation of contaminated sites has been discussed in detail elsewhere (see for example, Ref. 15).

In sampling inspection by variables, the number of data points on which measurements are obtained is first chosen to be large so that the parameters of the distribution are likely to have a normal distribution (i.e., Gaussian). The mean of the distribution, $\bar{x}$, and its standard deviation, s, are then related to a "test statistic", TS, as follows:

$$TS = \bar{x} + ks$$

where $\bar{x}$ = average (arithmetic mean of measured values)
s = observed sample standard deviation
k = tolerance factor calculated from the number of samples to achieve the desired sensitivity for the test

TS and $\bar{x}$ are then compared with an authorized acceptance limit, U, to determine acceptance or other plans of action, including rejection of the area as contaminated and requiring further remediation.

The sample mean and standard deviation are easily calculable quantities; the value of k, the tolerance factor, bears further discussion. Of the various criteria for selecting plans for acceptance sampling by variables, the most appropriate is the method of Lot Tolerance Percent Defective (LTPD), also referred to as the Rejectable Quality Level (RQL). The LTPD is defined as the poorest quality that should be accepted in an individual lot. Associated with the LTPD is a parameter referred to as consumer's risk (β), the risk of accepting a lot of quality equal to or poorer than the LTPD (or 10%). NRC Regulatory Guide 6.6 (Ref. 16) states that the value for the consumer's risk should be 0.10. Conventionally, the value assigned to the LTPD has been 10%.

The State of California, Department of Radiological Health Branch, has stated that the consumer's risk of acceptance (β) at 10% defective (LTPD) must be 0.1 (Ref. 17). For those choices of β and LTPD, $K_\beta = K_2 = 1.282$. The number of samples is n. Values of k for each sample size are calculated in accordance with the following equations:

$$k = \frac{K_2 + \sqrt{K_2^2 - ab}}{a}; \quad a = 1 - \frac{K_\beta}{2(n-1)}; \quad b = K_2^2 - \frac{K_\beta^2}{n}$$

where k = tolerance factor,
K_β = the normal deviate exceeded with probability of β, 0.10 (from tables, $K_2 = 1.282$, see Ref. 18),
K_2 = the normal deviate exceeded with probability equal to the LTPD, 10% (from tables, $K_\beta = 1.282$, see Ref. 18)[2], and
n = number of samples.

The statistical criteria for acceptance of a remediated area are presented below.

a) Acceptance: If the test statistic ($\bar{x} + ks$) is less than or equal to the guideline (U), accept the area as clean. If any single measured value exceeds 80% of the limit, decontaminate that location to as near background as is possible, but do not change the value in the analysis.

b) Collect additional measurements: If the test statistic ($\bar{x} + ks$) is greater that the limit (U), but $\bar{x}$ itself is less than U, independently resample and combine all measured values to determine if $\bar{x} + ks \leq = U$ for the combined set; if so, accept the area as clean. If not, the area is contaminated and must be remediated.

c) Rejection: If the test statistic ($\bar{x} + ks$) is greater than the limit (U) and $\bar{x} > = U$, the region is contaminated and must be remediated.

Thus, based on sampling inspection, we are willing to accept the hypothesis that the probability of accepting an area as not being contaminated which is, in fact, 10% or more contaminated is 0.10. Or in other words, the final survey acceptance criteria corresponds to assuring with 90% confidence that 90% of an area has residual contamination below 100% (a 90/90/100 test) of the authorized limit.

7. REFERENCES

1. "RADIATION PROTECTION OF THE PUBLIC AND ENVIRONMENT," DOE Order 5400.5, U. S. Department of Energy, February 8, 1989.

2. "Regulatory Impact Analysis for Radiation Site Cleanup Proposed Rule - Draft", U. S. Environmental Protection Agency, January 17, 1996.

3. "Health Effects of Exposure to Low Levels of Ionizing Radiation -- BEIR V," Committee on the Biological Effects of Ionizing Radiations, Board on Radiation Effects Research, Commission on Life Sciences, National Research Council. National Academy Press, Washington, 1990.

4. "A Manual for Implementing Residual Radioactive Material Guidelines," DOE/CH/8901, U. S. Department of Energy, June 1989.

5. "National Primary Drinking Water Regulations; Radionuclides," 40 CFR 141.15 and .16, U. S. Environmental Protection Agency, July 18, 1991.

6. "STANDARDS FOR PROTECTION AGAINST RADIATION," 10 CFR 20, U. S. Nuclear Regulatory Commission.

7. "CALIFORNIA RADIATION CONTROL REGULATIONS," CCR 17, State of California Department of Health Services.

8. "ORE MINING AND DRESSING POINT SOURCE CATEGORY," Subpart C--Uranium, Radium and Vanadium Ores Subcategory, 40 CFR 440, U. S. Environmental Protection Agency.

9. "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations," Federal Register . Vol. 46, No. 205, pp. 52061-52063, Friday, October 23, 1981. U. S. Nuclear Regulatory Commission.

10. "ENVIRONMENTAL PROTECTION STANDARDS FOR NUCLEAR POWER OPERATIONS," 40 CFR 190, U. S. Environmental Protection Agency.

11. "Environmental Health, Radioactivity," CCR 22, Article 5. State of California Department of Health Services.

12. "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", DOE Memorandum, DOE-OAK, January 5, 1996.

13. "Order Authorizing Dismantling of Facility and Disposition of Component Parts", Docket No. 50-375, Enclosure to NRC Letter dated February 22, 1983, D. Eisenhut to M. Remley.

14. DOE/CH/8901, A Manual for Implementing Residual Radioactive Material Guidelines, T. L. Gilbert, et al., June 1989.

15. "Statistical Treatment of Radiological Survey Data for Cleanup Decisions and Regulatory Compliance", Proc. Spectrum '92 Conference, Boise, Idaho, August 23 - 27, 1992.

16. "Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing By-Product Material", U. S. Nuclear Regulatory Commission Guide 6.6, dated June 1974.

17. DECON-1, State of California for Decontaminating Facilities and Equipment Prior to Release for Unrestricted Use, dated June 1977.

18. MIL-STD-414, Sampling Procedures and Tables for Inspection by Variables for Percent Defective, June 11, 1957.

19. NUREG-1575 (EPA 402-R-97-016), "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", December 1997.

Appendix A

Input Parameters for RESRAD Calculations (Sheet 1 of 3)

Parameter	Value Used for Scenario			RESRAD
	Industrial	Wilderness	Residential	Default
Area of contaminated zone (m^2)	1.000E+04	1.000E+04	1.000E+04	1.000E+04
Thickness of contaminated zone (m)	1.000E+00	2.000E+00	1.000E+00	2.000E+00
Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	1.000E+02	1.000E+02
Basic radiation dose limit (mrem/yr)	1.500E+01	1.500E+01	1.500E+01	3.000E+01
Time since placement of material (yr)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Times for calculations (yr)	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Times for calculations (yr)	3.000E+00	3.000E+00	3.000E+00	3.000E+00
Times for calculations (yr)	1.000E+01	1.000E+01	1.000E+01	1.000E+01
Times for calculations (yr)	3.000E+01	3.000E+01	3.000E+01	3.000E+01
Times for calculations (yr)	1.000E+02	1.000E+02	1.000E+02	1.000E+02
Times for calculations (yr)	3.000E+02	3.000E+02	3.000E+02	3.000E+02
Times for calculations (yr)	1.000E+03	1.000E+03	1.000E+03	1.000E+03
Times for calculations (yr)	3.000E+03	0.000E+00	3.000E+03	0.000E+00
Times for calculations (yr)	1.000E+04	0.000E+00	1.000E+04	0.000E+00
Cover depth (m)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Density of cover material (g/cm^3)	not used	not used	not used	1.500E+00
Cover depth erosion rate (m/yr)	not used	not used	not used	1.000E-03
Density of contaminated zone (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Contaminated zone total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Contaminated zone effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Contaminated zone hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+01
Contaminated zone b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Humidity in air (g/cm^3)	8.000E+00	8.000E+00	8.000E+00	8.000E+00
Evapotranspiration coefficient	5.000E-01	5.000E-01	5.000E-01	5.000E-01
Precipitation (m/yr)	4.700E-01	4.700E-01	4.700E-01	1.000E+00
Irrigation (m/yr)	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Irrigation mode	overhead	overhead	overhead	overhead
Runoff coefficient	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Watershed area for nearby stream or pond (m^2)	1.000E+06	1.000E+06	1.000E+06	1.000E+06
Accuracy for water/soil computations	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Density of saturated zone (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Saturated zone total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Saturated zone effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Saturated zone hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+02
Saturated zone hydraulic gradient	2.000E-02	2.000E-02	2.000E-02	2.000E-02
Saturated zone b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Water table drop rate (m/yr)	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Well pump intake depth (m below water table)	1.000E+01	1.000E+01	1.000E+01	1.000E+01

Input Parameters for RESRAD Calculations (Sheet 2 of 3)

Parameter	Value Used for Scenario			RESRAD Default
	Industrial	Wilderness	Residential	
Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	ND	ND
Well pumping rate (m^3/yr)	not used	not used	7.000E+01	2.500E+02
Number of unsaturated zone strata	1	1	1	1
Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	4.000E+00	4.000E+00
Unsat. zone 1, soil density (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Unsat. zone 1, total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Unsat. zone 1, hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+01
Inhalation rate (m^3/yr)	8.400E+03	8.400E+03	8.400E+03	8.400E+03
Mass loading for inhalation (g/m^3)	2.000E-04	2.000E-04	2.000E-04	2.000E-04
Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	3.000E+00	3.000E+00
Exposure duration	3.000E+01	3.000E+01	3.000E+01	3.000E+01
Shielding factor, inhalation	4.000E-01	4.000E-01	4.000E-01	4.000E-01
Shielding factor, external gamma	2.500E-01	7.000E-01	5.100E-01	7.000E-01
Fraction of time spent indoors	2.000E-01	0.000E+00	5.000E-01	5.000E-01
Fraction of time spent outdoors (on site)	4.000E-02	1.000E-01	2.500E-01	2.500E-01
Shape factor flag, external gamma	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Fruits, vegetables and grain consumption (kg/yr)	1.600E+00	1.600E+00	1.600E+01	1.600E+02
Leafy vegetable consumption (kg/yr)	0.000E+00	0.000E+00	1.400E+00	1.400E+01
Milk consumption (L/yr)	not used	not used	not used	9.200E+01
Meat and poultry consumption (kg/yr)	not used	not used	not used	6.300E+01
Fish consumption (kg/yr)	not used	not used	not used	5.400E+00
Other seafood consumption (kg/yr)	not used	not used	not used	9.000E-01
Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	3.650E+01	3.650E+01
Drinking water intake (L/yr)	not used	not used	5.100E+02	5.100E+02
Contamination fraction of drinking water	not used	not used	1.000E+00	1.000E+00
Contamination fraction of household water	1.000E+00	0.000E+00	1.000E+00	1.000E+00
Contamination fraction of livestock water	not used	0.000E+00	not used	1.000E+00
Contamination fraction of irrigation water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Contamination fraction of aquatic food	not used	not used	not used	5.000E-01
Contamination fraction of plant food	-1	-1	-1	-1
Contamination fraction of meat	not used	not used	not used	-1
Contamination fraction of milk	not used	not used	not used	-1
Livestock fodder intake for meat (kg/day)	not used	not used	not used	6.800E+01
Livestock fodder intake for milk (kg/day)	not used	not used	not used	5.500E+01
Livestock water intake for meat (L/day)	not used	not used	not used	5.000E+01
Livestock water intake for milk (L/day)	not used	not used	not used	1.600E+02
Livestock soil intake (kg/day)	not used	not used	not used	5.000E-01
Mass loading for foliar deposition (g/m^3)	1.000E-04	1.000E-04	1.000E-04	1.000E-04
Depth of soil mixing layer (m)	1.500E-01	1.500E-01	1.500E-01	1.500E-01
Depth of roots (m)	9.000E-01	9.000E-01	9.000E-01	9.000E-01

Input Parameters for RESRAD Calculations (Sheet 3 of 3)

Parameter	Value Used for Scenario			RESRAD Default
	Industrial	Wilderness	Residential	
Drinking water fraction from ground water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Household water fraction from ground water	not used	not used	1.000E+00	1.000E+00
Livestock water fraction from ground water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Irrigation fraction from ground water	not used	not used	not used	1.000E+00
C-12 concentration in water (g/cm^3)	not used	not used	not used	2.000E-05
C-12 concentration in contaminated soil (g/g)	not used	not used	not used	3.000E-02
Fraction of vegetation carbon from soil	not used	not used	not used	2.000E-02
Fraction of vegetation carbon from air	not used	not used	not used	9.800E-01
C-14 evasion layer thickness in soil (m)	not used	not used	not used	3.000E-01
C-14 evasion flux rate from soil (1/sec)	not used	not used	not used	7.000E-07
C-12 evasion flux rate from soil (1/sec)	not used	not used	not used	1.000E-10
Fraction of grain in beef cattle feed	not used	not used	not used	8.000E-01
Fraction of grain in milk cow feed	not used	not used	not used	2.000E-01
Storage times of contaminated foodstuffs (days):				
Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	1.400E+01	1.400E+01
Leafy vegetables	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Milk	not used	not used	not used	1.000E+00
Meat and poultry	not used	not used	not used	2.000E+01
Fish	not used	not used	not used	7.000E+00
Crustacea and mollusks	not used	not used	not used	7.000E+00
Well water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Surface water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Livestock fodder	not used	not used	not used	4.500E+01
Thickness of building foundation (m)	1.000E-01	not used	1.000E-01	1.500E-01
Bulk density of building foundation (g/cm)	2.400E+00	not used	2.400E+00	2.400E+00
Total porosity of the cover material	not used	not used	not used	4.000E-01
Total porosity of the building foundation	1.000E-01	not used	1.000E-01	1.000E-01
Volumetric water content of the cover material	not used	not used	not used	5.000E-02
Volumetric water content of the foundation	3.000E-02	not used	3.000E-02	3.000E-02
Diffusion coefficient for radon gas (m/sec):				
in cover material	not used	not used	not used	2.000E-06
in foundation material	3.000E-07	not used	3.000E-07	3.000E-07
in contaminated zone soil	2.000E-06	not used	2.000E-06	2.000E-06
Radon vertical dimension of mixing (m)	2.000E+00	not used	2.000E+00	2.000E+00
Average annual wind speed (m/sec)	2.000E+00	not used	2.000E+00	2.000E+00
Average building air exchange rate (1/hr)	5.000E-01	not used	5.000E-01	5.000E-01
Height of the building (room) (m)	2.500E+00	not used	2.500E+00	2.500E+00
Building interior area factor	0.000E+00	not used	0.000E+00	0.000E+00
Building depth below ground surface (m)	1.000E-01	not used	1.000E-01	-1.000E+00
Emanating power of Rn-222 gas	2.500E-01	not used	2.500E-01	2.500E-01
Emanating power of Rn-220 gas	not used	not used	not used	1.500E-01

Appendix B
Agency Approvals

1. Letter from Gerard Wong (DHS) to Majelle Lee (Rocketdyne), "Authorized Sitewide Radiological Guidelines for Release for Unrestricted Use", 96ETEC-DRF-0455, August 9, 1996.
2. Memorandum from Sally A. Robison (DOE-ER) to Roger Liddle (DOE-OAK), Sitewide Limits for Release of Facilities Without Radiological Restriction", 007857RC, September 17, 1996.

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, Governc

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96ETEC-DRF-0455

August 9, 1996

Ms. Majelle Lee, Program Manager
Environmental Management
Rocketdyne Division
Rockwell International Corporation
P. O. Box 7930
Canoga Park, CA 91309-7930

Subject: Authorized Sitewide Radiological Guidelines for Release of Unrestricted Use

Dear Ms. Lee:

This letter is to acknowledge the receipt of your letter dated June 28, 1996 requesting concurrence of the above subject. The above mentioned letter and its attachments have been reviewed by the staff of this office. The Radiologic Health Branch (RHB) concurs that the proposed release guidelines provide adequate assurance for the release of the facilities and properties at Rocketdyne's Santa Susana Field Laboratory (SSFL) and DeSoto sites without further radiological restrictions. Your letter dated June 28, 1996 with attachments will be incorporated into Rocketdyne's California Radioactive Material License # 0015-70 upon receipt of a commitment letter signed by Mr. Phil Rutherford.

If you have any questions concerning this matter, please feel free to call Mr. Stephen Hsu of this office at (916) 322-4797.

Sincerely,

Gerard Wong, Ph.D., Chief
Radioactive Material Licensing Section
Radiologic Health Branch

EXHIBIT III

INDEPENDENT WERIFICATION DOCUMENTATION OF THE RADIOLOGICAL CONDITION OF THE 17th STREET DRAINAGE AREA IN AREA IV AT SSFL

VERIFICATION SURVEY OF THE 17TH STREET DRAINAGE AREA SANTA SUSANA FIELD LABORATORY THE BOEING COMPANY VENTURA COUNTY, CALIFORNIA

Prepared by

John R. Morton

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Prepared for the
Office of Site Closure
U.S. Department of Energy

FINAL REPORT

APRIL 2000

This report is based on work performed under a contract with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE 17th STREET DRAINAGE AREA
SANTA SUSANA FIELD LABORATORY
THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

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ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

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ABBREVIATIONS AND ACRONYMS

µrem/h	microrem per hour
µR/h	microroentgens per hour
AEC	Atomic Energy Commission
ASME	American Society of Mechanical Engineers
cm	centimeter
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
EML	Environmental Measurements Laboratory
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
ha	hectare
ITP	Intercomparison Test Program
kg	kilogram
km	kilometer
m	meters
m^2	square meters
MAPEP	Mixed Analyte Performance Evaluation Program
MeV	million electron volts
M&O	Management and Operation
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
pCi/L	picocuries per liter
pCi/g	picocuries per gram
SSFL	Santa Susana Field Laboratory

VERIFICATION SURVEY
OF THE 17TH STREET DRAINAGE AREA
SANTA SUSANA FIELD LABORATORY
THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

INTRODUCTION AND SITE HISTORY

Rocketdyne Propulsion and Power of the Boeing Company (Rocketdyne), formerly Rockwell International Rocketdyne Division, operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the U.S. Department of Energy (DOE), which performed testing of equipment, materials, and components for nuclear and energy related programs. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved engineering, developing, testing, and manufacturing operations for nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the U.S. Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the U.S. Nuclear Regulatory Commission (NRC) and by the Radiologic Health Branch of the State of California Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (predominantly in enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), and activation products (tritium [H-3], Co-60, Eu-152, Eu-154 and Ni-63). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing. Decontamination and decommissioning (D&D) of contaminated facilities began in the late 1960's, but accelerated in the 1990's as the remaining DOE program operations at ETEC were terminated. As part of this D&D program, Rocketdyne performed decommissioning and final status surveys of a number of facilities that supported the various nuclear-related ETEC operations during the latter

part of the 1950's and continuing through to the present. Environmental management of DOE contaminated properties continues under the termination clause of the existing Management and Operation (M&O) contract. An area that was recently addressed was the 17th Street drainage area.

The 17th Street drainage area is the site of a natural rainwater channel where a berm was constructed in 1962 to permit the area to serve as a hold-up pond. Since that time, the area became overgrown with shrubs and trees and filled with silt. Characterization surveys performed in 1997 and 1998 identified elevated levels of Cs-137 within samples collected from the area. As a result, the area was remediated during 1998 and a final status survey performed.

DOE's Office of Site Closure—previously the Office of Environmental Restoration, Northwestern Area Programs—is responsible for oversight of a number of remedial actions that have been, or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities. The purpose of these independent verification activities is to confirm that remedial actions have been effective in meeting established and site-specific guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated as the organization responsible for this task at SSFL, and was requested to verify the current radiological status of the 17th Street drainage area.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (km [29 miles]) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha[2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations were conducted in Boeing/Rocketdyne-owned facilities located within the 117 ha Area IV. The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

The 17th Street drainage area is located to the southeast of the intersection of "G" Street and 17th Street in the central portion of Area IV (Figure 2). The former hold-up pond area measures approximately 85 m^2. The entire impacted area measures 2,230 m^2.

OBJECTIVES

The objectives of the verification process were to provide independent document reviews and measurement and sampling data for use by the DOE in determining the radiological status of the 17th Street drainage area and whether or not the area meets the guideline requirements for release without radiological restrictions.

DOCUMENT REVIEW

Survey plans and final status reports were reviewed for appropriateness of procedures and adequacy of the data for demonstrating compliance with established guidelines (Boeing 1999 and 2000a). Information was evaluated to ensure that areas identified as exceeding site guidelines had been decontaminated and that residual soil concentrations satisfied the established guidelines.

PROCEDURES

On October 27, 1999, ESSAP performed a verification survey of the 17th Street drainage area at the SSFL. The survey was performed in accordance with a survey plan, submitted to and approved by the DOE, and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 1999a, 1998a, and b).

REFERENCE SYSTEM

Measurement and sampling locations were referenced to the grid established by Rocketdyne.

SURFACE SCANS

Surface scans for gamma activity were performed over 100 percent of the remediated and adjacent impacted areas. Gamma scans were performed using NaI scintillation detectors coupled to ratemeters with audible indicators.

EXPOSURE RATE MEASUREMENTS

Exposure rates at one meter above the surface were measured at eight soil sample locations using a microrem meter (Figure 3). Background exposure rates, used for comparison, were performed during a previous site survey (ORISE 1996).

SOIL SAMPLING

Surface (0-15 cm) soil samples were collected from eight locations within the 17th Street drainage area (Figure 3). Background soil samples collected during a previous site survey were used for comparison purposes (ORISE 1996).

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 1999d). Soil samples were analyzed by gamma spectrometry and results reported in picocuries per gram (pCi/g). The radionuclides of interest were mixed fission and activation products, primarily Cs-137; however, gamma spectra were reviewed for other identifiable photopeaks. Exposure rates were reported in units of microroentgens per hour (μR/h). The data generated were compared with Rocketdyne documentation and the DOE generic and site-specific guidelines established for release for unrestricted use.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP review of Rocketdyne's project documentation indicated that most procedures and methods used by Rocketdyne were appropriate and that data were accurate. Comments identified were provided to the DOE (ORISE 1999b and c). Rocketdyne adequately addressed these comments in a subsequent correspondence (Boeing 2000b).

Surface Scans

Surface scans for gamma activity did not identify any locations of direct radiation in excess of ambient background levels.

Exposure Rates

Exposure rates are summarized in Table 1. Background exterior exposure rates for SSFL averaged 14 μR/h, while ESSAP site exposure rates, including background, ranged from 14 to 19 μR/h.

Radionuclide Concentrations in Soil

Concentrations of radionuclides in soil samples collected from the 17th Street drainage area are provided in Table 1. The radionuclide concentrations were as follows: less than 0.2 pCi/g for Am-241, less than 0.1 to 1.6 pCi/g for Cs-137, 0.8 to 2.2 pCi/g for Ra-226, 1.2 to 3.5 pCi/g for Th-228, less than 16.5 pCi/g for Th-230, 1.2 to 3.7 pCi/g for Th-232, less than 0.4 to 0.4 pCi/g for U-235, and 1.3 to 5.2 pCi/g for U-238.

COMPARISON OF RESULTS WITH GUIDELINES

The applicable site-specific soil guidelines are provided in Table 2 and have been approved by both the DOE and State of California (DOE 1996 and State of California 1996). The primary contaminant

of concern for the area was Cs-137. All Cs-137 concentrations were less than the Table 2 cleanup criterion. Concentrations of uranium and thorium were detected in excess of background concentrations, but individually were also less than the Table 2 cleanup criteria. One background-corrected sample exceeded the unity rule. Further evaluation of this criteria determined that Rocketdyne had adequately addressed this issue and satisfactorily demonstrated guideline compliance for the area.

The DOE's exposure rate guideline is 20 μR/h above background (DOE 1990), although Rocketdyne has elected to use a more restrictive guideline of 5 μR/h above background. All exposure rates were below this guideline.

SUMMARY

On October 27, 1999, the Environmental Survey and Site Assessment Program performed a verification survey of the 17th Street drainage area at the Santa Susana Field Laboratory. Verification activities included document reviews, surface scans, exposure rate measurements, and soil sampling.

The independent verification survey results indicate that soil concentrations for the 17th Street Drainage Area satisfied the applicable site-specific soil guidelines. In addition, exposure rates were comparable to background levels and satisfied both the DOE and the more restrictive exposure rate guideline that Rocketdyne has elected to use. The verification survey findings, therefore, support Rocketdyne's final status survey conclusion that the 17th Street Drainage Area radiological conditions satisfy the guidelines for release without radiological restrictions.

FIGURES

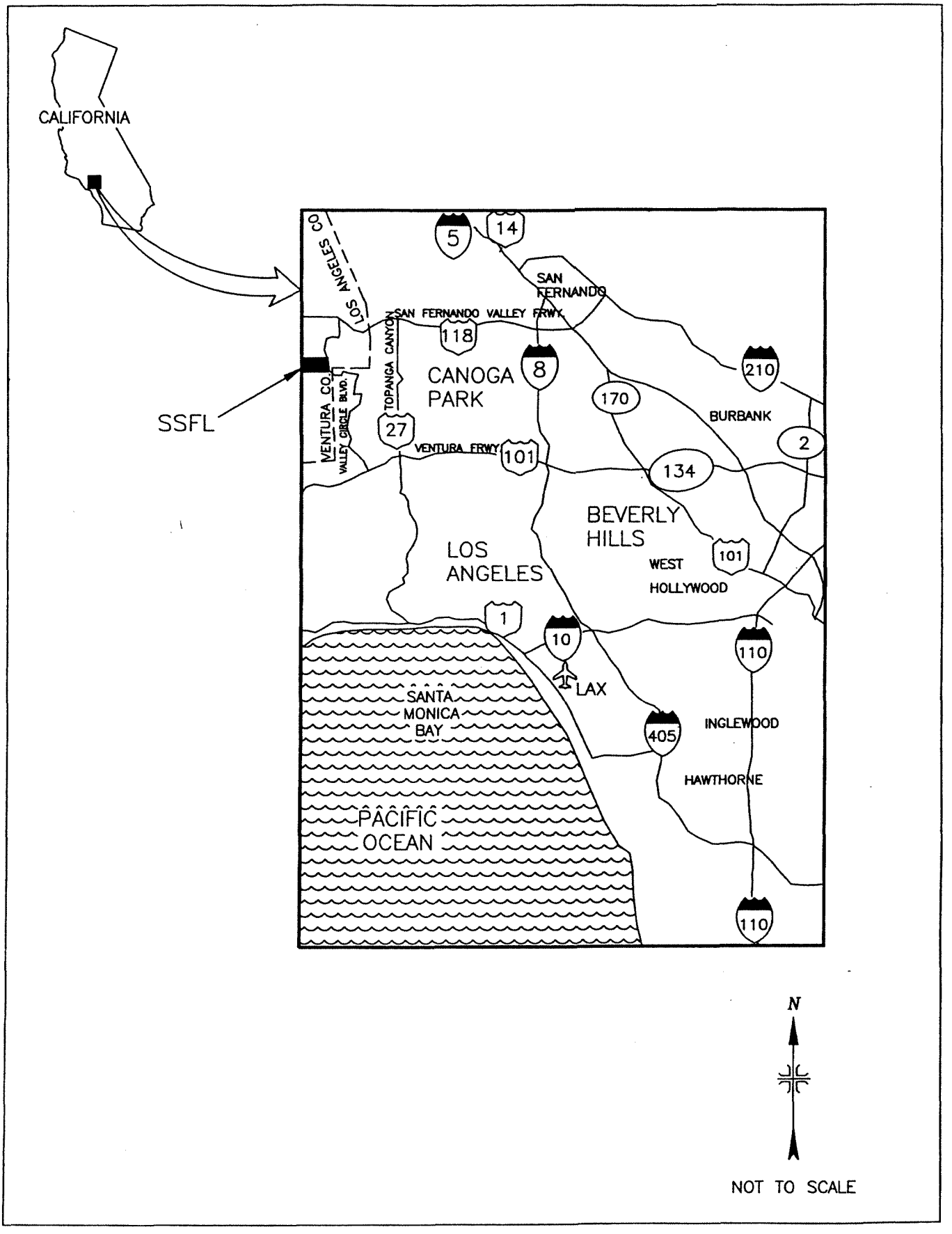

FIGURE 1: Los Angeles California Area – Location of Santa Susana Field Laboratory Site

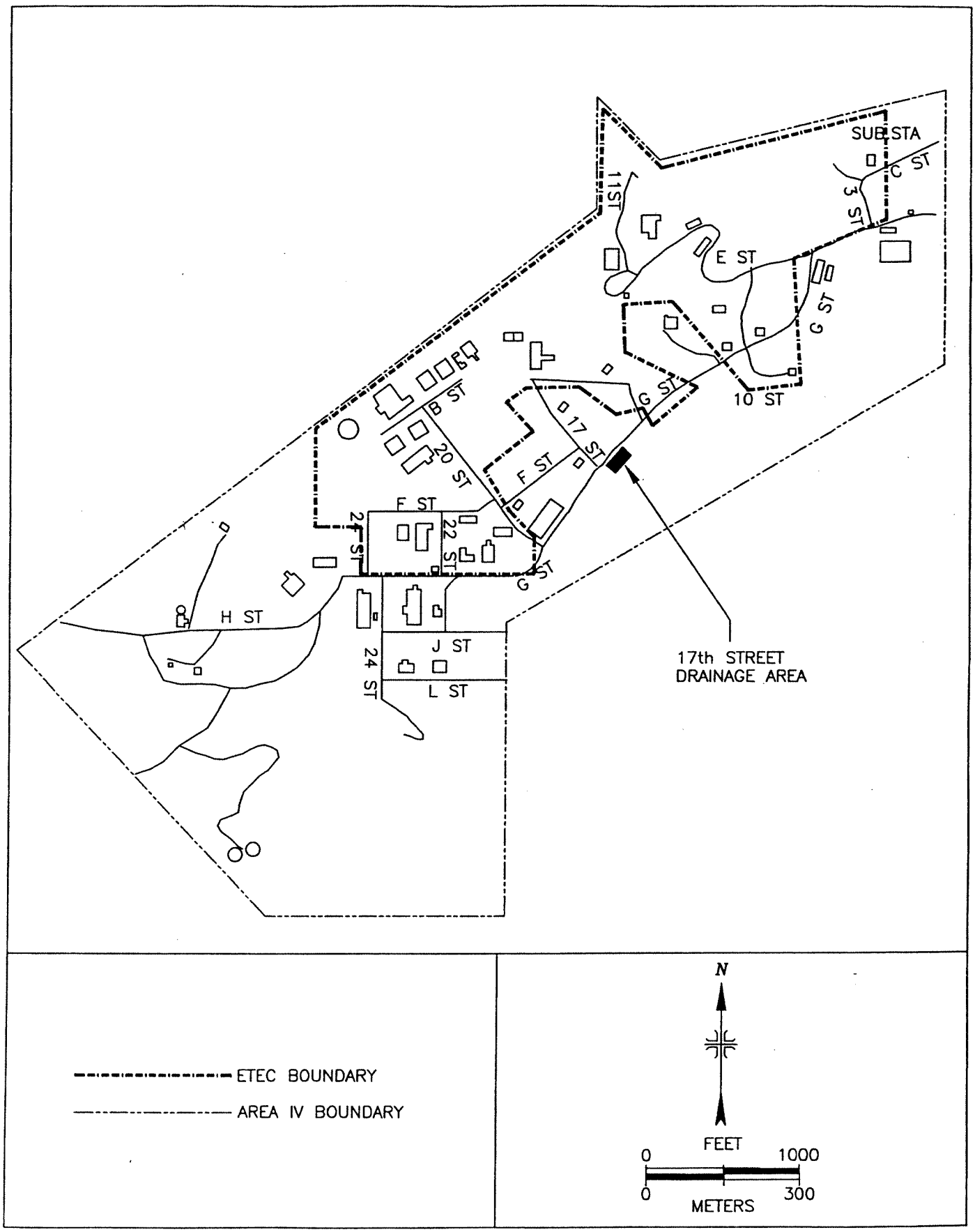

FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of the 17th Street Drainage Area

