RADIOLOGICAL CHARACTERIZATION OF DAYTON CANYON, WEST HILLS, CALIFORNIA

Prepared for:
Morrison & Foerster, LLP

February 2008

Prepared by:
Auxier & Associates, Inc.
9821 Cogdill Road, Suite 1
Knoxville, Tennessee 37932
(865) 675-3669 Fax: (865) 675-3677

LIMITATIONS

Information provided in this report by Auxier & Associates Inc., is intended exclusively for the use of Centex. The findings and conclusions discussed in this report are based on field and laboratory data provided by Allwest Remediation, Inc. during the course of this evaluation and our current understanding and interpretation of environmental regulatory agency regulations, guidance and policies. The professional services have been performed in accordance with practices generally accepted by other health physicists and environmental scientists practicing in this field. No other warranty, either expressed or implied, is made.

LIST OF CONTENTS

SECTION **PAGE**

List of Figures

List of Tables

Executive Summary

Centex Homes is proposing to build a residential development on 100 acres of undeveloped land in Dayton Canyon. The property evaluated is located in the community of West Hills, which is part of Los Angeles, California, just west of the intersection of Roscoe Boulevard and Valley Circle Boulevard.

Local residents have expressed concerns that radioactive material may have migrated from the Santa Susana Field Laboratory to Dayton Canyon. In response to those concerns, two radiological investigations were performed, one in 2005 and another in 2007. This report uses a combination of published reports and original data records from these investigations to describe the current radiological condition of Dayton Canyon. The report also contains the results of a radiological risk assessment that used industry-standard risk calculation methods and parameters to estimate risks to potential future residents from these radionuclides (Appendix A).

Both radiological surveys were performed by AllWest Remediation. The first survey allowed investigators to identify areas of the site for further study. Soil samples were subsequently collected from these areas of interest and sent to radiological laboratories for analysis. The second survey resampled many of the original locations, and collected additional surface and subsurface samples from different areas of the site. Primary radiological constituents of concern were Cs-137 and Sr-90, although some data were collected on isotopes of plutonium as well.

The quality of the data sets was evaluated by examining copies of the original analytical reports issued by the laboratories. Some Sr-90 data from the initial investigation were judged to be unusable for decision making, but most of the remaining data are judged to be usable with qualification.

Using the available information presented in this report, no areas of radiological concern were identified in the canyon. Visual examination of concentration data plotted on aerial photos of the site indicates that the higher results are scattered across the site and not clustered together. A statistical comparison of surface and subsurface concentrations failed to prove that they were different populations. These two observations indicate soil concentrations of the radionuclides investigated are relatively uniform across the entire study area.

The soil concentration data was used to calculate the exposure potential to a hypothetical receptor living on the property. Risks to this postulated receptor from Cs-137, Pu-238, Pu-239/240, and Sr-90 are relatively small, with the calculated upper-bound risk above background about 4×10^{-7}. Risks of this magnitude are less than the 10^{-6} to 10^{-4} risk range generally considered by EPA to be acceptable at Superfund sites.

1. INTRODUCTION

Auxier & Associates, Inc. was retained by the firm of Morrison & Foerster, LLP to compile existing data and use it to prepare a radiological characterization report for Dayton Canyon. The property evaluated is located in the community of West Hills, which is part of Los Angeles, California, just west of the intersection of Roscoe Boulevard and Valley Circle Boulevard.

1.1 Description of the Study Area

The Centex Homes-Sterling Residential Development property, referred to as the “Site” or “study area” in this report encompasses approximately 100 acres of undeveloped land. The principle drainage feature in the study area is Dayton Canyon Creek, which flows from west to east across the property. The majority of the property is vegetated and slopes toward this creek.

1.2 Description of Notable Off-site Properties

Boeing/Santa Susana Field Laboratory (SSFL) is located to the west of the study area. Water drains from the eastern part of the SSFL to the study area via Dayton Canyon Creek (Figure 1-1). The western boundary of the study area is located approximately 0.5 miles directly east of the Boeing/Santa Susana Field Laboratory facility (Figure 1-2).

Operational activities at the SSFL began in 1948. It hosted a variety of nuclear energy research and development projects. It is known that nuclear research like the Sodium Reactor Experiment was performed in its Area IV facilities, which are located approximately 3.5 miles west from the eastern border of the study area. (Figure 1-1).

1.3 Purpose of this Report

Local residents have expressed concerns that radioactive material may have migrated from the SSFL to Dayton Canyon. This report uses a combination of published reports and original data records to describe the current radiological condition of Dayton Canyon.

1.4 Organization of Report

The 2005 Radiological Investigation and its results are described in Section 2. A description of the 2007 Supplemental Investigation and its results are presented in Section 3. The report’s Summary and Conclusions are presented in Section 4.

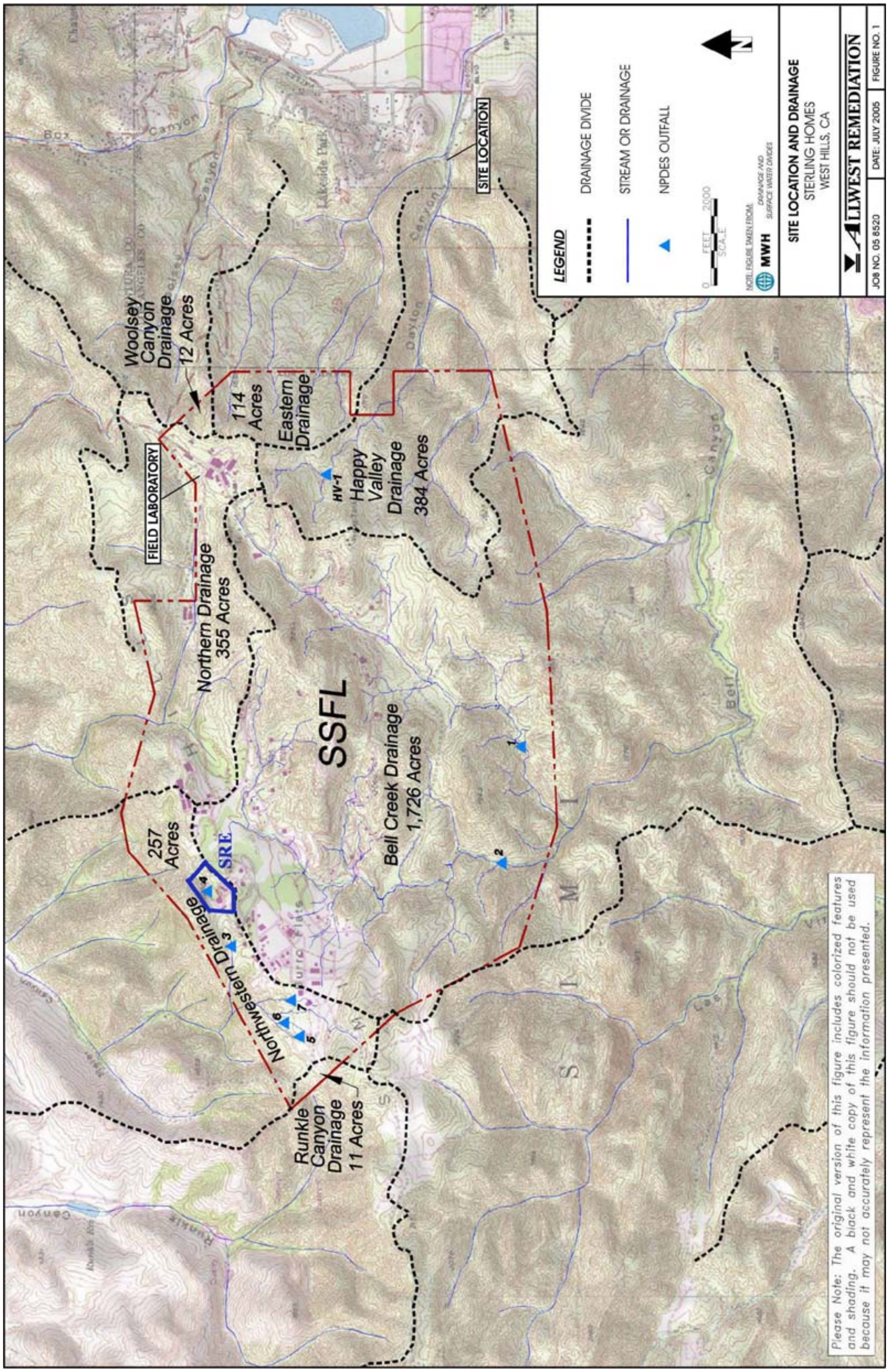

Figure 1-1 Locations of the SSFL, SRE and Dayton Canyon (AllWest 2005)

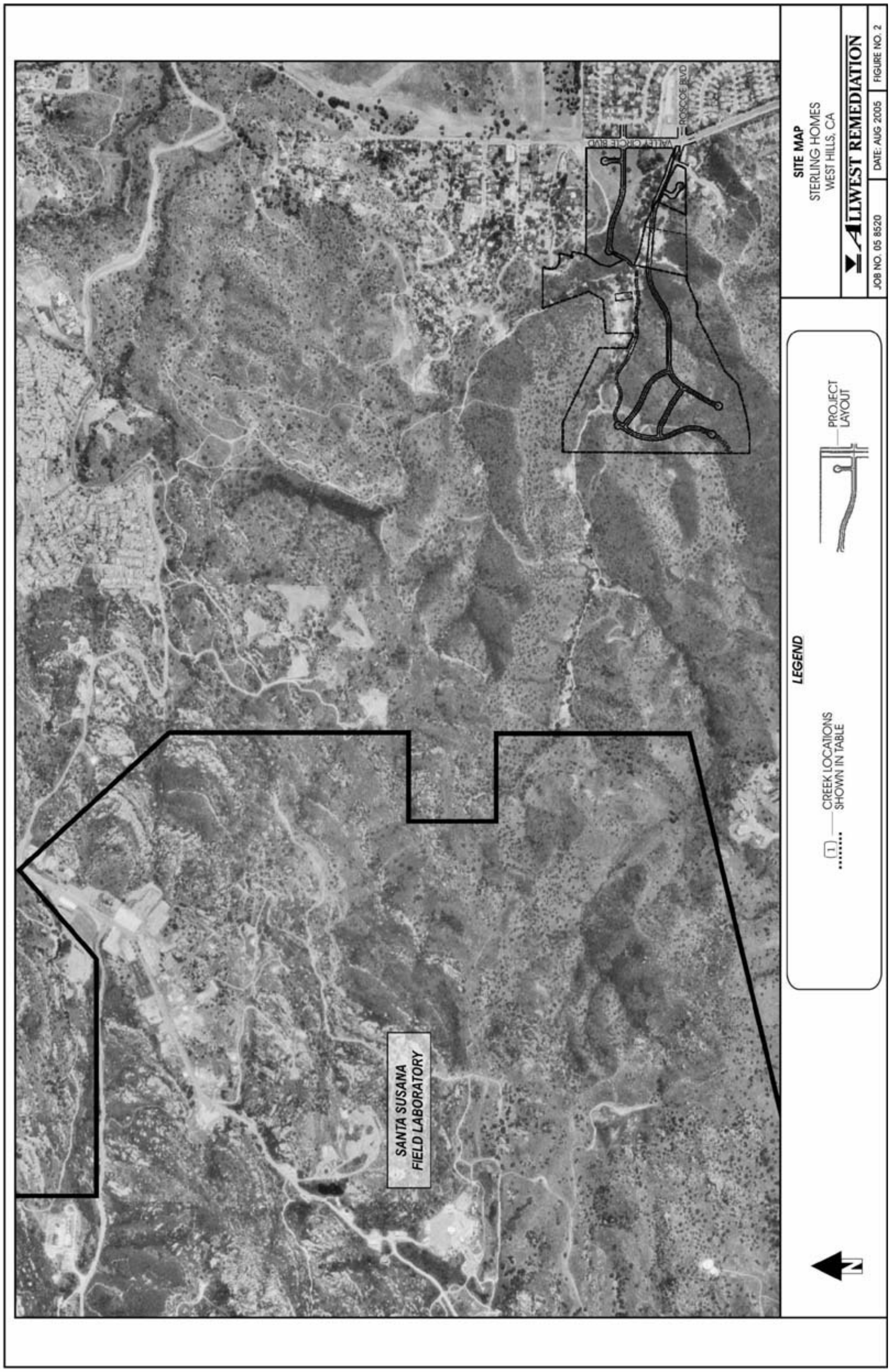

Figure 1-2 Position of Study Area Relative to Eastern Boundary of SSFL (AllWest 2005)

2. 2005 RADIOLOGICAL INVESTIGATION

In 2005, a radiological investigation was planned to evaluate the radiological conditions in the canyon. This initial radiological survey was performed by AllWest Remediation as part of a Preliminary Endangerment Assessment conducted the same year.

The California Department of Toxic Substances Control (DTSC) and the California Department of Human Services (DHS) were consulted during the planning stages of the radiological investigation and the combination of a radiological survey of accessible areas of the property, followed by soil sampling was developed (AllWest 2006).

2.1 Reference Grid

Prior to conducting the radiation survey, the Study area was divided into four areas: the creek, the North Area, the South Area, and the West Area (Figure 2-1). A reference grid was established in the North, South, and West Areas (AllWest 2005 PED WP). The grids were laid out on 100-foot centers yielding 407 grid blocks each measuring 100 feet long and 100 feet wide. Seven additional grid blocks were laid out at various locations along the creek. Figure 2-2 presents a map of the study area with the reference grids superimposed.

Grid blocks in each area were assigned a unique identifier, with columns (east-west direction) being identified by letters (A, B, …, etc.) and rows (north-south direction) being given a numerical identifier (1, 2, …, etc.). For example, the grid block located in the far northwest corner of the North Area would be designated as "A1" or sometimes "A1-N" to distinguish it from A1 in the West Area.

2.2 Description of Radiation Survey and Results

In order to get an indication of ambient radiation levels, each accessible grid block was surveyed with a hand-held Pancake probe[1]. This instrument is not ideal for use in an environmental radiation survey and is more typically used to survey solid objects and personnel for surface contamination. The results from this survey were reported in units of μR/h, but it should be noted that the instrument's response in units of μR/h should not be considered an absolute measurement of the true exposure rate in the area. However, the recorded results are useful because they can be compared against each other to provide a relative indication of the ambient radiation levels at different locations in the study area.

---

[1] A Victoreen Model 190 meter and 489-110D GM halogen-quenched pancake probe.

In this survey, the probe was held near the ground surface and the instrument response was observed. The highest and lowest measurements were recorded for 274 grid blocks. These instrument responses have been grouped by their magnitude and plotted in Figure 2-3. The results for the 548 measurements recorded range from 1.8 to 29.3 µR/h. The median value is 18.7 µR/h, and the arithmetic mean is 18.1 µR/h. As depicted in Figure 2-3, these instrument responses exhibit a slight bias to the higher side of the range, but no responses exceed the average by more than 50%.

The maximum values from each grid block were plotted on a map of the study area, with the highest 2% of the measurements[2] plotted in green, and the remainder of the results plotted in blue (Figure 2-4). This presentation shows that the most of the higher results were recorded in the higher elevations in the western portion of the survey area. Since one of the objectives of the initial investigation was to determine if elevated concentrations of radionuclides were present in canyon soil, these areas were selected for follow-up soil sampling (Allwest, 2006).

2.3 Description of Soil Sampling and Analysis

After the radiological survey was complete, fifteen (15) percent of the surveyed grid blocks were selected for soil sampling.[3] Radiation survey results described in the previous section were one of the criteria used to select locations for soil sampling in the West, South and North areas. Samples were also collected from the creek. (Figure 2-2). The work plan for this activity includes a description of the method used to collect the soils samples (Allwest, 2005).

Table 2-1 lists the number of soil samples collected from each area. During the field sampling activities, additional samples were collected from piles of concrete demolition debris from an old gas station and another sample from plant debris found on the property, making a total of 41 samples collected between 10/27/05 and 10/31/05 (AllWest 2006).

These 41 samples were first sent to FGL Environmental for gamma spectrographic analysis. This is a nondestructive analysis where the gamma radiation emitting from the sample is directly measured. The measurement is used to determine the types and amounts of gamma emitting radionuclides present in the sample. The results of these analyses are provided in Table 2-2.

---

[2] This value was selected because 98% roughly corresponds to a value that is two standard deviations above the average response. Instrument responses above this value were selected to illustrate any spatial distribution of the top 2% of the reported results from the 274 grid blocks surveyed.

[3] This exceeded the sampling frequency of 10% proposed on page 11 of the November 22, 2005 preliminary endangerment assessment work plan (Allwest, 2005).

After the gamma spectrographic analyses were complete, a subset of 18 samples was selected for additional analyses to determine their Sr-90, Pu-238 and Pu-239/240 concentrations. Five of these samples were sent to Paragon Analytics and thirteen were sent to SC&A Southeastern Environmental Laboratory. The results of these analyses are presented in Table 2-3.

2.4 Quality of Concentration Data Collected During Initial Investigation in 2005

The laboratories performing the radiological analyses produced reports containing the results of the analyses and varying amounts of quality control documentation. The quality control documentation was evaluated to determine if the quality of the radiological data were sufficient to characterize the radiological condition of the study area.

2.4.1 Quality of Sr-90 Soil Data

Inspection of the Sr-90 results in Table 2-3 indicates that the results have large uncertainties associated with them. Review of the laboratory reports provided for the Sr-90 data revealed the results from the blank samples that were run concurrently with the samples at SC&A Southeastern Environmental Laboratory were higher than expected. This can indicate the presence of laboratory contamination in the samples. Contamination in the samples would explain the high Sr-90 activities and large error bars reported. Based on the high blank results, this Sr-90 data were reported in this document as provided by the lab but it was not considered to be a reliable indicator of Sr-90 concentrations in the study area.

2.4.2 Quality of Cs-137 Soil Data

A similar inspection was conducted of laboratory reports provided by FGL Environment for the Cs-137 analyses. While the information available to the reviewers report is not adequate for complete validation of this data, duplicates, blanks, and generic analytical method were included in the laboratory reports.. The reports contained no information on the minimum detectable activity, blanks, sample weights, count times, or instrument background associated with these analyses.

Inspection of the 38 reported results for Cs-137 indicates that the total propagated error (TPE) for the Cs-137 result in 34 samples was less than the reported result. Because most of the data is reported to be accurate within a factor of two, the data are judged to be usable with the caveat that no statement can be made about the minimum detectable concentration for each sample.

2.4.3 Quality of Pu-238 Soil Data

Inspection of the Pu-238 results in Table 2-3 indicates that the results have relatively large uncertainties associated with them (when compared to the reported results). Review of the laboratory reports provided for the Pu-238 data found no problems with the quality control samples associated with these results. No field blanks were available for inspection. The data are judged to be usable with the caveat that most of the sample results are less than the method detection limits for the sample.

2.4.4 Quality of Pu-239/240 Soil Data

Inspection of the Pu-239/240 results in Table 2-3 indicates that the results have relatively large uncertainties associated with them (when compared to the reported results). Review of the laboratory reports provided for the Pu-239/240 data found no problems with the quality control samples associated with these results. No field blanks were available for inspection. The data are judged to be usable with the caveat that most of the sample results are less than the method detection limits for the sample.

2.5 Initial Soil Sample Results

As discussed in Section 2.3, 41 samples were sent for gamma spectrographic analysis (Table 2-2). Thirty-eight (38) of these samples were surface soil, and Cs-137 results were reported for 36 of these samples.[4] Cs-137 concentrations in these surface soil samples ranged from 0.002 to 0.38 pCi/g (Table 2-2). Figure 2-5 presents a map of the planned development with the Cs-137 soil results superimposed. As can be seen from this figure, six (6) of the seven (7) highest Cs-137 activities reported are in the western area of the study area.

Eighteen (18) of the soil samples were also analyzed for Sr-90, Pu-238, and Pu-239/240 (Table 2-3). Table 2-4 presents summary statistics for the reported concentrations of these four radionuclides.

2.6 Discussion of Results

Cs-137 emits gamma radiation when it decays. If the concentration of Cs-137 is high enough, that radiation should be detectable by the instrument used to perform the radiation survey. The levels and spatial distribution of Cs-137 found in the study area do not correlate well with the distribution of the radiation measurements recorded during the radiation survey. Because higher concentrations of Cs-137 do not always occur in areas producing higher radiation levels, it appears unlikely that variations in the measurements recorded during the radiation survey are due

[4] Two samples from the creek, LCR 8 and LCR 40, were analyzed using gamma spec, but their Cs-137 concentrations were not reported by the laboratory. No reason was given in the lab report for these samples.

to variations in Cs-137. The variations in the instrument readings are more likely due to variation in the natural radiation levels.

2.7 California Department of Toxic Substances Control Review

The California Department of Toxic Substances Control (DTSC) evaluated this data as part of its review of the June 7, 2006 Radiological Investigation Report. At the conclusion of this review, the DTSC recommended that additional radiological samples be collected and analyzed. This led to an expanded investigation of the canyon, as described in the following Section 3.0.

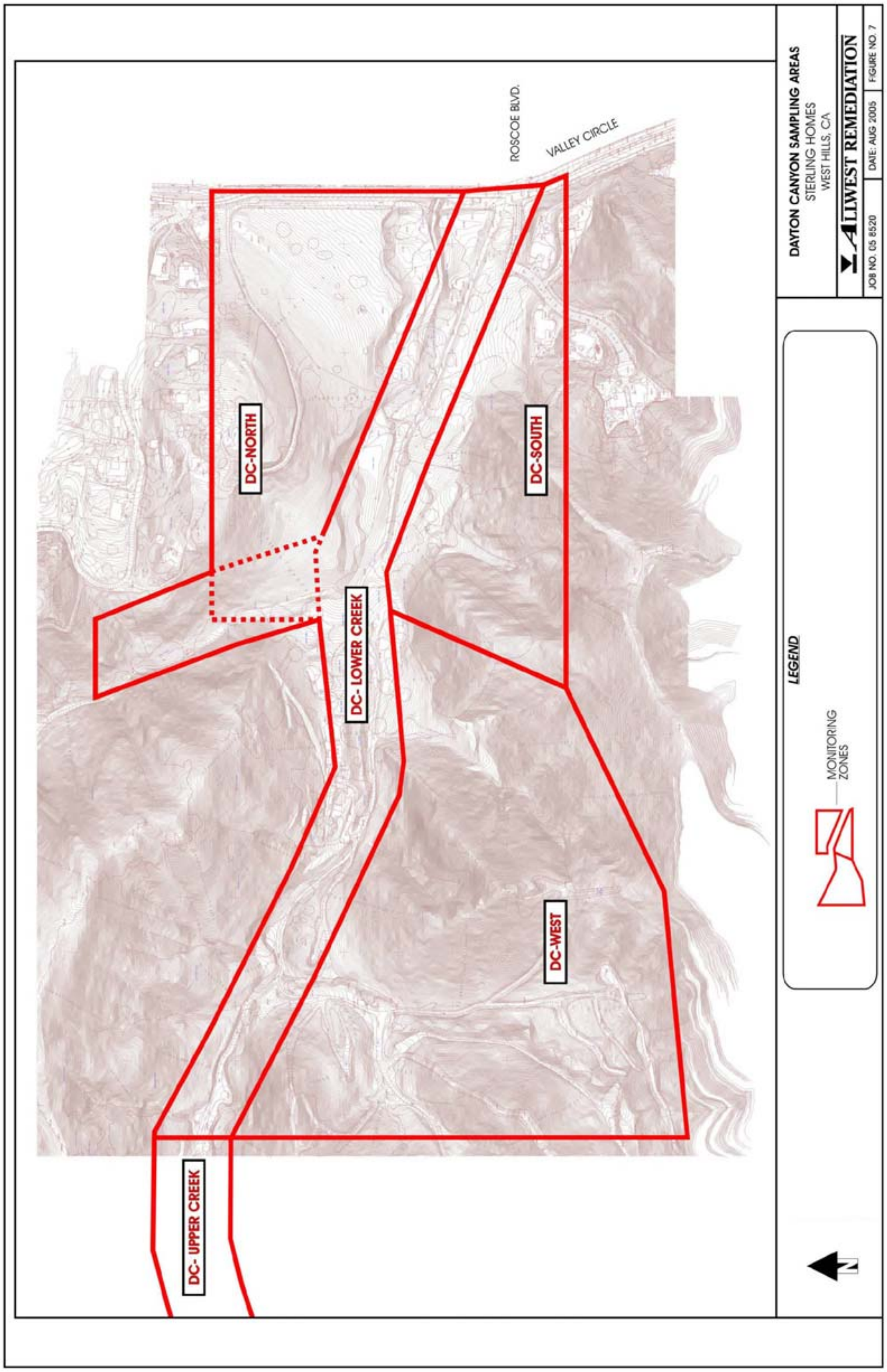

Figure 2-1 Subdivision of Canyon Used in Initial Investigation (AllWest 2005)

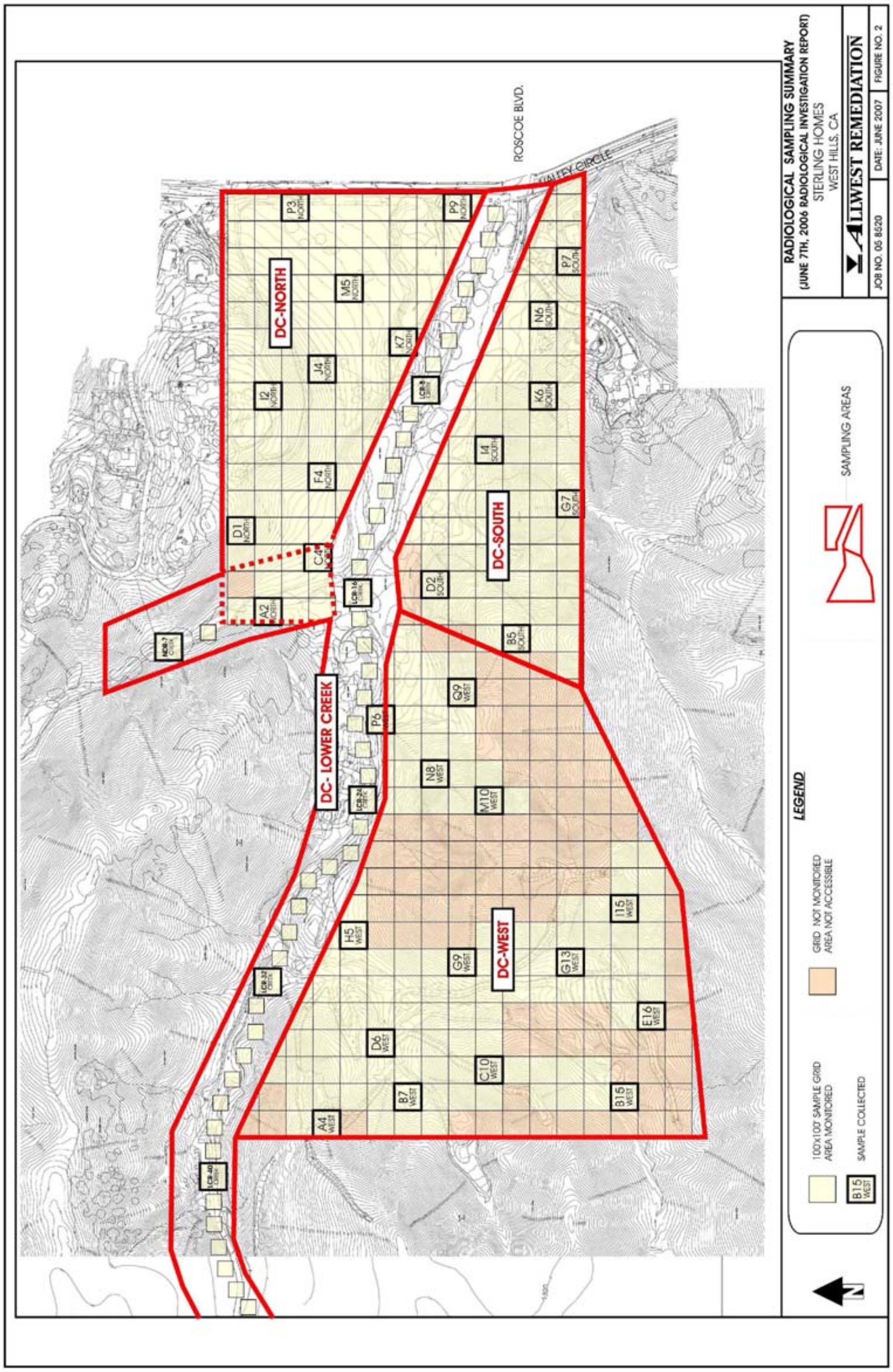

Figure 2-2 Reference Grid (AllWest 2005)

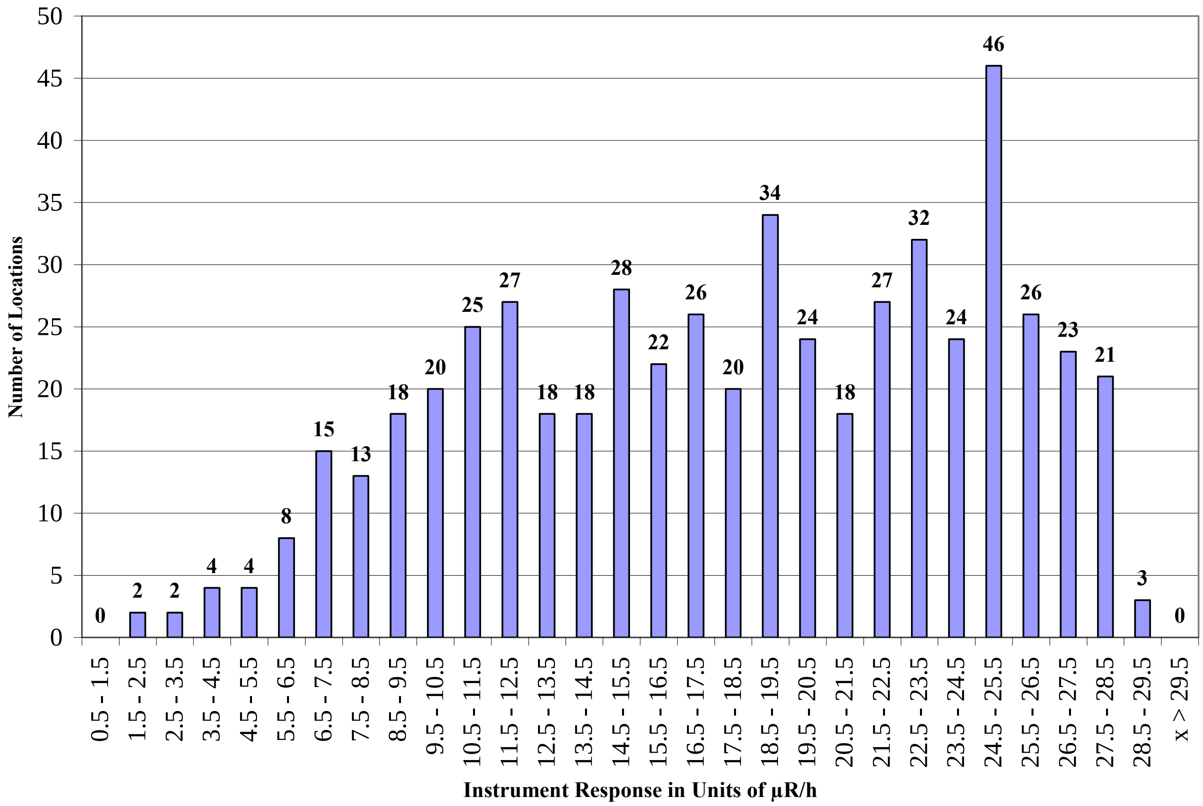

Figure 2-3 Instrument Responses, Grouped in µR/h Increments

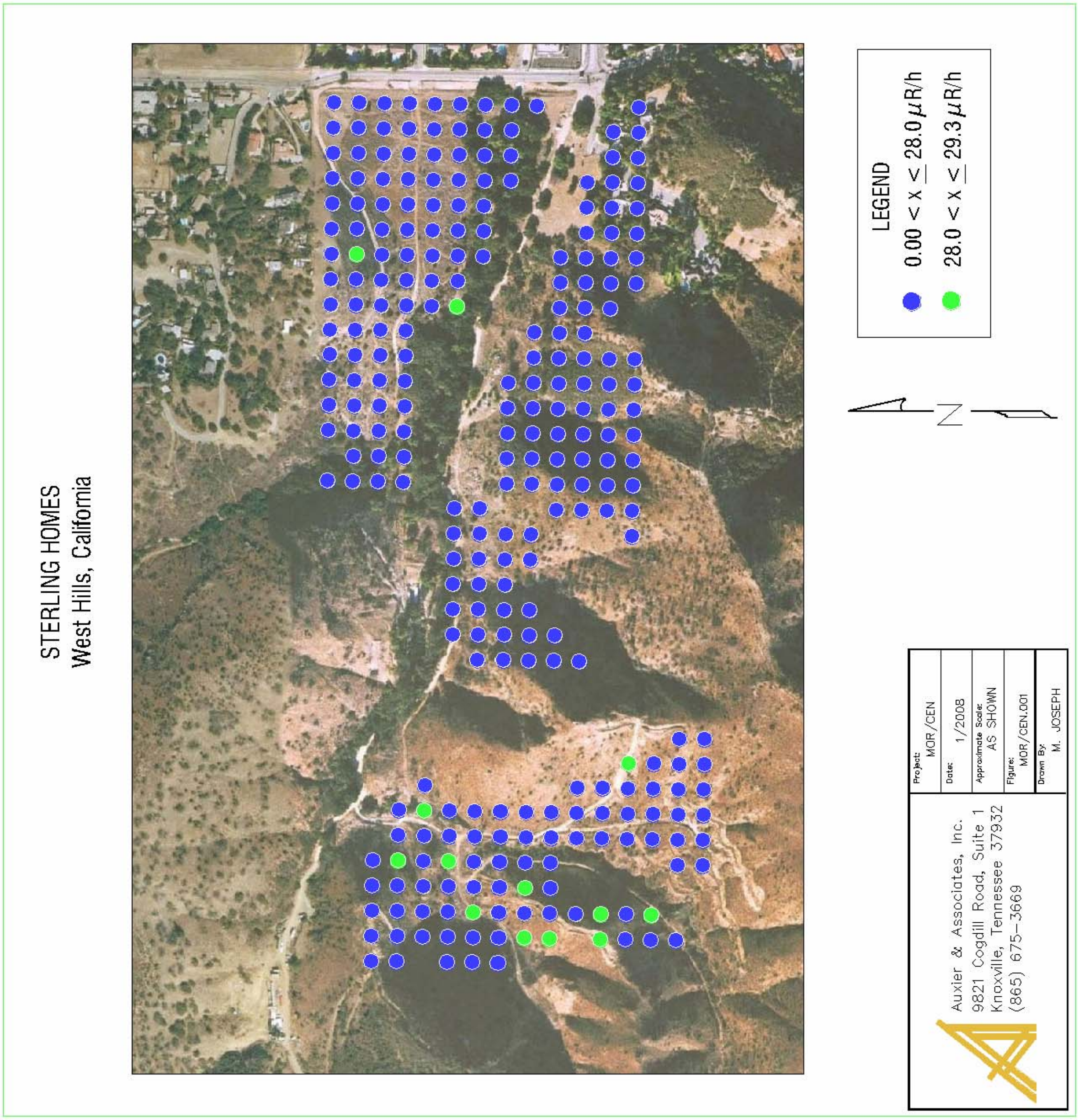

Figure 2-4 Plot of Highest Instrument Response Recorded in Each Grid Block. Highlighted Responses are Greater than the 95th Percentile.