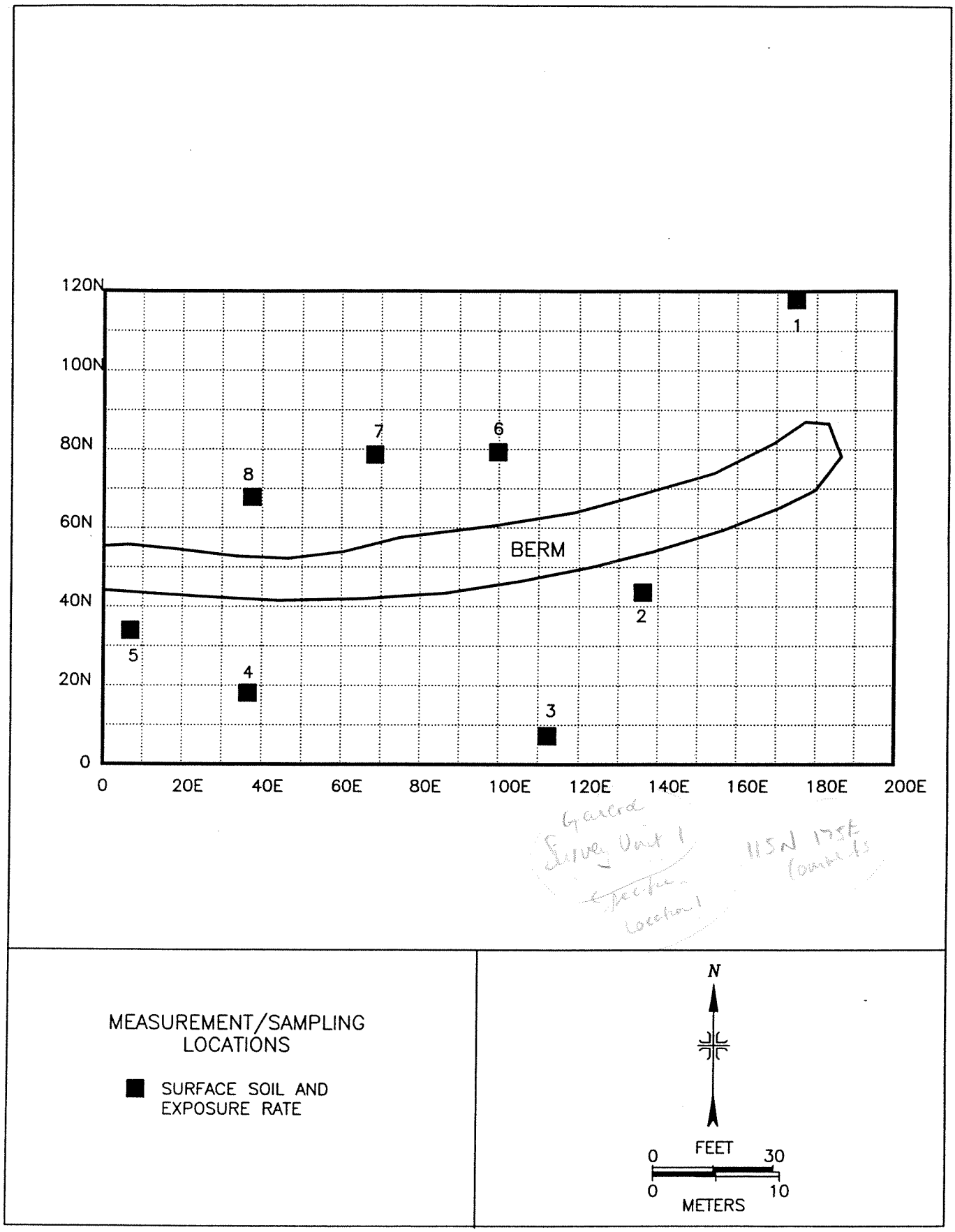

FIGURE 3: 17th Street Drainage Area – Measurement and Sampling Locations

TABLES

TABLE 1

RADIONUCLIDE CONCENTRATIONS IN SOIL
17th STREET DRAINAGE AREAS
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate 1m (μR/h)	Radionuclide Concentrations (pCi/g)							
		Am-241	Cs-137	Ra-226	Th-228	Th-230	Th-232	U-235	U-238
1	15	<0.2	1.4 ± 0.1[b]	1.5 ± 0.4	3.2 ± 0.9	<16.5	2.7 ± 0.4	<0.4	1.8 ± 1.2
2	15	<0.1	0.2 ± 0.1	0.9 ± 0.1	1.2 ± 0.1	<7.1	1.4 ± 0.2	0.2 ± 0.1	5.2 ± 0.9
3	15	<0.1	0.2 ± 0.1	1.8 ± 0.2	2.8 ± 0.3	<11.0	3.0 ± 0.4	<0.3	2.1 ± 1.0
4	14	<0.1	<0.1	1.0 ± 0.2	1.4 ± 0.4	<10.8	1.3 ± 0.2	<0.3	1.6 ± 0.7
5	16	<0.1	0.2 ± 0.1	0.8 ± 0.1	1.2 ± 0.1	<7.4	1.2 ± 0.2	<0.2	1.3 ± 0.7
6	15	<0.1	1.6 ± 0.1	2.2 ± 0.2	3.5 ± 0.3	<11.9	3.7 ± 0.5	0.4 ± 0.2	4.2 ± 1.1
7	16	<0.1	0.5 ± 0.1	1.1 ± 0.1	1.5 ± 0.2	<8.3	1.4 ± 0.3	<0.2	1.7 ± 0.7
8	19	<0.1	0.2 ± 0.1	1.1 ± 0.1	1.5 ± 0.1	6.4 ± 5.5	1.6 ± 0.2	<0.2	1.7 ± 0.6

[a] Refer to Figure 2.
[b] Uncertainties are total propagated uncertainties at the 95% confidence level.

TABLE 2

GENERIC LIMITS FOR SOIL AND WATER (REFERENCE N001SRR140127)[a] SANTA SUSANA FIELD LABORATORY VENTURA COUNTY, CALIFORNIA

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Am-241	5.44	1.5
Co-60	1.94	200
Cs-134	3.33	75
Cs-137	9.20	110
Eu-152	4.51	840
Eu-154	4.11	570
Fe-55	629,000	9,000
H-3	31,900	20,000[b]
K-40	27.6	290
Mn-54	6.11	2,000
Na-22	2.31	480
Ni-59	151,000	26,000
Ni-63	55,300	9,500
Pu-238	37.2	1.7
Pu-239	33.9	1.6
Pu-240	33.9	1.6
Pu-241	230	80
Pu-242	35.5	1.6
Ra-226	5[d] and 15[d]	4.1
Sr-90	36.0	8[b]
Th-228	5[d] and 15[d]	6.8

TABLE 2 (Continued)

GENERIC LIMITS FOR SOIL AND WATER
(REFERENCE N001SRR140127)
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Th-232	5[d] and 15[d]	2.0
U-234	30[c]	
U-235	30[c]	total uranium 20[b]
U-238	35[c]	
Gross alpha (not including radon and uranium)	---	15[b]
Gross beta	---	50[b]

[a]Reference taken from Rocketdyne/Boeing 96ETEC-DRF-0374, Enclosure A, June 28, 1996.
[b]State of California Maximum Contaminant Levels, CCR Title 22.
[c]Generally more conservative NRC limits for uranium isotopes are proposed.
[d]DOE Order 5400.5 limits are proposed (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15cm layers below the top 15 cm).

REFERENCES

Boeing. RS-00005,17th Street Drainage Area, Final Status Survey Procedure. Canoga Park, CA; July 21, 1999.

Boeing. "17th Street Drainage Area, Final Status Survey Report." R5-00009, Revision A, Santa Susana Field Laboratory. Canoga Park, CA; March 16, 2000a.

Boeing. Response to ORISE Comments on Final Status Survey Procedures for B/4059 Phase I, B/4020 and the 17th Street Drainage Area, and the final status survey reports for B/4059 Phase I and 17th Street Drainage Area. Canoga Park, CA; April 4, 2000b.

Oak Ridge Institute for Science and Education (ORISE). Verification Survey of the Interim Storage Facility; Buildings T030, T641, and T013; An Area northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038, Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; February 1996.

Oak Ridge Institute for Science and Education. Survey Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; January 1998a.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Environmental Survey and Site Assessment Program, Revision 8. Oak Ridge, Tennessee; May 1998b.

Oak Ridge Institute for Science and Education. Proposed Verification Survey Plan for the17th Street Drainage Area and Building 4059, Phase I, Santa Susana Field Laboratory, The Boeing Company, Ventura County, California. Oak Ridge, TN; October 13, 1999a.

Oak Ridge Institute for Science and Education. Document Review—Comments on the Final Status Survey Procedures for the 17th Street Drainage Area and Building 4059 Phase I, Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; August 30, 1999b.

Oak Ridge Institute for Science and Education. Document Review—Comments on the 17th Street Drainage Area, Final Status Survey, Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; October 28, 1999c.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; October 1999d.

State of California, Department of Health Services. Authorized Sitewide Radiological Guidelines for Release for Unrestricted Use. August 9, 1996.

U.S. Department of Energy (DOE). Radiation Protection of the Public and the Environment. Washington, DC: DOE Order 5400.5; February 1990.

U.S. Department of Energy. Memorandum from S. Robinson to R. Liddle, "Sitewide Limits for Release of Facilities Without Radiological Restrictions," September 17, 1996.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Detectors

Bicron Micro-Rem Meter
(Bicron Corporation, Newburg, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(ORTEC)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

High Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B
SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detectors slowly over the surface; the distance between the detector and the surface was maintained at a minimum—nominally about 6 cm. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. The combination of detector and instrument used for the scans were:

Gamma - NaI scintillation detector with ratemeter

Exposure Rate Measurements

Measurements of dose equivalent rates (μrem/h) were performed at 1 m above the surface using a Bicron microrem meter. Although the instrument displays data in μrem/h—the conversion to μR/h is essentially unity.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system.

Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concern were:

Am-241	0.059 MeV
Ra-226	0.351 MeV from Pb-214*
Th-228	0.239 MeV from Pb-212*
Th-230	0.067 MeV
Th-232	0.911 MeV from Ac-228*
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*
Cs-137	0.662 MeV

*Secular equilibrium assumed.
Spectra were also reviewed for other identifiable photopeaks.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent total propagated uncertainty at the 95% confidence level. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, (January 1998)
- Laboratory Procedures Manual, (October 1999)
- Quality Assurance Manual, (May 1998)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 414.1A and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EML, ITP, and MAPEP laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

BASIC DOSE LIMITS

The basic dose limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

EXTERNAL GAMMA RADIATION

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226, Radium-228, Thorium-230, Thorium-232	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.
Others	Calculated on a site-specific basis, using the DOE manual developed for this use.

[a] These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[b] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[c] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{½}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

EXHIBIT IV

THE 17th STREET DRAINAGE AREA FINAL REPORT

BOEING

Team Product Document

GO Number	S/A Number	Page 1 of	Rev. Ltr/Chg. No. See Summary of Chg.	Document Number
97055	**75300**	**12**	**NEW**	**EID-04725**

Program Title
ETEC Closure R21-RF

Document Title
Operations Report for 17th Street Decontamination

Document Type	Related Documents
Engineering Information Document	

Original Issue Date	Release Date	Approvals	Date
08/21/00	**RELEASE** 08/28/00 TV	**R. Meyer**	

Prepared By/Date	Dept.	Mail Addr.
Christina Ortega / 08-21-00	**694**	**T038**

IR&D Program? Yes ☐ No ☒
If Yes, Enter Authorization No.

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Abstract

This document summarizes the decontamination and survey process for the 17th Street Drainage Area at Boeing's Santa Susana Field Laboratory (SSFL).

The Metaphase on-line procedure system contains the latest revision of this document.

Responsible Person: Rodney E. Meyer

Title Page/Summary or Change Page Only.
Complete Document is available in Metaphase.

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FIGURES

TABLES

1.0 INTRODUCTION and SUMMARY

This report summarizes the decontamination and survey process for the 17th Street Drainage Area at Boeing's Santa Susana Field Lab (SSFL) in Southern California. The area consisted of a natural rainwater channel where a berm was constructed in 1962 to permit the area to serve as a hold-up pond. Characterization surveys performed in 1997 and 1998 identified uranium and thorium isotopes as well as elevated levels of Cs-137 within samples collected from the area. All soil exceeding cleanup standards was excavated, packaged as radioactive waste and shipped to the Envirocare disposal site in Utah. Subsequent surveys, completed in 1999, concluded that the area was suitable for release for unrestricted use (Refs. 3&4).

2.0 LOCATION

The 17th Street Drainage Area is located within Boeing's Santa Susana Field Laboratories (SSFL) in the Simi Hills of southeastern Ventura County, California, adjacent to the Los Angeles County Line and approximately 29 miles northwest of downtown Los Angeles. Location of the SSFL relative to Los Angeles and vicinities is shown in Figure 1. An enlarged map of neighboring SSFL communities is shown in Figure 2. Figure 3 shows the area to the southeast of the intersection of 'G' Street and 17th Street in the central portion of Area IV.

3.0 FACILITY DESCRIPTION AND SITE TOPOGRAPHY

The 17th Street Drainage Area is the site of a natural rainwater channel where a berm was constructed in 1962 to permit the area to serve as a hold-up pond (Figs. 4&5). The pond was functional for many years. It cycled through periods of evaporative drying in summer seasons and refilled during rainy seasons, causing the low-lying area to be marshy. Since that time, the area filled with silt and became overgrown with shrubs and trees. The hold-up pond area measured approximately 85 m^2.

4.0 RECENT OPERATIONS

In 1995, during the Area IV radiological survey, the pond area was completely overgrown, marshy, and inaccessible. Complete survey of the drainage area could not be performed due to dense, inaccessible brush. However, soil samples taken upstream and downstream of the pond indicated no contamination (Ref. 1).

In 1997, during an assessment of historical aerial photos, the existence and location of the pond was identified and investigated (Fig. 6). Several soil samples were then taken in the area, and two samples indicated levels of Cs-137 exceeding the cleanup standards by approximately 50% (Ref. 2).

In August 1998, the entire area was cleared of shrubs and trees. The original bermed pond area was gridded and surveyed including all the upper drainage into the pond and the

lower drainage away from the pond (Ref. 2). One-meter high exposure measurements did not exceed 18.4 µR/hr in a background of 15 µR/hr. Localized areas of elevated radiation at ground level were observed up to a maximum of twice background. All locations that exceeded ground level exposure rates of more than 5 µR/hr above background were identified and marked.

These areas of elevated radiation were soil sampled at varying depths (Ref. 2). Most locations indicated only naturally occurring radionuclides. However, several areas immediately to the north and immediately to the south of the berm showed levels of radionuclides above local background. Cesium-137 was again found up to 2 pCi/g (but less than the cleanup standard of 9.2 pCi/g), uranium isotopes were found up to 4 pCi/g (but less than the cleanup standard of 30 pCi/g) and thorium-228 was found up to 6 pCi/g (at around the cleanup standard). All uranium results showed ratios of uranium isotopes that were consistent with naturally occurring uranium and not processed or enriched uranium, which was typical of nuclear fuel used at SSFL. Although thorium-228 was found at 6 pCi/g, its parent isotope, thorium-232, was found at typical background levels (e.g. 1 pCi/g), thus the origin or cause of elevated thorium-228 is uncertain since this specific thorium isotope was not processed or used at SSFL.

Even though the majority of samples did not exceed cleanup standards and did not pose a risk to anyone, any area having measured levels above background was excavated. Soil sampling performed after excavation showed that excavation had been effective in reducing even these low levels further below cleanup standards (Ref.2)

In January 1999, the main storm drainage system was re-routed by blocking and plugging the old drainage system. A new route was created along the north side of “G” Street to keep the natural rainwater channel dry all year long.

In June 1999, a final status survey was performed of the entire bermed pond area and its surroundings, comprising approximately 2,230 m^2. Surface radiation and soil samples were taken based on MARSSIM guidelines (Ref. 3). The measurements confirmed that the area met Department of Energy and Department of Health Services approved limits and was suitable for release for unrestricted use.

In September 1999, the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Institute of Science and Education (ORISE) performed a verification survey. The results indicated that soil concentrations satisfied the applicable site-specific soil clean-up guidelines. The verification findings support Rocketdyne’s final status survey conclusion that the 17th Street Drainage Area radiological conditions satisfy the guidelines for release without radiological restrictions (Ref. 4).

In September 1999, the State Department of Health Services also performed a verification survey and confirmed that the area was suitable for release for unrestricted use.

5.0 SURVEY RESULTS

Please refer to References 1, 2, 3, and 4.

6.0 PERSONNEL RADIATION EXPOSURE

No significant personnel radiation exposure was anticipated or encountered from the D&D activities for the 17th Street Drainage Area.

7.0 PROJECT COST SUMMARY

The total cost associated with the decontamination and decommissioning of the 17th Street Drainage Area is given in Table 7-1.

TABLE 1

	Labor & Overhead	*Material*	*Subcontractor*
Cost $	244,363	65,684	20,356

Total Cost: $330,403

8.0 WASTE VOLUMES

The volume of soil removed was approximately 2,000 ft^3 (55 m^3). All the soil was transported and properly disposed of as radioactive low level waste at Envirocare in Utah, a licensed disposal facility.

9.0 REFERENCES

1. A4CM-ZR-0011, "Area IV Radiological Characterization Survey" (August 15, 1996)

2. SHEA-016799, "17th Street Drainage Area- Radiation Characterization Surveys and Excavation", John Shao (January 1999)

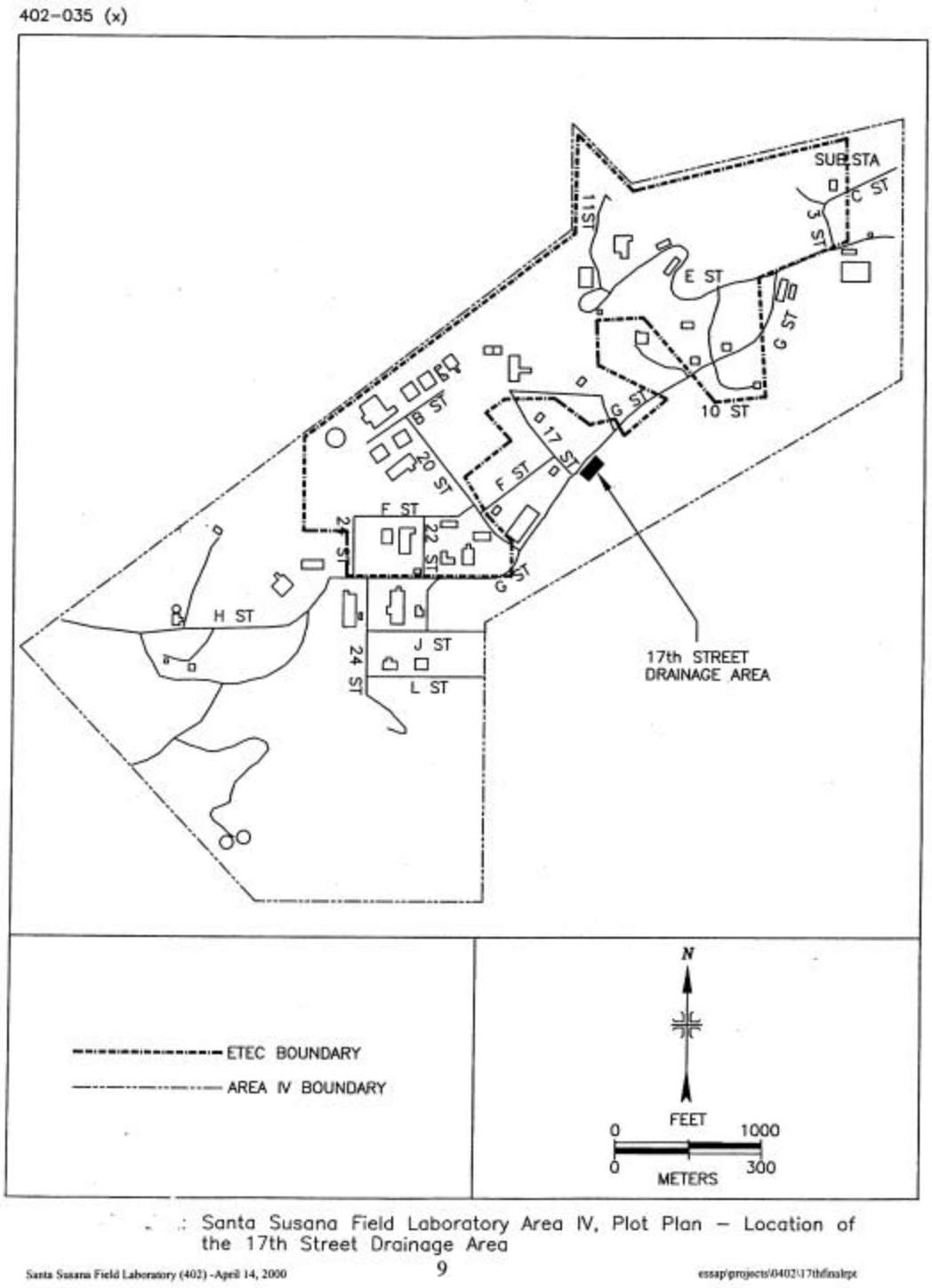
3. RS-00009, "17th Street Drainage Area, Final Status Survey", Rev. A (March 2000)

4. "Verification Survey of the 17th Street Drainage Area, Santa Susana Field Laboratory, The Boeing Company, Ventura County, California", John R. Morton, ORISE (April 2000)

Map of Los Angeles Area

Figure 1. Map of Los Angeles Area

Figure 2. Map of Neighboring SSFL Communities



Santa Susana Field Laboratory Area IV, Plot Plan – Location of the 17th Street Drainage Area

Figure 3. Santa Susana Field Laboratory Area IV, Plot Plan – Location of the 17th Street Drainage Area

Figure 4. Berm

Figure 5. 17th Street Drainage Area

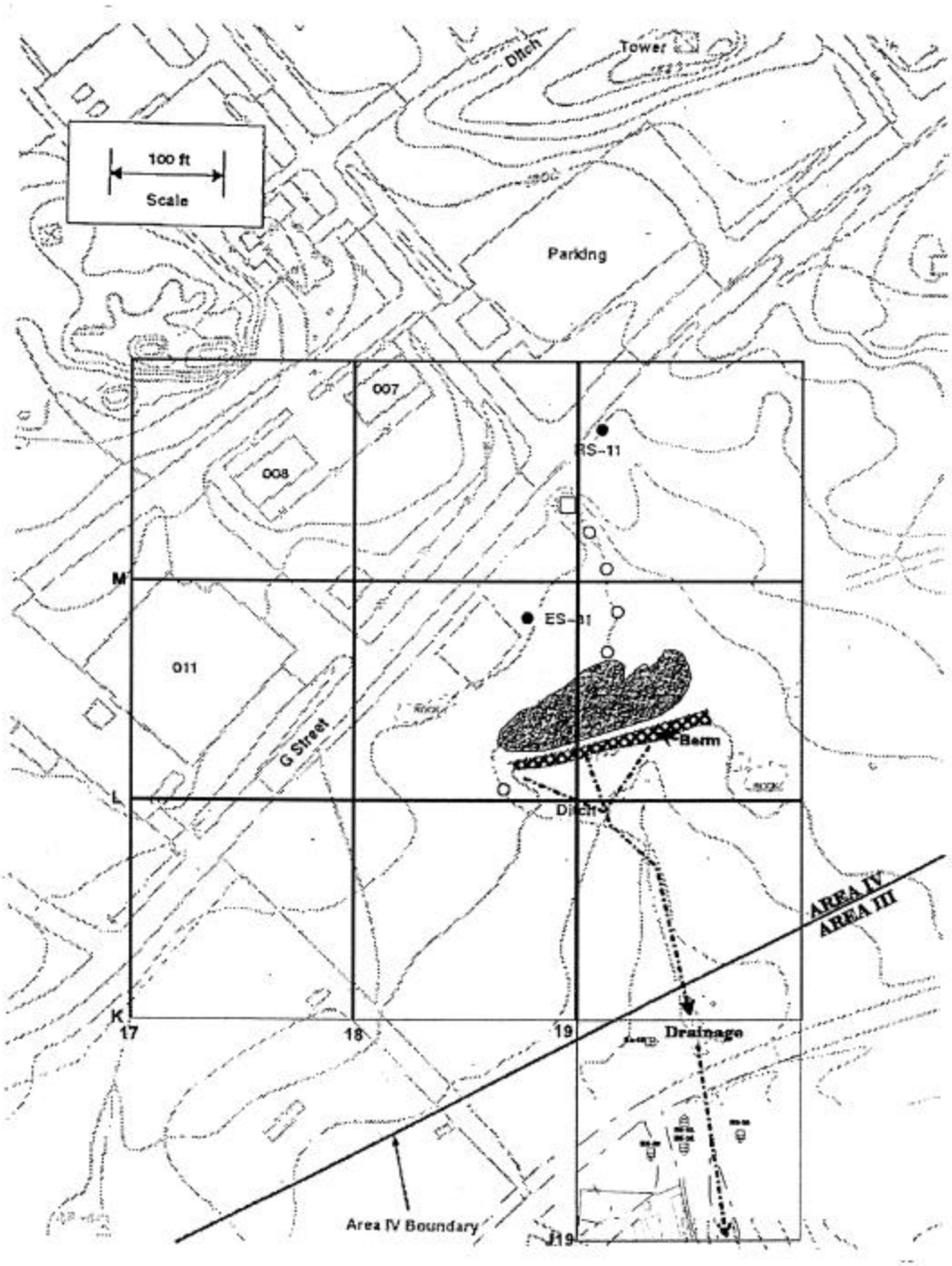


Figure 6. Topographical Map of the 17th Street Drainage Area

EXHIBIT V

FINAL DOCUMENTATION AND RADIOLOGICAL SURVEY OF THE 17th STREET DRAINAGE AREA AFTER DECONTAMINATION

BOEING

Engineering Product Document

GO Number	S/A Number	Page 1 of	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	37629	70	73	Rev. A	RS-00009

Program Title
Closure of ETEC (R21-RF)

Document Title
17th Street Drainage Area, Final Status Survey

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Distribution

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*	Engineering Data Mgmt	AB18
*	Facility Release Files	T057
*		

Abstract
This document provides results of the Final Status Survey of the 17th Street Drainage Area at the Santa Susana Field Laboratory. All measurements confirm that the area meets the release limits approved by the Department of Energy and the State of California, Department of Health Services. Accordingly, the area is suitable for release for unrestricted use.

* Complete Document
No Asterisk, Title Page/Summary or Change Page Only.

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Rocketdyne Form 651-F REV. 2-97

Supporting Document
Summary of Change

Report	17th Street Drainage Area Final Status Survey	No. (RZI-RF) RS-00009 Page 1.1 of 70

Rev.	Summary of Change	Approvals and Date
A	Page 4, added: "The survey unit also passed the Wilcoxon Rank Sum test using the unity rule." Page 6, changed: PCI/g to pCi/g. Page 8, Section 3.2: omitted paragraph beginning from "Background Cs-137..." Replaced with "and other isotope DCGLs are provided in Reference 6.3 and Appendix B." Page 18, Section 3.9.5: added Sections 3.9.5.1 and 3.9.5.2. Page 19: Added under **Cs-137**, the reference to Tables B1 and B1.1 Page 19: Added Table 4: Background Dose Rate Levels Page 21, Section 4.2: Omitted paragraph beginning from "...detect if the....". Replaced with "test the Null Hypothesis for all isotopes combined. (see Tables C1 and C2). Page 21, Section 4.2: Omitted paragraph beginning from "For every isotope...." Replaced with "From Table C2, the sum of the Referenced area ranks is 720. This exceeds the Critical Value of 565 calculated from equation I.1 of Reference 6.1 for 22 SU area samples, 22 Reference area samples, and an α of 0.05. Hence the Null Hypothesis "that residual radioactivity concentrations exceed the reference criteria" is rejected. Page 21, Deleted Section 4.2, Sign Test Analysis,.Replaced with Section 4.2 Wilcoxon Rank Sum Test. Page 22, Section 5.0: Added "The survey unit also passed the multi-isotope Wilcoxon Rank Sum Test using the Utility Rule." Page23, Section 6.0: Omitted control number "3131500002 BCSSR". Replaced with "Bell Canyon Area Soil Sampling Report". Page 23, Added reference on *Bell Canyon Soil Sampling Report* to Reference Section. Page 26, Deleted Sign Test column on Table A.1: Ambient Gamma Exposure Chart. Page 26: Revised chart to reflect gross and net ambient exposure Measurements. Pages 29, 30, 32, 34, 36, 38, 42, 44, 46, 48, and 50. Deleted Sign Test column on Tables B.1 through B11, Page 30, Added Table B1.1 Cs-137 Re-analysis. Page 54, Added Table C1: WRS Analysis.	M. Lee 3/15/00 R. Rutherford 3-15-2000 R. Meyer 3/15/00 P. Liddy 3/15/00

Supporting Document
Summary of Change

17th Street Drainage Area Final Status Survey Report	No. (R21-RF) RS-00009 Page 1.2 of 70

Rev.	Summary of Change	Approvals and Date
A	Page 55, Added Table C2 WRS Test Re-analysis. Page 56, Appendix D: Omitted "Characterization Report". Replaced with "1998 Soil Sample Results".	

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EXECUTIVE SUMMARY

On June 1, 1999, a MARSSIM final status survey was completed at the 17th Street Drainage Area confirming that the area meets release limits approved by the Department of Energy, and the Department of Health Services. Accordingly, the area is suitable for release for unrestricted use.

During 1998, a comprehensive decontamination and decommissioning effort was initiated in the 17th Street Drainage Area. After D&D efforts, a comprehensive final status survey of the area concluded in 1999. The final status survey classified the area into a Class I survey unit, since contamination had been identified, above the $DCGL_W$. This area comprised a 120-ft by 200-ft section of land. All measurements were tested statistically for compliance within the regulatory acceptable derived concentration guideline limits (DCGLs), and ambient exposure rates.

In all of the Class I area, the highest background subtracted ambient gamma measurement was 3 μR/hr (see Appendix A). A 100% qualitative surface radiation exposure survey found no detectable activity. The soil results proved all samples taken were well below the $DCGL_w$ for each radioisotope (see Appendix B). The survey unit also passed the multi-isotope Wilcoxon Rank Sum test using the unity rule (see Appendix C).