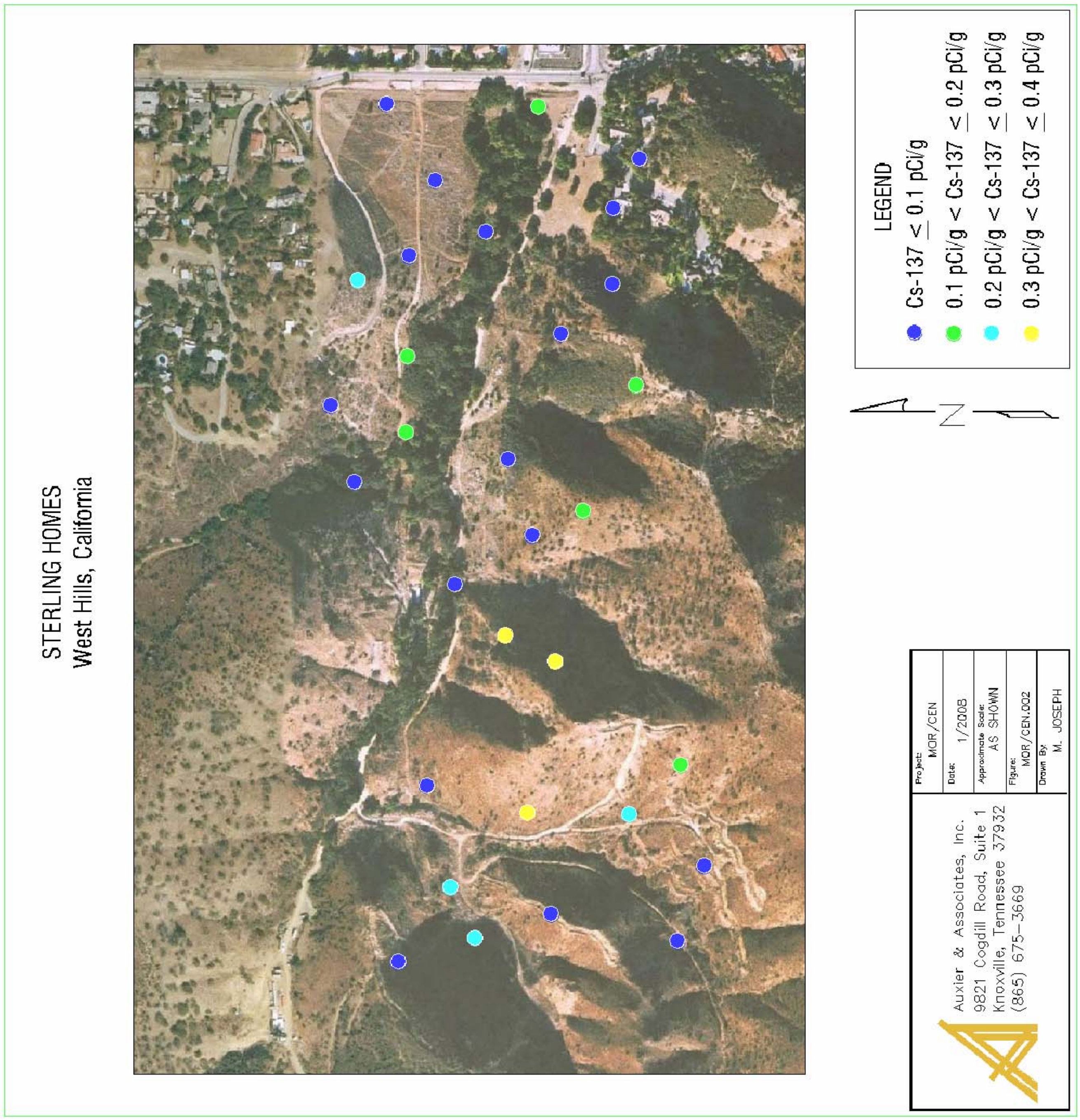

Figure 2-5 Cs-137 Results from Initial Investigation, Plotted by Sample Location

Table 2-1 Number of Soil Samples Taken in 2005, By Area

Nuclide	Area of the Site				
	Creek	North	South	West	Total
Cs-137	7	10	7	14	38
Pu-238	3	3	3	9	18
Pu-239/240	3	3	3	9	18
Sr-90	3	3	3	9	18

Table 2-2 Gamma Spectroscopy Results from 2005 Reported for Cs-137

Area	Sample Id	Average Radiation Survey Results (μR/h)	Cs-137 Result ± 2 σ TPE (pCi/g)
North	A2 -N	16.5	0.00201 ± 0.0326
North	C4 -N	17.8	0.150 ± 0.0596
North	D1 -N	12.4	0.0424 ± 0.036
North	F4 -N	20.3	0.134 ± 0.0532
North	I2 -N	19.3	0.260 ± 0.0728
North	J4 -N	12	0.093 ± 0.0481
North	K7 -N	19	0.0408 ± 0.0293
North	M5 -N	13	0.0434 ± 0.034
North	P3 -N	13.3	0.050 ± 0.031
North	P9 -N	11.5	0.128 ± 0.0523
South	B5 -S	17.2	0.167 ± 0.0615
South	D2 -S	19.2	0.031 ± 0.0403
South	G7 -S	16.3	0.133 ± 0.0609
South	I4 -S	23.6	0.0316 ± 0.034
South	K6 -S	22.5	0.0965 ± 0.0538
South	N6 -S	21.3	0.055 ± 0.0543
South	P7 -S	17.2	0.0356 ± 0.0303
West	A4 -W	15.6	0.0552 ± 0.0349
West	B15 -W	16.1	0.0769 ± 0.039
West	B7 -W	19.2	0.215 ± 0.0652
West	C10 -W	18.6	0.0578 ± 0.0332
West	D6 -W	20.6	0.217 ± 0.0713
West	E16 -W	16	0.0127 ± 0.0211
West	G13 -W	18.8	0.262 ± 0.0806
West	G9 -W	18.1	0.310 ± 0.0892
West	H5 -W	21.5	0.0889 ± 0.0442
West	I15 -W	23.4	0.187 ± 0.0668
West	M10 -W	19.9	0.377 ± 0.0884
West	N8 -W	18.2	0.378 ± 0.0811
West	P6 -W	13.8	0.0989 ± 0.0535
West	R9 -W	20.1	0.036 ± 0.0348
Creek	LCR -8	no data	no data [a]
Creek	LCR -16	no data	0.0368 ± 0.0313
Creek	LCR -24	no data	0.0388 ± 0.0372
Creek	LCR -32	no data	0.0689 ± 0.0504
Creek	LCR -40	no data	no data
Creek	LCR -46	no data	0.0585 ± 0.0365
Creek	NDR -5	no data	0.0503 ± 0.0351
	CONC -1	no data	no data
	CONC -2	no data	0.0578 ± 0.036
	Debris P6	no data	0.035 ± 0.0335

[a] Sample was analyzed by gamma spectroscopy, but no Cs-137 result was reported.

Table 2-3 Results from 2005 Radiochemical Analysis of Pu-238, Pu-239/240, and Sr-90

Area	Sample ID	Nuclide: Pu-238 Value ± 2 Sig TPU (MDC) (pCi/g)	Pu-239/240 Value ± 2 Sig TPU (MDC) (pCi/g)	Sr-90 Value ± 2 Sig TPU (MDC) (pCi/g)
Creek	LCR -8	0.000 ± 0.000 (0.043)	0.000 ± 0.000 (0.043)	0.013 ± 0.293 (0.523)
	LCR -24	0.016 ± 0.032 (0.043)	0.000 ± 0.000 (0.043)	-0.198 ± 0.363 (0.674)
	LCR -40	0.000 ± 0.000 (0.046)	0.000 ± 0.000 (0.046)	-0.306 ± 0.340 (0.652)
North	A2 -N	-0.003 ± 0.006 (0.025)	0.002 ± 0.011 (0.025)	0.155 ± 0.422 (0.740)
	F4 -N	0.005 ± 0.011 (0.016)	0.006 ± 0.011 (0.008)	0.300 ± 0.130 (0.210)
	M5 -N	0.002 ± 0.009 (0.019)	0.002 ± 0.008 (0.019)	0.064 ± 0.367 (0.665)
South	B5 -S	0.002 ± 0.011 (0.016)	0.019 ± 0.016 (0.009)	0.038 ± 0.099 (0.217)
	I4 -S	-0.002 ± 0.004 (0.020)	-0.002 ± 0.004 (0.020)	0.470 ± 0.490 (0.782)
	N6 -S	0.002 ± 0.009 (0.021)	0.016 ± 0.016 (0.011)	-0.256 ± 0.372 (0.761)
West	A4 -W	0.004 ± 0.009 (0.012)	0.006 ± 0.014 (0.023)	0.586 ± 0.504 (0.778)
	C10 -W	0.003 ± 0.012 (0.009)	-0.001 ± 0.012 (0.017)	0.043 ± 0.093 (0.202)
	D6 -W	0.000 ± 0.000 (0.012)	0.005 ± 0.009 (0.012)	0.192 ± 0.413 (0.715)
	G13 -W	-0.003 ± 0.005 (0.023)	0.026 ± 0.022 (0.012)	0.087 ± 0.487 (0.872)
	G9 -W	0.000 ± 0.000 (0.011)	0.008 ± 0.012 (0.011)	0.824 ± 0.495 (0.703)
	M10 -W	-0.002 ± 0.012 (0.020)	0.016 ± 0.016 (0.023)	0.120 ± 0.100 (0.210)
	N8 -W	0.003 ± 0.013 (0.019)	0.019 ± 0.018 (0.023)	0.350 ± 0.140 (0.210)
	P6 -W	0.000 ± 0.000 (0.010)	0.012 ± 0.014 (0.010)	-0.586 ± 0.443 (0.904)
	R9 -W	0.000 ± 0.000 (0.010)	0.004 ± 0.008 (0.010)	-0.183 ± 0.437 (0.843)

Table 2-4 Summary Statistics for Radioanalysis of Soil Samples Collected During the Initial Investigation (2005)

Statistic	Cs-137	Pu-238	Pu-239/240	Sr-90	Units
Count	36	18	18	18	Samples
Min	0.002	-0.003	-0.002	-0.586	pCi/g
Max	0.378	0.016	0.026	0.824	pCi/g
Median	0.073	0.000	0.005	0.076	pCi/g
Arithmetic Mean	0.114	0.002	0.008	0.095	pCi/g
Standard Deviation	0.101	0.004	0.008	0.339	pCi/g

3. 2007 SUPPLEMENTAL INVESTIGATION

A supplemental investigation was conducted in 2007 to augment the data collected in the previous (2005) investigation. This supplemental investigation had two objectives. One objective was to verify and supplement the information collected in the initial survey. The other objective was to expand the area investigated by collecting additional radiological data from the proposed residential area in Dayton Canyon. The objectives of the survey and the proposed methods for investigating the study area are presented in greater detail in the "Supplemental Radiological Investigation Sampling and Analysis Plan" (AllWest 2007a).

3.1 Selection of Sample Locations

Because there were two objectives for the supplemental investigation, samples were selected using two different methods. Each method was intended to satisfy the data requirements one of the objectives.

3.1.1 <u>Selection of Step-out Sampling Locations</u>

The initial sampling investigation reported soil concentrations for four radionuclides: Cs-137, Sr-90, Pu-238, and Pu-239/240. Locations producing concentrations exceeding investigative criteria set by AllWest were singled out for additional investigation. This technique identified ten (10) grid blocks of potential interest (Table 3-1, reproduced using information from AllWest 2006, Table 3). Three additional grid blocks with results ranked in the lower half of the data range were also selected. This produced a total of 13 grid blocks for inclusion in the step-out sampling program.

Five locations were selected for sampling of each grid block identified:

- The original sampling location used by the initial investigation,
- a location approximately 100 feet to the NW of the initial location,
- a location approximately 100 feet to the NE of the initial location,
- a location approximately 100 feet to the SW of the initial location, and
- a location approximately 100 feet to the SE of the initial location.

This generated a sampling pattern where the initial point was in the center, and the four "step-out" locations surrounded the initial location. Figure 3-1 illustrates the pattern and the planned step-out sampling locations.

3.1.2 <u>Selection of "Spatial Sampling" Locations</u>

Spatial sample locations were selected to expand the area of investigation beyond the initial sampling locations. Representatives of DTSC and AllWest decided to collect samples on the planned lot lines so each building lot would have one sample next to it. Land survey teams marked the lot lines and sample locations were selected near the midpoint of each lot line. Figure 3-2 shows the intended spatial sampling locations described in the sampling and analysis plan.

3.2 Description of Sampling

3.2.1 Step-out Samples

A total of 72 samples was collected in March 2007 during the step-out sampling task. These included 63 surface soil (0 to 6 inch) and nine (9) subsurface soil samples.

Four locations described in the sampling plan were merged during sampling:

- The NE corner location of B7 and the SW corner location for D6 were relatively close together. These were merged to create a single, new location called D6/B7.
- The NE corner location of M10 and the SW corner location for N8 were relatively close together. These were merged to create a single, new location called N8/M10.

3.2.2 Spatial Soil Samples

A total of 95 locations was sampled as part of the spatial sampling task in March 2007 (AllWest 2007b). One-hundred-and-five (105) samples were collected and sent for analysis during the spatial sampling task. These included 71 surface soil samples[5], 32 subsurface soil samples and two concrete samples. Figure 3-2 presents the planned locations of the spatial samples.

3.3 Sample Analysis

A combined total of 177 samples was sent to Paragon Analytics for radiological analysis from the step-out and spatial analysis tasks. Seventy-four (72) samples from the step-out program were analyzed for Cs-137, Sr-90, Pu-239 and Pu-239/240. One-hundred-and-five (105) samples from the spatial sampling program were analyzed for Cs-137 and Sr-90. None of the samples collected during the spatial sampling task were submitted for plutonium analysis.

3.4 Results

This section presents the results of the supplemental investigation. The results from the step-out and spatial sampling tasks are first provided separately, and then the combined results are presented. Sections 3.4.1 and 3.4.2 also contain discussions about surface soil results.

---

[5] These samples were labeled with the suffix "@1' " for sample tracking purposes, but the work plan and personal interviews indicate that these were surface grab-samples from the first six inches of soil.

Subsurface soil results are discussed in the Section 3.4.3, which describes the combined sampling results.

3.4.1 Step-out Sample Results

The laboratory reported Cs-137, Sr-90, Pu-238 and Pu-239/240 results for 63 surface soil and 9 subsurface soil samples. Table 3-2 presents summary statistics for these results. Statistics are presented for each media type. For example, the Cs-137 concentrations reported for the 63 surface soil samples range from -0.190 to 0.18 pCi/g, with a median value of 0.005 pCi/g and an average value of 0.076 pCi/g.

Figure 3-3 displays the Cs-137 concentrations in surface soil samples collected during this task on an aerial photo of the site. The results are color coded by the magnitude of the result. Dark green indicates the result is less than the average local background value presented in a previous study (McLaren/Hart 1995). Green indicates the value is higher than the average McLaren/Hart value but lower than the 98th percentile of the supplemental data set (Stepout + Spatial). Light blue indicates the value is in the top two percent of that data set. Figure 3-4 displays similar information for Sr-90 concentrations.

3.4.2 Concentrations in Surface Soil from Step-out Sampling Task

The concentrations of Cs-137, Sr-90, Pu-238, and Pu-239/240 in the step-out samples from surface soil are presented in Tables 3-3 through 3-6, respectively. These tables contain a lot of information, and a description of their layout is provided here. The first column in the tables contains the area designation used in the initial sampling investigation. The second column lists the parcel the samples are associated with. The third column presents the results of the 2005 investigation and the fourth column lists the concentration in the corresponding samples taken from those same locations in 2007. The last three columns list the locations and results of the step-out samples associated with the initial (center) sampling location. This format allows the concentrations in soil from the initial sample location to be compared with the concentration reported in the samples collected by the 2007 investigation.

3.4.2.1 Step-out Surface Soil Sample Results for Cs-137

Table 3-3 presents the Cs-137 results for the samples collected during initial investigation in 2005 and the step-out sampling task in 2007. Six grid blocks were selected for further investigation because of their 2005 Cs-137 results: B7-W, D6-W, G9-W, G13-W, and M10-W. The Cs-137 concentrations from these grid blocks reported by the initial investigation are highlighted in red.

Comparing the results from samples collected at these locations in 2005 and 2007 shows that in all cases the 2007 Cs-137 concentrations are lower than the earlier results. Cs-137 concentrations reported for the samples from the four corner points around each location are also lower than the initial concentrations in all cases.

3.4.2.2 Step-out Surface Soil Sample Results for Sr-90

Table 3-4 presents the Sr-90 results for the samples collected during initial investigation in 2005 and the step-out sampling task in 2007. Four grid blocks were selected for further investigation because of their 2005 Sr-90 results: I4-S, A4-W, G9-W, and N8-W. The Sr-90 concentrations from these grid blocks reported by the initial investigation are highlighted in red.

Comparing the results from samples collected at these locations in 2005 and 2007 shows that in all cases the 2007 Sr-90 concentrations are lower than the earlier results. Sr-90 concentrations reported for the samples from the four corner points around each location are also lower than the initial samples in all cases.

3.4.2.3 Step-out Surface Soil Sample Results for Pu-238

The Pu-238 concentrations in the samples collected during the step-out sampling task are presented in Table 3-5. One grid block, F4-S, was selected for further investigation because of its 2005 Pu-238 result. The Pu-238 concentration for the initial sample from that grid block is highlighted in red.

Comparing the results from the sample collected at this location in 2005 and 2007 shows that the Pu-238 concentration in the 2007 sample result is lower than the concentration reported by the 2005 investigation. The Pu-238 concentrations reported for the samples from the four corner points are also equal to or lower than the initial sample.

3.4.2.4 Step-out Surface Soil Sample Results for Pu-239/240.

The Pu-239/240 concentrations in the samples collected during the step-out sampling task are presented in Table 3-6. One grid block, G13-W was selected for further investigation because of its 2005 Pu-239/240 result. The Pu-239/140 concentration for the initial sample from that grid block is highlighted in red.

Comparing the results from samples collected at this location in 2005 and 2007 shows that the 2007 sample results are lower than the Pu-239/240 concentrations reported by the 2005 investigation. The Pu-239/240 concentrations reported for the samples from the four corner points are also lower than the initial sample collected in 2005.

3.4.3 Results from Spatial Sampling Task

AllWest Remediation collected and analyzed 105 samples as part of the spatial sampling task. Seventy-one (71) of these were surface soil samples, and 32 were subsurface soil samples. The remaining two (2) samples were concrete samples. Table 3-7 presents the reported Cs-137 and Sr-90 concentrations in surface soil and surface fill samples. Table 3-8 contains results reported for subsurface and concrete samples. The Cs-137 and Sr-90 concentrations from surface soil samples collected during this task are displayed on Figure 3-5 and Figure 3-6, respectively. The data is color coded using the scheme described in Section 3.4.1.

Table 3-9 presents summary statistics for the results from the spatial samples. Statistics are presented for each radionuclide and each media type.[6] For example, the Cs-137 concentrations reported for the 71 surface soil samples range from -0.075 to 0.36 pCi/g, with a median value of 0.054 pCi/g and an average value of 0.0707 pCi/g. The Sr-90 results ranges from –0.083 to 0.73 pCi/g, with a median value of 0.051 pCi/g, and an average value of 0.075 pCi/g.

3.4.4 Combined Results from Step-out and Spatial Sampling

The step-out and spatial sampling tasks collected and an analyzed a total of 177 samples. These included 134 surface samples, 41 subsurface samples, and two concrete samples. All 177 samples were analyzed for Cs-137 and Sr-90. Pu-238 and Pu-239/240 results are available on the 72 step-out samples.

Summary statistics for Cs-137, Sr-90, Pu-238, and Pu-239/240 concentrations in samples collected during the two supplemental sampling tasks are presented in Table 3-10. Separate statistics are presented for all radionuclides in surface soil and subsurface soil. Summary statistics for the concrete samples are not included in these tables because there were only two samples.

Figure 3-7 displays the Cs-137 concentrations in surface soil samples collected during this task on an aerial photo of the site. In places where sample locations coincide with another investigation, the individual data points are represented by two “half-moon” shapes. Figure 3-8 displays similar information for Sr-90 concentrations.

3.4.4.1 Ratios of Radionuclides in Surface soil

Sr-90 and Cs-137 are produced together by nuclear fission. If these radionuclides are released into the air together they will travel along the same air currents until they are deposited on soil

---

[6] Summary statistics for the two concrete samples are not provided.

together. Once deposited, they will move through the soil at different rates, which means the ratios of Cs-137 to Sr-90 in surface soil will change over time. However, the ratios should change at a similar rate across the area of the hypothetical deposition, so the ratio of Cs-137 to Sr-90 should be similar from one sample location to the next.

Table 3-11 presents the paired Cs-137 and Sr-90 concentrations for each surface sample collected during the supplemental investigation. The table also lists the ratio of these two radionuclides for each sample. While one must be careful drawing conclusions from this information, it can be seen that the Cs-137 to Sr-90 ratios in these samples vary greatly from one location to the next.

3.4.4.2 Comparison of Surface and Subsurface Results

If a large amount of Cs-137 were deposited on the soil surface in recent years (from any source) one would expect to find residual levels in the soil. Because Cs-137 tends to adhere to soil once it is deposited, it is more likely to remain on or near the surface and not seep far into subsurface soil. In areas with measurable surface deposition of Cs-137, one would expect to find concentrations of Cs-137 to be higher in surface soil than subsurface soil years after the event. To test this, the analytical results from subsurface soil samples in the study area were compared to surface soil samples to determine if they were statistically different.

To make this comparison, each subsurface sample was first paired with a surface sample. In the case of the step-out sampling program, the surface and subsurface samples from the same borehole were selected for inclusion in the comparison. In the spatial sampling program the subsurface samples did not have a matching surface sample, so the subsurface samples were paired to the nearest surface sample.

Once the sample pairs were selected they were all listed together and ranked by the sample concentrations. These ranked values are presented in Table 3-12 for Cs-137. The ranked format allows one to test the hypothesis that the populations of surface and subsurface concentrations are different from one another. This is done by applying the Wilcoxson Rank Sum (WRS) test to the ranked samples.

Table 3-12 presents the ranked Cs-137 concentrations for the paired surface and subsurface samples. Because the sum of the subsurface ranks is between the Upper and Lower Critical Values, the sample populations are not statistically different from on another, and the hypothesis that Cs-137 is higher in surface soil cannot be proven to be true.

Similar information is presented in Table 3-13 for Sr-90. Again, because the sum of the subsurface ranks is between the Upper and Lower Critical Values, the surface soil and subsurface soil data sets for Sr-90 concentrations are not proven to be statistically different from on another.

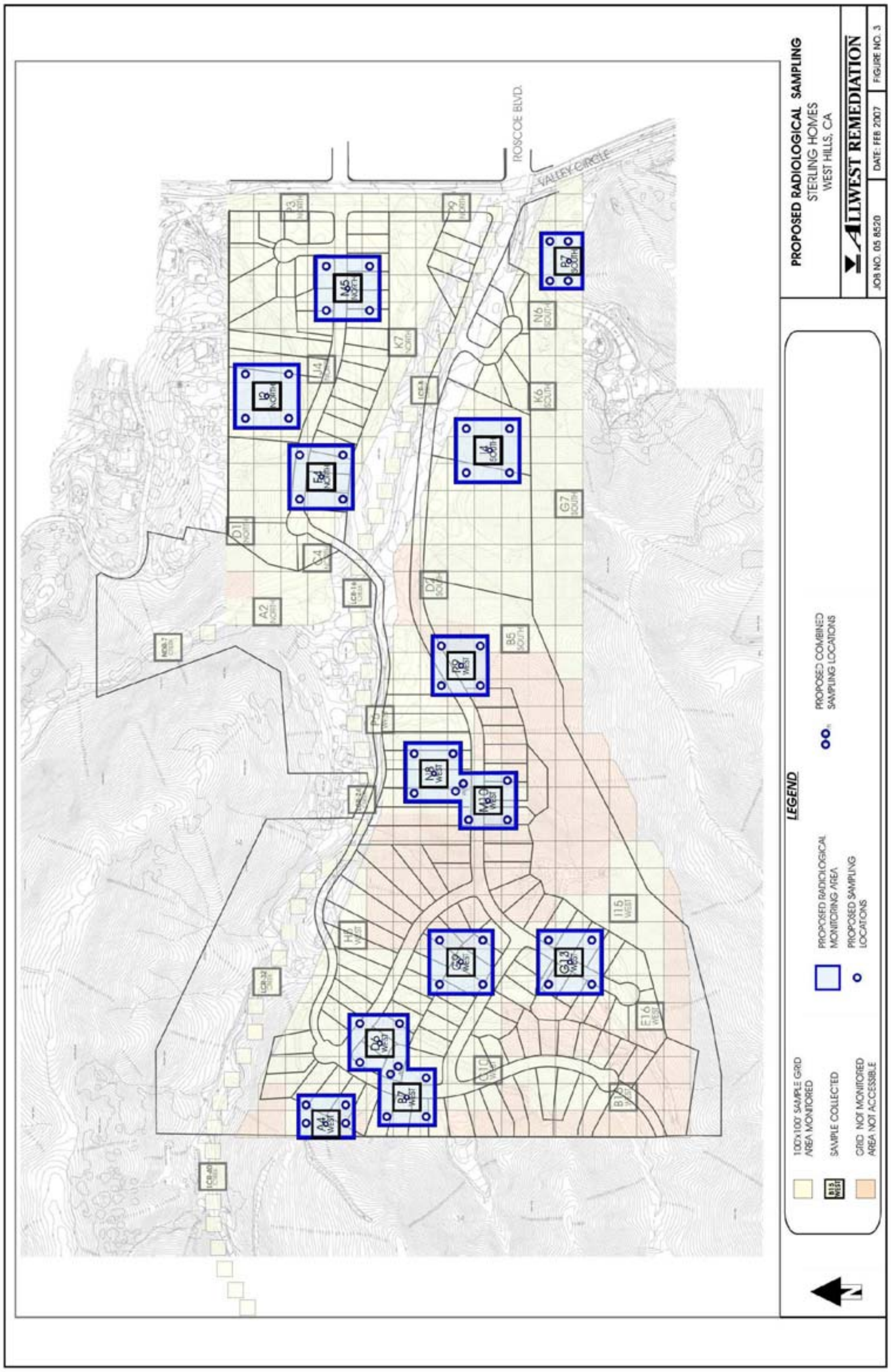

Figure 3-1 Planned Step-out Sampling Locations

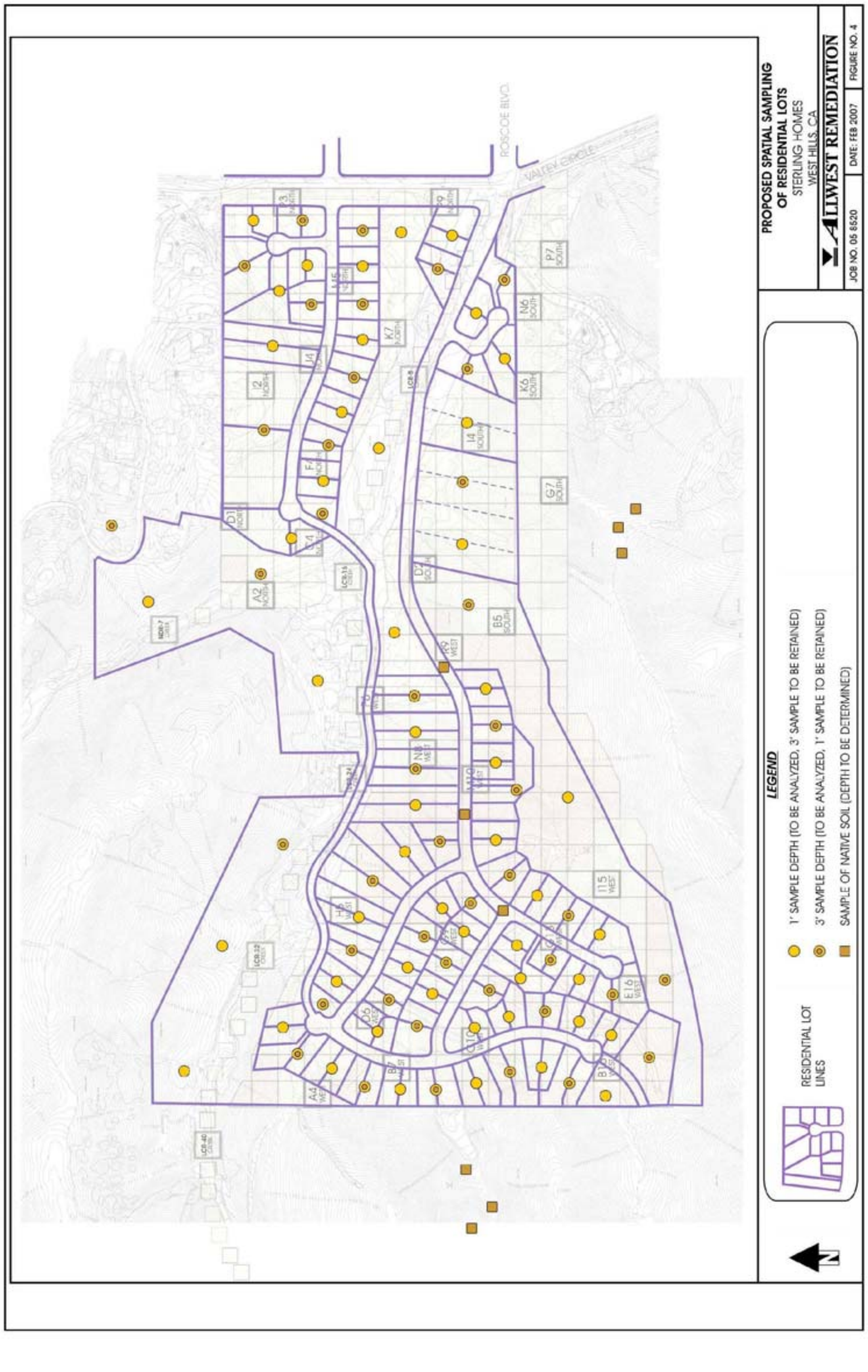

Figure 3-2 Planned Spatial Sampling Locations

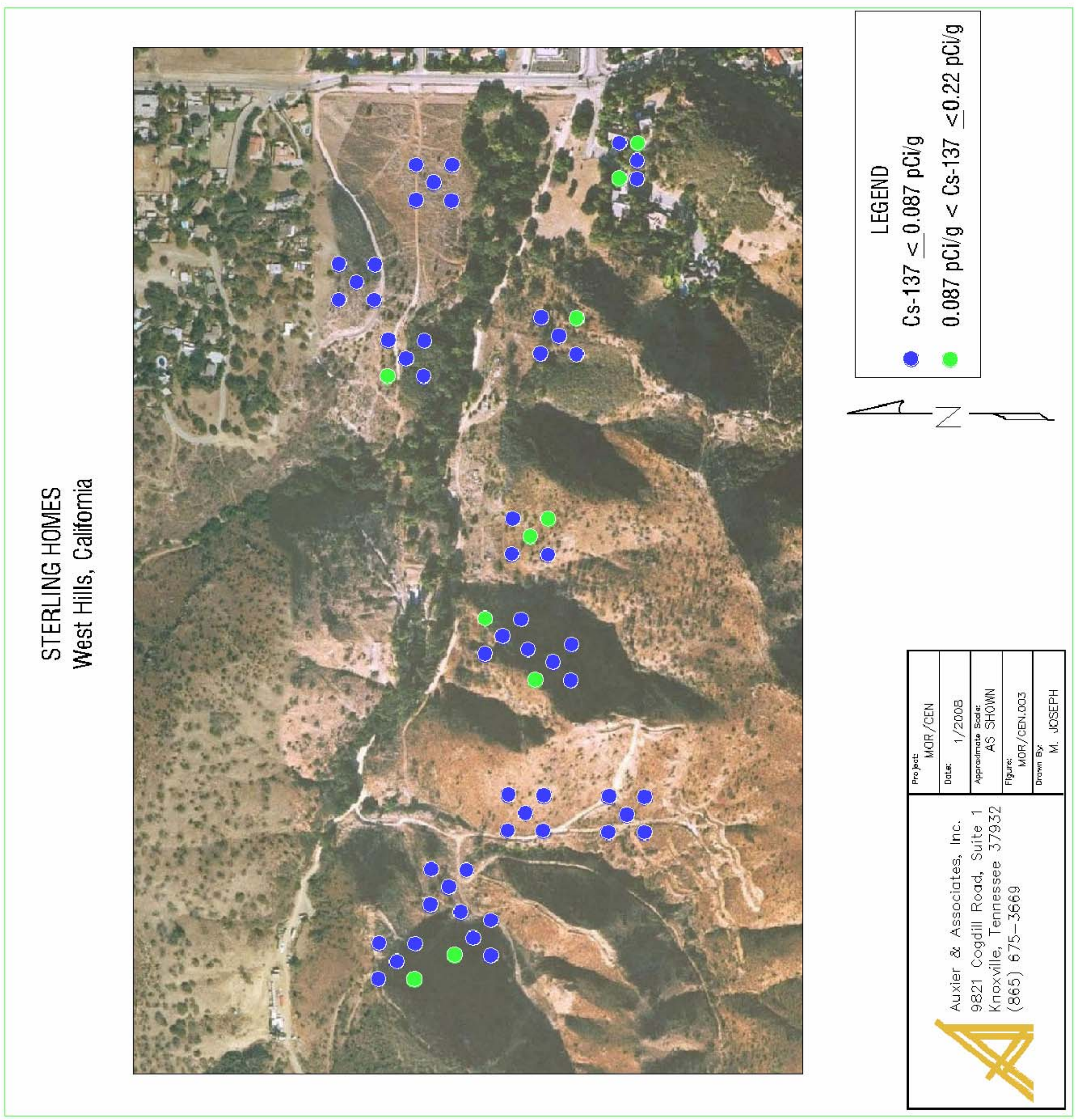

Figure 3-3 Cs-137 Results for Step-out Sampling

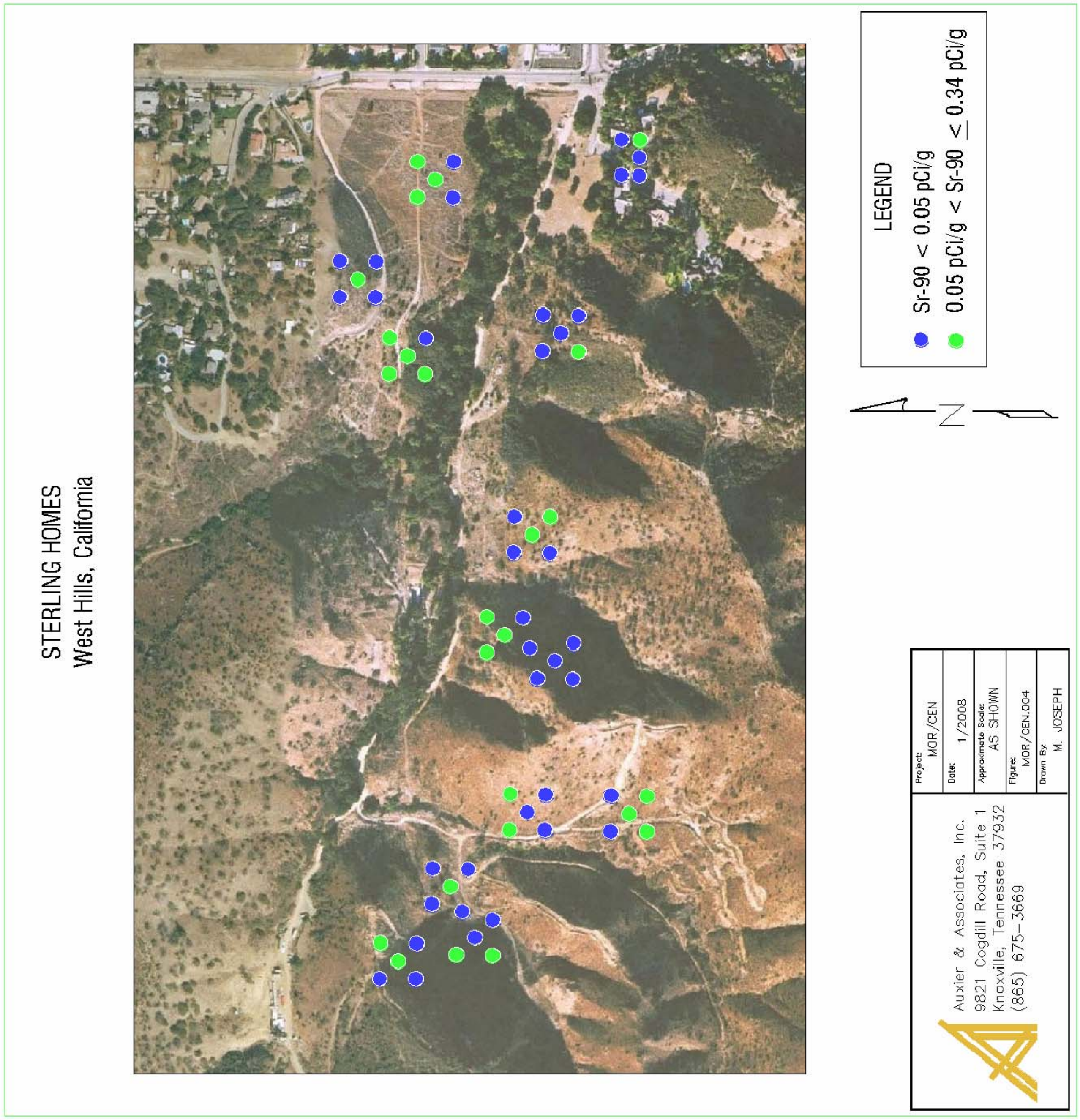

Figure 3-4 Sr-90 Results for Step-out Sampling

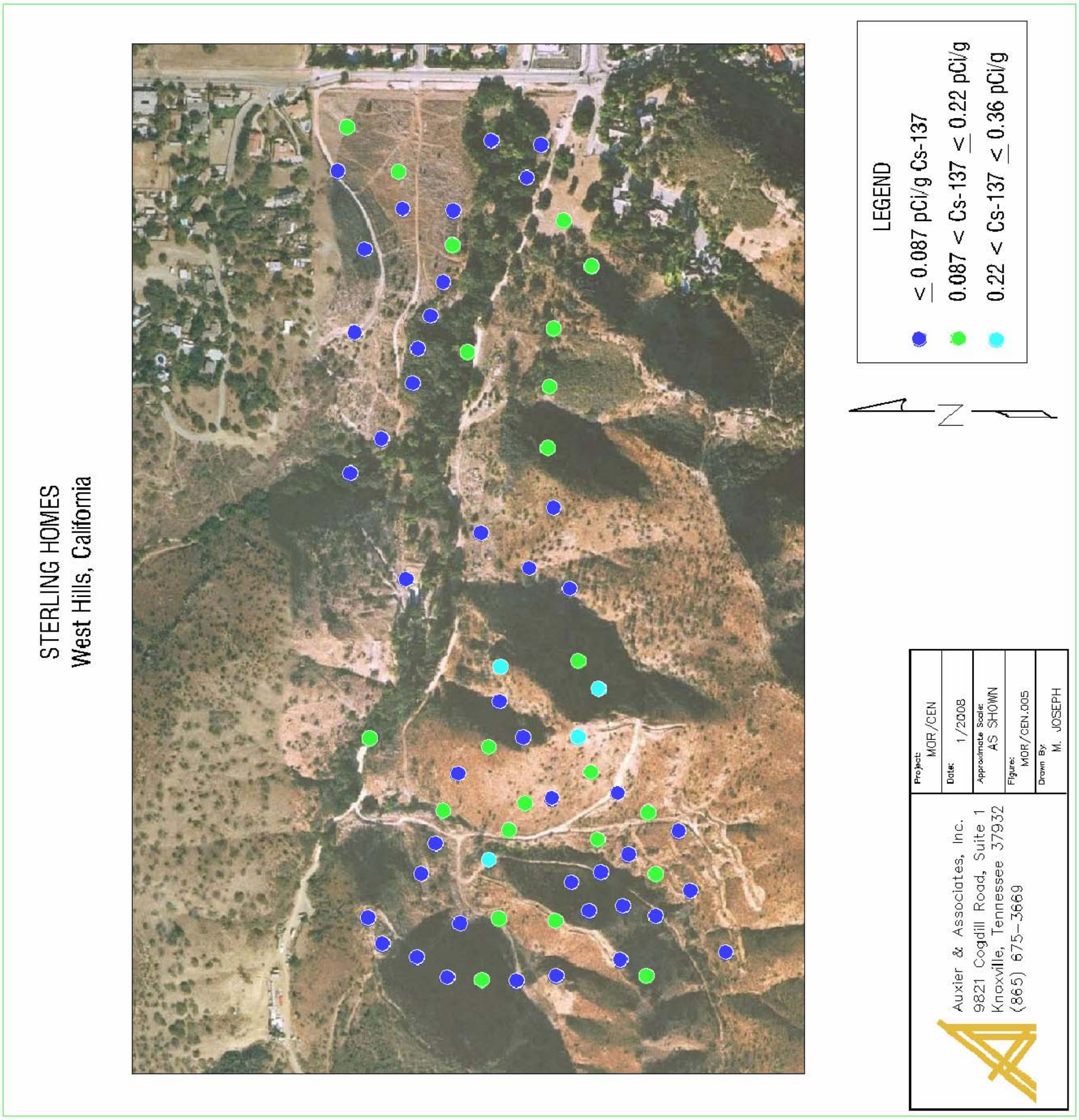

Figure 3-5 Cs-137 Results for Spatial Sampling, Plotted by Location

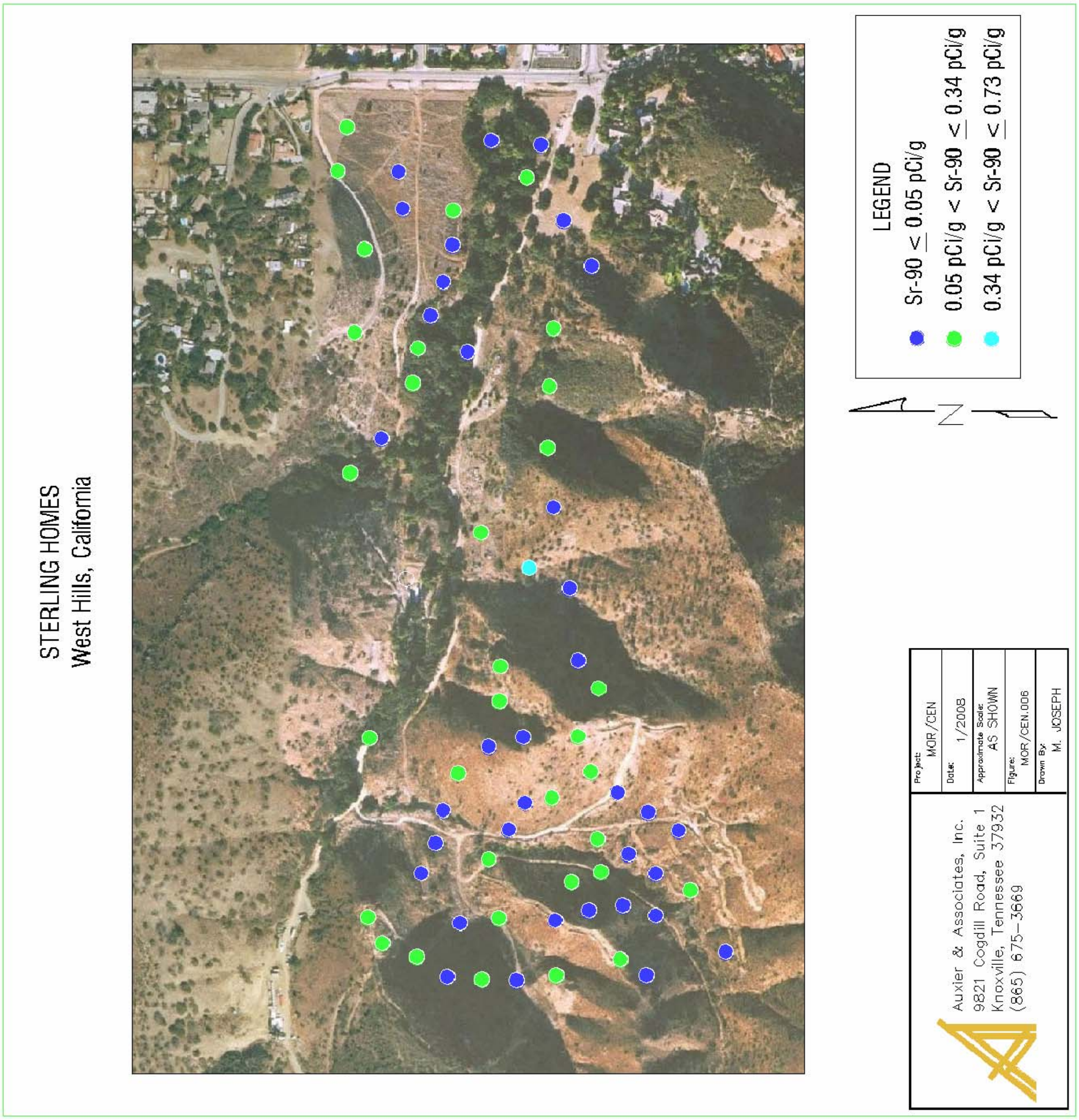

Figure 3-6 Sr-90 Results for Spatial Sampling, Plotted by Location

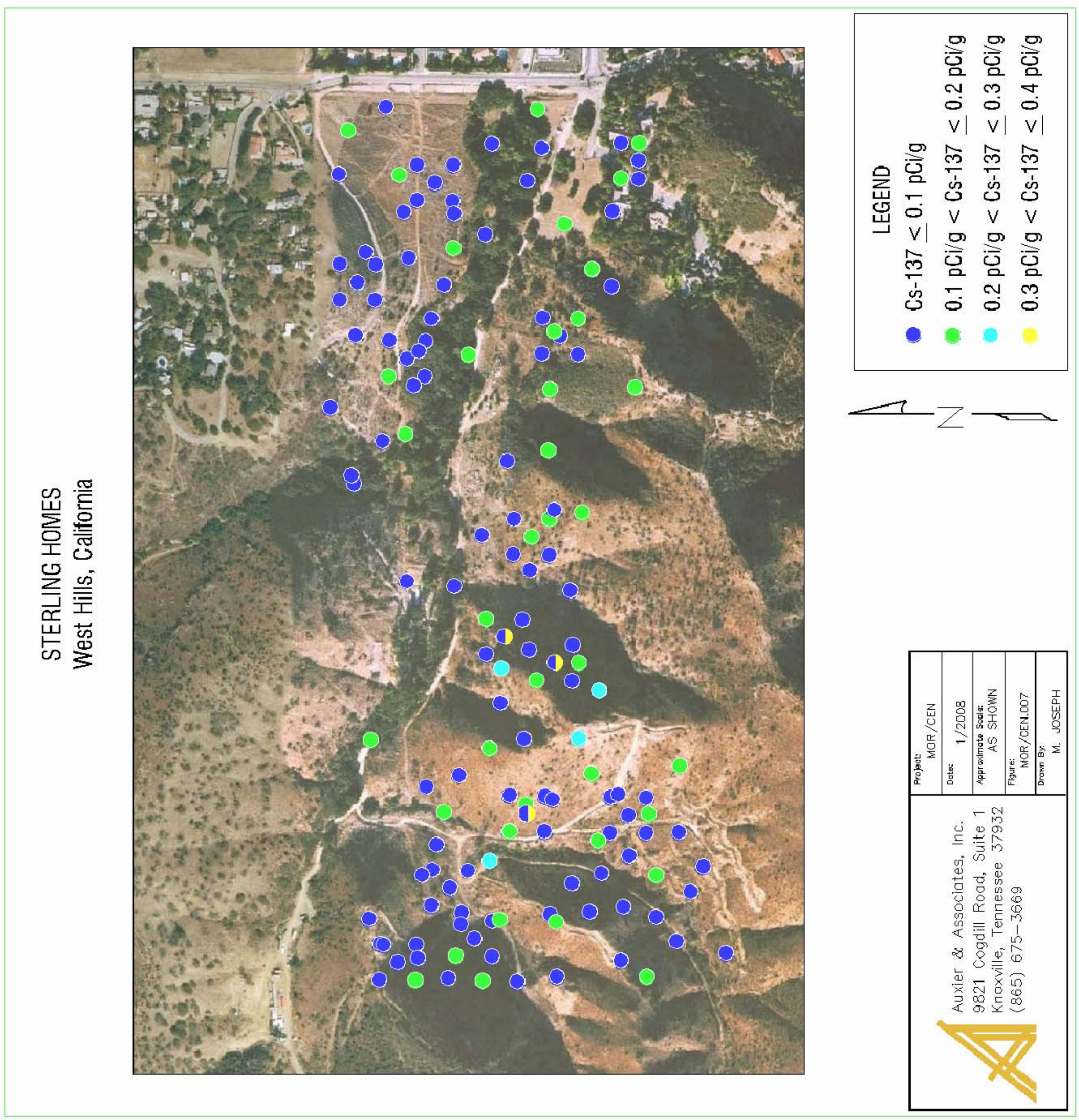

Figure 3-7 Cs-137 Concentrations in Surface Soil, Initial and Supplemental Sampling, Plotted by Location

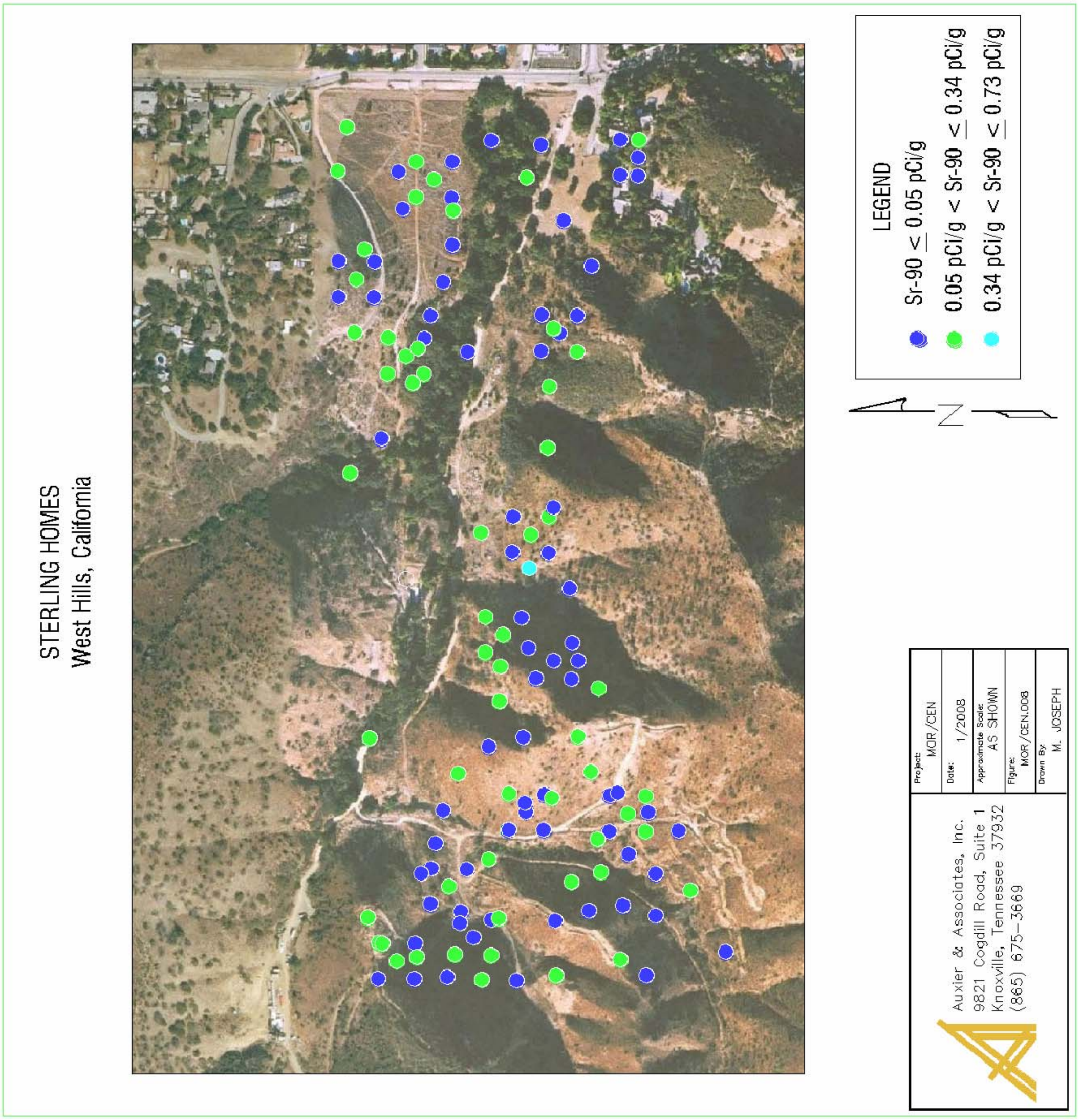

Figure 3-8 Sr-90 Concentrations in Surface Soil, Initial and Supplemental Sampling, Plotted by Location

Table 3-1 Data Used to Select 13 Locations of Step-out Samples

Sample Id	Sample Date	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-238 (pCi/g)	Pu-239/240 (pCi/g)	Location Selected for Supplemental Radiological Investigation
AllWest Investigation Criteria►		**0.21**	**0.34**	**0.005**	**0.025**	
A2-N	10/27/2005	0.00201	0.155	-0.003	0.002	
C4-N	10/27/2005	0.150				
D1-N	10/27/2005	0.0424				
F4-N	10/27/2005	0.134	0.3	**0.005**	0.006	**Yes, =0.005**
I2-N	10/27/2005	**0.260**				**Yes, > 0.21**
J4-N	10/27/2005	0.093				
M5-N	10/27/2005	0.0434	0.064	0.002	0.002	**Yes**
K7-N	10/27/2005	0.0408				
P3-N	10/27/2005	0.050				
P9-N	10/27/2005	0.128				
B5-S	10/27/2005	0.167	0.038	0.002	0.019	
D2-S	10/28/2005	0.031				
G7-S	10/28/2005	0.133				
I4-S	10/27/2005	0.0316	**0.47**	-0.002	-0.002	**Yes, > 0.34**
N6-S	10/28/2005	0.055	-0.256	0.002	0.016	
K6-S	10/28/2005	0.0965				
P7-S	10/28/2005	0.0356				**Yes**
A4-W	10/31/2005	0.0552	**0.586**	0.004	0.006	**Yes, > 0.34**
B7-W	10/31/2005	**0.215**				**Yes, > 0.21**
B15-W	10/31/2005	0.0769				
C10-W	10/31/2005	0.0578	0.043	0.003	-0.001	
D6-W	10/31/2005	**0.217**	0.192	0	0.005	**Yes, > 0.21**
E16-W	10/31/2005	0.0127				
G9-W	10/31/2005	**0.310**	**0.824**	0	0.008	**Yes, > 0.21**
G13-W	10/31/2005	**0.262**	0.087	-0.003	**0.026**	**Yes, > 0.21**
H5-W	10/31/2005	0.0889				
I15-W	10/31/2005	0.187				
M10-W	10/31/2005	**0.377**	0.12	-0.002	0.016	**Yes, > 0.21**
N8-W	10/28/2005	**0.378**	**0.35**	0.003	0.019	**Yes, > 0.21**