1.0 INTRODUCTION

The final status survey conducted by Rocketdyne Propulsion and Power for the 17th Street Drainage Area followed the protocols of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Reference 6.1. The objective of this survey was to demonstrate that no residual contamination remains that could result in any exposure or risk to current or future occupants.

2.0 FACILITY HISTORY

2.1 Background

At Rocketdyne Propulsion and Power, Santa Susana Field Laboratory, a natural rainwater channel is located in Area IV, south of the intersection of "G" Street and 17th Street. In 1962, a berm was constructed around the area to provide a 30-ft. by 30-ft hold-up pond. The pond was functional for many years. It cycled through periods of evaporative drying in summer seasons, and refilled during rainy seasons causing the low-lying area to be marshy. In subsequent years, the area became overgrown with shrubs and trees, and filled with silt.

In 1995, during the Area IV radiological survey, the pond area was found to be completely overgrown, marshy, and inaccessible. Soil from the drainage areas to the north and south of the pond area was sampled, but no contamination was found in those locations.

In 1997, during an assessment of historical aerial photos, the existence and location of the pond was identified and investigated. Several soil samples were taken in the area (which was then dry), and two of the soil samples indicated Cs-137 exceeding the cleanup standards by 50%. A radiation scoping survey was subsequently conducted in the pond area, and any locations found over the background limits were identified.

In 1998, the entire drainage area was cleared of shrubs and trees. The original bermed pond area was mapped, gridded and surveyed, including all upper flow intake to the pond; and lower discharge drainage out of the pond. The one-meter high, exposure measurements conducted did not exceed 18.4 μR/hr in a background of 15 μR/hr. Some elevated radiation measurements in localized areas at ground level were observed at a maximum of twice the background levels.

All locations exceeding ground level exposure rates of more than 5 μR/hr above background were identified and marked. All elevated radiation areas were sampled at varying depths of soil. However, most of the soil samples indicated naturally occurring radionuclides. Soil samples in areas immediately north and immediately south of the berm indicated levels of radionuclides above local background levels. Cs-137 was found at 2 pCi/g, which was less than the cleanup standard of 9.2 pCi/g. Th-228 was found at 6 pCi/g, which was close to the cleanup standard limit. Uranium isotopes were found at 4 pCi/g, which was less than the cleanup standard of 30 pCi/g. All uranium sample results showed ratios of uranium isotopes consistent with naturally occurring uranium.

There were no processed or enriched uranium isotopes found typical of the nuclear fuel used at the SSFL. Although thorium-228 was discovered at 6 pCi/g, its parent isotope thorium-232 was found at background levels of 1 pCi/g. Since this specific thorium isotope was not processed or used at the SSFL, the origin or cause of elevated thorium-228 is presently unknown.

Although the majority of the soil samples did not exceed cleanup standards, and did not pose a health risk, portions of the 17th Street Drainage area were excavated. Post excavation soil sampling showed that excavation had been effective in reducing soil concentrations much further below the cleanup standards. Prior sampling and remediation is described in Reference 6.2, and is included here in Appendix D. The results from Reference 6.2 demonstrated that the drainage channel both upstream and downstream of the bermed area undergoing a MARSSIM final release survey were indeed free of contamination.

2.2 Approach

Table 1 depicts the survey and remediation schedule for the 17th Street Drainage Area.

TASK	SCHEDULED DATE
Initial Soil Sampling	1995
Follow-up Soil Sampling	1997
Rocketdyne Characterization Survey	September 1998
Remediation	October 1998
Post-remediation Survey	November 1998
Rocketdyne Final Survey	June 1999
ORISE Verification Survey	October 1999
DHS Verification Survey	October 1999

TABLE 1: KEY MILESTONES

3.0 SURVEY DESIGN

The MARSSIM final status survey for the 17th Street Area followed the guidelines of the Rocketdyne Procedure R21-RF-RS00005 (see Reference 6.4). The objective of this survey was to demonstrate that no residual contamination remained that could result in any exposure or risk.

3.1 Identification of Radionuclides of Concern

The principle contaminant of concern at the 17th Street Drainage Area was Cs-137. Uranium and Thorium isotopes were also found in the soil but always with the accompanying presence of Cs-137. Cesium was used as a tracer for all potential contaminants and MDCs for the scanning portion of the survey (*refer to Section 3.9*) was based on the Cs-137 detectability. Soil sample analysis was performed for all gamma emitting radionuclides, Sr-90, Am-241 and isotopic Plutonium, Thorium, and Uranium.

3.2 Derived Concentration Guideline Limits ($DCGL_w$)

The objective of the survey was to demonstrate that residual contamination in excess of the derived concentration guideline limits (DCGLs) was not present at the site. The $DCGL_w$ for Cs-137 in soil is 9.2 pCi/g above background and other isotope DCGLs are provided in Reference 6.3 and Appendix B.

3.3 Classification of Areas Based on Contamination Potential

3.2.1 Impacted Areas

The impacted area was considered to be the area within geodetic land blocks L18 and L19 that surrounded the berm (*see Figure 1*). This is an area of 120 ft x 200 ft = 24,000 ft^2 (approximately 2230 m^2)

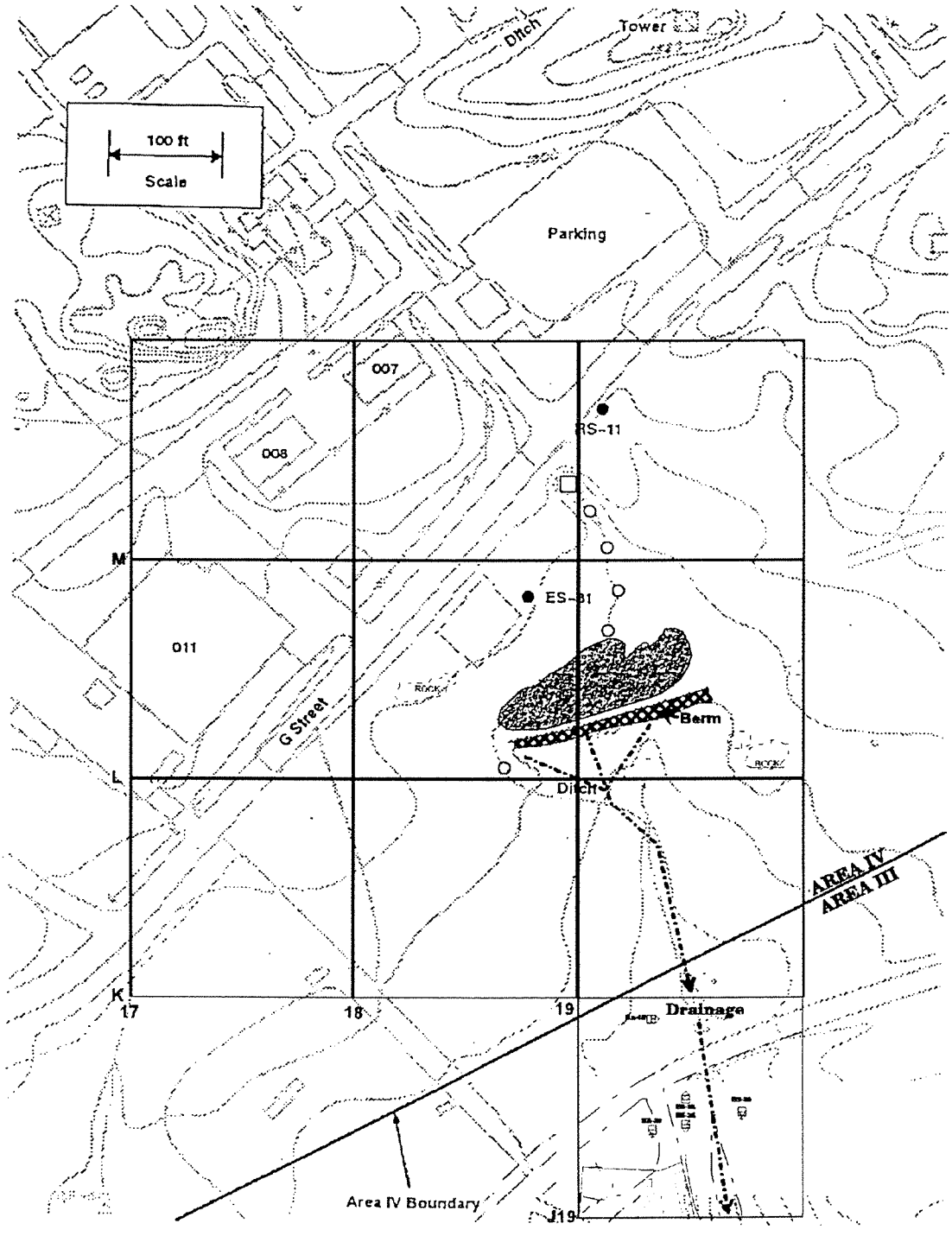


FIGURE 1: TOPIGRAPHICAL MAP OF 17TH STREET DRAINAGE AREA

CLASS I

The impacted area was determined to be the entire Class I area. The area is enclosed within four corners identified by Area IV's geodetic coordinate system as:

- Block L18 located North at 0-ft and East at 120-ft,
- Block L18 located North at120-ft and East at 120-ft,
- Block L19 located North at 0-ft and East at 120-ft, and
- Block L19 located North at 120-ft and East at 120-ft.

CLASS II

There are no Class II areas in this survey. Survey results reported in Appendix C demonstrated that no contamination exists in the drainage channel to the North and South of the identified Class I Survey Unit.

CLASS III

There are no Class III areas in this survey. Survey results reported in Appendix C demonstrated that no contamination exists in the drainage channel to the North and South of the identified Class I Survey Unit.

3.3.2 Non-Impacted Area

Areas surrounding the impacted area were surveyed in earlier projects (*see Reference 6.2*) and demonstrated to be non-contaminated. These surrounding areas were not part of the survey.

3.4 Identification of Survey Units

3.4.1 Area Classification

Roadmap-6, from the MARSSIM Manual, limits the maximum Survey Unit areas as shown in Table 2:

CLASSIFICATION	MAX SURVEY UNIT AREA
Class I	2,000 m^2
Class II	2,000 m^2 to 10,000 m^2
Class III	No limit

TABLE 2: AREA CLASSIFICATION

Figure 2 depicts the Class I area, which consisted of one survey unit of 24000- ft^2 (2230m^2). This diagram is an example, and not true to scale.

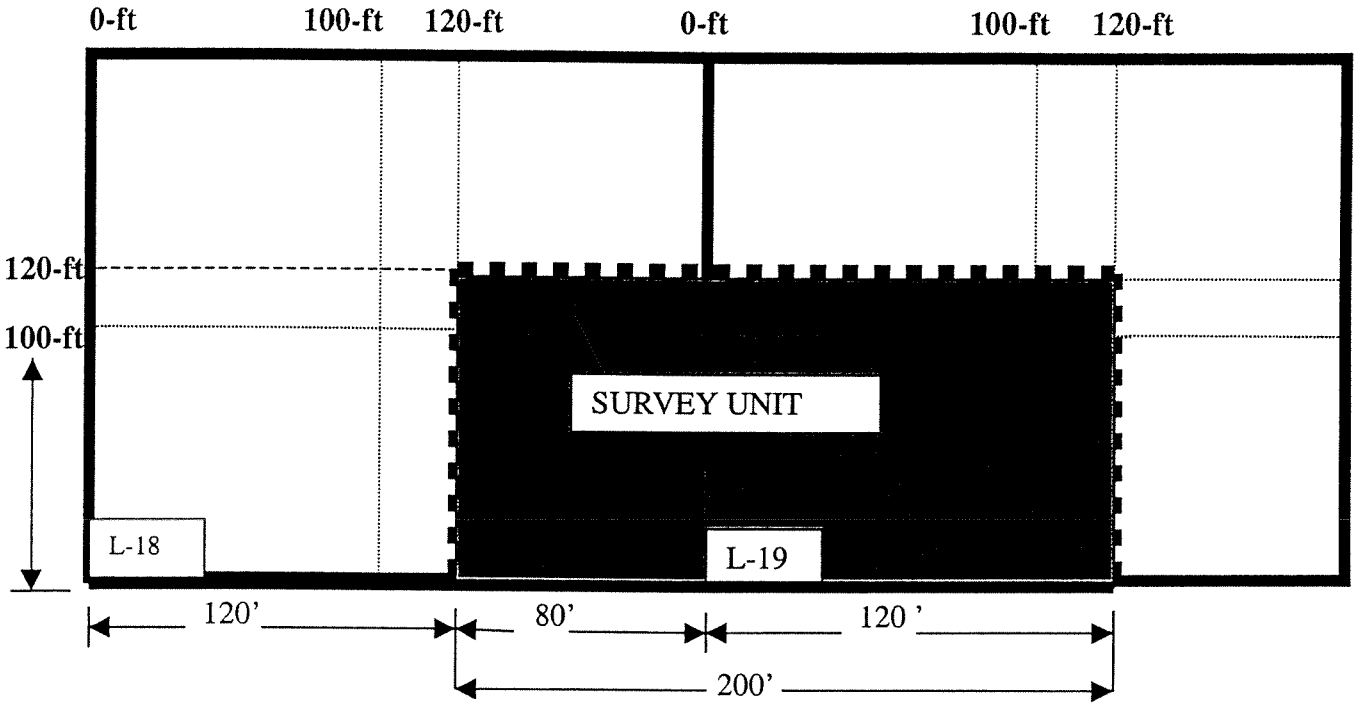


FIGURE 2: LOCATION OF SURVEY UNIT

3.5 Decision Objectives

- The objective of the survey was to achieve release of the area for unrestricted use.
- The null hypothesis (H_0) for the survey unit was that the residual radioactivity concentrations exceed the release criterion. The null hypothesis had to be rejected for the site to be released for unrestricted use.
- Acceptable decision error probabilities were α (regulatory risk) = 0.05 and β (users risk) = 0.05. Where Alpha (α) is defined as the probability that the known hypothesis will be rejected when in fact it is true (e.g. *a contaminated site is declared clean*). Beta (β) is defined as the probability that the null hypothesis will be accepted when in fact it is false (e.g. *a clean site is declared contaminated*).
- The derived concentration guideline limits (DCGLw) for the primary contaminant of concern (Cs-137) was 9.2 pCi/g, equivalent to an annual dose to a residential user of 15 mrem/year.
- The lower bound of the gray area (LBGR) used was *one half of the DCGLw* or 4.6 pCi/g of Cs-137.
- The regulator's risk (α) was established for the DCGLw.
- The user's (Rocketdyne) risk (β) was established at the LBGR.

3.5.1 Power Curve

The desired power curve indicated the gray region extended from 4.6 pCi/g to 9.2 pCi/g of Cs-137. The survey was designed for the statistical test to have a 95% power to decide the survey unit containing less than 4.2 pCi/g of Cs-137 met the release criterion. For the same test, a survey unit containing over 9.2 pCi/g of Cs-137 had less than 5% probability of being released.

3.6 Area Preparation

3.6.1 Number of Survey Units

There was a total of one (1), Class I, Survey Unit of 24,000-ft^2 (or each 2230 m^2). The number of surface soil samples taken was derived in Section 3.7.

Survey Unit 1 consists of 24,000-ft^2 (2230-m^2)

3.7 Analysis Procedures

3.7.1 Statistical Test

Since the gross (non-background subtracted) Cs-137 data are to be subjected to statistical test, the Wilcoxon Rank Sum test was used as recommended by MARSSIM.

3.7.2 Relative Shift

The shift Δ is the $DCGL_w$ minus the LBGR ($\Delta = DCGL_w - LBGR$). In other words, the shift was the width of the gray region. σ was the expected standard deviation of the measurements of the survey unit. Based on prior sampling of the land and excavations at the 17th Street Drainage Area, the σ for Cs-137 resulted in 3.39 pCi/g.

The **relative shift** Δ/σ was therefore (9.2 - 4.6)/3.39 = **1.4**

3.7.3 Number of Data Points (Soil Samples)

From Table 5.5 of Reference 6.1, the number of samples required for a relative shift of 1.4 and $\alpha = \beta = 0.05$ was 20. However, the Class I area (2230 m^2) was 11% larger than the recommended size of 2000 m^2. Therefore, the number of sample was adjusted accordingly to reflect this size difference. The adjusted number of samples was **22**. Locations of soil samples were also be obtained at these locations.

Total number of sample points required for 24,000 ft^2 (2230 m^2) was 22.

3.8 Reference Coordinate System

3.8.1 Sample Point Spacing

For the Survey Unit, the grid spacing and scan area between sample points (for a square grid) were calculated as follows:

Scan Area = A = 24,000 ft^2/22 = 1090.9-ft^2 = 101 m^2
L =√A = √1090.9= **33.02-ft** (10.06 meters) **distance apart**

In accordance with the MARSSIM Manual, *Survey Planning and Design*, page 5-38, "*Grid spacing should generally be rounded down to the nearest distance that can be measured in the field*". Therefore, the distance between sample points was 33-ft or 10 meters.

Distance (L) between sample points was 33-ft or 10 meters

3.8.2 Starting Point Coordinates

In order to designate the starting point of soil sample locations, a pair of random numbers was generated from Table 1.6 of the MARSSIM Manual, Reference 1. Rectangular coordinates from the southwest corner of the survey unit were then calculated by multiplying by the dimensions of the survey unit (120 ft x 200 ft). Survey unit coordinates were designated as follows:

0.707773 x 200 ft = 141.5 ft (43.1 m)
0.426444 x 120 ft = 51.1 ft (15.5 m)

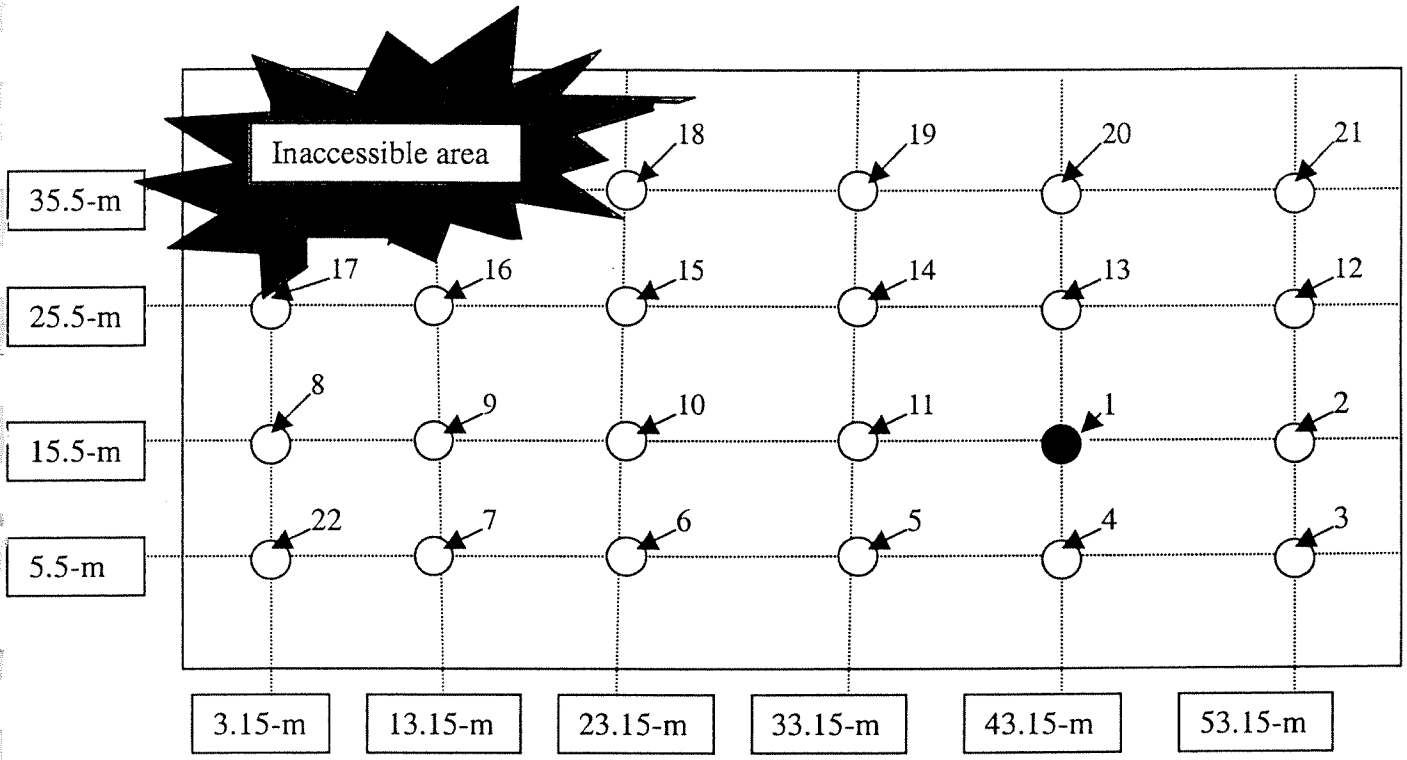
Starting from the southwest corner origin of the Survey Unit, the point of origin to begin measuring was:

Starting Point Coordinates
(X) East 141.5-ft (43.1meters)
(Y) North 51.1-ft (15.5 meters)

3.8.3 Spacing

In summary, a minimum of 22 soil samples was taken at 33-ft (or 10-m) distances apart; beginning at the (E141.5-ft, N51.1-ft) or (E43.1-m, N15.5-m) coordinates.

Figure 3 shows the soil locations in the Class I survey unit. Refer to Table 3 on page 16 for the identification numbers.



● =starting point Location number = 17S-99-00X, see page 16.

NOTE: SURVEY UNIT IS 200-FT BY 120-FT (60.9-M X 36.5-M). SAMPLE POINTS ARE 33-FT (10-M) DISTANCE APART.

FIGURE 3: SURVEY UNIT SOIL SAMPLE GRID

Table 3 shows the soil sample identification numbers attached to the sample location coordinates in Figure 3, page 15.

GRID COORDINATES (NORTH/EAST) METERS*	SOIL SAMPLE NUMBER
N15.5/E43.1	17S-99-0001
N15.5/E53.1	17S-99-0002
N5.5/E53.1	17S-99-0003
N5.5/E43.1	17S-99-0004
N5.5/E33.1	17S-99-0005
N5.5/E23.1	17S-99-0006
N5.5/E13.1	17S-99-0007
N5.5/E3.1	17S-99-0008
N15.5/E13.1	17S-99-0009
N15.5/E23.2	17S-99-0010
N15.5/E33.1	17S-99-0011
N25.5/E53.1	17S-99-0012
N25.5/E43.1	17S-99-0013
N25.5/E33.1	17S-99-0014
N25.5/E23.1	17S-99-0015
N25.5/E13.1	17S-99-0016
N25.5/E3.1	17S-99-0017
N35.5/E23.2	17S-99-0018
N35.5/E33.1	17S-99-0019
N35.5/E43.1	17S-99-0020
N35.5/E53.1	17S-99-0021
N5.5/E3.1	17S-99-0022
BLIND SPLIT FROM N15.5/E43.1	17S-99-0023
MATRIX SPIKE SAMPLE FROM N5.5/E53.1	17S-99-0024

* ORIGIN MEASURING FROM THE N0/E0 COORDINATE, SOUTHWEST CORNER OF THE SURVEY UNIT

TABLE 3: SOIL SAMPLE LOCATIONS

3.9 Instrumentation and Techniques

3.9.1 Required Scan MDC

Scanning of soil sample grids was performed to ensure small areas of contamination did not remain undetected. The $DCGL_w$ was calculated in RESRAD 5.6[1] using default of 10,000 m^2. Running RESRAD with smaller areas progressed to a relatively higher release criteria. From Table 5.6 of Reference 6.1, the area dose factor for 101 m^2 for Cs-137 is 1.4. Therefore the elevated measurement concentration $DCGL_{EMC}$ was: $DCGL_{EMC} = DCGL_W$ x Area Factor = 9.2 x 1.4 = 12.9 pCi/g

Required Scan MDC = 12.9 pCi/g

3.9.2 Actual Scan MDC

Surface scans were performed with a 1 in. x 1 in. NaI detector moving at 1 ft/sec. Actual scan MDC for this technique was calculated below following the procedure outlined in page 6-45 of MARSSIM, Reference 1.

Background = B = 3000 counts/min
Assumed hot spot dimensions = 1.5 ft x 1.5 ft
Assumed hot spot depth = 0.5 ft
Scan speed = 1 ft/sec
Observation interval = 1.5 sec
Delectability index 1.38
Surveyor efficiency 0.5
CPM/Exposure ratio = 215 cpm per μR/h

Minimum Detectable Count Rate (MDCR) =
$1.38 \times (3000 \times 1.5/60)^{0.5} / ((1.5/60) \times 0.5^{0.5}) = 676$ counts/min

Minimum Detectable Exposure Rate (MDE) = 676/215 = 3.1 μR/h

A microshield analysis was performed for the hot spot size defined above, for cesium-137 and its progeny barium-137 at a 1 pCi/g concentration and soil density of 1.4 g/cm3. The exposure rate at 2 in. from the surface was 0.3 μR/h.

Actual Scan MDC = 3.1/0.3 = **10.3 pCi/g**

Since the actual scan MDC of 10.3 pCi/g was less than the required scan MDC (or $DCGL_{EMC}$) of 12.9 pCi/g, the scanning technique was adequate for detecting hot spots above $DCGL_{EMC}$ between the soil sample locations. Therefore no adjustment to the number of soil samples to account for elevated activity was necessary.

3.9.3 Instrument Performance Check

Measurement integrity of the instruments was monitored throughout all parts of gamma surveys by periodic checks of the instrument's response to normal background radiation, and to a *Field Check Source.* A record of these instrument checks was maintained by the daily completion of Instrument Qualification Reports.

3.9.4 Environmental Calibration Site

A Reuters-Stokes ambient gamma exposure site was the location where the instrument calibration and efficiency checks were conducted. The detector was source checked at the 1-meter height, and remained the daily source check area throughout the Area 17th Street Drainage Area surveys.

3.9.5 Representative Reference Background Areas

3.9.5.1 Soil

When performing the WRS Test, samples from a "reference" background area to the immediate south of the Santa Susana Field Lab (SSFL) were used. These samples taken in 1998 are judged as representative since the geology and terrain are similar to the SSFL.

3.9.5.2 Exposure level

A series of background exposure levels were obtained around the entire survey unit area within grid blocks L-18, and L-19. This action assisted in determining the average and highest background levels where the survey was conducted.

3.9.6 Ambient Survey Detector Fixtures

To accurately obtain a 1-meter ambient gamma measurement at each sample point location, the sodium iodide detector was mounted on a lightweight PVC fixture. This fixture held the detector oriented towards the ground at a 1-meter height. Its use facilitated quick placement at each measurement location, while eliminating errors due to detector distance or orientation.

3.9.7 Walk-about Survey Detector Fixtures

During the walk-about survey, a sodium iodide detector probe was mounted at the end of a balanced boom, so the surveyor could sweep the probe over a large area while walking along the survey path. The fixture for this survey had a length of stainless steel tubing for the boom, with a bracket at one end to hold the detector upright to the ground, and a counterbalance weight at the other end. A shoulder strap was attached to the balance point of the fixture. The arrangement allowed the surveyor to sweep the detector over an area about 5 feet wide while walking a straight line.

3.10 Pre-survey Preparation

Brush was cleared from the survey unit prior to conducting the Final status survey.

4.0 SURVEY RESULTS

4.1 Class I Survey Results

4.1.1 Surface Exposure Rate

The average, gross surface walk-about exposure level observed was 3268 cpm (15.2 μR/hr). The maximum surface walk-about exposure level observed was 4050 cpm (18.8 μR/hr). When the background level of 2704 cpm (12.6 μR/hr) was subtracted for these values, the net average and maximum surface exposure levels were 564 cpm (2.6 μR/hr) and 1346 cpm (6.3 μR/hr) respectively.

4.1.2 Ambient Exposure Rate

The average, gross, 1-meter ambient exposure level observed was 3259 cpm (15.2 μR/hr). The maximum 1-meter ambient exposure level was 3719 cpm (17.3 μR/hr). When the background level of 2943 cpm (13.7 μR/hr) was subtracted from these numbers, the net average and maximum 1-meter ambient exposure levels were 316 cpm (1.5 μR/hr), and 776 cpm (3.6 μR/hr) respectively. Both these numbers are below the approved $DCGL_W$ of 5 μR/hr above background (see Appendix A).

Table 4 shows how the average background dose rates were established prior to conducting the survey.

BACKGROUND WALK-ABOUT DOSE RATES	BACKGROUND AMBIENT DOSE RATES
2682 cpm	2984 cpm
2720 cpm	2971 cpm
2770 cpm	2915 cpm
2713 cpm	2888 cpm
2739 cpm	3030 cpm
2633 cpm	2933 cpm
2652 cpm	2985 cpm
2736 cpm	2892 cpm
2709 cpm	2884 cpm
2682 cpm	2951 cpm
AVERAGE: 2704 cpm	**AVERAGE: 2943 cpm**
MAX: 2770 cpm	MAX:3030 cpm

TABLE 4: BACKGROUND DOSE RATE LEVELS

4.1.3 Soil Radioisotope Concentrations

Soil radioisotope concentrations are summarized in Appendix B. Note that some results are reported as negative. This is a common occurrence if the laboratory counter blank background count exceeds the sample count.

Cs-137

Initial Analysis

Fourteen samples were non-detect. Eight samples had detectable cesium between 0.63 and 1.9 pCi/gm (gross). All samples were below the of 9.2 pCi/gm (net) clean-up standard. (Refer to Table B1).

Reanalysis

It was observed that the initial gamma analysis reported very high MDAs for Cs-137 (0.2 to 0.4 pCi/gm). As a result, many samples were non-detect. Contact with the radiochemistry laboratory indicated that a small mass and low count time had been used. The laboratory was requested to reanalyze the original samples to achieve the contractually required MDA of 0.02 pCi/gm. Reanalysis results ranged from 0.01 to 2.93 pCi/gm (gross) with one non-detect. All samples were below the 9.2 pCi/gm (net) clean-up standard (see Table B.1.1).

Th-228

Thorium 228 results ranged from 1.07 to 2.61 pCi/gm (gross). These results are typical of background levels and below the 5 pCi/gm (net) clean-up standard.

Th-230

Thorium 230 results ranged from 0.87 to 2.7 pCi/gm (gross). These results are typical of background levels and below the 5 pCi/gm (net) clean-up standard.

Th-232

Thorium 232 results ranged from 0.87 to 1.65 pCi/gm (gross). These results are typical of background levels and below the 5 pCi/gm (net) clean-up standard.

U-234

Uranium 234 results ranged from 0.59 to 1.71 pCi/gm (gross). These results are typical of background levels and below the 30 pCi/gm (net) clean-up standard.

U-235/236

Uranium 235/236 results had 17 non-detects. Detectable U-235/236 in 5 samples ranged from 0.069 to 0.25 pCi/gm (gross). These results are typical of background levels and below the 30 pCi/gm (net) clean-up standard.

U-238

Uranium 238 results ranged from 0.56 to 2.01 pCi/gm (gross). These results are typical of background levels and below the 35 pCi/gm (net) clean-up standard

Isotopic Ratios of U-234 /U-238

Isotopic ratios of uranium 234/238 results ranged from 0.48 to 1.64 with an average of 1.07. This is typical of non-enriched, non-processed, naturally occurring uranium.

Pu-238
All plutonium 238 soil samples were non-detect.