P6-W	10/28/2005	0.0989	-0.586	0	0.012	
R9-W	10/28/2005	0.036	-0.183	0	0.004	**Yes**
LCR-8	11/29/2005	No data	0.013	0	0	
LCR-24	11/29/2005	0.0388	-0.198	0.016	0	
LCR-40	12/01/2005	No data	-0.306	0	0	

Note: From Table 3, AllWest 2007a. Locations selected for supplemental sampling are highlighted in red.

Table 3-2 Summary Statistics for Step-out Samples

Radionuclide	Statistic	Media			Units
		All	Surface Soil	Subsurface Soil	
Cs-137	Number	72	63	9	Samples
	Minimum	-0.190	-0.190	-0.110	pCi/g
	Maximum	0.180	0.180	0.040	pCi/g
	Median	0.010	0.010	0.000	pCi/g
	Arithmetic Mean	0.005	0.007	-0.015	pCi/g
	Standard Deviation	0.076	0.079	0.051	pCi/g
Sr-90	Number	72	63	9	Samples
	Minimum	-0.092	-0.092	-0.030	pCi/g
	Maximum	0.260	0.260	0.160	pCi/g
	Median	0.020	0.020	0.010	pCi/g
	Arithmetic Mean	0.039	0.041	0.022	pCi/g
	Standard Deviation	0.080	0.083	0.057	pCi/g
Pu-238	Number	72	63	9	Samples
	Minimum	-0.0031	-0.0031	-0.0020	pCi/g
	Maximum	0.0080	0.0070	0.0080	pCi/g
	Median	0.0000	0.0000	-0.0008	pCi/g
	Arithmetic Mean	0.0002	0.00005	0.0010	pCi/g
	Standard Deviation	0.0024	0.0023	0.0034	pCi/g
Pu-239/240	Number	72	63	9	Samples
	Minimum	-0.0080	-0.0080	-0.002	pCi/g
	Maximum	0.0130	0.0130	0.007	pCi/g
	Median	0.0012	0.0012	0.001	pCi/g
	Arithmetic Mean	0.0021	0.0022	0.001	pCi/g
	Standard Deviation	0.0041	0.0043	0.003	pCi/g

Table 3-3 Comparison of 2005 and 2007 Surface Soil Results for Cs-137

Area	Parcel	2005 Sample Results (pCi/g)	Results from Resampling at 2005 Location in 2007 (pCi/g)	2007 Results Reported for Samples Collected Around 2005 Location: Direction from 2005 Location	2007 Results Reported for Samples Collected Around 2005 Location: 2007 Results (pCi/g)	Average of All 2007 Results in Area (pCi/g)
North	F4-North	0.134 +/- 0.0532	0.07 +/- 0.15	NE	-0.06 +/- 0.15	0.018 +/- 0.000
				NW	0.13 +/- 0.14	
				SE	-0.02 +/- 0.15	
				SW	-0.03 +/- 0.12	
	I2-North	**0.26 +/- 0.0728**	**0.05 +/- 0.11**	NE	0.04 +/- 0.15	0.023 +/- 0.047
				NW	-0.057 +/- 0.098	
				SE	0.06 +/- 0.16	
				SW	0.02 +/- 0.13	
	M5-North	0.0434 +/- 0.034	-0.06 +/- 0.13	NE	-0.1 +/- 0.12	-0.038 +/- 0.064
				NW	0.03 +/- 0.16	
				SE	-0.09 +/- 0.11	
				SW	0.03 +/- 0.15	
South	I4-South	0.0316 +/- 0.034	-0.08 +/- 0.13	NE	-0.04 +/- 0.13	-0.004 +/- 0.075
				NW	0 +/- 0.16	
				SE	0.12 +/- 0.14	
				SW	-0.02 +/- 0.13	
	P7-South	0.0356 +/- 0.0303	0.03 +/- 0.14	NE	-0.06 +/- 0.13	0.042 +/- 0.075
				NW	0.13 +/- 0.12	
				SE	0.1 +/- 0.13	
				SW	0.01 +/- 0.12	
West	A4-West	0.0552 +/- 0.0349	0.01 +/- 0.12	NE	-0.01 +/- 0.15	0.008 +/- 0.056
				NW	-0.01 +/- 0.11	
				SE	-0.05 +/- 0.22	
				SW	0.1 +/- 0.15	
	B7-West	**0.215 +/- 0.0652**	**0.01 +/- 0.12**	NE	-0.14 +/- 0.12	-0.012 +/- 0.094
				NW	0.12 +/- 0.14	
				SE	-0.01 +/- 0.13	
				SW	-0.04 +/- 0.13	
	D6-West	**0.217 +/- 0.0713**	**0.05 +/- 0.12**	NE	0.044 +/- 0.099	0.0088 +/- 0.083
				NW	0.04 +/- 0.12	
				SE	0.05 +/- 0.18	
				SW	-0.14 +/- 0.12	
	G13-West	**0.262 +/- 0.0806**	**0.04 +/- 0.15**	NE	-0.03 +/- 0.12	-0.053 +/- 0.084
				NW	-0.04 +/- 0.11	
				SE	-0.047 +/- 0.097	
				SW	-0.19 +/- 0.13	
	G9-West	**0.31 +/- 0.0892**	**-0.07 +/- 0.12**	NE	0.01 +/- 0.099	0.0020 +/- 0.061
				NW	0.07 +/- 0.13	
				SE	-0.05 +/- 0.13	
				SW	0.05 +/- 0.12	
	M10-West	**0.377 +/- 0.0884**	**0.04 +/- 0.1**	NE	0.04 +/- 0.11	0.070 +/- 0.058
				NW	0.17 +/- 0.14	
				SE	0.03 +/- 0.12	
				SW	0.07 +/- 0.11	
	N8-West	**0.378 +/- 0.0811**	**0.02 +/- 0.1**	NE	0.11 +/- 0.12	-0.012 +/- 0.11
				NW	-0.04 +/- 0.15	
				SE	-0.19 +/- 0.15	
				SW	0.04 +/- 0.11	
	R9-West	0.036 +/- 0.0348	0.13 +/- 0.14	NE	-0.11 +/- 0.12	0.020 +/- 0.13
				NW	-0.03 +/- 0.17	
				SE	0.18 +/- 0.25	
				SW	-0.07 +/- 0.14	

Note: Locations selected based on earlier Cs-137 results are highlighted in red, resample results are in bold.