Pu-239/240
All plutonium 239/240 soil samples were non-detect.

Am-241
All americium 241 soil samples were non-detect.

Sr-90
Twenty strontium 90 soil samples were non-detect. Two soil samples had detectable Sr-90 at 1.42 and 3.08 pCi/gm (gross). However, these samples are below the 36 pCi/gm (net) clean up standard.

4.2 Wilcoxon Rank Sum Test

The survey unit measurements were compared to the reference area measurements using the multi-isotope Wilcoxon Rank Sum (WRS) test designed to test the null hypothesis for all isotopes combined. Table C1 uses the original Cs-137 results, while Table C2 uses the reanalyzed Cs-137 results.

The reference area measurements used in the WRS test were taken from the 1998 Bell Canyon soil sampling project (see Reference 6.5). From Table C2 , the sum of the reference area ranks is 711. This exceeds the critical value of 565 calculated from equation I.1 of Reference 6.1 for 22 SU area samples, 22 reference area samples and an α of 0.05. Hence, the null hypothesis *"that residual radioactivity concentrations exceed the release criteria"* is rejected.

In simple terms, this means that the statistical test has demonstrated to a confidence level of 95% that residual radioactivity is below the clean-up standards.

5.0 CONCLUSION

All radiation exposure measurements and soil radioisotope concentrations were below the Department of Energy approved $DCGL_{WS}$. The survey unit also passed the multi-isotope Wilcoxon Rank Sum test using the unity rule. Based on the results of the investigations reported here, the 17th Street Drainage Area meets the Department of Energy approved acceptance criteria. The area is therefore suitable for release for "unrestricted use" with no radiological restrictions.

6.0 REFERENCES

6.1 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), December 1997.

6.2 Rocketdyne Document, SHEA-016779, "17th Street Drainage Area-Characterization Surveys and Excavation", John Shao, December 21, 1998.

6.3 Rocketdyne Report N001SRR140131, "Approved Sitewide Release Criteria for Remediation of Radiological Facilities at SSFL", February, 1999.

6.4 Rocketdyne Procedure R21-RF-RS00005, "17th Street Drainage Area Final status survey Procedure", Patricia Liddy, July 21, 1999.

6.5 "Bell Canyon Area Soil Sampling Report, Ventura County, California, Volume 1", Ogden Environmental and Energy Services, Dixie A. Hambrick, October 1998.

APPENDIX A

AMBIENT GAMMA SURVEY RESULTS

Table A.1. Ambient Gamma Exposure

		GROSS		NET	
LOCATION	DATE	CPM	µR/hr	CPM*	µR/hr*
N15.5/E43.15	5/12/99	3173	14.8	230	1.1
N15.5/E53.15	5/12/99	3299	15.3	356	1.7
N5.5/E53.15	5/12/99	3193	14.9	250	1.2
N5.5/E43.15	5/12/99	3356	15.6	413	1.9
N5.5/E33.15	5/12/99	3306	15.4	363	1.7
N5.5/E23.15	5/12/99	3230	15.0	287	1.3
N5.5/E13.15	5/12/99	3200	14.9	257	1.2
N5.5/E3.15	5/12/99	3181	14.8	238	1.1
N15.5/E13.15	5/12/99	3719	17.3	776	3.6
N15.5/E23.15	5/12/99	3227	15.0	284	1.3
N15.5/E33.15	5/12/99	3212	14.9	269	1.3
N15.5/E53.15	5/12/99	3199	14.9	256	1.2
N15.5/E43.15	5/12/99	3336	15.5	393	1.8
N25.5/E33.15	5/12/99	3094	14.4	151	0.7
N25.5/E23.15	5/12/99	3372	15.7	429	2.0
N25.5/E13.15	5/12/99	3367	15.7	424	2.0
N25.5/E3.15	5/12/99	3214	14.9	271	1.3
N35.5/E23.15	5/12/99	3191	14.8	248	1.2
N35.5/E33.15	5/12/99	3018	14.0	75	0.3
N35.5/E43.15	5/12/99	3058	14.2	115	0.5
N35.5/E53.15	5/12/99	3487	16.2	544	2.5
N5.5/E3.15	5/12/99	3268	15.2	325	1.5
AVERAGE		**3259**	**15.2**	**316**	**1.5**

*** Background subtracted using a background of 2943 cpm [13.7 mR/hr]**

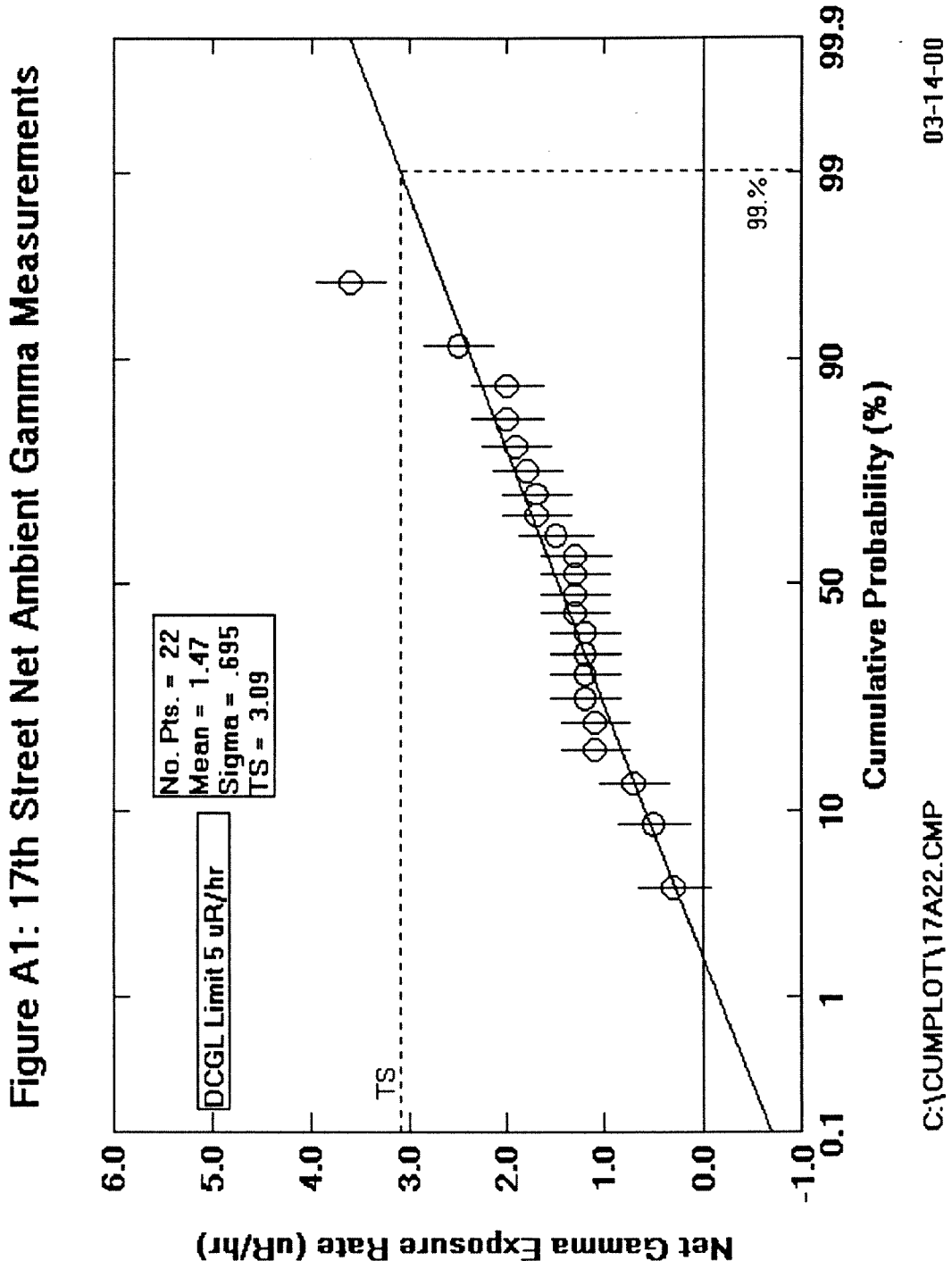


Figure A1: 17th Street Net Ambient Gamma Measurements
Net Gamma Exposure Rate (uR/hr)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
DCGL Limit 5 uR/hr
No. Pts. = 22
Mean = 1.47
Sigma = .695
TS = 3.09
TS
99.%
0.1
1
10
50
90
99
99.9
Cumulative Probability (%)
C:\CUMPLOT\17A22.CMP
03-14-00

APPENDIX B

SOIL SAMPLING RESULTS

Figure B1: Soil Sample for Cesium-137

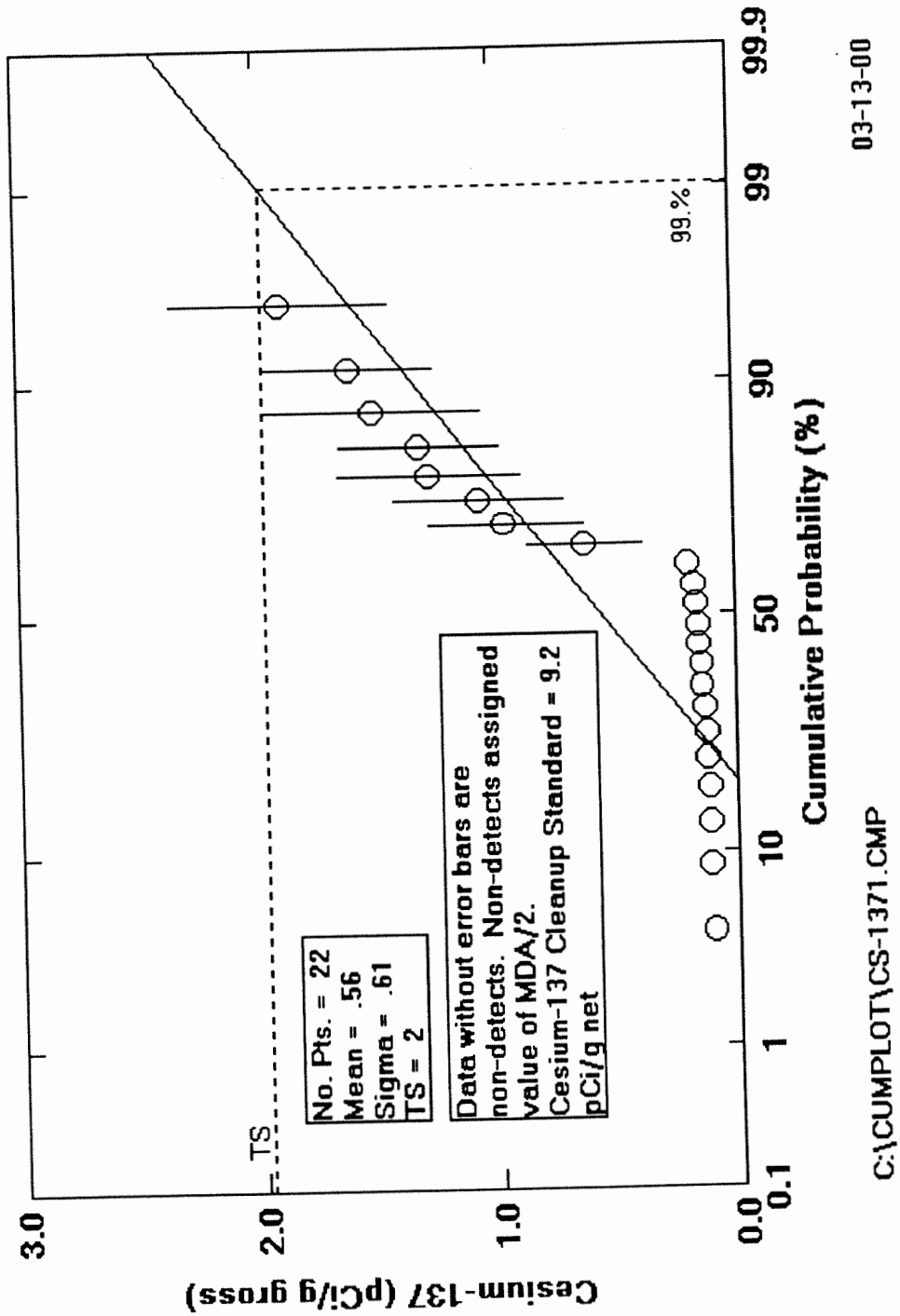


Table B1: Soil Samples for Cesium-137 (pCi/g) Cs-137

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	0.15		ND	0.3
17S-99-0002	0.16		ND	0.31
17S-99-0003	0.13		ND	0.25
17S-99-0004	0.11		ND	0.22
17S-99-0005	0.96	0.33	-	0.32
17S-99-0006	0.17		ND	0.34
17S-99-0007	0.14		ND	0.28
17S-99-0008	0.13		ND	0.25
17S-99-0009	0.12		ND	0.23
17S-99-0010	0.18		ND	0.36
17S-99-0011	0.12		ND	0.24
17S-99-0012	0.12		ND	0.24
17S-99-0013	1.90	0.46	-	0.34
17S-99-0014	1.51	0.46	-	0.3
17S-99-0015	1.61	0.36	-	0.36
17S-99-0016	1.07	0.36	-	0.31
17S-99-0017	0.20		ND	0.39
17S-99-0018	0.15		ND	0.3
17S-99-0019	0.63	0.24	-	0.2
17S-99-0020	1.32	0.34	-	0.18
17S-99-0021	1.28	0.39	-	0.29
17S-99-0022	0.16		ND	0.32

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 9.2 pCi/gm net
ND = Non-detect. Gamma spec. results reported as <MDA. For the purposes of statistical analysis, non-detects are quantified as MDA/2.

FIGURE B1.1: CS-137 RE-ANALYSIS

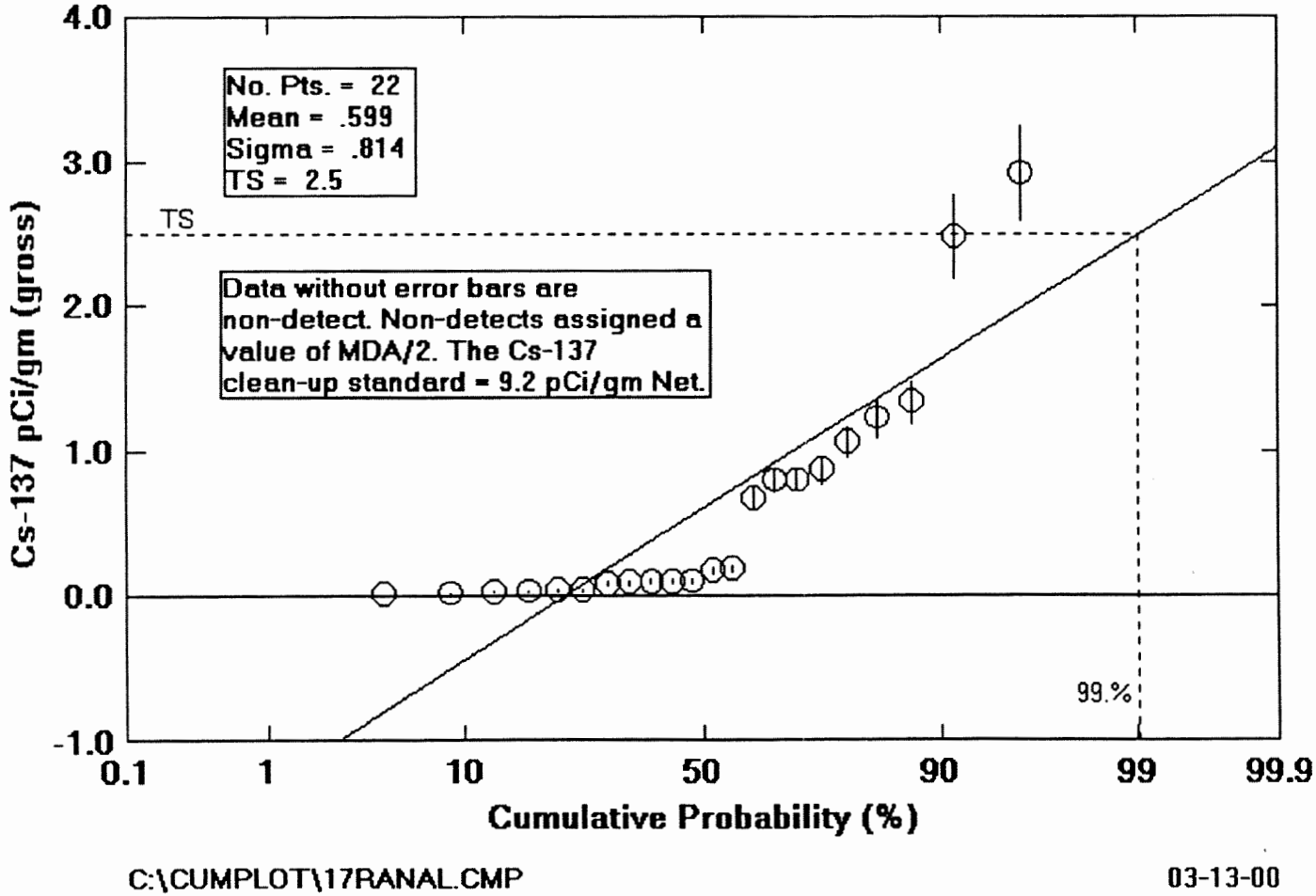


Table B1.1 Cesium-137 (pCi/g) Re-analysis

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	0.087	0.017		0.014
17S-99-0002	0.097	0.02		0.015
17S-99-0003	0.083	0.017		0.014
17S-99-0004	0.038	0.01		0.012
17S-99-0005	0.800	0.09		0.016
17S-99-0006	0.170	0.03		0.015
17S-99-0007	0.095	0.018		0.015
17S-99-0008	0.018	0.01		0.013
17S-99-0009	0.008		ND	0.015
17S-99-0010	0.100	0.02		0.014
17S-99-0011	0.042	0.012		0.013
17S-99-0012	0.870	0.1		0.014
17S-99-0013	2.930	0.33		0.022
17S-99-0014	2.490	0.3		0.015
17S-99-0015	1.340	0.15		0.015
17S-99-0016	0.800	0.08		0.018
17S-99-0017	0.190	0.03		0.015
17S-99-0018	0.032	0.013		0.015
17S-99-0019	0.670	0.08		0.015
17S-99-0020	1.060	0.11		0.022
17S-99-0021	1.230	0.14		0.018
17S-99-0022	0.030	0.01		0.012

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 9.2 pCi/gm net
ND = Non-detect. Gamma spec. results reported as <MDA. For the purposes of statistical analysis, non-detects are quantified as MDA/2

FIGURE B2: 17th St Soil Samples for Th-228

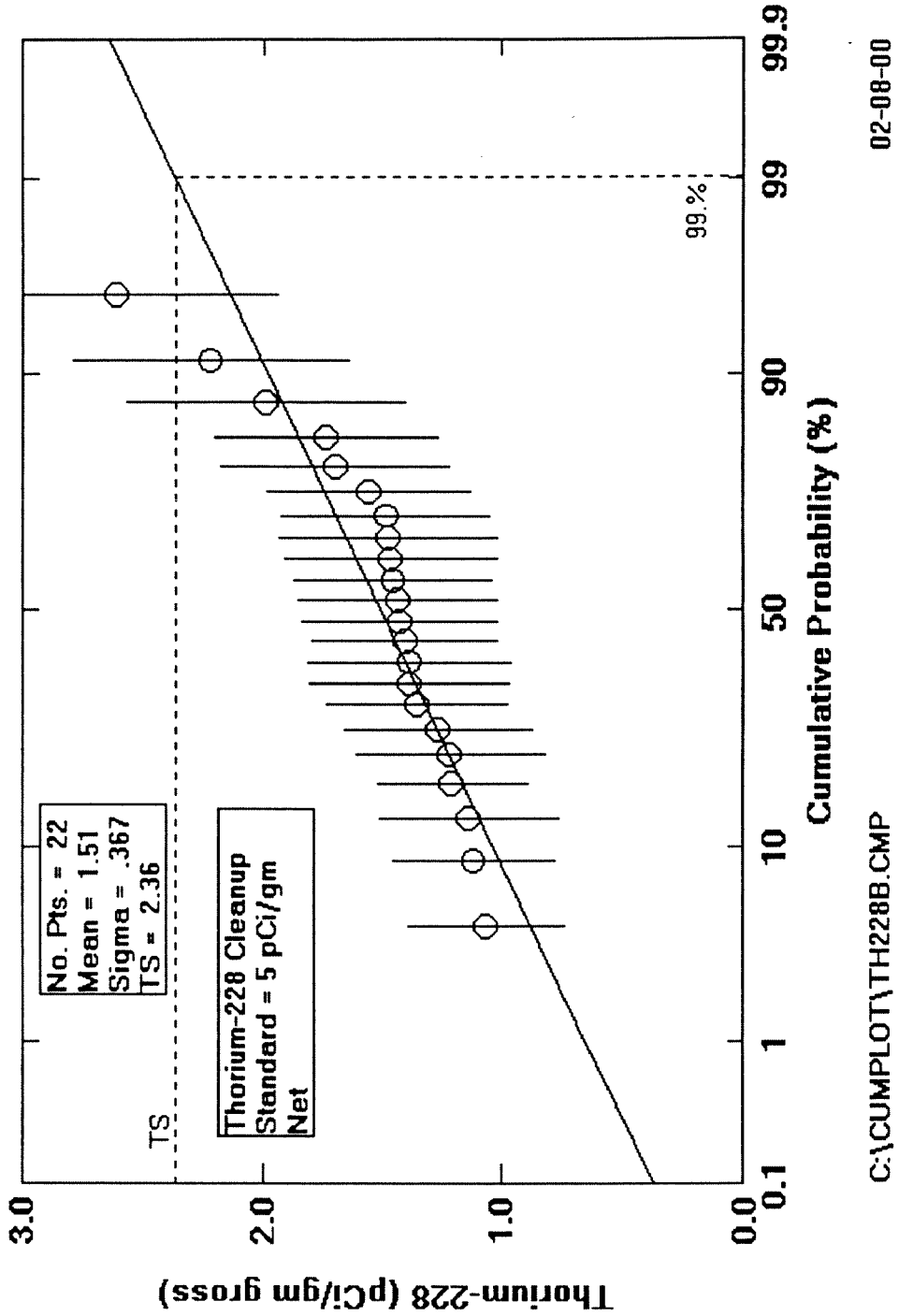


Table B2: Soil Samples for Thorium-228 (pCi/g) Th-228

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	1.47	0.45	-	0.081
17S-99-0002	1.21	0.32	-	0.079
17S-99-0003	1.36	0.38	-	0.070
17S-99-0004	1.70	0.48	-	0.100
17S-99-0005	1.74	0.47	-	0.059
17S-99-0006	1.22	0.40	-	0.140
17S-99-0007	1.27	0.40	-	0.120
17S-99-0008	1.39	0.42	-	0.110
17S-99-0009	1.39	0.43	-	0.130
17S-99-0010	1.44	0.42	-	0.100
17S-99-0011	1.12	0.34	-	0.110
17S-99-0012	1.49	0.44	-	0.100
17S-99-0013	1.48	0.46	-	0.120
17S-99-0014	1.41	0.39	-	0.089
17S-99-0015	2.22	0.58	-	0.100
17S-99-0016	1.99	0.58	-	0.140
17S-99-0017	1.14	0.38	-	0.120
17S-99-0018	1.07	0.33	-	0.086
17S-99-0019	1.43	0.41	-	0.092
17S-99-0020	1.56	0.43	-	0.070
17S-99-0021	2.61	0.67	-	0.100
17S-99-0022	1.46	0.42	-	0.120

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 5 pCi/gm net
ND = If result is less than MDA then result is non-detect.

FIGURE B3: 17th St Soil Samples for Th-230

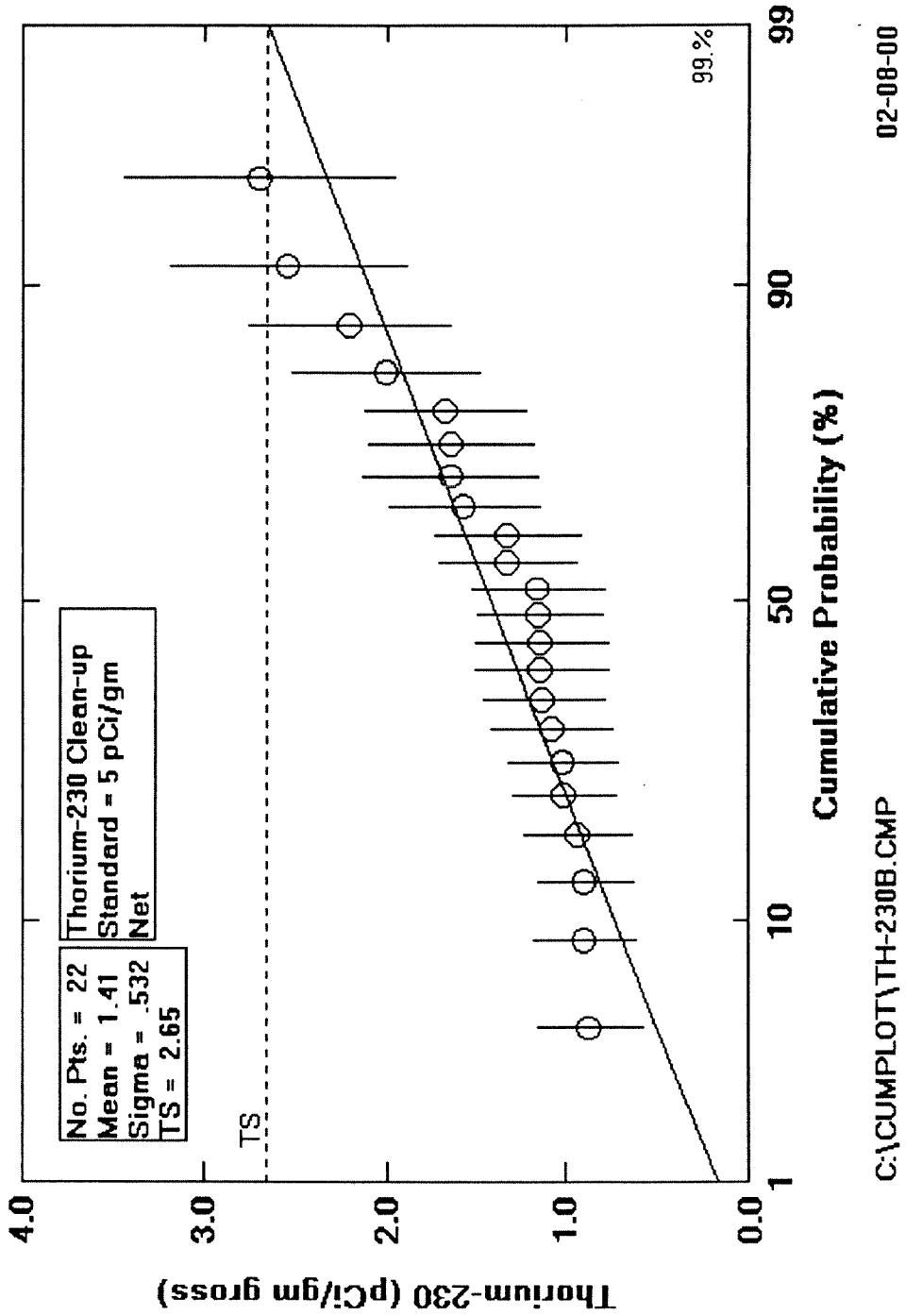


Table B3: Soil Samples for Thorium-230 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non- Detect ?	MDA
17S-99-0001	1.14	0.37	-	0.091
17S-99-0002	1.01	0.29	-	0.026
17S-99-0003	0.90	0.27	-	0.045
17S-99-0004	1.33	0.39	-	0.063
17S-99-0005	1.57	0.43	-	0.066
17S-99-0006	0.87	0.30	-	0.090
17S-99-0007	1.33	0.41	-	0.094
17S-99-0008	1.15	0.35	-	0.034
17S-99-0009	1.16	0.37	-	0.077
17S-99-0010	0.94	0.30	-	0.054
17S-99-0011	1.13	0.34	-	0.064
17S-99-0012	1.08	0.34	-	0.100
17S-99-0013	2.70	0.75	-	0.095
17S-99-0014	2.20	0.56	-	0.045
17S-99-0015	2.00	0.52	-	0.080
17S-99-0016	1.64	0.49	-	0.068
17S-99-0017	1.14	0.37	-	0.094
17S-99-0018	0.90	0.29	-	0.096
17S-99-0019	1.02	0.31	-	0.03
17S-99-0020	1.67	0.45	-	0.049
17S-99-0021	2.54	0.65	-	0.059
17S-99-0022	1.64	0.46	-	0.11

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 5 pCi/gm net
ND = If result is less than MDA then result is non-detect.