Table 3-4 Comparison of 2005 and 2007 Surface Soil Results for Sr-90

Area	Parcel	2005 Sample Results (pCi/g)	Results from Resampling at 2005 Location in 2007 (pCi/g)	2007 Results Reported for Samples Collected Around 2005 Location: Direction from 2005 Location	2007 Results Reported for Samples Collected Around 2005 Location: 2007 Results (pCi/g)	Average of All 2007 Results in Area (pCi/g)
North	F4-North	0.3 +/- 0.13	0.12 +/- 0.1	NE	0.22 +/- 0.12	0.14 +/- 0.10
				NW	0.12 +/- 0.11	
				SE	-0.024 +/- 0.089	
				SW	0.24 +/- 0.2	
	I2-North	No Data	0.09 +/- 0.11	NE	-0.063 +/- 0.098	0.013 +/- 0.055
				NW	0.03 +/- 0.1	
				SE	0.01 +/- 0.11	
				SW	0 +/- 0.1	
	M5-North	0.064 +/- 0.367	0.26 +/- 0.15	NE	0.21 +/- 0.15	0.13 +/- 0.12
				NW	0.16 +/- 0.13	
				SE	0.03 +/- 0.11	
				SW	-0.01 +/- 0.11	
South	I4-South	**0.47 +/- 0.49**	**0.042 +/- 0.099**	NE	-0.059 +/- 0.098	0.033 +/- 0.079
				NW	-0.018 +/- 0.089	
				SE	0.05 +/- 0.11	
				SW	0.15 +/- 0.12	
	P7-South	No Data	-0.002 +/- 0.092	NE	-0.092 +/- 0.089	-0.0056 +/- 0.056
				NW	-0.012 +/- 0.091	
				SE	0.061 +/- 0.096	
				SW	0.017 +/- 0.097	
West	A4-West	**0.586 +/- 0.504**	**0.1 +/- 0.13**	NE	0.11 +/- 0.12	0.038 +/- 0.063
				NW	0.02 +/- 0.11	
				SE	-0.01 +/- 0.1	
				SW	-0.028 +/- 0.094	
	B7-West	No Data	-0.02 +/- 0.11	NE	-0.02 +/- 0.11	0.044 +/- 0.10
				NW	0.15 +/- 0.13	
				SE	-0.05 +/- 0.11	
				SW	0.16 +/- 0.19	
	D6-West	0.192 +/- 0.413	0.07 +/- 0.12	NE	-0.07 +/- 0.11	-0.032 +/- 0.063
				NW	-0.05 +/- 0.1	
				SE	-0.09 +/- 0.1	
				SW	-0.02 +/- 0.11	
	G13-West	0.087 +/- 0.487	0.06 +/- 0.1	NE	-0.02 +/- 0.11	0.042 +/- 0.042
				NW	0.02 +/- 0.11	
				SE	0.08 +/- 0.11	
				SW	0.07 +/- 0.11	
	G9-West	**0.824 +/- 0.495**	**-0.04 +/- 0.1**	NE	0.07 +/- 0.11	0.028 +/- 0.082
				NW	0.15 +/- 0.12	
				SE	-0.04 +/- 0.1	
				SW	0 +/- 0.11	
	M10-West	0.12 +/- 0.1	0 +/- 0.12	NE	0.05 +/- 0.11	0.000 +/- 0.038
				NW	-0.02 +/- 0.13	
				SE	0.02 +/- 0.12	
				SW	-0.05 +/- 0.11	
	N8-West	**0.35 +/- 0.14**	**0.09 +/- 0.1**	NE	0.06 +/- 0.1	0.053 +/- 0.054
				NW	0.1 +/- 0.1	
				SE	-0.036 +/- 0.096	
				SW	0.05 +/- 0.11	
	R9-West	-0.183 +/- 0.437	0.13 +/- 0.12	NE	0.011 +/- 0.091	0.049 +/- 0.068
				NW	-0.04 +/- 0.1	
				SE	0.1 +/- 0.11	
				SW	0.043 +/- 0.099	

Note: Locations selected based on earlier Cs-137 results are highlighted in red, resample results are in bold.

Table 3-5 Comparison of 2005 and 2007 Surface Soil Results for Pu-238

Area	Parcel	2005 Sample Results (pCi/g)	Results from Resampling at 2005 Location in 2007 (pCi/g)	2007 Results Reported for Samples Collected Around 2005 Location: Direction from 2005 Location	2007 Results (pCi/g)	Average of All 2007 Results in Area (pCi/g)
North	F4-North	0.005 +/- 0.011	**-0.003 +/- 0.012**	NE	-0.002 +/- 0.011	-0.0002 +/- 0.0031
				NW	0 +/- 0.012	
				SE	-0.001 +/- 0.011	
				SW	0.005 +/- 0.012	
	I2-North	No Data	0 +/- 0.011	NE	0.003 +/- 0.011	0.0004 +/- 0.0018
				NW	0 +/- 0.012	
				SE	-0.002 +/- 0.012	
				SW	0.001 +/- 0.012	
	M5-North	0.002 +/- 0.009	-0.002 +/- 0.011	NE	-0.002 +/- 0.011	-0.0008 +/- 0.0018
				NW	0 +/- 0.012	
				SE	0.002 +/- 0.011	
				SW	-0.002 +/- 0.012	
South	I4-South	-0.002 +/- 0.004	0.0006 +/- 0.0064	NE	0 +/- 0.011	0.0003 +/- 0.0018
				NW	-0.0003 +/- 0.006	
				SE	-0.002 +/- 0.011	
				SW	0.003 +/- 0.011	
	P7-South	No Data	0 +/- 0.0059	NE	-0.0009 +/- 0.006	-0.0003 +/- 0.0021
				NW	0.0031 +/- 0.0063	
				SE	-0.0009 +/- 0.006	
				SW	-0.0026 +/- 0.0058	
West	A4-West	0.004 +/- 0.009	0 +/- 0.0058	NE	0.0028 +/- 0.0063	0.0007 +/- 0.0013
				NW	-0.0006 +/- 0.0062	
				SE	0.0012 +/- 0.0059	
				SW	0.0003 +/- 0.0061	
	B7-West	No Data	-0.003 +/- 0.012	NE	-0.001 +/- 0.011	0.0014 +/- 0.0047
				NW	0.006 +/- 0.012	
				SE	0.007 +/- 0.011	
				SW	-0.002 +/- 0.012	
	D6-West	0 +/- 0	0 +/- 0.011	NE	0.001 +/- 0.011	-0.0010 +/- 0.0016
				NW	-0.003 +/- 0.012	
				SE	-0.002 +/- 0.011	
				SW	-0.001 +/- 0.011	
	G13-West	-0.003 +/- 0.005	0.002 +/- 0.011	NE	-0.003 +/- 0.012	0.0006 +/- 0.0040
				NW	0.007 +/- 0.012	
				SE	-0.001 +/- 0.011	
				SW	-0.002 +/- 0.01	
	G9-West	0 +/- 0	0.001 +/- 0.011	NE	0 +/- 0.012	0.0002 +/- 0.0008
				NW	0 +/- 0.012	
				SE	-0.001 +/- 0.011	
				SW	0.001 +/- 0.013	
	M10-West	-0.002 +/- 0.012	-0.0009 +/- 0.0058	NE	-0.0006 +/- 0.0057	-0.0010 +/- 0.0013
				NW	-0.0031 +/- 0.0069	
				SE	-0.0008 +/- 0.0055	
				SW	0.0006 +/- 0.0057	
	N8-West	0.003 +/- 0.013	0 +/- 0.011	NE	-0.002 +/- 0.011	-0.0009 +/- 0.0010
				NW	-0.002 +/- 0.012	
				SE	0 +/- 0.012	
				SW	-0.0006 +/- 0.0057	
	R9-West	0 +/- 0	-0.001 +/- 0.011	NE	0.002 +/- 0.012	0.0008 +/- 0.0016
				NW	0 +/- 0.011	
				SE	0.003 +/- 0.011	
				SW	0 +/- 0.012	

Note: Locations selected based on earlier Pu-238 results are highlighted in red, resample results are in bold.

Table 3-6 Comparison of 2005 and 2007 Surface Soil Results for Pu-239/240

Area	Parcel	2005 Sample Results (pCi/g)	Results from Resampling at 2005 Location in 2007 (pCi/g)	2007 Results Reported for Samples Collected Around 2005 Location: Direction from 2005 Location	2007 Results Reported for Samples Collected Around 2005 Location: 2007 Results (pCi/g)	Average of All 2007 Results in Area (pCi/g)
North	F4-North	0.006 +/- 0.011	-0.001 +/- 0.012	NE	-0.002 +/- 0.011	-0.0012 +/- 0.0054
				NW	0.007 +/- 0.012	
				SE	-0.002 +/- 0.011	
				SW	-0.008 +/- 0.012	
	I2-North	No Data	0.005 +/- 0.011	NE	-0.002 +/- 0.011	0.0040 +/- 0.0053
				NW	0.01 +/- 0.014	
				SE	0.008 +/- 0.012	
				SW	-0.001 +/- 0.012	
	M5-North	0.002 +/- 0.008	0.011 +/- 0.013	NE	0.002 +/- 0.011	0.0050 +/- 0.0046
				NW	0.001 +/- 0.012	
				SE	0.009 +/- 0.012	
				SW	0.002 +/- 0.012	
South	I4-South	-0.002 +/- 0.004	0.0009 +/- 0.0064	NE	0.009 +/- 0.011	0.0020 +/- 0.0044
				NW	0.003 +/- 0.0061	
				SE	-0.001 +/- 0.011	
				SW	-0.002 +/- 0.011	
	P7-South	No Data	0.0012 +/- 0.0059	NE	0.0012 +/- 0.006	0.0017 +/- 0.0018
				NW	0.0046 +/- 0.0063	
				SE	-0.0003 +/- 0.006	
				SW	0.002 +/- 0.0058	
West	A4-West	0.006 +/- 0.014	-0.0009 +/- 0.0058	NE	0.0046 +/- 0.0063	0.0015 +/- 0.0022
				NW	0.0021 +/- 0.0062	
				SE	0.002 +/- 0.0059	
				SW	-0.0003 +/- 0.0077	
	B7-West	No Data	-0.001 +/- 0.012	NE	0.003 +/- 0.011	-0.0008 +/- 0.0038
				NW	0 +/- 0.012	
				SE	-0.007 +/- 0.011	
				SW	0.001 +/- 0.012	
	D6-West	0.005 +/- 0.009	0.002 +/- 0.011	NE	-0.002 +/- 0.011	0.0018 +/- 0.0036
				NW	0.007 +/- 0.014	
				SE	-0.001 +/- 0.011	
				SW	0.003 +/- 0.011	
	G13-West	**0.026 +/- 0.022**	**0.001 +/- 0.011**	NE	-0.001 +/- 0.012	0.0024 +/- 0.0040
				NW	0.005 +/- 0.012	
				SE	-0.001 +/- 0.011	
				SW	0.008 +/- 0.01	
	G9-West	0.008 +/- 0.012	0.002 +/- 0.011	NE	0.013 +/- 0.014	0.028 +/- 0.082
				NW	0.009 +/- 0.012	
				SE	-0.002 +/- 0.011	
				SW	-0.002 +/- 0.013	
	M10-West	0.016 +/- 0.016	-0.0017 +/- 0.0058	NE	0.0011 +/- 0.0057	0.0013 +/- 0.0022
				NW	0.0041 +/- 0.0069	
				SE	0.0005 +/- 0.0055	
				SW	0.0025 +/- 0.0057	
	N8-West	0.019 +/- 0.018	0.007 +/- 0.013	NE	0.011 +/- 0.012	0.0062 +/- 0.0041
				NW	0.009 +/- 0.014	
				SE	0.003 +/- 0.012	
				SW	0.0011 +/- 0.0057	
	R9-West	0.004 +/- 0.008	0 +/- 0.011	NE	0.002 +/- 0.012	0.0008 +/- 0.0011
				NW	0 +/- 0.011	
				SE	0.002 +/- 0.011	
				SW	0 +/- 0.012	

Note: Locations selected based on earlier Pu-239/240 results are highlighted in red, resample results are in bold.

Table 3-7 Spatial Sampling Results for Surface Soil

Sample ID	Cs-137 Results +/- 2 TPU (MDC) (pCi/g)	Sr-90 Results +/- 2 TPU (MDC) (pCi/g)
4000 @1'	0.096 +/- 0.078 (0.122)	0.07 +/- 0.11 (0.25)
4001 @1'	-0.075 +/- 0.08 (0.164)	0.12 +/- 0.12 (0.26)
4003 @1'	0.093 +/- 0.094 (0.148)	0.05 +/- 0.12 (0.27)
4005 @1'	0.033 +/- 0.086 (0.151)	0.03 +/- 0.12 (0.27)
4006 @1'	0.049 +/- 0.061 (0.099)	0.16 +/- 0.13 (0.25)
4007 @1'	0.05 +/- 0.074 (0.124)	0.17 +/- 0.12 (0.24)
4008 @1'	0.07 +/- 0.098 (0.168)	0.14 +/- 0.13 (0.26)
4009 @1'	0.049 +/- 0.072 (0.199)	0.02 +/- 0.11 (0.25)
4011 @1'	0.057 +/- 0.098 (0.165)	0.11 +/- 0.12 (0.24)
4012 @1'	0.039 +/- 0.066 (0.11)	0.07 +/- 0.12 (0.28)
4013 @1'	0.024 +/- 0.068 (0.116)	0.01 +/- 0.11 (0.26)
4014 @1'	0.025 +/- 0.058 (0.098)	-0.01 +/- 0.15 (0.35)
4015 @1'	0.115 +/- 0.079 (0.121)	-0.02 +/- 0.14 (0.33)
4016 @1'	0.021 +/- 0.068 (0.115)	0.15 +/- 0.12 (0.25)
4019 @1'	-0.018 +/- 0.072 (0.14)	0.051 +/- 0.092 (0.201)
4020 @1'	-0.042 +/- 0.064 (0.117)	-0.03 +/- 0.1 (0.24)
4021 @1'	-0.05 +/- 0.12 (0.23)	0.08 +/- 0.13 (0.28)
4023 @1'	0.127 +/- 0.093 (0.138)	-0.03 +/- 0.11 (0.25)
4024 @1'	0.16 +/- 0.1 (0.14)	-0.02 +/- 0.11 (0.26)
4026 @1'	0.18 +/- 0.1 (0.15)	0.11 +/- 0.11 (0.24)
4027 @1'	0.087 +/- 0.08 (0.123)	0 +/- 0.11 (0.27)
4028 @1'	0.085 +/- 0.094 (0.15)	0.1 +/- 0.12 (0.27)
4029 @1'	0.15 +/- 0.11 (0.16)	0.16 +/- 0.12 (0.24)
4030 @1'	0.03 +/- 0.11 (0.19)	0.05 +/- 0.11 (0.25)
4031 @1'	0.018 +/- 0.057 (0.097)	0.48 +/- 0.17 (0.22)
4032 @1'	0.037 +/- 0.071 (0.122)	-0.07 +/- 0.1 (0.25)
4034 @1'	0.11 +/- 0.1 (0.16)	0.05 +/- 0.11 (0.26)
4035 @1'	0.24 +/- 0.11 (0.14)	0.06 +/- 0.13 (0.28)
4036 @1'	0.36 +/- 0.16 (0.21)	0.18 +/- 0.14 (0.27)
4037 @1'	0.09 +/- 0.1 (0.17)	0.08 +/- 0.12 (0.26)
4038 @1'	0.032 +/- 0.075 (0.13)	0.04 +/- 0.11 (0.26)
4039 @1'	0.09 +/- 0.088 (0.139)	0.03 +/- 0.11 (0.25)
4040 @1'	-0.071 +/- 0.082 (0.167)	0.04 +/- 0.13 (0.28)
4042 @1'	-0.051 +/- 0.081 (0.159)	-0.04 +/- 0.12 (0.28)
4045 @1'	0.021 +/- 0.092 (0.165)	0.14 +/- 0.13 (0.26)
4046 @1'	0.12 +/- 0.11 (0.17)	-0.05 +/- 0.11 (0.27)
4047 @1'	-0.019 +/- 0.074 (0.14)	0 +/- 0.11 (0.26)
4048 @1'	0.17 +/- 0.12 (0.18)	0.05 +/- 0.12 (0.27)
4049 @1'	0.018 +/- 0.081 (0.144)	0.07 +/- 0.12 (0.27)

Table 3-7 Spatial Sampling Results for Surface Soil, cont.

Sample ID	Cs-137 Results +/- 2 TPU (MDC) (pCi/g)	Sr-90 Results +/- 2 TPU (MDC) (pCi/g)
4050 @1'	0.019 +/- 0.094 (0.168)	-0.01 +/- 0.11 (0.26)
4051 @1'	0.021 +/- 0.07 (0.123)	0.05 +/- 0.12 (0.26)
4052 @1'	0.117 +/- 0.085 (0.122)	0.15 +/- 0.11 (0.21)
4053 @1'	0.058 +/- 0.086 (0.144)	0.056 +/- 0.099 (0.217)
4054 @1'	0.07 +/- 0.1 (0.17)	0 +/- 0.098 (0.226)
4056 @1'	0.077 +/- 0.075 (0.117)	0.09 +/- 0.1 (0.22)
4057 @1'	0.123 +/- 0.096 (0.142)	0 +/- 0.1 (0.23)
4058 @1'	0.006 +/- 0.068 (0.125)	0.1 +/- 0.11 (0.22)
4060 @1'	0.039 +/- 0.083 (0.144)	0.08 +/- 0.11 (0.23)
4062 @1'	0.098 +/- 0.096 (0.152)	0.03 +/- 0.11 (0.24)
4063 @1'	0.19 +/- 0.12 (0.17)	0.02 +/- 0.11 (0.25)
4066 @1'	0.27 +/- 0.13 (0.17)	0.13 +/- 0.1 (0.2)
4068 @1'	0.109 +/- 0.091 (0.14)	0.113 +/- 0.096 (0.195)
4069 @1'	0.047 +/- 0.088 (0.15)	0.046 +/- 0.09 (0.198)
4070 @1'	0.016 +/- 0.064 (0.116)	0.001 +/- 0.093 (0.214)
4071 @1'	0.09 +/- 0.097 (0.155)	0.082 +/- 0.095 (0.201)
4072 @1'	0.044 +/- 0.07 (0.118)	0.003 +/- 0.086 (0.197)
4073 @1'	-0.006 +/- 0.086 (0.158)	0.14 +/- 0.12 (0.24)
4074 @1'	0.031 +/- 0.079 (0.138)	0.07 +/- 0.12 (0.27)
4075 @1'	0.04 +/- 0.1 (0.17)	0.14 +/- 0.12 (0.24)
4077 @1'	0.057 +/- 0.095 (0.16)	0.05 +/- 0.11 (0.25)
4080 @1'	0.2 +/- 0.12 (0.18)	0.14 +/- 0.14 (0.3)
4081 @1'	0.01 +/- 0.095 (0.171)	0 +/- 0.11 (0.25)
4082 @1'	0.1 +/- 0.1 (0.17)	0.03 +/- 0.12 (0.27)
4083 @1'	0.08 +/- 0.1 (0.17)	0.14 +/- 0.13 (0.27)
4084 @1'	0.15 +/- 0.11 (0.15)	0.01 +/- 0.12 (0.27)
4085 @1'	-0.025 +/- 0.066 (0.128)	0.048 +/- 0.099 (0.223)
4086 @1'	0.06 +/- 0.1 (0.17)	0.06 +/- 0.12 (0.26)
4088 @1'	0.3 +/- 0.14 (0.17)	0.07 +/- 0.11 (0.23)
4091 @1'	0.04 +/- 0.096 (0.166)	0.21 +/- 0.14 (0.27)
4092 @1'	0.013 +/- 0.092 (0.166)	0.31 +/- 0.15 (0.26)
W.FILL2 @1'	0.054 +/- 0.038 (0.058)	0.73 +/- 0.23 (0.24)

Table 3-8 Spatial Sampling Results for Subsurface Soil and Concrete

Sample ID	Cs-137 Results +/- 2 TPU (MDC) (pCi/g)	Sr-90 Results +/- 2 TPU (MDC) (pCi/g)
Subsurface Soil		
4002 @3'	0.036 +/- 0.082 (0.143)	0.09 +/- 0.14 (0.29)
4004 @3'	0.012 +/- 0.076 (0.138)	0.07 +/- 0.12 (0.27)
4010 @3'	-0.025 +/- 0.082 (0.156)	0.1 +/- 0.14 (0.3)
4017 @3'	-0.018 +/- 0.079 (0.151)	0.016 +/- 0.088 (0.199)
4018 @3'	-0.001 +/- 0.075 (0.14)	0.026 +/- 0.091 (0.204)
4022 @3'	-0.006 +/- 0.064 (0.123)	0.06 +/- 0.11 (0.25)
4025 @3'	0.053 +/- 0.081 (0.135)	0.13 +/- 0.12 (0.24)
4031 @5'	0 +/- 0.07 (0.129)	0.37 +/- 0.15 (0.21)
4033 @3'	0.083 +/- 0.08 (0.124)	0.02 +/- 0.11 (0.26)
4041 @3'	0.083 +/- 0.074 (0.111)	0.11 +/- 0.12 (0.25)
4043 @3'	0.024 +/- 0.084 (0.147)	0.06 +/- 0.12 (0.27)
4044 @3'	-0.056 +/- 0.077 (0.154)	0.08 +/- 0.12 (0.25)
4055 @3'	0.031 +/- 0.064 (0.11)	-0.083 +/- 0.095 (0.226)
4061 @3'	0.038 +/- 0.07 (0.12)	0.01 +/- 0.1 (0.23)
4064 @3'	0.023 +/- 0.081 (0.143)	0.02 +/- 0.085 (0.192)
4065 @3'	0.046 +/- 0.08 (0.136)	0.07 +/- 0.094 (0.202)
4067 @3'	0 +/- 0.076 (0.142)	0.049 +/- 0.086 (0.187)
4076 @3'	-0.006 +/- 0.077 (0.145)	0 +/- 0.11 (0.27)
4089 @3'	0.01 +/- 0.069 (0.124)	0.05 +/- 0.1 (0.23)
4090 @3'	0.036 +/- 0.088 (0.152)	0.02 +/- 0.1 (0.23)
4093 @3'	-0.006 +/- 0.084 (0.155)	-0.069 +/- 0.087 (0.216)
FA#1 @12'	-0.017 +/- 0.074 (0.141)	0.1 +/- 0.13 (0.27)
FA#1 @5'	0.051 +/- 0.072 (0.119)	-0.02 +/- 0.11 (0.27)
FA#2 @12'	0 +/- 0.079 (0.145)	0.09 +/- 0.11 (0.24)
FA#2 @5'	0.037 +/- 0.085 (0.147)	-0.04 +/- 0.1 (0.25)
FA#3 @12'	-0.071 +/- 0.091 (0.179)	0.03 +/- 0.11 (0.26)
FA#3 @5'	0.034 +/- 0.069 (0.119)	0.03 +/- 0.12 (0.27)
FILL PILE @3'	-0.13 +/- 0.11 (0.23)	0.19 +/- 0.15 (0.29)
S.FILL1 @5'	-0.047 +/- 0.071 (0.141)	0.38 +/- 0.15 (0.22)
S.FILL1 @7'	-0.016 +/- 0.058 (0.103)	0.038 +/- 0.092 (0.208)
S.FILL2 @8'	0.005 +/- 0.072 (0.132)	0 +/- 0.11 (0.25)
W.FILL1 @3'	0.065 +/- 0.077 (0.124)	-0.016 +/- 0.089 (0.213)
Concrete		
CONCRETE @5'	-0.01 +/- 0.066 (0.129)	0.08 +/- 0.12 (0.26)
CONCRETE @12'	-0.008 +/- 0.088 (0.165)	0.1 +/- 0.12 (0.25)

Table 3-9 Summary Statistics for Spatial Samples

Radionuclide	Statistic	Media: All	Media: Surface Soil	Media: Subsurface Soil	Units
Cs-137	Count	105	71	32	Results
	Minimum	-0.130	-0.075	-0.130	pCi/g
	Maximum	0.360	0.360	0.083	pCi/g
	Median	0.0370	0.0540	0.0075	pCi/g
	A. Mean	0.0502	0.0707	0.0084	pCi/g
	StDev	0.0769	0.0812	0.0444	pCi/g
Sr-90	Count	105	71	32	Results
	Minimum	-0.083	-0.070	-0.083	pCi/g
	Maximum	0.730	0.730	0.380	pCi/g
	Median	0.051	0.056	0.043	pCi/g
	A. Mean	0.075	0.080	0.062	pCi/g
	StDev	0.109	0.115	0.100	pCi/g

Table 3-10 Summary Statistics for Combined Spatial and Step-out Samples

		Media			
Radionuclide	**Statistics**	**All**	**Surface Soil**	**Subsurface Soil**	**Units**
Cs-137	Number	177	134	41	Samples
	Minimum	-0.190	-0.190	-0.130	pCi/g
	Maximum	0.360	0.360	0.083	pCi/g
	Median	0.030	0.039	0.005	pCi/g
	Arithmetic Mean	0.032	0.041	0.003	pCi/g
	Standard Deviation	0.079	0.086	0.046	pCi/g
	98 %tile	0.219	0.250	0.083	pCi/g
Sr-90	Number	177	134	41	Samples
	Minimum	-0.092	-0.092	-0.083	pCi/g
	Maximum	0.730	0.730	0.380	pCi/g
	Median	0.049	0.050	0.030	pCi/g
	Arithmetic Mean	0.060	0.062	0.053	pCi/g
	Standard Deviation	0.100	0.102	0.093	pCi/g
	98 %tile	0.339	0.277	0.372	pCi/g
Pu-238	Number	72	63	9	Samples
	Minimum	-0.0031	-0.0031	-0.0020	pCi/g
	Maximum	0.0080	0.0070	0.0080	pCi/g
	Median	0.0000	0.0000	-0.0008	pCi/g
	Arithmetic Mean	0.0002	0.00005	0.0010	pCi/g
	Standard Deviation	0.0024	0.0023	0.0034	pCi/g
	98 %tile	0.0070	0.0068	0.0075	pCi/g
Pu-239/240	Number	72	63	9	Samples
	Minimum	-0.0080	-0.0080	-0.002	pCi/g
	Maximum	0.0130	0.0130	0.007	pCi/g
	Median	0.0012	0.0012	0.001	pCi/g
	Arithmetic Mean	0.0021	0.0022	0.001	pCi/g
	Standard Deviation	0.0041	0.0043	0.003	pCi/g
	98 %tile	0.0110	0.0110	0.007	pCi/g

Table 3-11 Comparison of Cs-137 to Sr-90 Ratios in Soil Samples

	Nuclide				Nuclide				Nuclide		
Sample ID	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Cs-137 / Sr-90 Ratio	Sample ID	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Cs-137 / Sr-90 Ratio	Sample ID	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Cs-137 / Sr-90 Ratio
4000 @1'	0.096	0.07	**1.4**	**4068 @1'**	0.109	0.113	**1.0**	**G13SE @1'**	-0.047	0.08	**-0.6**
4001 @1'	-0.075	0.12	**-0.6**	**4069 @1'**	0.047	0.046	**1.0**	**G13SW @1'**	-0.19	0.07	**-2.7**
4003 @1'	0.093	0.05	**1.9**	**4070 @1'**	0.016	0.001	**16.0**	**G9 @1'**	-0.07	-0.04	**1.8**
4005 @1'	0.033	0.03	**1.1**	**4071 @1'**	0.09	0.082	**1.1**	**G9 -W**	0.31	0.824	**0.4**
4006 @1'	0.049	0.16	**0.3**	**4072 @1'**	0.044	0.003	**14.7**	**G9NE @1'**	0.01	0.07	**0.1**
4007 @1'	0.05	0.17	**0.3**	**4073 @1'**	-0.006	0.14	**0.0**	**G9NW @1'**	0.07	0.15	**0.5**
4008 @1'	0.07	0.14	**0.5**	**4074 @1'**	0.031	0.07	**0.4**	**G9SE @1'**	-0.05	-0.04	**1.3**
4009 @1'	0.049	0.02	**2.5**	**4075 @1'**	0.04	0.14	**0.3**	**I2 @1'**	0.05	0.09	**0.6**
4011 @1'	0.057	0.11	**0.5**	**4077 @1'**	0.057	0.05	**1.1**	**I2NE @1'**	0.04	-0.063	**-0.6**
4012 @1'	0.039	0.07	**0.6**	**4080 @1'**	0.2	0.14	**1.4**	**I2NW @1'**	-0.057	0.03	**-1.9**
4013 @1'	0.024	0.01	**2.4**	**4082 @1'**	0.1	0.03	**3.3**	**I2SE @1'**	0.06	0.01	**6.0**
4014 @1'	0.025	-0.01	**-2.5**	**4083 @1'**	0.08	0.14	**0.6**	**I4 @1'**	-0.08	0.042	**-1.9**
4015 @1'	0.115	-0.02	**-5.8**	**4084 @1'**	0.15	0.01	**15.0**	**I4 -S**	0.0316	0.47	**0.1**
4016 @1'	0.021	0.15	**0.1**	**4085 @1'**	-0.025	0.048	**-0.5**	**I4NE @1'**	-0.04	-0.059	**0.7**
4019 @1'	-0.018	0.051	**-0.4**	**4086 @1'**	0.06	0.06	**1.0**	**I4SE @1'**	0.12	0.05	**2.4**
4020 @1'	-0.042	-0.03	**1.4**	**4088 @1'**	0.3	0.07	**4.3**	**I4SW @1'**	-0.02	0.15	**-0.1**
4021 @1'	-0.05	0.08	**-0.6**	**4091 @1'**	0.04	0.21	**0.2**	**LCR -24**	0.0388	-0.198	**-0.2**
4023 @1'	0.127	-0.03	**-4.2**	**4092 @1'**	0.013	0.31	**0.0**	**M10 -W**	0.377	0.12	**3.1**
4024 @1'	0.16	-0.02	**-8.0**	**A2 -N**	0.00201	0.155	**0.0**	**M10NW @1'**	0.17	-0.02	**-8.5**
4026 @1'	0.18	0.11	**1.6**	**A4 @1'**	0.01	0.1	**0.1**	**M10SE @1'**	0.03	0.02	**1.5**
4028 @1'	0.085	0.1	**0.9**	**A4 -W**	0.0552	0.586	**0.1**	**M10SW @1'**	0.07	-0.05	**-1.4**
4029 @1'	0.15	0.16	**0.9**	**A4NE @1'**	-0.01	0.11	**-0.1**	**M5 @1'**	-0.06	0.26	**-0.2**
4030 @1'	0.03	0.05	**0.6**	**A4NW @1'**	-0.01	0.02	**-0.5**	**M5 -N**	0.0434	0.064	**0.7**
4031 @1'	0.018	0.48	**0.0**	**A4SE @1'**	-0.05	-0.01	**5.0**	**M5NE @1'**	-0.1	0.21	**-0.5**
4032 @1'	0.037	-0.07	**-0.5**	**A4SW @1'**	0.1	-0.028	**-3.6**	**M5NW @1'**	0.03	0.16	**0.2**
4034 @1'	0.11	0.05	**2.2**	**B5 -S**	0.167	0.038	**4.4**	**M5SE @1'**	-0.09	0.03	**-3.0**
4035 @1'	0.24	0.06	**4.0**	**B7 @1'**	0.01	-0.02	**-0.5**	**M5SW @1'**	0.03	-0.01	**-3.0**
4036 @1'	0.36	0.18	**2.0**	**B7NW @1'**	0.12	0.15	**0.8**	**N6 -S**	0.055	-0.256	**-0.2**
4037 @1'	0.09	0.08	**1.1**	**B7SE @1'**	-0.01	-0.05	**0.2**	**N8 @1'**	0.02	0.09	**0.2**
4038 @1'	0.032	0.04	**0.8**	**B7SW @1'**	-0.04	0.16	**-0.3**	**N8 -W**	0.378	0.35	**1.1**
4039 @1'	0.09	0.03	**3.0**	**C10 -W**	0.0578	0.043	**1.3**	**N8/M10 @1'**	0.04	0.05	**0.8**
4040 @1'	-0.071	0.04	**-1.8**	**D6 @1'**	0.05	0.07	**0.7**	**N8NE @1'**	0.11	0.06	**1.8**
4042 @1'	-0.051	-0.04	**1.3**	**D6 -W**	0.217	0.192	**1.1**	**N8NW @1'**	-0.04	0.1	**-0.4**
4045 @1'	0.021	0.14	**0.2**	**D6/B7 @1'**	-0.14	-0.02	**7.0**	**N8SE @1'**	-0.19	-0.036	**5.3**
4046 @1'	0.12	-0.05	**-2.4**	**D6NE @1'**	0.044	-0.07	**-0.6**	**P6 -W**	0.0989	-0.586	**-0.2**
4048 @1'	0.17	0.05	**3.4**	**D6NW @1'**	0.04	-0.05	**-0.8**	**P7 @1'**	0.03	-0.002	**-15.0**
4049 @1'	0.018	0.07	**0.3**	**D6SE @1'**	0.05	-0.09	**-0.6**	**P7NE @1'**	-0.06	-0.092	**0.7**
4050 @1'	0.019	-0.01	**-1.9**	**F4 @1'**	0.07	0.12	**0.6**	**P7NW @1'**	0.13	-0.012	**-10.8**
4051 @1'	0.021	0.05	**0.4**	**F4 -N**	0.134	0.3	**0.4**	**P7SE @1'**	0.1	0.061	**1.6**
4052 @1'	0.117	0.15	**0.8**	**F4NE @1'**	-0.06	0.22	**-0.3**	**P7SW @1'**	0.01	0.017	**0.6**
4053 @1'	0.058	0.056	**1.0**	**F4NW @1'**	0.13	0.12	**1.1**	**R9 @1'**	0.13	0.13	**1.0**
4056 @1'	0.077	0.09	**0.9**	**F4SE @1'**	-0.02	-0.024	**0.8**	**R9 -W**	0.036	-0.183	**-0.2**
4058 @1'	0.006	0.1	**0.1**	**F4SW @1'**	-0.03	0.24	**-0.1**	**R9NE @1'**	-0.11	0.011	**-10.0**
4060 @1'	0.039	0.08	**0.5**	**G13 @1'**	0.04	0.06	**0.7**	**R9NW @1'**	-0.03	-0.04	**0.8**
4062 @1'	0.098	0.03	**3.3**	**G13 -W**	0.262	0.087	**3.0**	**R9SE @1'**	0.18	0.1	**1.8**
4063 @1'	0.19	0.02	**9.5**	**G13NE @1'**	-0.03	-0.02	**1.5**	**R9SW @1'**	-0.07	0.043	**-1.6**
4066 @1'	0.27	0.13	**2.1**	**G13NW @1'**	-0.04	0.02	**-2.0**	**W.FILL2 @1'**	0.054	0.73	**0.1**