FIGURE B4: 17th St Soil Samples for Th-232

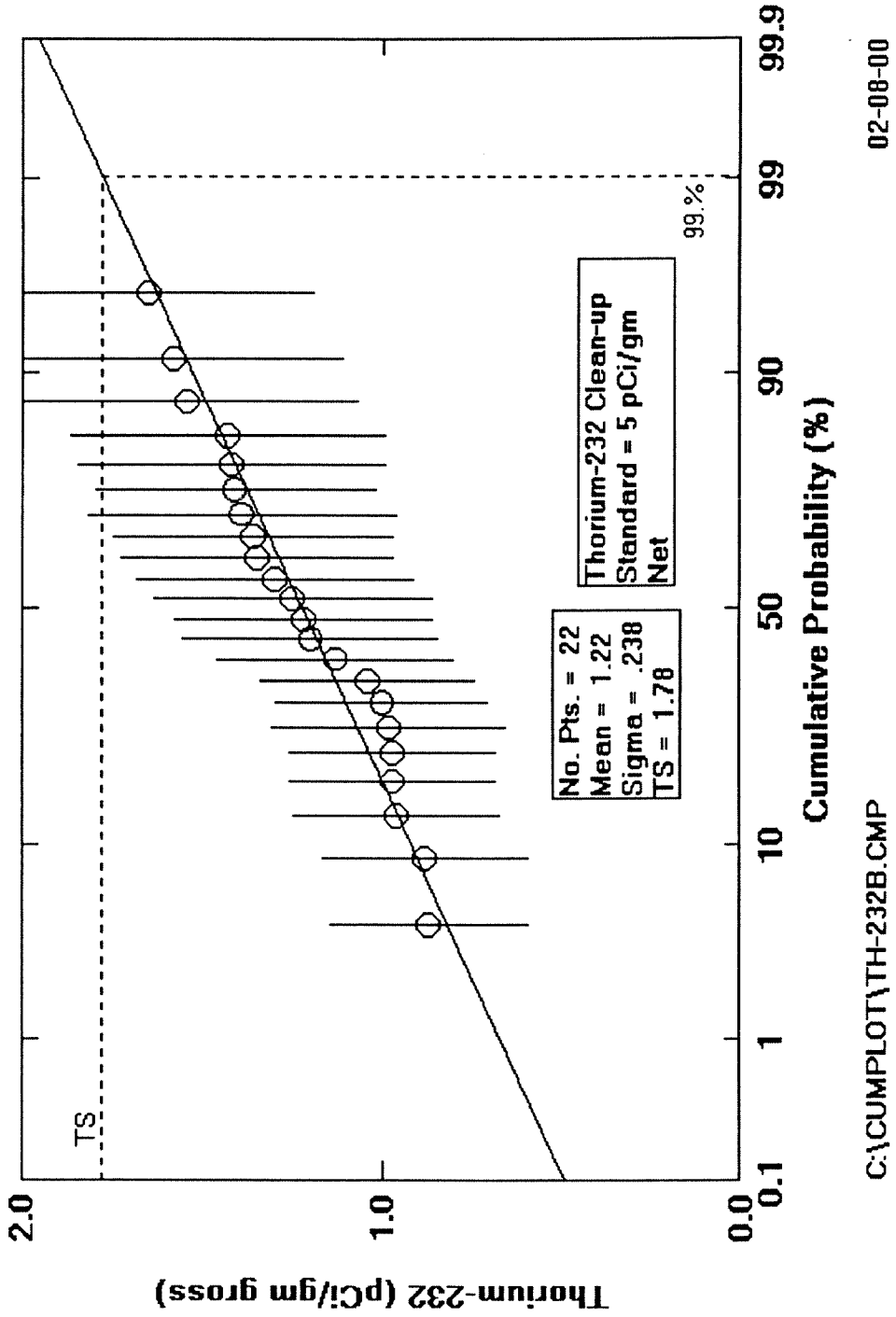


Table B4: Soil Samples for Thorium-232 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	1.39	0.43	-	0.099
17S-99-0002	0.97	0.29	-	0.046
17S-99-0003	1.41	0.39	-	0.053
17S-99-0004	1.65	0.46	-	0.053
17S-99-0005	1.13	0.33	-	0.072
17S-99-0006	0.98	0.33	-	0.068
17S-99-0007	1.42	0.43	-	0.037
17S-99-0008	0.88	0.29	-	0.034
17S-99-0009	1.25	0.39	-	0.076
17S-99-0010	1.36	0.39	-	0.064
17S-99-0011	1.20	0.36	-	0.030
17S-99-0012	1.30	0.39	-	0.058
17S-99-0013	1.54	0.47	-	0.041
17S-99-0014	1.04	0.30	-	0.064
17S-99-0015	1.35	0.38	-	0.062
17S-99-0016	1.58	0.47	-	0.110
17S-99-0017	1.43	0.44	-	0.040
17S-99-0018	0.87	0.28	-	0.091
17S-99-0019	1.00	0.30	-	0.053
17S-99-0020	0.96	0.29	-	0.057
17S-99-0021	0.97	0.29	-	0.071
17S-99-0022	1.22	0.36	-	0.092

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 5 pCi/gm
ND = If result is less than MDA then result is non-detect.

FIGURE B5: 17th St Soil Samples for U-234

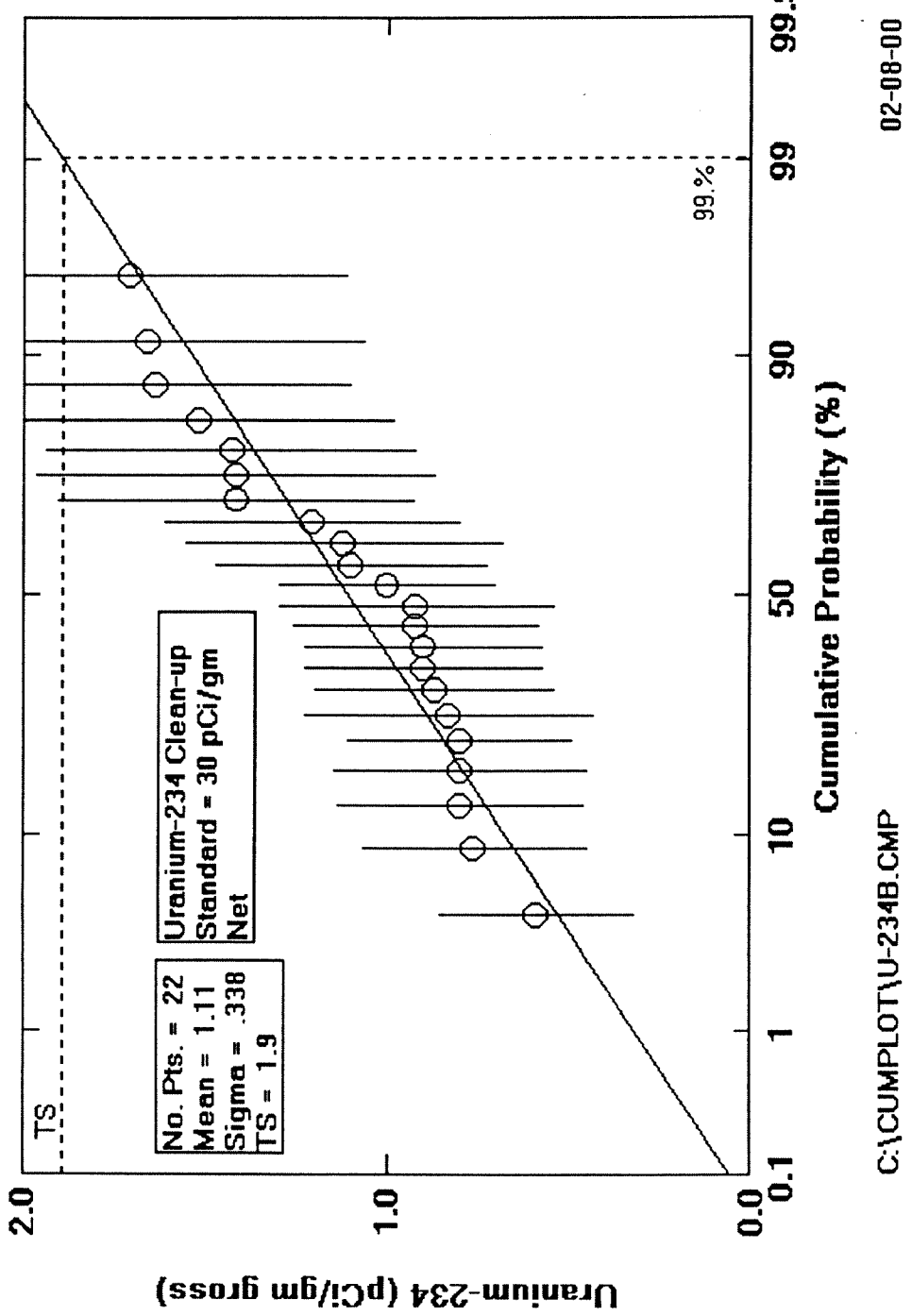


Table B5: Soil Samples for Uranium-234 (pCi/g) U-234

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	1.10	0.38	-	0.078
17S-99-0002	1.66	0.60	-	0.160
17S-99-0003	0.80	0.34	-	0.140
17S-99-0004	0.90	0.33	-	0.110
17S-99-0005	1.64	0.54	-	0.059
17S-99-0006	0.76	0.31	-	0.100
17S-99-0007	1.12	0.44	-	0.070
17S-99-0008	0.59	0.27	-	0.061
17S-99-0009	0.87	0.33	-	0.097
17S-99-0010	0.92	0.38	-	0.180
17S-99-0011	0.83	0.40	-	0.093
17S-99-0012	1.42	0.55	-	0.180
17S-99-0013	1.52	0.54	-	0.140
17S-99-0014	1.43	0.51	-	0.130
17S-99-0015	1.71	0.60	-	0.110
17S-99-0016	1.42	0.49	-	0.110
17S-99-0017	0.92	0.34	-	0.055
17S-99-0018	1.00	0.30	-	0.030
17S-99-0019	1.21	0.41	-	0.097
17S-99-0020	0.80	0.31	-	0.054
17S-99-0021	0.80	0.35	-	0.190
17S-99-0022	0.90	0.33	-	0.052

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 30 pCi/gm net
ND = If result is less than MDA then result is non-detect.

FIGURE B6: 17th St Soil Samples for U-235/236

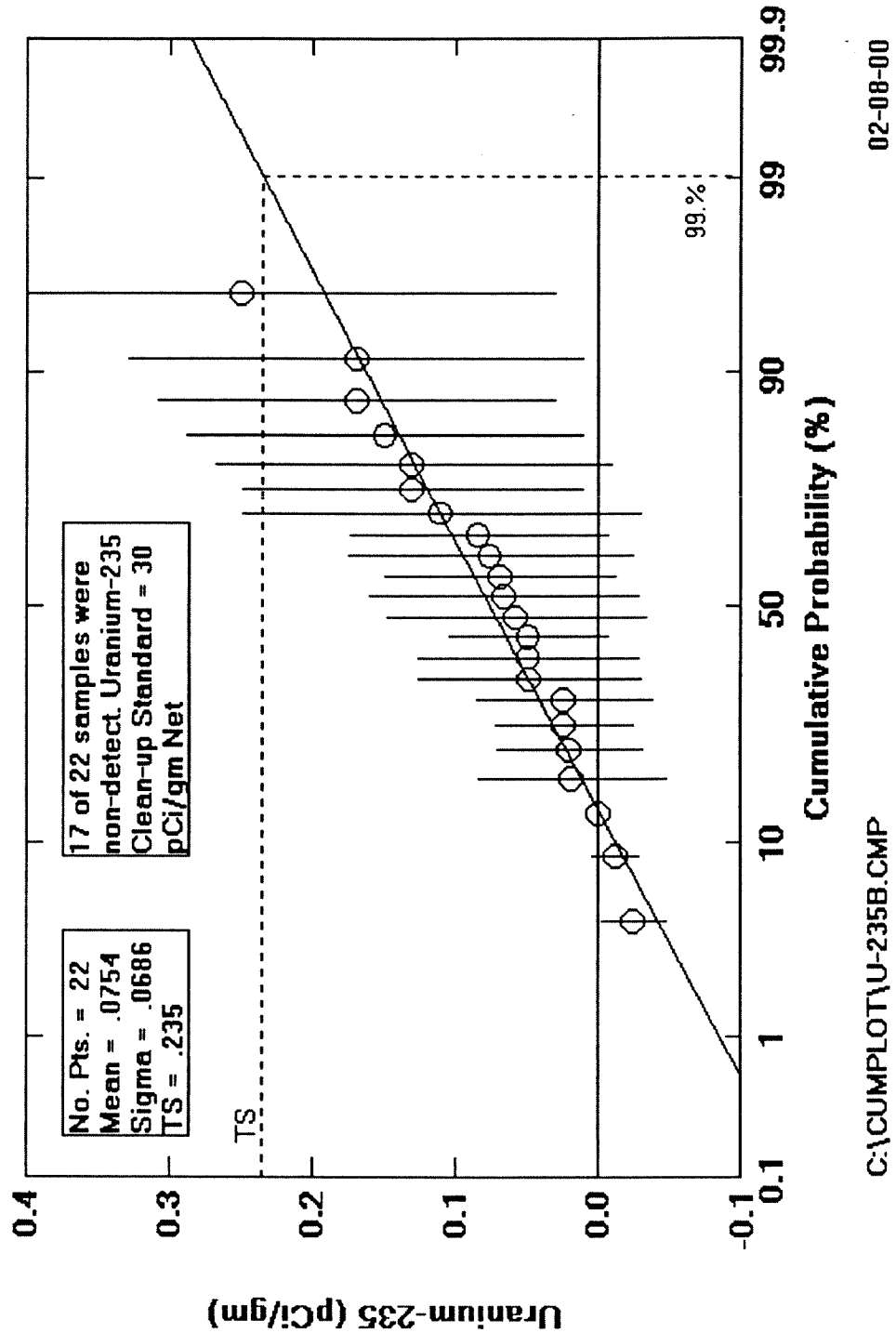


Table B6: Soil Samples for Uranium-235/236 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	0.069	0.082	-	0.063
17S-99-0002	0.170	0.160	-	0.095
17S-99-0003	0.024	0.062	ND	0.140
17S-99-0004	0.084	0.091	ND	0.110
17S-99-0005	0.150	0.140	ND	0.150
17S-99-0006	0.048	0.078	ND	0.130
17S-99-0007	0.058	0.092	ND	0.150
17S-99-0008	0.170	0.140	-	0.075
17S-99-0009	0.020	0.051	ND	0.120
17S-99-0010	-0.012	0.017	ND	0.170
17S-99-0011	0.250	0.220	-	0.110
17S-99-0012	0.110	0.140	ND	0.180
17S-99-0013	0.130	0.140	ND	0.190
17S-99-0014	0.076	0.100	ND	0.140
17S-99-0015	0.066	0.095	ND	0.090
17S-99-0016	0.049	0.078	ND	0.110
17S-99-0017	-0.025	0.023	ND	0.150
17S-99-0018	0.049	0.056	ND	0.065
17S-99-0019	0.130	0.120	-	0.095
17S-99-0020	0.000	0.000	ND	0.067
17S-99-0021	0.019	0.066	ND	0.180
17S-99-0022	0.024	0.048	ND	0.064

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 30 pCi/gm net
ND = If result is less than MDA then result is non-detect.

FIGURE B7: 17th St Soil Samples for U-238

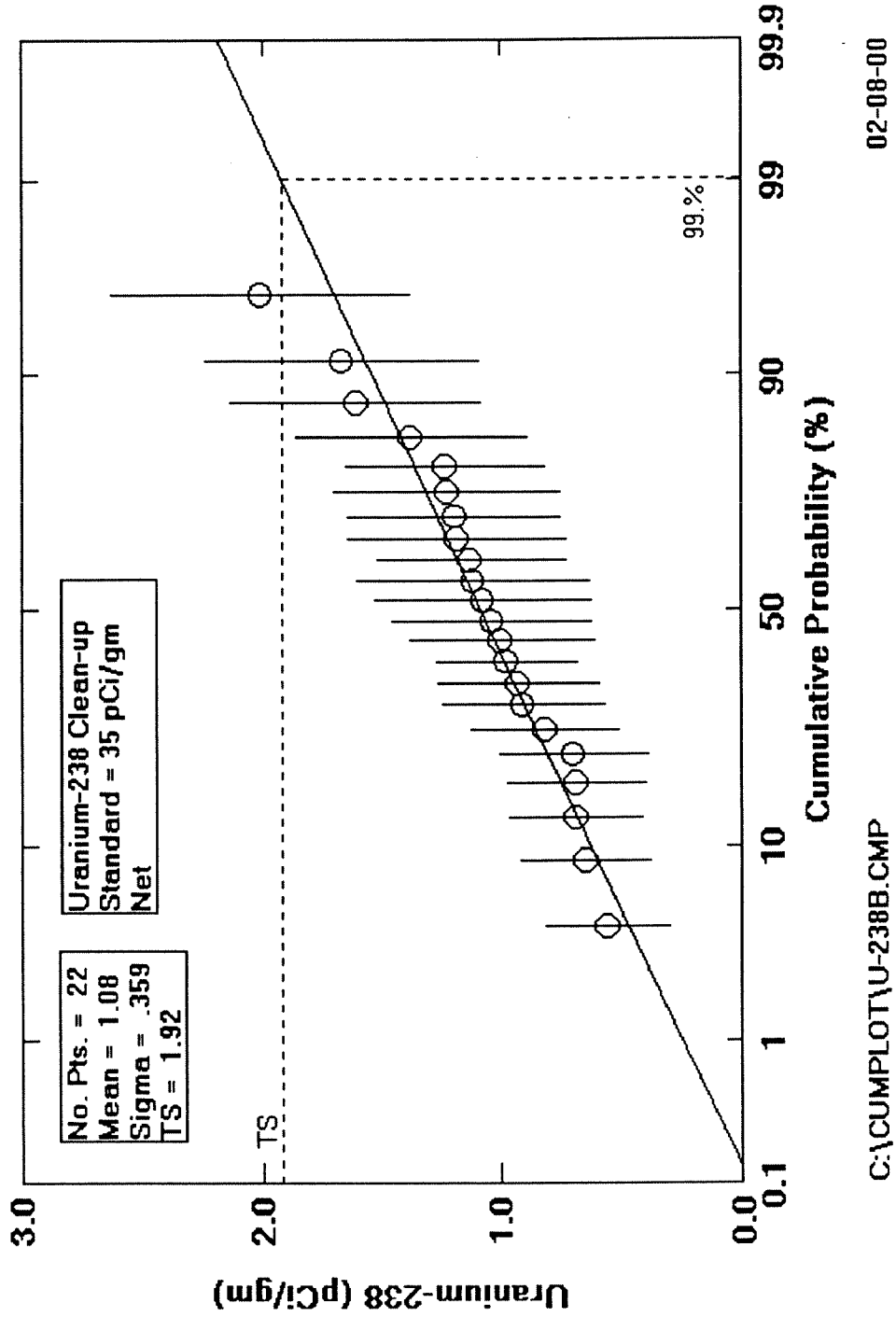


Table B7: Soil Samples for Uranium-238 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	0.930	0.340	-	0.050
17S-99-0002	1.230	0.480	-	0.160
17S-99-0003	0.700	0.310	-	0.120
17S-99-0004	0.820	0.310	-	0.086
17S-99-0005	2.010	0.630	-	0.059
17S-99-0006	0.690	0.290	-	0.100
17S-99-0007	1.190	0.460	-	0.070
17S-99-0008	0.560	0.260	-	0.061
17S-99-0009	0.650	0.270	-	0.055
17S-99-0010	1.000	0.390	-	0.150
17S-99-0011	1.120	0.490	-	0.160
17S-99-0012	1.080	0.460	-	0.150
17S-99-0013	1.200	0.450	-	0.120
17S-99-0014	1.380	0.490	-	0.110
17S-99-0015	1.040	0.420	-	0.072
17S-99-0016	1.610	0.530	-	0.100
17S-99-0017	0.690	0.280	-	0.055
17S-99-0018	0.980	0.300	-	0.030
17S-99-0019	1.240	0.420	-	0.077
17S-99-0020	1.130	0.400	-	0.096
17S-99-0021	1.670	0.580	-	0.160
17S-99-0022	0.910	0.340	-	0.091

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 35 pCi/gm net
ND = If result is less than MDA then result is non-detect.

URANIUM 234 AND URANIUM 238 COMPARISON

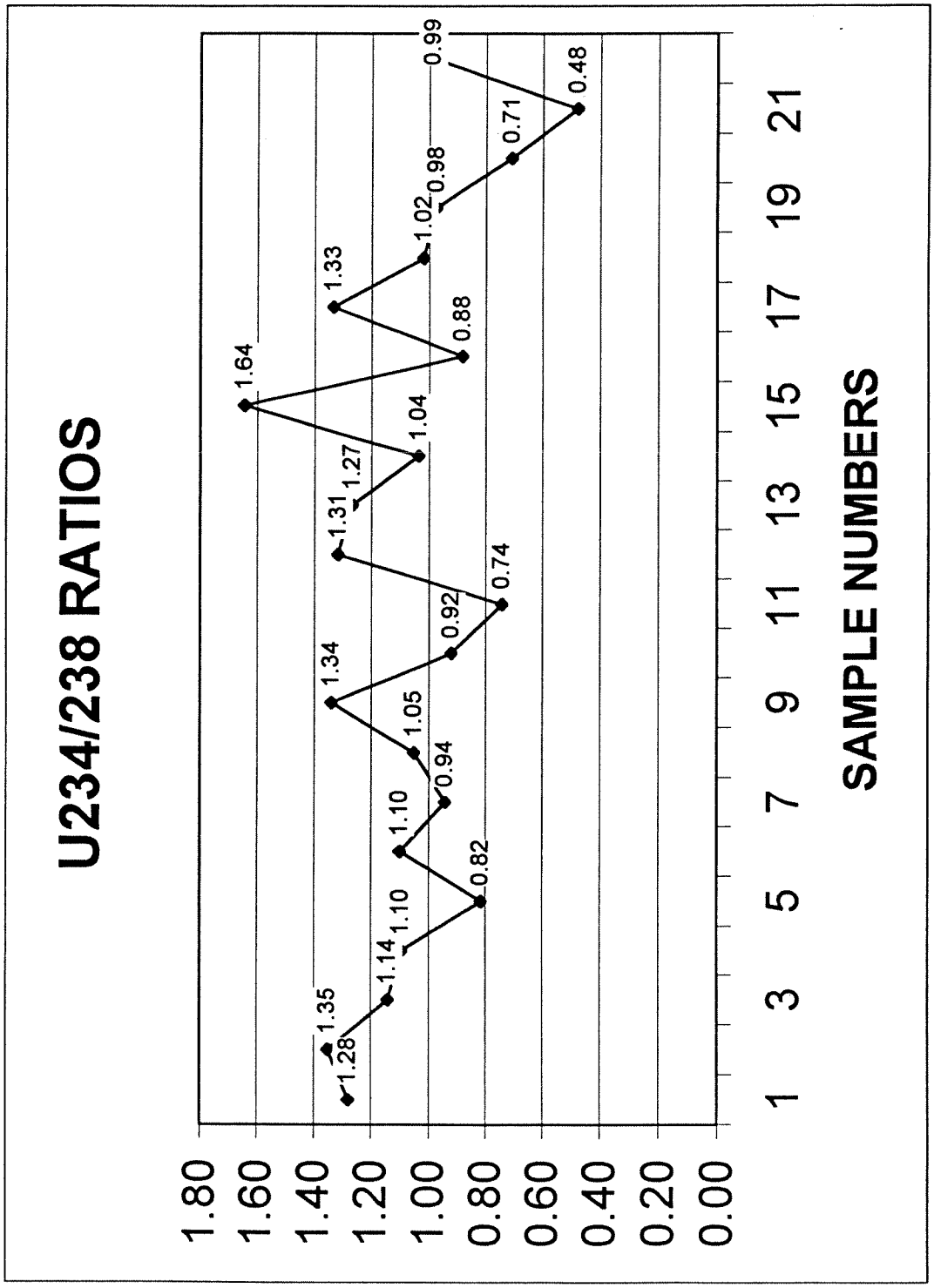


TABLE B7.1: U234/238 RATIOS

Soil I.D.	U-234 RESULTS	U-238 RESULTS	Ratio U-234/238
17S-99-0001	0.87	0.68	1.28
17S-99-0002	1.66	1.23	1.35
17S-99-0003	0.80	0.70	1.14
17S-99-0004	0.90	0.82	1.10
17S-99-0005	1.64	2.01	0.82
17S-99-0006	0.76	0.69	1.10
17S-99-0007	1.12	1.19	0.94
17S-99-0008	0.59	0.56	1.05
17S-99-0009	0.87	0.65	1.34
17S-99-0010	0.92	1.00	0.92
17S-99-0011	0.83	1.12	0.74
17S-99-0012	1.42	1.08	1.31
17S-99-0013	1.52	1.20	1.27
17S-99-0014	1.43	1.38	1.04
17S-99-0015	1.71	1.04	1.64
17S-99-0016	1.42	1.61	0.88
17S-99-0017	0.92	0.69	1.33
17S-99-0018	1.00	0.98	1.02
17S-99-0019	1.21	1.24	0.98
17S-99-0020	0.80	1.13	0.71
17S-99-0021	0.80	1.67	0.48
17S-99-0022	0.90	0.91	0.99
AVERAGE	1.1	1.1	1.1
MAXIMUM	1.7	2.0	1.6
MINIMUM	0.6	0.6	0.5

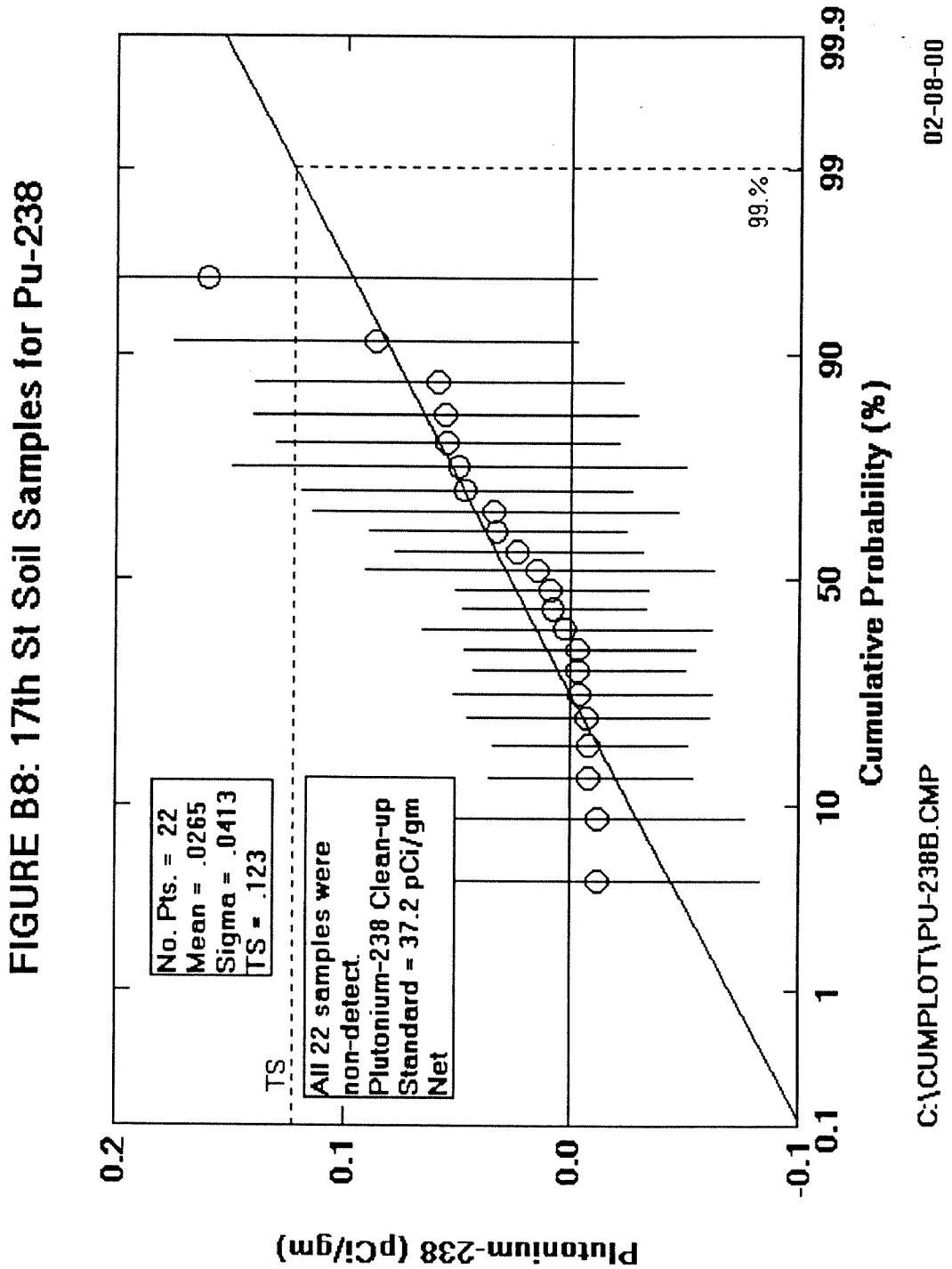


FIGURE B8: 17th St Soil Samples for Pu-238
No. Pts. = 22
Mean = .0265
Sigma = .0413
TS = .123
All 22 samples were non-detect.
Plutonium-238 Clean-up Standard = 37.2 pCi/gm
Net
TS
99.%
Plutonium-238 (pCi/gm)
0.2
0.1
0.0
-0.1
0.1
1
10
50
90
99
99.9
Cumulative Probability (%)
C:\CUMPLOT\PU-238B.CMP
02-08-00

Table B8: Soil Samples for Pu-238 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	0.050	0.100	ND	0.220
17S-99-0002	-0.012	0.064	ND	0.210
17S-99-0003	0.009	0.043	ND	0.120
17S-99-0004	-0.012	0.070	ND	0.250
17S-99-0005	0.034	0.081	ND	0.180
17S-99-0006	0.008	0.041	ND	0.110
17S-99-0007	0.033	0.057	ND	0.120
17S-99-0008	0.047	0.073	ND	0.150
17S-99-0009	-0.004	0.057	ND	0.170
17S-99-0010	0.059	0.081	ND	0.130
17S-99-0011	-0.003	0.047	ND	0.200
17S-99-0012	-0.007	0.053	ND	0.170
17S-99-0013	-0.008	0.043	ND	0.160
17S-99-0014	-0.003	0.051	ND	0.120
17S-99-0015	0.056	0.085	ND	0.170
17S-99-0016	0.024	0.055	ND	0.120
17S-99-0017	0.015	0.077	ND	0.210
17S-99-0018	0.160	0.170	ND	0.290
17S-99-0019	-0.008	0.045	ND	0.160
17S-99-0020	0.087	0.089	ND	0.140
17S-99-0021	0.055	0.076	ND	0.120
17S-99-0022	0.003	0.064	ND	0.180

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 37.2 pCi/gm net
ND = If result is less than MDA then result is non-detect.

FIGURE B9: 17th St Soil Samples for Pu-239/240

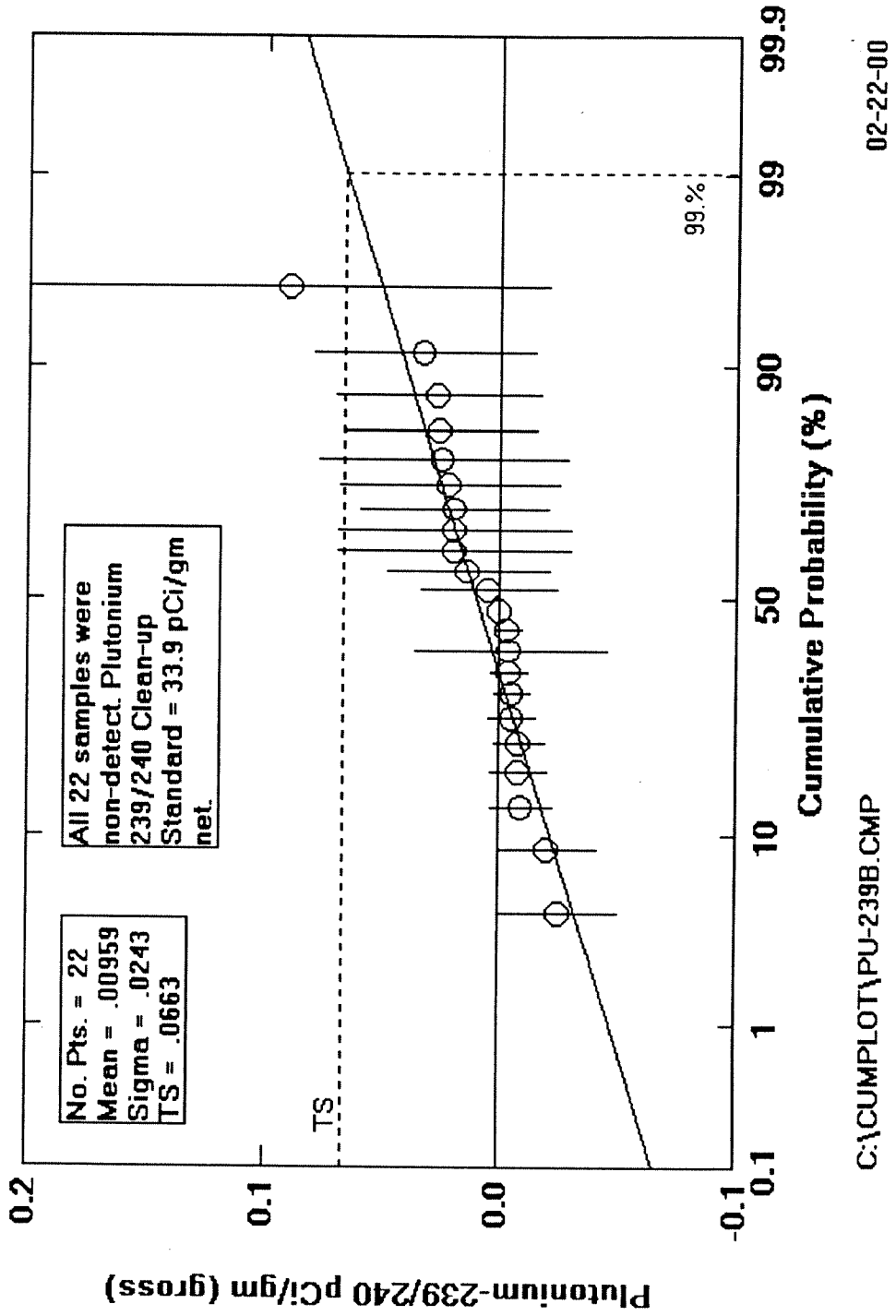


Table B9: Plutonium-239/240 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	-0.005	0.010	ND	0.120
17S-99-0002	0.020	0.040	ND	0.054
17S-99-0003	0.026	0.041	ND	0.069
17S-99-0004	-0.025	0.025	ND	0.210
17S-99-0005	0.020	0.050	ND	0.120
17S-99-0006	-0.005	0.008	ND	0.077
17S-99-0007	0.005	0.029	ND	0.086
17S-99-0008	-0.003	0.006	ND	0.075
17S-99-0009	0.025	0.053	ND	0.110
17S-99-0010	-0.009	0.013	ND	0.130
17S-99-0011	-0.004	0.008	ND	0.090
17S-99-0012	0.020	0.050	ND	0.120
17S-99-0013	-0.004	0.041	ND	0.130
17S-99-0014	0.000	0.000	ND	0.044
17S-99-0015	0.033	0.047	ND	0.045
17S-99-0016	0.027	0.044	ND	0.073
17S-99-0017	-0.020	0.021	ND	0.170
17S-99-0018	0.090	0.110	ND	0.180
17S-99-0019	-0.008	0.011	ND	0.110
17S-99-0020	0.022	0.047	ND	0.100
17S-99-0021	-0.008	0.012	ND	0.120
17S-99-0022	0.014	0.035	ND	0.082

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 33.9 pCi/gm net
ND = If result is less than MDA then result is non-detect.

FIGURE B10: 17th St Soil Samples for Am-241

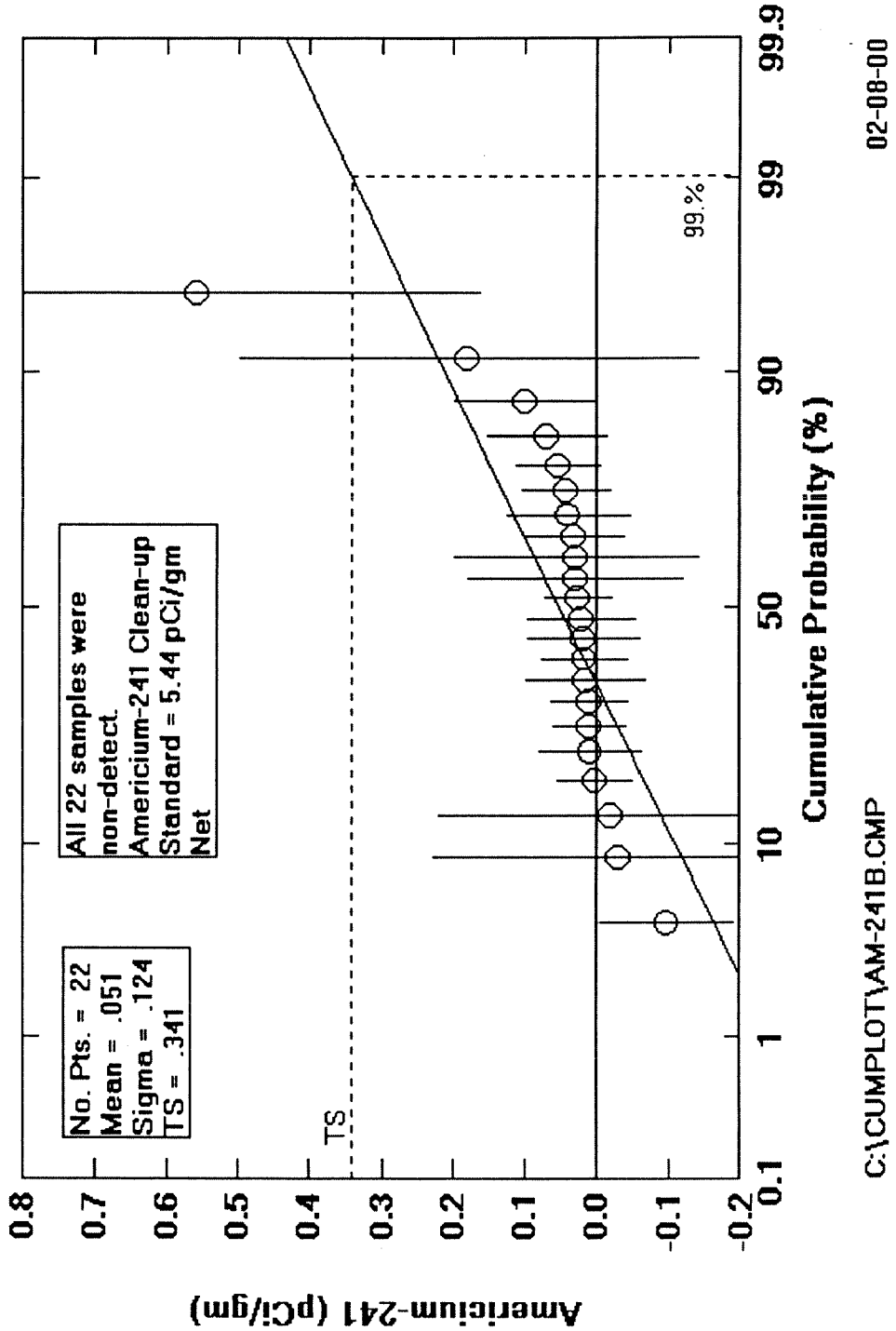


Table B10: Soil Samples for Americium-241 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	-0.020	0.240	ND	0.670
17S-99-0002	0.100	0.100	ND	0.120
17S-99-0003	0.040	0.085	ND	0.150
17S-99-0004	0.069	0.084	ND	0.110
17S-99-0005	0.010	0.052	ND	0.110
17S-99-0006	0.053	0.060	ND	0.070
17S-99-0007	0.016	0.084	ND	0.170
17S-99-0008	0.031	0.070	ND	0.130
17S-99-0009	0.042	0.062	ND	0.091
17S-99-0010	0.018	0.079	ND	0.150
17S-99-0011	0.003	0.052	ND	0.150
17S-99-0012	0.022	0.075	ND	0.180
17S-99-0013	0.011	0.054	ND	0.150
17S-99-0014	0.560	0.400	ND	1.120
17S-99-0015	0.180	0.320	ND	0.640
17S-99-0016	-0.030	0.260	ND	0.810
17S-99-0017	-0.096	0.092	ND	0.710
17S-99-0018	0.030	0.150	ND	0.420
17S-99-0019	0.030	0.170	ND	0.510
17S-99-0020	0.026	0.047	ND	0.092
17S-99-0021	0.017	0.060	ND	0.110
17S-99-0022	0.009	0.072	ND	0.160

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 5.44 pCi/gm net
ND = If result is less than MDA then result is non-detect.

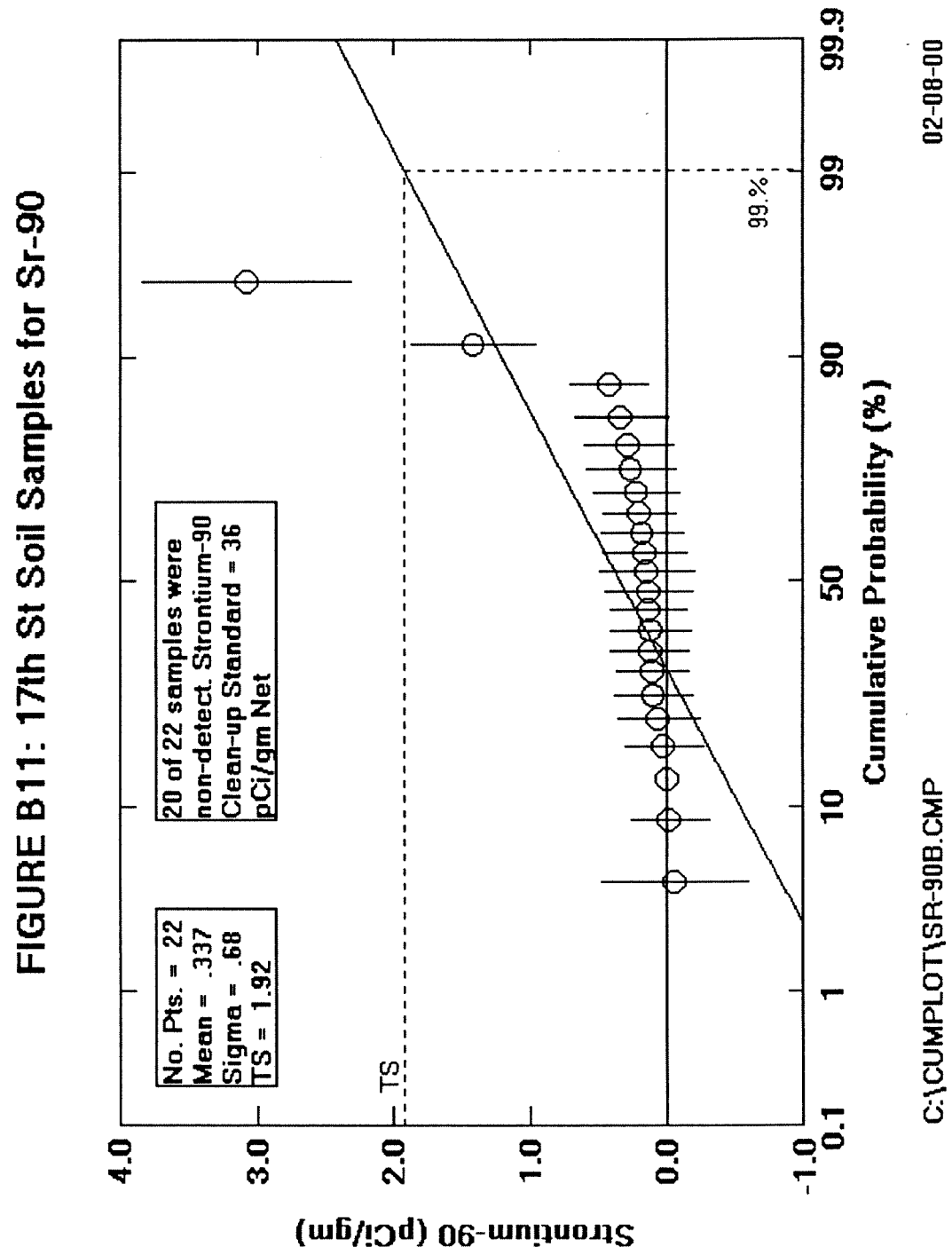


FIGURE B11: 17th St Soil Samples for Sr-90
No. Pts. = 22
Mean = .337
Sigma = .68
TS = 1.92
20 of 22 samples were non-detect. Strontium-90 Clean-up Standard = 36 pCi/gm Net
TS
99.%
Strontium-90 (pCi/gm)
4.0
3.0
2.0
1.0
0.0
-1.0
0.1
1
10
50
90
99
99.9
Cumulative Probability (%)
02-08-00
C:\CUMPLOT\SR-90B.CMP

Table B11: Soil Samples for Strontium-90 (pCi/g)

Soil ID	Result	+/- 1 sigma error	Non-Detect ?	MDA
17S-99-0001	-0.060	0.540	ND	0.940
17S-99-0002	0.160	0.310	ND	0.520
17S-99-0003	0.220	0.320	ND	0.540
17S-99-0004	0.120	0.290	ND	0.490
17S-99-0005	0.100	0.290	ND	0.500
17S-99-0006	0.180	0.300	ND	0.510
17S-99-0007	3.080	0.770	-	0.670
17S-99-0008	0.330	0.340	ND	0.560
17S-99-0009	0.280	0.330	ND	0.550
17S-99-0010	0.130	0.320	ND	0.550
17S-99-0011	0.260	0.330	ND	0.550
17S-99-0012	0.120	0.300	ND	0.510
17S-99-0013	0.150	0.350	ND	0.600
17S-99-0014	0.000	0.000	ND	0.590
17S-99-0015	0.020	0.290	ND	0.510
17S-99-0016	0.200	0.270	ND	0.440
17S-99-0017	-0.020	0.290	ND	0.500
17S-99-0018	0.130	0.280	ND	0.470
17S-99-0019	0.060	0.300	ND	0.510
17S-99-0020	1.420	0.470	-	0.560
17S-99-0021	0.110	0.270	ND	0.460
17S-99-0022	0.420	0.290	ND	0.460

MDA = Minimum Detectable Activity
$DCGL_W$ = Derived Concentratration Guideline 36 pCi/gm net
ND = If result is less than MDA then result is non-detect.

APPENDIX C

WILCOXON RANK SUM TESTS

Table C1: 17th Street Soil Sampling
Wilcoxon Rank Sum Test

		Soil Concentrations (pCi/g)											Isotopic Fractions (concentration/DCGL)											Sum of Fractions	Adjusted Reference	Rank	Reference Area Rank
		Cs-137	Th-228	Th-230	Th-232	U-234	U-235	U-238	Pu-238	Pu-239	Am-241	Sr-90	Cs-137	Th-228	Th-230	Th-232	U-234	U-235	U-238	Pu-238	Pu-239	Am-241	Sr-90				
Sample Type	Sample ID	9.2	5	5	5	30	30	35	37.2	33.9	5.44	36															
S	17S-99-0001	0.150	1.47	1.14	1.39	1.10	0.069	0.93	0.05	-0.005	-0.02	-0.06	0.016	0.294	0.228	0.278	0.037	0.002	0.027	0.001	0.000	-0.004	-0.002	0.678	0.678	12	0
S	17S-99-0002	0.155	1.21	1.01	0.97	1.66	0.17	1.23	-0.012	0.02	0.1	0.16	0.017	0.242	0.202	0.194	0.055	0.006	0.035	0.000	0.001	0.018	0.004	0.774	0.774	4	0
S	17S-99-0003	0.125	1.36	0.90	1.41	0.60	0.024	0.7	0.009	0.026	0.04	0.22	0.014	0.272	0.180	0.282	0.027	0.001	0.020	0.000	0.001	0.007	0.006	0.810	0.810	7	0
S	17S-99-0004	0.110	1.70	1.33	1.65	0.90	0.084	0.82	-0.012	-0.025	0.069	0.12	0.012	0.340	0.266	0.330	0.030	0.003	0.023	0.000	-0.001	0.013	0.003	1.019	1.019	15	0
S	17S-99-0005	0.960	1.74	1.57	1.13	1.64	0.15	2.01	0.034	0.02	0.01	0.1	0.104	0.348	0.314	0.226	0.055	0.005	0.057	0.001	0.001	0.002	0.003	1.116	1.116	17	0
S	17S-99-0006	0.170	1.22	0.87	0.98	0.76	0.048	0.69	0.008	-0.005	0.053	0.18	0.018	0.244	0.174	0.196	0.025	0.002	0.020	0.000	0.000	0.010	0.005	0.694	0.694	2	0
S	17S-99-0007	0.140	1.27	1.33	1.42	1.12	0.058	1.19	0.033	0.005	0.016	3.08	0.015	0.254	0.266	0.284	0.037	0.002	0.034	0.001	0.000	0.003	0.086	0.982	0.982	14	0
S	17S-99-0008	0.125	1.39	1.15	0.88	0.59	0.17	0.56	0.047	-0.003	0.031	0.33	0.014	0.278	0.230	0.176	0.020	0.006	0.016	0.001	0.000	0.006	0.009	0.755	0.755	3	0
S	17S-99-0009	0.115	1.39	1.16	1.25	0.87	0.02	0.65	-0.004	0.025	0.042	0.26	0.013	0.278	0.232	0.250	0.029	0.001	0.019	0.000	0.001	0.008	0.008	0.837	0.837	9	0
S	17S-99-0010	0.180	1.44	0.94	1.36	0.92	-0.012	1	0.059	-0.009	0.018	0.13	0.020	0.288	0.188	0.272	0.031	0.000	0.029	0.002	0.000	0.003	0.004	0.835	0.835	8	0
S	17S-99-0011	0.120	1.12	1.13	1.20	0.83	0.25	1.12	-0.003	-0.004	0.003	0.26	0.013	0.224	0.226	0.240	0.028	0.008	0.032	0.000	0.000	0.001	0.007	0.779	0.779	5	0
S	17S-99-0012	0.120	1.49	1.08	1.30	1.42	0.11	1.08	-0.007	0.02	0.022	0.12	0.013	0.298	0.216	0.260	0.047	0.004	0.031	0.000	0.001	0.004	0.003	0.877	0.877	11	0
S	17S-99-0013	1.900	1.48	2.70	1.54	1.52	0.13	1.2	-0.008	-0.004	0.011	0.15	0.207	0.296	0.540	0.308	0.051	0.004	0.034	0.000	0.000	0.002	0.004	1.446	1.446	28	0
S	17S-99-0014	1.510	1.41	2.20	1.04	1.43	0.076	1.38	-0.003	0	0.56	0	0.164	0.282	0.440	0.208	0.048	0.003	0.039	0.000	0.000	0.103	0.000	1.287	1.287	19	0
S	17S-99-0015	1.610	2.22	2.00	1.35	1.71	0.066	1.04	0.056	0.033	0.16	0.02	0.175	0.444	0.400	0.270	0.057	0.002	0.030	0.002	0.001	0.033	0.001	1.414	1.414	25	0
S	17S-99-0016	1.070	1.99	1.64	1.58	1.42	0.049	1.61	0.024	0.027	-0.03	0.2	0.116	0.398	0.328	0.316	0.047	0.002	0.046	0.001	0.001	-0.006	0.006	1.255	1.255	18	0
S	17S-99-0017	0.195	1.14	1.14	1.43	0.92	-0.025	0.69	0.015	-0.02	-0.096	-0.02	0.021	0.228	0.228	0.286	0.031	-0.001	0.020	0.000	-0.001	-0.018	-0.001	0.794	0.794	6	0
S	17S-99-0018	0.150	1.07	0.90	0.87	1.00	0.049	0.98	0.16	0.09	0.03	0.13	0.016	0.214	0.180	0.174	0.033	0.002	0.028	0.004	0.003	0.006	0.004	0.663	0.663	1	0
S	17S-99-0019	0.630	1.43	1.02	1.00	1.21	0.13	1.24	-0.008	-0.008	0.03	0.06	0.068	0.286	0.204	0.200	0.040	0.004	0.035	0.000	0.000	0.006	0.002	0.845	0.845	10	0
S	17S-99-0020	1.320	1.56	1.67	0.96	0.80	0	1.13	0.087	0.022	0.026	1.42	0.143	0.312	0.334	0.192	0.027	0.000	0.032	0.002	0.001	0.005	0.039	1.088	1.088	16	0
S	17S-99-0021	1.280	2.61	2.54	0.97	0.80	0.019	1.67	0.055	-0.008	0.017	0.11	0.139	0.522	0.508	0.194	0.027	0.001	0.048	0.001	0.000	0.003	0.003	1.446	1.446	27	0
S	17S-99-0022	0.160	1.46	1.64	1.22	0.90	0.024	0.91	0.003	0.014	0.009	0.42	0.017	0.292	0.328	0.244	0.030	0.001	0.026	0.000	0.000	0.002	0.012	0.952	0.952	13	0
R	RH002	0.045	0.83	0.73	0.81	0.65	0.05	0.58	0	0	0	0.02	0.005	0.166	0.146	0.162	0.022	0.002	0.017	0.000	0.000	0.000	0.001	0.519	1.519	32	32
R	RH003	0.016	1.2	1.1	1.2	1	0.06	0.99	0	0	0	-0.01	0.002	0.240	0.220	0.240	0.033	0.002	0.028	0.000	0.000	0.000	0.000	0.765	1.765	43	43
R	RH004	0.01	0.67	0.47	0.67	1	0.05	0.94	0	0	0	-0.02	0.001	0.134	0.094	0.134	0.033	0.002	0.027	0.000	0.000	0.000	-0.001	0.424	1.424	26	26
R	RH005	0.009	1.1	1.4	0.89	0.41	0.03	0.46	0	0	0	0.01	0.001	0.220	0.280	0.178	0.014	0.001	0.013	0.000	0.000	0.000	0.000	0.707	1.707	42	42
R	RH006	0.150	1.1	0.97	0.96	1	0.067	0.98	0	0.01	0	0.03	0.016	0.220	0.194	0.192	0.033	0.002	0.028	0.000	0.000	0.000	0.001	0.687	1.687	41	41
R	RH007	0.089	1	0.92	1.1	1	0.07	1.1	0	0.01	0	-0.01	0.010	0.200	0.184	0.220	0.033	0.002	0.031	0.000	0.000	0.000	0.000	0.681	1.681	40	40
R	RH011	0.026	1	0.85	1	0.88	0.07	0.77	0	0	0	-0.09	0.003	0.200	0.170	0.200	0.029	0.002	0.022	0.000	0.000	0.000	-0.003	0.624	1.624	38	38
R	RH012	0.015	0.93	0.57	0.91	0.58	0.03	0.61	0.03	0	0	-0.06	0.002	0.186	0.114	0.182	0.019	0.001	0.017	0.001	0.000	0.000	-0.002	0.520	1.520	33	33
R	RH013	0.012	0.83	0.69	0.92	0.44	0.03	0.42	0.01	0	0	-0.08	0.001	0.166	0.138	0.184	0.015	0.001	0.012	0.000	0.000	0.000	-0.002	0.515	1.515	31	31
R	RH014	0.034	0.92	0.58	0.98	0.43	0.03	0.52	0	0	0	-0.03	0.004	0.184	0.116	0.196	0.014	0.001	0.015	0.000	0.000	0.000	-0.001	0.529	1.529	34	34
R	RH015	0.008	1	0.55	0.83	0.54	0.03	0.68	0	0	0	-0.04	0.001	0.200	0.110	0.166	0.018	0.001	0.019	0.000	0.000	0.000	-0.001	0.514	1.514	30	30
R	RH016	0.013	0.87	0.56	0.87	0.57	0.03	0.5	-0.01	0	0	-0.04	0.001	0.174	0.112	0.174	0.019	0.001	0.014	0.000	0.000	0.000	-0.001	0.494	1.494	29	29
R	RH021	0.008	0.88	0.83	1	0.57	0.03	0.55	0	0	0	-0.03	0.001	0.176	0.166	0.200	0.019	0.001	0.016	0.000	0.000	0.000	-0.001	0.578	1.578	36	36
R	RH025	0.007	0.7	0.59	0.54	0.49	0.03	0.51	0	0	0	0	0.001	0.140	0.118	0.108	0.016	0.001	0.015	0.000	0.000	0.000	0.000	0.399	1.399	24	24
R	RH026	0.007	0.87	0.7	0.98	0.79	0.06	0.88	0	0	0	-0.05	0.001	0.174	0.140	0.196	0.026	0.002	0.025	0.000	0.000	0.000	-0.001	0.563	1.563	35	35
R	RH030	0.014	1.2	0.71	1	0.73	0.04	0.68	0	0	0	-0.07	0.002	0.240	0.142	0.200	0.024	0.001	0.019	0.000	0.000	0.000	-0.002	0.627	1.627	39	39
R	RH031	0.013	1.3	1	1.5	0.72	0.05	0.67	0.01	0.01	0	-0.01	0.001	0.260	0.200	0.300	0.024	0.002	0.019	0.000	0.000	0.000	0.000	0.806	1.806	44	44
R	RH032	0.011	0.66	0.35	0.79	0.36	0.01	0.37	0.01	0.01	0	-0.09	0.001	0.132	0.070	0.158	0.012	0.000	0.011	0.000	0.000	0.000	-0.003	0.382	1.382	23	23
R	RH033	0.08	0.71	1.2	0.66	0.9	0.06	0.86	0	0	0	0.01	0.009	0.142	0.240	0.132	0.030	0.002	0.025	0.000	0.000	0.000	0.000	0.580	1.580	37	37
R	RH036	0.15	0.44	0.42	0.54	0.77	0.03	0.74	0.01	0	0	0.01	0.016	0.088	0.084	0.108	0.026	0.001	0.021	0.000	0.000	0.000	0.000	0.345	1.345	20	20
R	RH041	0.1	0.52	0.49	0.49	0.8	0.05	0.8	0	0	0	0.04	0.011	0.104	0.098	0.098	0.027	0.002	0.023	0.000	0.000	0.000	0.001	0.363	1.363	22	22
R	RH046	0.18	0.43	0.48	0.44	0.94	0.03	0.99	-0.01	0.02	0	0.04	0.020	0.086	0.096	0.088	0.031	0.001	0.028	0.000	0.001	0.000	0.001	0.352	1.352	21	21

Sum of Reference Ranks = WRS_R = **720**
Survey unit sample number = n= **22**
Reference area sample number = m= **22**
α = **0.05**
z = **1.645**
Critical Value = WRS_C = **565**

Table C2: 17th Street Soil Sampling
Wilcoxon Rank Sum Test With Re-analysis

		Soil Concentrations (pCi/g)											Isotopic Fractions (concentration/DCGL)											Sum of Fractions	Adjusted Reference	Rank	Reference Area Rank
		Cs-137	Th-228	Th-230	Th-232	U-234	U-235	U-238	Pu-238	Pu-239	Am-241	Sr-90	Cs-137	Th-228	Th-230	Th-232	U-234	U-235	U-238	Pu-238	Pu-239	Am-241	Sr-90				
Sample Type	Sample ID	9.2	5	5	5	30	30	35	37.2	33.9	5.44	36															
S	17S-99-0001	0.087	1.47	1.14	1.39	1.10	0.069	0.93	0.05	-0.005	-0.02	-0.06	0.009	0.294	0.228	0.278	0.037	0.002	0.027	0.001	0.000	-0.004	-0.002	0.871	0.871	11	0
S	17S-99-0002	0.097	1.21	1.01	0.97	1.66	0.17	1.23	-0.012	0.02	0.1	0.16	0.011	0.242	0.202	0.194	0.055	0.006	0.035	0.000	0.001	0.018	0.004	0.768	0.768	4	0
S	17S-99-0003	0.083	1.36	0.90	1.41	0.80	0.024	0.7	0.009	0.026	0.04	0.22	0.009	0.272	0.180	0.282	0.027	0.001	0.020	0.000	0.001	0.007	0.006	0.805	0.805	7	0
S	17S-99-0004	0.038	1.70	1.33	1.65	0.90	0.084	0.82	-0.012	-0.025	0.069	0.12	0.004	0.340	0.266	0.330	0.030	0.003	0.023	0.000	-0.001	0.013	0.003	1.011	1.011	15	0
S	17S-99-0005	0.800	1.74	1.57	1.13	1.64	0.15	2.01	0.034	0.02	0.01	0.1	0.087	0.348	0.314	0.226	0.055	0.005	0.057	0.001	0.001	0.002	0.003	1.098	1.098	17	0
S	17S-99-0006	0.170	1.22	0.87	0.98	0.76	0.048	0.69	0.008	-0.005	0.053	0.18	0.018	0.244	0.174	0.196	0.025	0.002	0.020	0.000	0.000	0.010	0.005	0.694	0.694	2	0
S	17S-99-0007	0.095	1.27	1.33	1.42	1.12	0.058	1.19	0.033	0.005	0.016	3.08	0.010	0.254	0.266	0.284	0.037	0.002	0.034	0.001	0.000	0.003	0.086	0.977	0.977	14	0
S	17S-99-0008	0.018	1.39	1.15	0.88	0.59	0.17	0.56	0.047	-0.003	0.031	0.33	0.002	0.278	0.230	0.176	0.020	0.006	0.016	0.001	0.000	0.006	0.009	0.743	0.743	3	0
S	17S-99-0009	0.008	1.39	1.16	1.25	0.87	0.02	0.65	-0.004	0.025	0.042	0.28	0.001	0.278	0.232	0.250	0.029	0.001	0.019	0.000	0.001	0.008	0.008	0.825	0.825	8	0
S	17S-99-0010	0.100	1.44	0.94	1.36	0.92	-0.012	1	0.059	-0.009	0.018	0.13	0.011	0.288	0.188	0.272	0.031	0.000	0.029	0.002	0.000	0.003	0.004	0.826	0.826	9	0
S	17S-99-0011	0.042	1.12	1.13	1.20	0.83	0.25	1.12	-0.003	-0.004	0.003	0.26	0.005	0.224	0.226	0.240	0.028	0.008	0.032	0.000	0.000	0.001	0.007	0.770	0.770	5	0
S	17S-99-0012	0.870	1.49	1.08	1.30	1.42	0.11	1.08	-0.007	0.02	0.022	0.12	0.095	0.298	0.216	0.260	0.047	0.004	0.031	0.000	0.001	0.004	0.003	0.958	0.958	13	0
S	17S-99-0013	2.930	1.48	2.70	1.54	1.52	0.13	1.2	-0.008	-0.004	0.011	0.15	0.318	0.296	0.540	0.308	0.051	0.004	0.034	0.000	0.000	0.002	0.004	1.558	1.558	34	0
S	17S-99-0014	2.490	1.41	2.20	1.04	1.43	0.076	1.38	-0.003	0	0.56	0	0.271	0.282	0.440	0.208	0.048	0.003	0.039	0.000	0.000	0.103	0.000	1.393	1.393	24	0
S	17S-99-0015	1.340	2.22	2.00	1.35	1.71	0.066	1.04	0.056	0.033	0.18	0.02	0.146	0.444	0.400	0.270	0.057	0.002	0.030	0.002	0.001	0.033	0.001	1.385	1.385	23	0
S	17S-99-0016	0.800	1.99	1.64	1.58	1.42	0.049	1.61	0.024	0.027	-0.03	0.2	0.087	0.398	0.328	0.316	0.047	0.002	0.046	0.001	0.001	-0.006	0.006	1.225	1.225	18	0
S	17S-99-0017	0.190	1.14	1.14	1.43	0.92	-0.025	0.69	0.015	-0.02	-0.096	-0.02	0.021	0.228	0.228	0.286	0.031	-0.001	0.020	0.000	-0.001	-0.018	-0.001	0.794	0.794	6	0
S	17S-99-0018	0.032	1.07	0.90	0.87	1.00	0.049	0.98	0.16	0.09	0.03	0.13	0.003	0.214	0.180	0.174	0.033	0.002	0.028	0.004	0.003	0.006	0.004	0.651	0.651	1	0
S	17S-99-0019	0.670	1.43	1.02	1.00	1.21	0.13	1.24	-0.008	-0.008	0.03	0.06	0.073	0.286	0.204	0.200	0.040	0.004	0.035	0.000	0.000	0.006	0.002	0.850	0.850	10	0
S	17S-99-0020	1.060	1.56	1.67	0.96	0.80	0	1.13	0.087	0.022	0.026	1.42	0.115	0.312	0.334	0.192	0.027	0.000	0.032	0.002	0.001	0.005	0.039	1.059	1.059	16	0
S	17S-99-0021	1.230	2.61	2.54	0.97	0.80	0.019	1.67	0.055	-0.008	0.017	0.11	0.134	0.522	0.508	0.194	0.027	0.001	0.048	0.001	0.000	0.003	0.003	1.440	1.440	27	0
S	17S-99-0022	0.030	1.46	1.64	1.22	0.90	0.024	0.91	0.003	0.014	0.009	0.42	0.003	0.292	0.328	0.244	0.030	0.001	0.026	0.000	0.000	0.002	0.012	0.938	0.938	12	0
R	RH002	0.045	0.83	0.73	0.81	0.65	0.05	0.58	0	0	0	0.02	0.005	0.166	0.146	0.162	0.022	0.002	0.017	0.000	0.000	0.000	0.001	0.519	1.519	31	31
R	RH003	0.016	1.2	1.1	1.2	1	0.06	0.99	0	0	0	-0.01	0.002	0.240	0.220	0.240	0.033	0.002	0.028	0.000	0.000	0.000	0.000	0.765	1.765	43	43
R	RH004	0.01	0.67	0.47	0.67	1	0.05	0.94	0	0	0	-0.02	0.001	0.134	0.094	0.134	0.033	0.002	0.027	0.000	0.000	0.000	-0.001	0.424	1.424	26	26
R	RH005	0.009	1.1	1.4	0.89	0.41	0.03	0.46	0	0	0	0.01	0.001	0.220	0.280	0.178	0.014	0.001	0.013	0.000	0.000	0.000	0.000	0.707	1.707	42	42
R	RH006	0.150	1.1	0.97	0.96	1	0.067	0.98	0	0.01	0	0.03	0.016	0.220	0.194	0.192	0.033	0.002	0.028	0.000	0.000	0.000	0.001	0.687	1.687	41	41
R	RH007	0.089	1	0.92	1.1	1	0.07	1.1	0	0.01	0	-0.01	0.010	0.200	0.184	0.220	0.033	0.002	0.031	0.000	0.000	0.000	0.000	0.681	1.681	40	40
R	RH011	0.026	1	0.85	1	0.88	0.07	0.77	0	0	0	-0.09	0.003	0.200	0.170	0.200	0.029	0.002	0.022	0.000	0.000	0.000	-0.003	0.624	1.624	38	38
R	RH012	0.015	0.93	0.57	0.91	0.58	0.03	0.61	0.03	0	0	-0.06	0.002	0.186	0.114	0.182	0.019	0.001	0.017	0.001	0.000	0.000	-0.002	0.520	1.520	32	32
R	RH013	0.012	0.83	0.69	0.92	0.44	0.03	0.42	0.01	0	0	-0.08	0.001	0.166	0.138	0.184	0.015	0.001	0.012	0.000	0.000	0.000	-0.002	0.515	1.515	30	30
R	RH014	0.034	0.92	0.58	0.98	0.43	0.03	0.52	0	0	0	-0.03	0.004	0.184	0.116	0.196	0.014	0.001	0.015	0.000	0.000	0.000	-0.001	0.529	1.529	33	33
R	RH015	0.008	1	0.55	0.83	0.54	0.03	0.68	0	0	0	-0.04	0.001	0.200	0.110	0.166	0.018	0.001	0.019	0.000	0.000	0.000	-0.001	0.514	1.514	29	29
R	RH016	0.013	0.87	0.56	0.87	0.57	0.03	0.5	-0.01	0	0	-0.04	0.001	0.174	0.112	0.174	0.019	0.001	0.014	0.000	0.000	0.000	-0.001	0.494	1.494	28	28
R	RH021	0.008	0.88	0.83	1	0.57	0.03	0.55	0	0	0	-0.03	0.001	0.176	0.166	0.200	0.019	0.001	0.016	0.000	0.000	0.000	-0.001	0.578	1.578	36	36
R	RH025	0.007	0.7	0.59	0.54	0.49	0.03	0.51	0	0	0	0	0.001	0.140	0.118	0.108	0.016	0.001	0.015	0.000	0.000	0.000	0.000	0.399	1.399	25	25
R	RH026	0.007	0.87	0.7	0.98	0.79	0.06	0.88	0	0	0	-0.05	0.001	0.174	0.140	0.196	0.026	0.002	0.025	0.000	0.000	0.000	-0.001	0.563	1.563	35	35
R	RH030	0.014	1.2	0.71	1	0.73	0.04	0.68	0	0	0	-0.07	0.002	0.240	0.142	0.200	0.024	0.001	0.019	0.000	0.000	0.000	-0.002	0.627	1.627	39	39
R	RH031	0.013	1.3	1	1.5	0.72	0.05	0.67	0.01	0.01	0	-0.01	0.001	0.260	0.200	0.300	0.024	0.002	0.019	0.000	0.000	0.000	0.000	0.806	1.806	44	44
R	RH032	0.011	0.66	0.35	0.79	0.36	0.01	0.37	0.01	0.01	0	-0.09	0.001	0.132	0.070	0.158	0.012	0.000	0.011	0.000	0.000	0.000	-0.003	0.382	1.382	22	22
R	RH033	0.08	0.71	1.2	0.66	0.9	0.06	0.86	0	0	0	0.01	0.009	0.142	0.240	0.132	0.030	0.002	0.025	0.000	0.000	0.000	0.000	0.580	1.580	37	37
R	RH036	0.15	0.44	0.42	0.54	0.77	0.03	0.74	0.01	0	0	0.01	0.016	0.088	0.084	0.108	0.026	0.001	0.021	0.000	0.000	0.000	0.000	0.345	1.345	19	19
R	RH041	0.1	0.52	0.49	0.49	0.8	0.05	0.8	0	0	0	0.04	0.011	0.104	0.098	0.098	0.027	0.002	0.023	0.000	0.000	0.000	0.001	0.363	1.363	21	21
R	RH046	0.18	0.43	0.48	0.44	0.94	0.03	0.99	-0.01	0.02	0	0.04	0.020	0.086	0.096	0.088	0.031	0.001	0.028	0.000	0.001	0.000	0.001	0.352	1.352	20	20

Sum of Reference Ranks = WRS_R = **711**
Survey unit sample number = n = **22**
Reference area sample number = m = **22**
α = **0.05**
z = **1.645**
Critical Value = WRS_C = **565**

APPENDIX D

1998 SOIL SAMPLE RESULTS

BOEING

The Boeing Company
Rocketdyne Propulsion & Power

6633 Canoga Ave.
P.O. Box 7922
Canoga Park, CA 91309-7922

Date: December 21, 1998

No.: SHEA-016779

To: Philip Rutherford
D/641, 055, T487
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Subject: 17th Street Drainage Area - Radiation Characterization Surveys and Excavation

This report summarizes past and present soil sampling results, radiation characterization surveys, and soil excavation at the 17th Street Drainage Area.

1995 Soil Sampling and Radiation Survey Results

Soil samples from five locations were taken as part of the Area IV Characterization Survey (see Figure 1). The samples were sent to an outside laboratory for gamma spectroscopy, isotopic thorium, isotopic uranium, and strontium analyses. The analytical results indicated all five sampling locations were at background or slightly above background radiological activity (see Table 1), therefore, no remediation was deemed necessary at this time. Ambient gamma and walkabout surveys were conducted as shown in Figures B-89, B-97, and B-98 for grid blocks K19, L18, and L19 (from A4CM-ZR-0011). However, areas of dense inaccessible brush made a complete survey of the drainage area impossible.

1997 Soil Sampling Results

In 1997, seven locations were sampled and analyzed in-house for gamma spectroscopy during a subsequent radiation survey. The sampling results are shown in Table 1, and the locations are shown in Figure 1. Two of the samples (ENV-97-0035 & ENV-97-0036) contained Cs-137 levels above the release limit. However, as the 1998 characterization survey and soil sampling will show, all soil containing Cs-137 activity above the release limit was removed by the act of sampling in 1997. Three other samples (ENV-97-0049, ENV-97-0052, & ENV-97-0056) contained slightly above background Cs-137 and above background Th-232 daughters. These five sampling locations were included in the excavation that took place in 1998.

Radiation Characterization Survey (1998)

The area surveyed is outlined in Figure 2. Both walkabout and ambient gamma surveys were conducted in the area using two separate Ludlum 2221 1"x1" NaI detectors. The walkabout gamma survey was performed by swinging a NaI probe near the surface as the health physics technician walked the entire area. The 1-minute ambient gamma survey was measured at 1-meter height at 10-ft square grid spacing. Background measurements for both surveys were taken at Area IV's solar dish area.

A total of 66 hotspot locations were found during the walkabout survey (see Figure 2). A hotspot location is where the total gamma radiation is greater than 5 μR/hr over the background level. For this survey, a hotspot location was calculated to be ≥ 4100 counts per minute for the detector used.

The ambient gamma survey resulted in only one hotspot location (see Figure 3). This location (L19-20N-60E) was located next to hotspot #6 and was included in the excavation. The gross and net gamma survey data were also plotted using Cumplot Version 2.20[1] (see Figures 4 & 5). Two other locations (near hotspots #8 and #26) that exhibited net ambient gamma close to 5 μR/hr over the background were also excavated. In calculating the net gamma activity, daily background readings were subtracted from gross gamma activity.

Soil Sampling of Hotspots (1998)

A total of 13 representative surface walkabout hotspot locations were sampled and analyzed to characterize the hotspot areas (see Figure 2). Initially, samples from six hotspots were analyzed in-house using a Ge(Li) gamma spectrometer. Hotspot #7 was found to contain thorium and uranium daughters higher than background levels. In order to determine the actual thorium and uranium isotope concentrations, and to ascertain whether these isotopes were naturally occurring or not, samples from hotspot #7 and eight other hotspots were sent to Mountain States Analytical, Inc. for alpha isotopic analysis.

Table 2 summarizes the soil sampling results from in-house and outside laboratories. Hotspots #7, #13, #24, and #31 were found to contain above background Cs-137 levels as high as 2.11 pCi/g, but were below the release limit of 9.20 pCi/g. Hotspots #7 and #13 also contained high Th-228 concentrations at 6.24 and 4.01 pCi/g respectively (release limit is 5 pCi/g over background). To determine whether the Th-228 levels were natural background or not, the Th-228/Th-232 ratios were calculated for these two samples. Th-228/Th-232 ratios of hotspots #7 and #13 were 4.00 and 2.78 respectively, which indicated they were not natural (ratio of natural thorium ≅ 1). The parent isotope Th-232 was very typical of background at ≅ 1 pCi/g, therefore, the cause of elevated Th-228 (its daughter) is not apparent. Although the parent U-238 was somewhat elevated over typical background in some samples, the isotopic ratios of U-234/U-238 were all ≅ 1 indicating non-enriched, non-processed uranium.

Hotspots #7 #13, #24, and #31 and their surrounding areas were eventually excavated (see Figure 2). Although hotspot #1 also showed higher than natural Th-228/Th-232 ratio at 2.36, this location was not excavated because it contained low level of Th-228 (average = 1.84 pCi/g) and background level of Cs-137 (average = 0.21 pCi/g). The rest of the sampling locations were also not excavated because they were at background radiological activity.

Post-Excavation Sample Results (1998)

Table 3 lists the excavation areas and compares the results of radiological activity before and after excavation. The highest post-excavation Cs-137 activity is 0.72 pCi/g, or 8% of the cleanup standard of 9.20 pCi/g. Since isotopic thorium is not analyzed for in post-excavation samples, the post excavation Th-228 is calculated by averaging the Th-232 daughters and then comparing this average to the pre-excavation ratio of Th-228 to average Th-232 daughters. The highest post-excavation Th-228 is estimated to be 1.4 pCi/g, typical of background.

[1] Proprietary Software. Boeing

Summary

Several areas north of the berm were excavated because they had Cs-137 and Th-228 levels higher than background levels but below release limits. One area south of the berm was excavated because it contained Th-228 close to the release limit. The total area excavated was approximately 1400 ft^2. The volume of soil removed was approximately 2100 ft^3 or 78 yd^3. Results from post-excavation sampling indicate the excavated areas are now at levels well below the radiological release limits. Representative samples from other hotspot areas indicate only background or slightly above background levels of radiological activity. Therefore, the radiation remediation effort has been completed, and no further excavation is necessary.

If you have any questions regarding this report, please call me at (818) 586-8024.

John Shao

Radiation Safety

cc: James Barnes
Robert Hardy
Philip Horton
Rodney Meyer
17th Street Drainage Area File

Table 1.
17th Street Drainage Area
1995 and 1997 Soil Sampling Results

			Alpha Isotopic Results						Sr Results	Gamma Spectroscopy		
Sampling Year	Sample #	Depth (ft)	Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Sr-90 (pCi/g) (MDA=0.1)	Avg. of Th-232 daughters (pCi/g)	Avg. of U-238 daughters (pCi/g)	Cs-137 (pCi/g) (MDA=0.02)
1995	A4CM-95-0043	<0.5	0.81	0.66	0.81	0.62	0.02	0.65	<MDA	N/C	N/C	<MDA
	A4CM-95-0044	<0.5	0.68	0.63	0.60	0.70	0.04	0.67	<MDA	N/C	N/C	0.17
	A4CM-95-0045	<0.5	0.95	0.69	0.57	1.20	0.06	1.10	<MDA	N/C	N/C	0.67
	A4CM-95-0046	2.5	0.85	0.72	0.82	1.20	0.05	1.20	<MDA	N/C	N/C	0.09
	A4CM-95-0072	<0.5	0.85	0.94	0.59	0.60	0.03	0.58	<MDA	N/C	N/C	0.12
	A4CM-95-0073	2.5	1.10	0.72	0.94	0.98	0.06	0.74	<MDA	N/C	N/C	0.23
	A4CM-95-0074	<0.5	1.30	1.10	1.20	1.10	0.05	1.00	<MDA	N/C	N/C	0.07
1997	ENV-97-0035*	<0.5	-	-	-	-	-	-	-	1.50	1.50	13.50
	ENV-97-0036*	<0.5	-	-	-	-	-	-	-	2.00	1.40	14.90
	ENV-97-0049*	<0.5	-	-	-	-	-	-	-	4.00	3.00	1.49
	ENV-97-0050	<0.5	-	-	-	-	-	-	-	1.60	2.50	0.44
	ENV-97-0051	<0.5	-	-	-	-	-	-	-	1.00	2.20	0.25
	ENV-97-0052*	<0.5	-	-	-	-	-	-	-	2.70	2.00	1.60
	ENV-97-0056*	<0.5	-	-	-	-	-	-	-	5.50	3.00	1.02

* areas excavated in 1998
"-" means no data
MDA = minimum detectable activity
N/C = not calculated

Table 2.
17th Street Drainage Area
Hotspot Soil Sample Results (1998)

Hotspot #	Location	Depth (ft)	Sample #	Alpha Isotopic Results						Alpha Isotopic Ratios				Sr Results	Gamma Spec.
				Th-228 (pCi/g)	Th-230 (pCi/g)	Th-232 (pCi/g)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Th-228 / Th-232	U-234 / U-238	U-235 / U-238	Th-230 / U238	Sr-90 (pCi/g)	Cs-137 (pCi/g)
1	L19-7N-46E	<0.5	017-98-0016	2.12	0.91	0.90	2.49	0.02	2.49	2.36	1.00	0.01	0.37	0.92	0.17
		<0.5	017-98-0020 (dup. of 0016)	1.55	0.97	0.69	2.26	0.15	1.90	2.25	1.19	0.08	0.51	0.13	0.24
7*	L19-22N-63E	0 - 0.7	017-98-0005	6.24	2.12	1.56	2.74	0.37	2.42	4.00	1.13	0.15	0.88	-0.22	1.37
		0.7-1.3	ENV-98-251	-	-	-	-	-	-	-	-	-	-	-	0.78
		1.3 - 2	ENV-98-252	-	-	-	-	-	-	-	-	-	-	-	0.23
13*	L19-109N-105E	<0.5	017-98-0018	4.01	1.89	1.44	3.48	0.34	3.35	2.78	1.04	0.10	0.56	-0.12	1.07
15	L18-40N-169E	<0.5	017-98-0013	1.35	1.37	1.24	1.09	0.18	1.11	1.09	0.98	0.16	1.23	0.30	0.10
24*	L18-64N-175E	0 - 0.7	017-98-0002	2.15	2.69	1.94	4.28	0.21	3.70	1.11	1.16	0.06	0.73	-0.15	2.11
		0.7-1.3	ENV-98-248	-	-	-	-	-	-	-	-	-	-	-	1.01
		1.3 - 2	ENV-98-249	-	-	-	-	-	-	-	-	-	-	-	0.02
31*	L18-88N-178E	<0.5	017-98-0017	2.20	1.86	1.61	2.80	0.08	2.37	1.37	1.18	0.03	0.78	0.28	0.95
33	L18-6N-150E	<0.5	017-98-0014	0.95	0.78	0.78	1.97	0.16	2.63	1.22	0.75	0.06	0.30	0.30	0.01
40	K19-169N-26E	<0.5	ENV-98-254	-	-	-	-	-	-	-	-	-	-	-	0.25
47	K19-130N-44E	<0.5	017-98-0015	1.14	1.13	0.96	1.93	0.26	1.48	1.19	1.30	0.18	0.76	-0.11	0.14
49	K19-115N-62E	<0.5	ENV-98-255	-	-	-	-	-	-	-	-	-	-	-	<0.04
53	K19-80N-80E	<0.5	ENV-98-256	-	-	-	-	-	-	-	-	-	-	-	0.05
61	K19-41N-93E	<0.5	017-98-0019	1.15	1.11	1.15	1.93	0.13	1.78	1.00	1.08	0.07	0.62	0.00	0.05
65	K19-10N-105E	<0.5	ENV-98-253	-	-	-	-	-	-	-	-	-	-	-	0.11

* locations included in the excavation
"-" means no data

RDOO-198

R21-RF-RS0009
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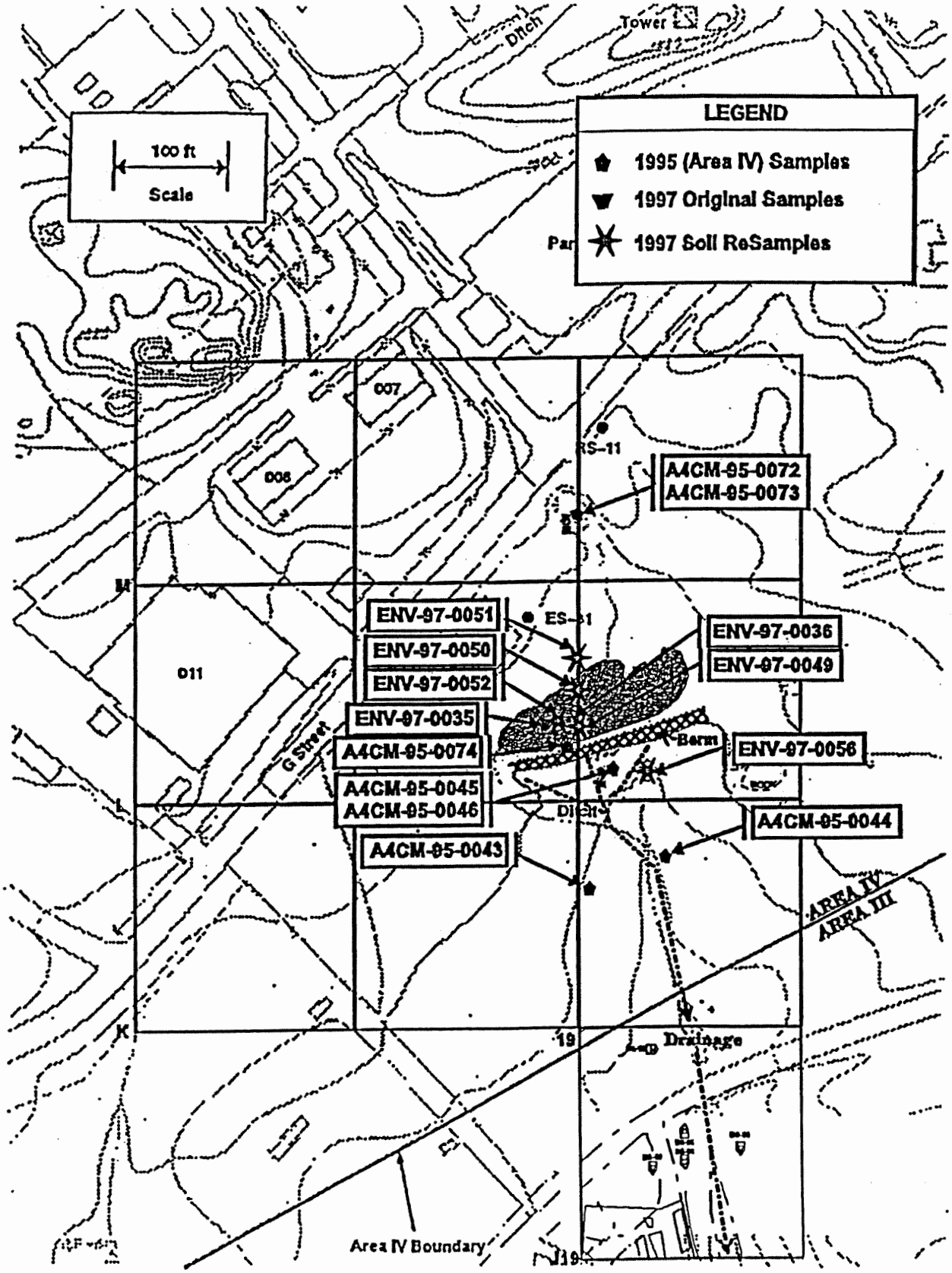
Table 3.
17th Street Drainage Area
Pre- And Post-Excavation Soil Sample Results

			Pre-Excavation		Post-Excavation	
General Location	Hotspot #	Composite Sample Location	Radioisotope of Interest (pCi/g)	Sample #	Radioisotope of Interest (pCi/g)	Sample #
NORTH OF BERM	9,10	L19-66N-5E	-	-	Cs-137 = 0.39	ENV-98-263
	17,22,27,28	L18-57N-195E	-	-	Cs-137 = 0.49	ENV-98-261
	18,19,23,24*, 25,26,29	L18-65N-185E	Cs-137 = 2.11	017-98-0002	Cs-137 = 0.53	ENV-98-262
	20,21	L18-66N-195E	-	-	Cs-137 = 0.58	ENV-98-260
	30	L18-67N-190E	-	-	Cs-137 = 0.72	ENV-98-264
	31*	L18-68N-178E	Cs-137 = 0.95	017-98-0017	Cs-137 = 0.07	ENV-98-265
	32	L18-95N-179E	-	-	Cs-137 = 0.34	ENV-98-266
	11	L19-77N-51E	-	-	Cs-137 = 0.39	ENV-98-259
	12	L19-104N-106E	-	-	Cs-137 = 0.28 avg. of Th-232 daughters ≅ 1.1	ENV-98-268
	13*	L19-109N-105E	Cs-137 = 1.07 Th-228 = 4.01	017-98-0018	Cs-137 = 0.34 avg. of Th-232 daughters ≅ 1.0	ENV-98-269
SOUTH OF BERM	5,6,7*,8	L19-23N-62E	Cs-137 = 1.37 Th-228 = 6.24 avg. of Th-232 daughters ≅ 5.0	017-98-0005 ENV-98-250	Cs-137 = 0.06 Th-228 ≅ 1.4** avg. of Th-232 daughters ≅ 1.1	ENV-98-267

* hotspot sampled
** calculated Th-228 concentration (see text)
"-" means no sample taken

Figure 1
1995 and 1997 Soil Sampling Locations for 17th Street Drainage Channel



17st_f97.dsf
dahl 11/25/98

Figure 2

17th Street Drainage Area Soil Excavation and Sample Location

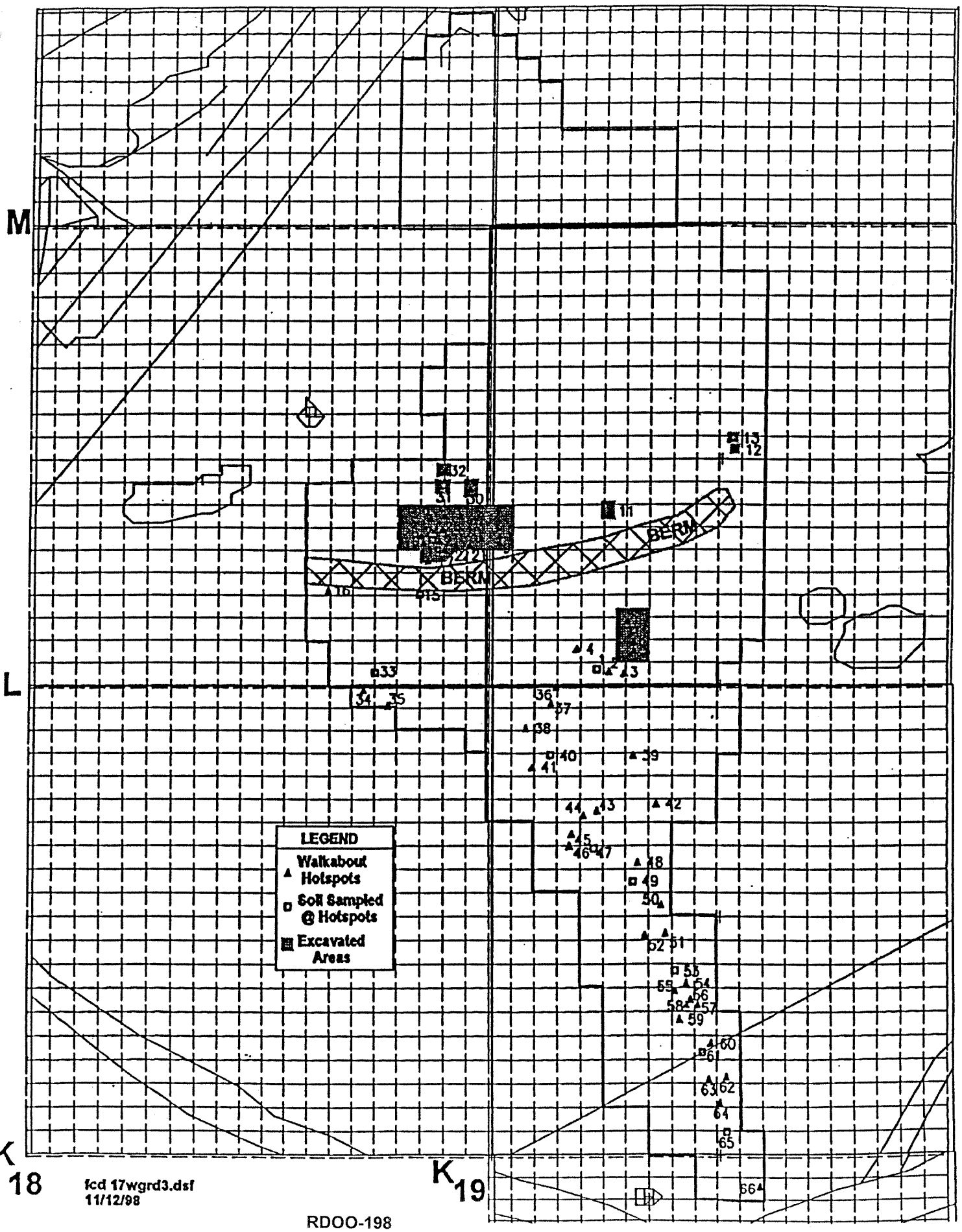


Figure 3

17th St. Drainage Area Ambient Gamma Survey (@ 1 meter)

Raw data converted to µR/h. Contour Intervals 2.0 µR/h. Data on 10 ft x 10 ft Grid.
Triangle indicates a reading = 18.4 µR/h and squares indicate < 18 µR/h. *(17wgrd1a.dsf)*

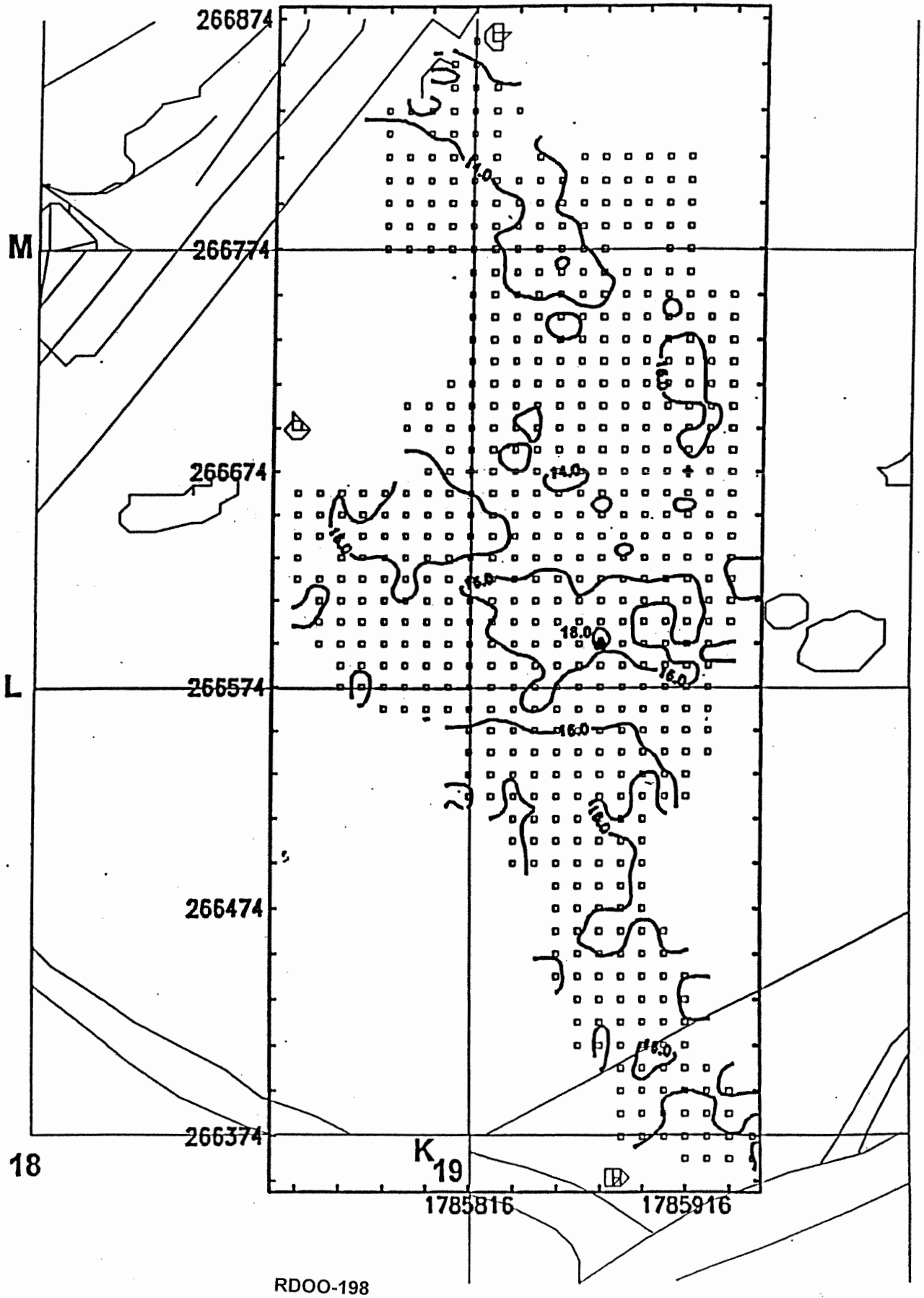


Figure 4
Gross Ambient 1-Meter Gamma Measurements (17th St.)

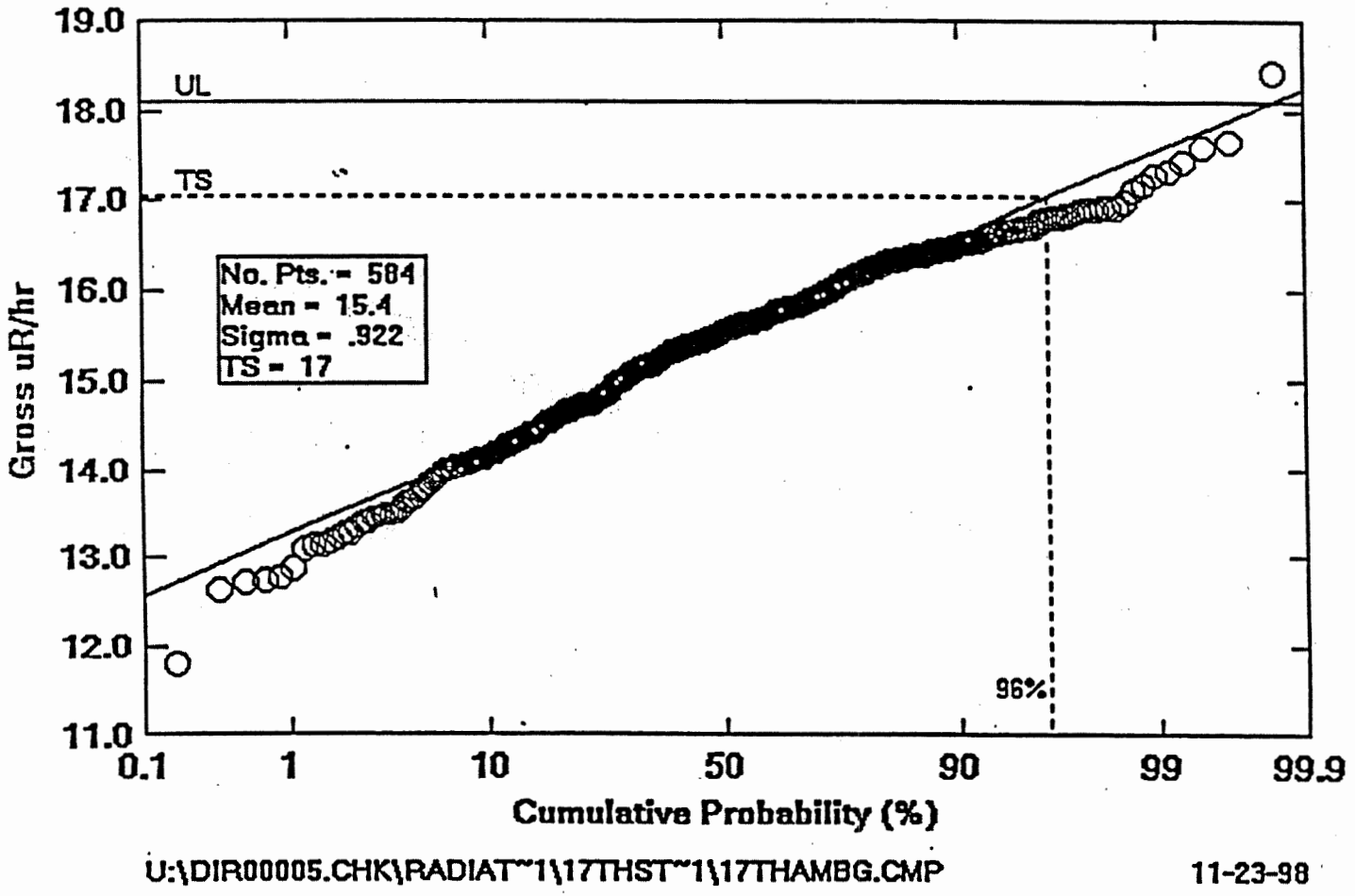


Figure 5
Net Ambient 1-Meter Gamma Measurements (17th St.)

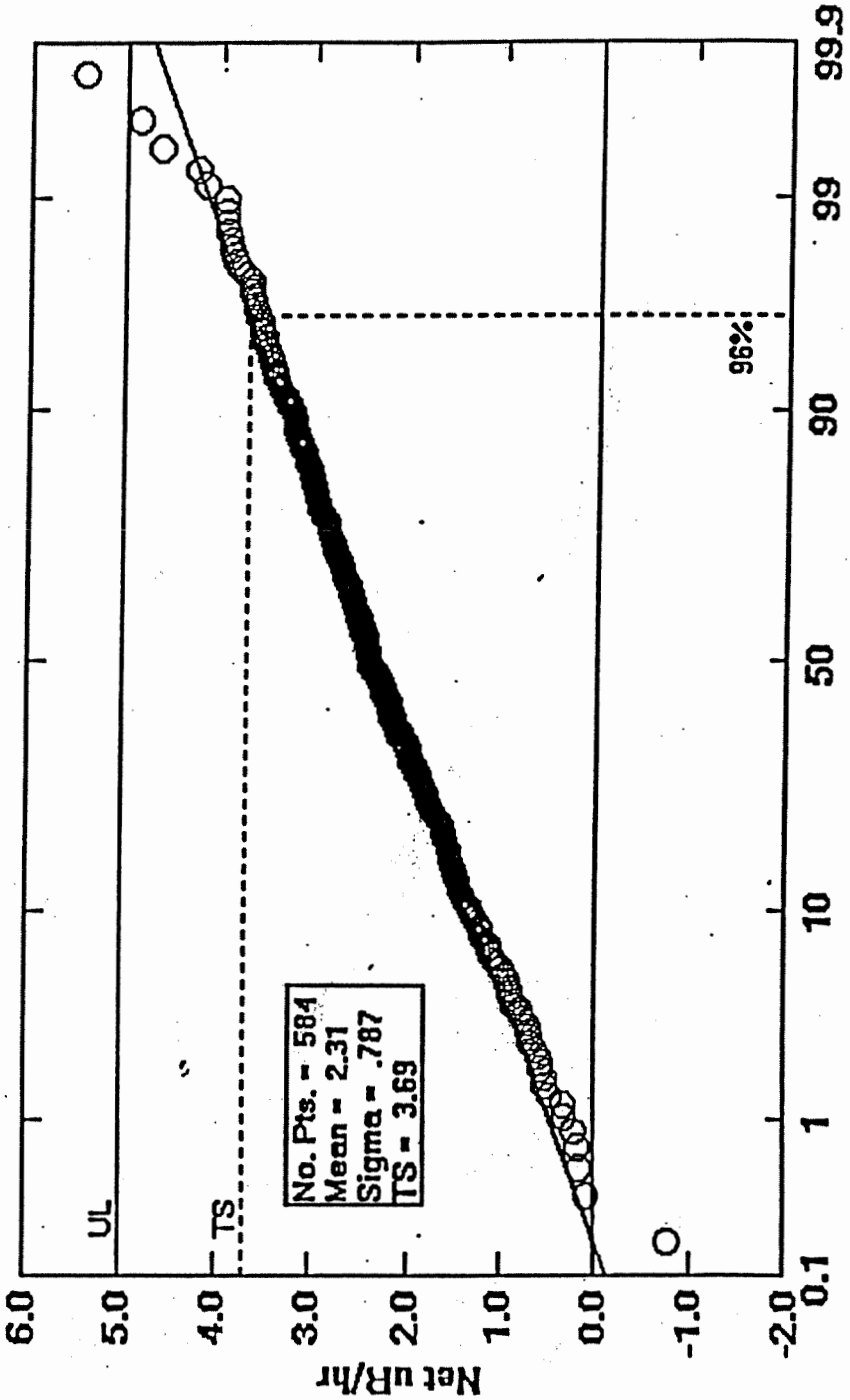
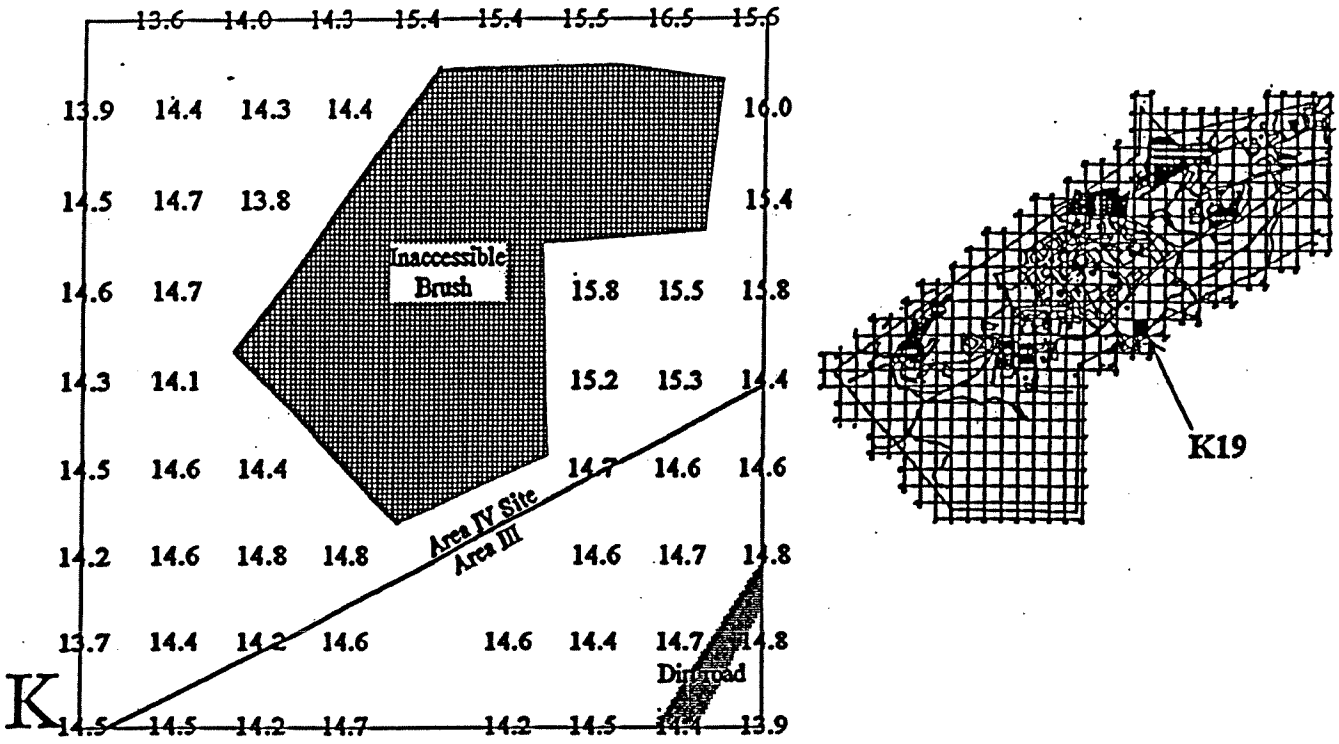


Figure B-89. Ambient Gamma Survey Results - Survey Block K19



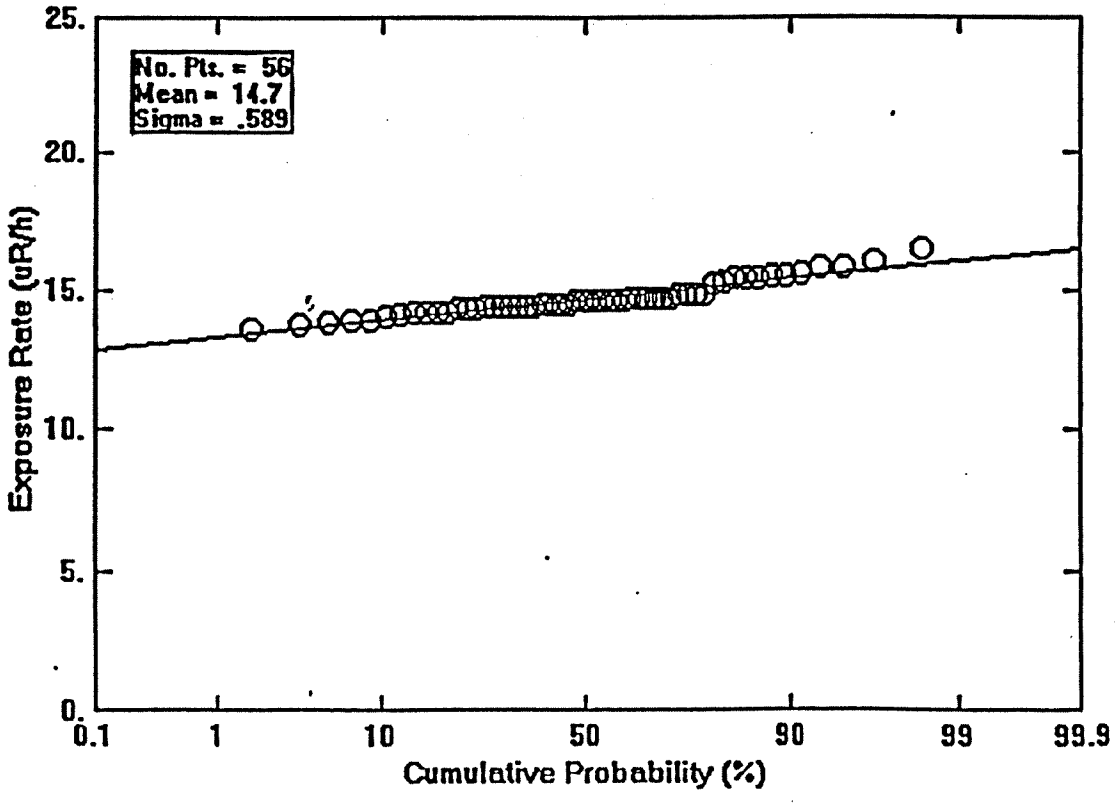
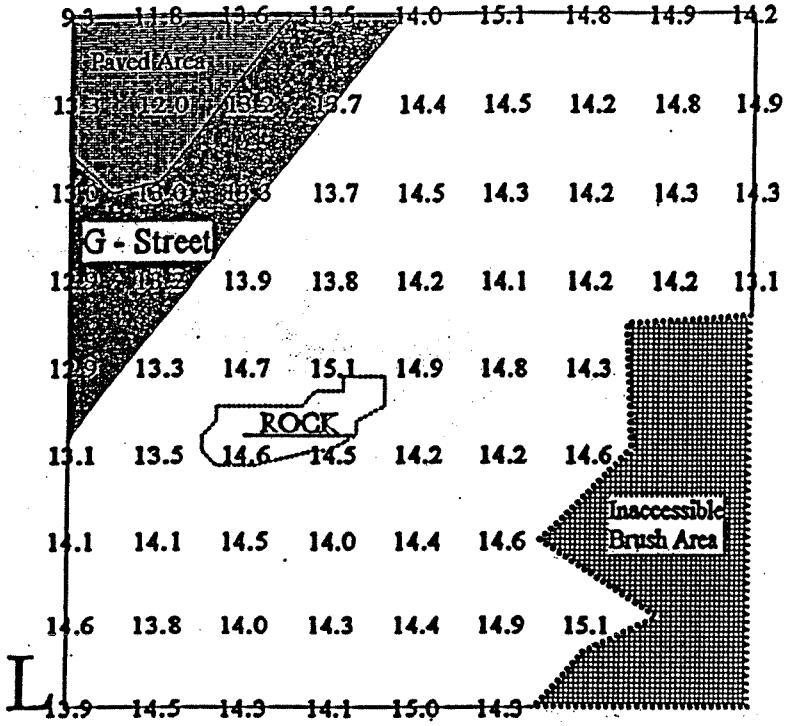
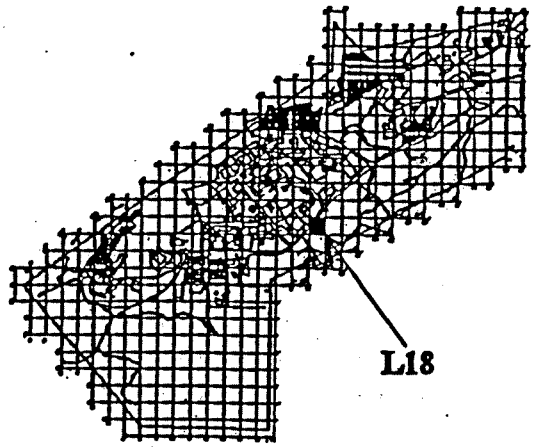


Figure B-97. Ambient Gamma Survey Results - Survey Block L18





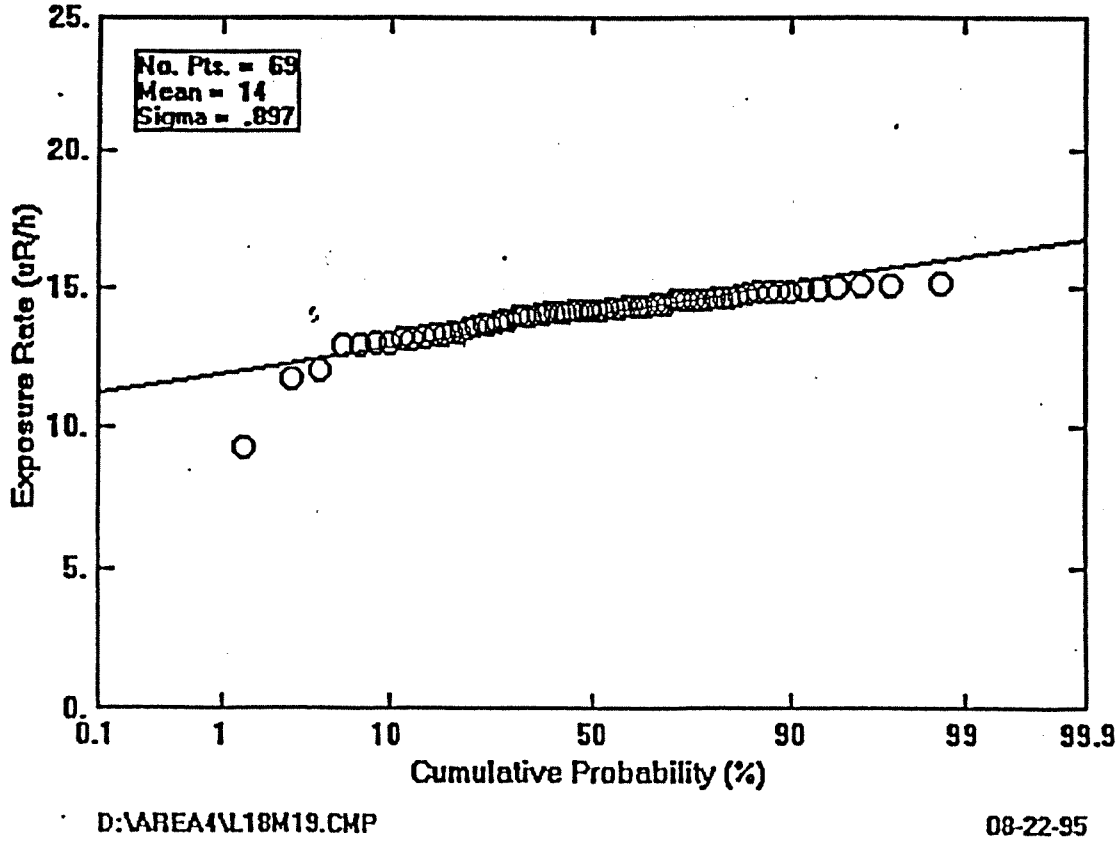
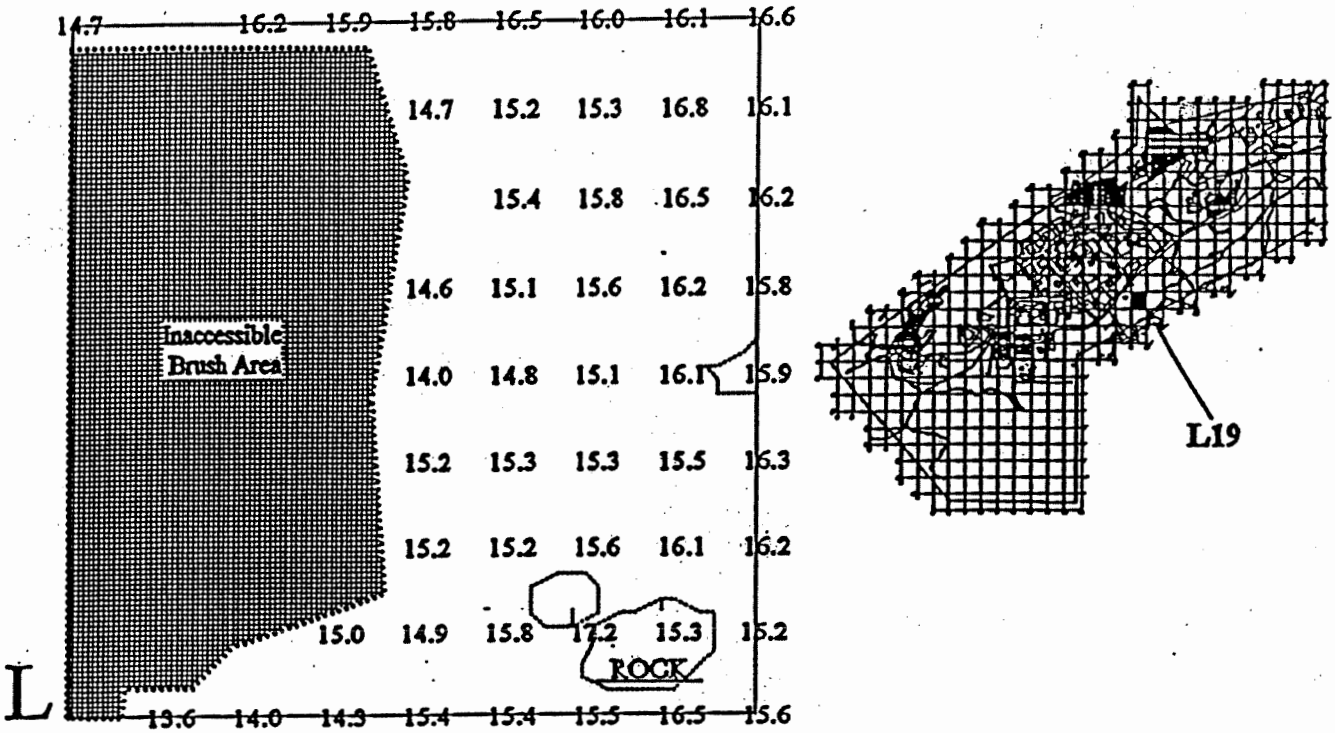


Figure B-98. Ambient Gamma Survey Results - Survey Block L19



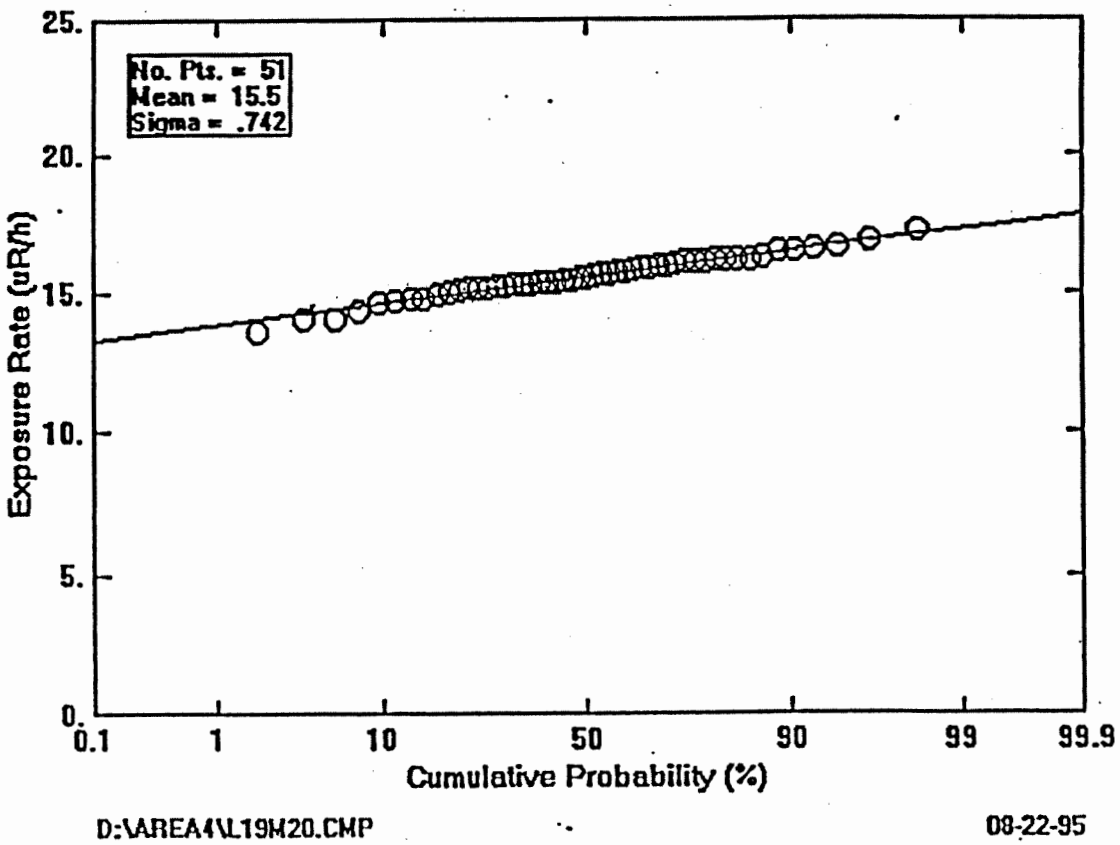


EXHIBIT VI

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)
DOCUMENTATION FOR DECONTAMINATION OF THE
17th STREET DRAINAGE AREA

Department of Energy
San Francisco Operations Office
Energy Technology Engineering Center Site Office
P.O. Box 7929
Canoga Park, CA 91309

July 28, 1993

Dr. D. C. Gibbs
General Manager
Energy Technology Engineering Center
Rocketdyne Division
Rockwell International Corporation
6633 Canoga Avenue
Canoga Park, CA 91309-7930

Subject: Approval of NEPA Categorical Exclusion for ET-NE-93-04

Dear Dr. Gibbs:

DOE-SF has reviewed the proposed action to conduct investigations for environmental contamination of areas related to specific facilities where there is a relation to DOE-sponsored activities.

It has been determined that the requirements for a CX have been met. The two-week time period for DOE-HQ (EH-25) comments has been made available. This letter serves as approval to proceed with the project described in the enclosure.

If you have any questions, please contact me at (818) 586-5417 or Donna Spencer at (818) 586-5420.

Sincerely,

Donna Spencer

for Robert Le Chevalier
DOE ETEC Site Manager

Enclosure

United States Government Department of Energy

memorandum

DATE: JUL 14 1993

REPLY TO ATTN OF: DOE San Francisco Operations Office (ETEC)

SUBJECT: **Categorical Exclusion (CX) Under DOE NEPA Regulations for Environmental Site Characterization at ETEC (ET-EM-93-04)**

TO: James T. Davis, AMEMS
Assistant Manager for
Environment, Management & Support

In accordance with DOE NEPA Regulations, Section D, and SEN-15-90, I have determined that the subject project satisfies the requirements for exclusion from further NEPA review based on the following:

CX DETERMINATION

NEPA Document Number: ET-EM-93-04

Proposed Action:

Conduct investigations for environmental contamination of areas related to specific facilities where there is a relation to DOE-sponsored activities.

Location: Energy Technology Engineering Center (ETEC), Santa Susana Field Laboratory (SSFL), Ventura County, CA

Prepared by: U. S. Department of Energy, San Francisco Operations Office

Description of the Proposed Actions:

ETEC will conduct systematic investigations of areas surrounding specific facilities in SSFL Area IV where DOE-sponsored activities were performed. The investigations are intended to identify areas of contamination in Area IV which have not previously been identified.

Investigations at specific sites will be supplemented by a systematic survey of Area IV to assure that contaminants from facility activities are not overlooked, even in case of unexpected migration. Areas outside the boundary will be addressed only so far as they affect migration of contamination to and from Area IV. It is intended that data obtained during this program will be of such a quality level that they will

contribute to a basis for site remediation, and if required at a later date, they could be used in a health-based risk assessment. Remediation activities and risk assessment are not within the scope of this investigative program.

No additional DOE facilities would be constructed as part of this proposed action.

CX to be Applied (from Subpart D, DOE NEPA Regulations):

Subpart D, Department of Energy (DOE) National Environmental Policy Act (NEPA) Regulations: Appendix B - Categorical Exclusion Applicable to Specific Agency Actions as identified in the Federal Register Volume 57, Number 80, dated April 24, 1992:

B3.1 Site characterization and environmental monitoring, including siting, construction, operation, and dismantlement or closing (abandonment) of characterization and monitoring devices and siting, construction, and operation of a small-scale laboratory building or renovation of a room in an existing building for sample analysis. Activities covered include, but are not limited to, site characterization and environmental monitoring under CERCLA and RCRA. Specific activities include, but are not limited to:

(a) Geological, geophysical (such as gravity, magnetic, electrical, seismic, and radar), geochemical, and engineering surveys and mapping, including the establishment of survey marks;

(b) Installation and operation of field instruments, such as stream-gauging stations or flow-measuring devices, telemetry systems, geochemical monitoring tools, and geophysical exploration tools;

(c) Drilling of wells for sampling or monitoring of groundwater or the vadose (unsaturated) zone, well logging, and installation of water-level recording devices in wells;

(d) Aquifer response testing;

(e) Installation and operation of ambient air monitoring equipment;

(f) Sampling and characterization of water, soil, rock, or contaminants;

(g) Sampling and characterization of water effluents, air emissions, or solid waste streams;

(h) Installation and operation of meteorological towers and

associated activities, including assessment of potential wind energy resources;

(i) Sampling of flora or fauna; and

(j) Archeological, historic, and cultural resource identification in compliance with 36 CFR Part 800 and 43 CFR Part 7.

There are no extraordinary circumstances related to the project that may affect the significance of the environmental effects of the project. The project is not connected to other actions with potentially significant impacts, is not related to other proposed actions with cumulatively significant impacts, and is not part of a DOE proposal for which an EIS is being prepared.

The project will not threaten a violation of applicable ES&H regulatory requirements; will not require siting, construction or major expansion of waste storage, disposal, recovery, or treatment facilities; will not disturb hazardous materials that preexist in the environment such that there would be uncontrolled or unpermitted releases; and will not adversely affect environmentally sensitive resources.

I have determined that the proposed action meets the requirements for the CX referenced above. Therefore, I have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

Terry A. Vaeth
Acting Manager

cc: C. Borgstrom, EH25, DOE-HQ
J. Semko, NE-472, DOE-HQ
R. Sharma, NE-474, DOE-HQ