Table 3-12 Comparison of Cs-137 Concentrations in Surface and Subsurface Samples

Sample ID	Depth	Cs-137(pCi/g)	All Ranked	Subsurface Ranked
F4NE @3'	Subsurface	-0.110	1	1
M5NE @1'	Surface	-0.100	2	
I4 @1'	Surface	-0.080	3	
4040 @1'	Surface	-0.071	4	
F4NE @1'	Surface	-0.060	5.5	
I4 @3'	Subsurface	-0.060	5.5	5.5
4044 @3'	Subsurface	-0.056	7	7
4042 @1'	Surface	-0.051	8	
4021 @1'	Surface	-0.050	9.5	
G9SE @1'	Surface	-0.050	9.5	
R9NW @1'	Surface	-0.030	11	
4010 @3'	Subsurface	-0.025	12	12
4019 @1'	Surface	-0.018	13.5	
4017 @3'	Subsurface	-0.018	13.5	13.5
B7SE @1'	Surface	-0.010	15	
4022 @3'	Subsurface	-0.006	17	17
4076 @3'	Subsurface	-0.006	17	17
4093 @3'	Subsurface	-0.006	17	17
4018 @3'	Subsurface	-0.001	19	19
4031 @5'	Subsurface	0.000	21.5	21.5
4067 @3'	Subsurface	0.000	21.5	21.5
B7SE @3'	Subsurface	0.000	21.5	21.5
R9NW @3'	Subsurface	0.000	21.5	21.5
4089 @3'	Subsurface	0.010	26	26
A4 @1'	Surface	0.010	26	
P7SW @1'	Surface	0.010	26	
G9SE @3'	Subsurface	0.010	26	26
P7SW @3'	Subsurface	0.010	26	26
4004 @3'	Subsurface	0.012	29	29
4092 @1'	Surface	0.013	30	
4031 @1'	Surface	0.018	31	
4016 @1'	Surface	0.021	32.5	
4045 @1'	Surface	0.021	32.5	
4064 @3'	Subsurface	0.023	34	34
4043 @3'	Subsurface	0.024	35	35
4055 @3'	Subsurface	0.031	36	36
4002 @3'	Subsurface	0.036	37.5	37.5
4090 @3'	Subsurface	0.036	37.5	37.5
4061 @3'	Subsurface	0.038	39	39
4060 @1'	Surface	0.039	40	
4075 @1'	Surface	0.040	43	
4091 @1'	Surface	0.040	43	
D6NW @1'	Surface	0.040	43	
A4 @3'	Subsurface	0.040	43	43
D6NW @3'	Subsurface	0.040	43	43
4065 @3'	Subsurface	0.046	46	46
4009 @1'	Surface	0.049	47	
4025 @3'	Subsurface	0.053	48	48
M5NE @3'	Subsurface	0.063	49	49
4054 @1'	Surface	0.070	50	
4033 @3'	Subsurface	0.083	51.5	51.5
4041 @3'	Subsurface	0.083	51.5	51.5
4003 @1'	Surface	0.093	53	
4000 @1'	Surface	0.096	54	
4068 @1'	Surface	0.109	55	
4034 @1'	Surface	0.110	56	
4024 @1'	Surface	0.160	57	
4063 @1'	Surface	0.190	58	
4066 @1'	Surface	0.270	59	
4088 @1'	Surface	0.300	60	
		Number of samples	**60**	**30**
		Rank Sums =	**1830**	**853**
		Upper Critical Value =	**1026**	
		Lower Critical Value =	**804**	
		Subsurface Rank Sum Between Critical Values?	**TRUE**	

Table 3-13 Comparison of Sr-90 Concentrations in Surface and Subsurface Samples

Sample ID	Depth	Sr-90 (pCi/g)	All Ranked	Subsurface ranked
4055 @3'	Subsurface	-0.083	1.0	1
4093 @3'	Subsurface	-0.069	2.0	2
B7SE @1'	Surface	-0.05	3.5	
D6NW @1'	Surface	-0.05	3.5	
4042 @1'	Surface	-0.04	6.0	
G9SE @1'	Surface	-0.04	6.0	
R9NW @1'	Surface	-0.04	6.0	
B7SE @3'	Subsurface	-0.03	8.5	8.5
M5NE @3'	Subsurface	-0.03	8.5	8.5
4024 @1'	Surface	-0.02	10.0	
F4NE @3'	Subsurface	-0.01	11.0	11
4054 @1'	Surface	0	12.5	
4076 @3'	Subsurface	0	12.5	12.5
4061 @3'	Subsurface	0.01	15.0	15
P7SW @3'	Subsurface	0.01	15.0	15
R9NW @3'	Subsurface	0.01	15.0	15
4017 @3'	Subsurface	0.016	17.0	17
P7SW @1'	Surface	0.017	18.0	
4009 @1'	Surface	0.02	21.5	
4063 @1'	Surface	0.02	21.5	
4033 @3'	Subsurface	0.02	21.5	21.5
4064 @3'	Subsurface	0.02	21.5	21.5
4090 @3'	Subsurface	0.02	21.5	21.5
G9SE @3'	Subsurface	0.02	21.5	21.5
I4 @3'	Subsurface	0.024	25.0	25
4018 @3'	Subsurface	0.026	26.0	26
4040 @1'	Surface	0.04	27.5	
A4 @3'	Subsurface	0.04	27.5	27.5
I4 @1'	Surface	0.042	29.0	
4067 @3'	Subsurface	0.049	30.0	30
4003 @1'	Surface	0.05	32.0	
4034 @1'	Surface	0.05	32.0	
4089 @3'	Subsurface	0.05	32.0	32
4019 @1'	Surface	0.051	34.0	
4022 @3'	Subsurface	0.06	35.5	35.5
4043 @3'	Subsurface	0.06	35.5	35.5
4000 @1'	Surface	0.07	38.5	
4088 @1'	Surface	0.07	38.5	
4004 @3'	Subsurface	0.07	38.5	38.5
4065 @3'	Subsurface	0.07	38.5	38.5
4021 @1'	Surface	0.08	42.0	
4060 @1'	Surface	0.08	42.0	
4044 @3'	Subsurface	0.08	42.0	42
4002 @3'	Subsurface	0.09	44.0	44
4010 @3'	Subsurface	0.1	45.5	45.5
A4 @1'	Surface	0.1	45.5	
4041 @3'	Subsurface	0.11	47.0	47
4068 @1'	Surface	0.113	48.0	
4066 @1'	Surface	0.13	49.5	
4025 @3'	Subsurface	0.13	49.5	49.5
4045 @1'	Surface	0.14	51.5	
4075 @1'	Surface	0.14	51.5	
4016 @1'	Surface	0.15	53.0	
D6NW @3'	Subsurface	0.16	54.0	54
4091 @1'	Surface	0.21	55.5	
M5NE @1'	Surface	0.21	55.5	
F4NE @1'	Surface	0.22	57.0	
4092 @1'	Surface	0.31	58.0	
4031 @5'	Subsurface	0.37	59.0	59
4031 @1'	Surface	0.48	60.0	
		Number of samples	**60**	**30**
		Rank Sums =	**1830**	**821**
		Upper Critical Value =	**1026**	
		Lower Critical Value =	**804**	
	Subsurface Rank Sum Between Critical Values?		**TRUE**	

4. SUMMARY

There has been conjecture that Cs-137 and Sr-90 may have migrated into the study area from the Santa Susana Field Laboratory. In order to investigate this claim, the radiological condition of Dayton Canyon has been studied for the past two years. Field data were collected in the canyon during two time periods, October 2005 and March 2007.

The initial investigation in 2005 collected information on ambient radiation levels, and the concentrations of Cs-137 and Sr-90 in the study area. This investigation did not identify any areas of radiological concern. In response to community requests, a second, more extensive, investigation was conducted in March 2007. The information obtained in the first survey was used to focus this later investigation in the areas which were most likely to have elevated levels of Cs-137, Sr-90, Pu-238 and Pu-239/240, if any elevated levels did exist. No elevated areas of radiological contamination were identified in the report about the 2007 investigation. These results are in agreement with the first investigation's findings.

4.1 Data Summary

The data collected during these investigations and their findings were reviewed during the preparation of this report. Several observations were made about the data collected by AllWest Remediation during the past two years of sampling:

- The radionuclide concentrations in the samples from both investigations were low enough that three different laboratories had difficulty determining the quantities of the radionuclides in the samples with a high degree of certainty. The radionuclides were positively detected in only a few samples. These detections were scattered across different samples. No sample contained detectable concentrations of both Cs-137 and Sr-90.
- The detection limits of the analyses were above local background concentrations in most cases. This makes a simple comparison with regional background values difficult. The detection limits are low enough to demonstrate that the levels of Cs-137 and Sr-90 in Dayton Canyon are lower than those found in some other areas of the country.
- The laboratories reported the analytical results generated by their instruments measuring the radioactivity in the samples. While these values have a relatively large uncertainty associated with them, they are the best available information on the concentration in those samples and are considered to be usable for a gross characterization of the study area.

- The Sr-90 data from the initial 2005 investigation appear to be compromised. The blanks that accompanied the samples through the analytical process should have contained little or no Sr-90. Instead the blank for samples in the main areas of interest contained measurable levels of Sr-90. One explanation for this would be Sr-90 contamination in the analytical process. While the Sr-90 data are presented in this report for completeness, they should not be relied upon for risk assessment or decision-making.

Most of the available data are considered to be usable for a gross characterization of the study area. The data are also adequate to support a scoping level risk assessment, if the uncertainties are identified and properly qualified.

4.2 Observations

A small amount of Cs-137 and Sr-90 is present in Dayton Canyon soils. The available data indicates that surface soil concentrations of the radionuclides investigated are relatively uniform across the entire area. Subsurface and surface concentrations of Sr-90 and Cs-137 are not statistically different. No patterns of elevated concentrations emerge from the data.

Determining if any of the reported Cs-137 and Sr-90 activities are attributable to a local source is complicated by the presence of global fallout from atmospheric testing in the Pacific. This fallout deposited measurable amounts of Cs-137 and Sr-90 throughout southern California during the 1950’s and 1960’s. This can be demonstrated by comparing the average Cs-137 concentration in canyon soils (0.032 ± 0.079 pCi/g,[7] Table 3-10) with the average value of Cs-137 in local background soil (0.087± 0.12 pCi/g, McLaren/Hart, 1995). Considering the error bounds on the results, these two numbers are not remarkably different from each other. Comparing the average Sr-90 results from the two studies yields similar results. If there are differences, they are low. Distinguishing if any of the Cs-137 or Sr-90 currently present in Dayton Canyon surface soil came from sources other than fallout is not possible with any degree of certainty.

[7] Average ± 2 standard deviations

5. REFERENCES

ALLWEST, 2005 "Preliminary Endangerment Assessment, Workplan, Dayton Canyon Site, West Hills, CA". ALLWEST Remediation, Inc. 1201 North Barsten Way, Anaheim, CA 92806, November 22, 2005.

ALLWEST, 2006 "Radiological Investigation Report, Dayton Canyon Site, West Hills, CA". ALLWEST Remediation Inc. 1201 North Barsten Way, Anaheim, CA 92806, June 7, 2006.

ALLWEST, 2007a "Supplemental Radiological Investigation, Sampling and Analysis Plan, Sterling Homes Development, West Hills, CA". ALLWEST Remediation Inc. 1201 North Barsten Way, Anaheim, CA 92806, March 9, 2007.

ALLWEST, 2007b "Supplemental Radiological Investigation, Sampling and Analysis Results, Sterling Homes Development, West Hills, CA". ALLWEST Remediation Inc. 1201 North Barsten Way, Anaheim, CA 92806, June 4, 2007.

DTSC 2005 "Responses to Public Comments on Centex Homes-Sterling Property Site Characterization and PEA Workplan", Department of Toxic Substances Control, October 27, 2005.

McLaren/Hart 1995 "Additional Soil and Water Sampling, The Brandeis-Bardin Institute and Santa Monica Mountains Conservatory". McLaren/Hart Environmental Engineering Corporation, Irvine, CA., January 19, 1995.

USNRC 2002 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", NUREG-1575, Rev 1, US Nuclear Regulatory Commission, August 2000 with revisions through August 2002.

APPENDIX A RISK ASSESSMENT

RADIOLOGICAL RISK ASSESSMENT FOR THE PROPOSED STERLING RESIDENTIAL DEVELOPMENT WITHIN DAYTON CANYON, WEST HILLS, CALIFORNIA

Prepared for:
Morrison & Foerster, LLP

February 2008

Prepared by:
Auxier & Associates, Inc.
9821 Cogdill Road, Suite 1
Knoxville, Tennessee 37932
(865) 675-3669 Fax: (865) 675-3677

LIMITATIONS

Information provided in this report by Auxier & Associates Inc., is intended exclusively for the use of Centex. The findings and conclusions discussed in this report are based on field and laboratory data provided by Allwest Remediation, Inc. during the course of this evaluation and our current understanding and interpretation of environmental regulatory agency regulations, guidance and policies. The professional services have been performed in accordance with practices generally accepted by other health physicists and environmental scientists practicing in this field. No other warranty, either expressed or implied, is made.

CONTENTS

SECTION **PAGE**

EXECUTIVE SUMMARY

The Sterling Project is a proposed residential development located on property in West Hills, California, just west of the intersection of Roscoe Boulevard and Valley Circle Boulevard. The property encompasses 355 acres of undeveloped land. As proposed, approximately 255 acres of land will be permanently dedicated to open space as part of the Santa Monica Mountains Conservancy, and another 100 acres ("the Site") will be developed into single-family residences. The property is bisected by Dayton Canyon Creek, an intermittent stream which flows from west to east across the property.

Members of the public have expressed concerns over the potential levels of cesium-137, strontium-90, and isotopes of plutonium at the Site. This report uses industry-standard risk calculation methods and parameters to estimate risks to potential future residents from these radionuclides.

A hypothetical receptor scenario was created to simulate the lifestyles of these future residents. This receptor scenario postulates that residents live in homes built on the Site for 30 years and supplement their diet with food grown on the Site. Once the receptor scenario was chosen, recent soil concentration data was used to calculate the exposure potential to the hypothetical receptor. Risks to this postulated receptor are small, ranging from normal background (1.6 $x10^{-6}$) up to an upper-bound risk of 2 x 10^{-6}. This calculated upper-bound risk is about 4 x 10^{-7} above the background risk. Risks of this magnitude are less than the 10^{-6} to 10^{-4} risk range generally considered by EPA to be acceptable at Superfund sites.

It should also be noted that the risk estimates presented in this report were calculated using methods developed and endorsed by the US Environmental Protection Agency (EPA). These methods were designed to be health-protective. During development of these methods, EPA encountered uncertainties in many areas, such as radiation dose-response and receptor behavior. EPA consistently addressed these unknowns by selecting methods and data that overestimate impacts to human receptors. A quantitative evaluation of the uncertainties associated with radiological risks that may exist at this Site is outside the scope of this document, but it is very likely that the risks presented in this report overestimate any real radiological risks that may be incurred by future residents as a result of living in the proposed development.

1. INTRODUCTION

Auxier & Associates, Inc. was retained by the firm of Morrison & Foerster, LLP to prepare a radiological risk assessment for the proposed Centex Homes-Sterling Residential Development. The property evaluated is located in the community of West Hills, which is part of Los Angeles, California, just west of the intersection of Roscoe Boulevard and Valley Circle Boulevard.

1.1 Description of Site

The Centex Homes-Sterling Residential Development property, referred to as the "Site" in this report encompasses 100 acres of undeveloped land. The principle drainage feature on the Site is Dayton Canyon Creek, which flows from west to east across the property. The majority of the property is vegetated and slopes toward this creek.

1.2 Description of Notable Off-site Properties

Boeing/Santa Susana Field Laboratory (SSFL) is located to the west of the Site. Water drains from a portion of the SSFL to the Site via Dayton Canyon Creek. The western boundary of the Site is located approximately 0.5 miles directly east of the Boeing/Santa Susana Field Laboratory facility.

Operational activities at the SSFL began in 1948. It is known that a variety of nuclear energy research and development projects were performed in its Area IV facilities, which are located approximately 3.5 miles west from the eastern border of the proposed development.

2. RADIONULCIDES OF CONCERN

2.1 Selection of Radionuclides of Concern

The postulated source of radioactive materials on the Site is the SSFL. The SSFL facility used various radioactive materials on the western portion of the facility, including strontium-90 (Sr-90), plutonium, and cesium-137(Cs-137). (ALLWEST, 2005, DTSC, 2005). Based on this information, Sr-90, Cs-137, plutonium- 238 (Pu-238), and plutonium-239/240 (Pu-239/240) have been selected as the radionuclides of concern in this risk assessment.

2.2 Data Sources

2.2.1 Source of Data Pertaining to Current Radiological Condition of Site

The primary sources of site-related radiological data used in this risk assessment were two radiological investigations conducted in 2005 and 2007, as reported in ALLWEST 2006 and ALLWEST 2007, respectively. This data was reviewed during the preparation of this risk assessment and found to generally suitable for use in a scoping level risk assessment (Auxier 2007).

The sampling locations, the method of collection, and the analytical requirements are described in ALLWEST 2006 and ALLWEST 2007 and their supporting documents. Sampling teams working during the two investigations collected 218 samples from 147 locations. Many locations were sampled more than once or had samples collected at various depths. These 218 samples included 171 surface soil samples which were submitted various laboratories for different analyses depending on the sampling program.

2.2.2 Sources of Data Pertaining to Local or Regional Background

Two different sources of information were identified as sources of information on the background concentration of Cs-137 and Sr-90. One of these contains some information on plutonium isotopes as well.

2.2.2.1 UNSCEAR 2000

The 2000 United Nations Scientific Committee on the effects of Atomic Radiation (UNSCEAR) report on sources and effects of radiation contains a discussion on global fallout. The UNSCEAR report does not contain direct measurements of surface soil in the vicinity of the Site. It does provide a regional deposition estimate originally generated in 1993 (UNSCEAR 1993). These deposition estimates can be used to calculate background concentrations for Cs-137, Sr-

90, and plutonium isotopes in surface soil. Because the UNSCEAR report does not contain direct measurements of surface soil in the vicinity of the Site, these derived concentrations were used as a "sanity check" on background concentrations reported by other sources.

2.2.2.2 McLaren/Hart 1995

McLaren/Hart published a report containing the results of background studies conducted in 1992 and 1995 (McLaren/Hart, 1995). Eleven background sample areas within a 12.5 mile radius of the SSFL were selected for sampling. Multiple samples were collected in each background area. The selection of these sample locations was intended to produce samples that were unaffected by water run-off or wind-borne particulates from the SSFL.

Because of the distance from the Site, and the lack of a plausible transport pathway, the study concluded that the soils sampled should not have been measurably affected by activities at the SSFL. The sampling methodology and discussion of results is provided in McLaren/Hart, 1995. The average background concentrations reported by this study are summarized in Table 2-1.

Table 2-1 Background Concentrations (McLaren/Hart, 1995)

Study/Location	Cs-137 (pCi/g)	Pu-238 (pCi/g)	Pu-239/240 (pCi/g)	Sr-90 (pCi/g)
McLaren/Hart, 2005	0.087	nd	nd	0.052

`[a] nd – no data

2.3 Data Analysis

The site-related datasets for all radionuclides of concern contain a large number of results where the reported concentrations in the samples were less than the Minimum Detectable Concentration (MDC).[1] These results are sometimes called "non-detects".

Many of the Dayton Canyon sample results are non-detects, making it difficult to use the data to determine the actual concentration of these radionuclides with a high degree of certainty. However, it can be stated with a high degree of certainty that the concentrations in these samples will be lower than the MDC. Thus, the data allows one to place an upper limit on the amount of

[1] The MDC is an estimate of the amount of radioactivity in a sample that can practically be quantified under a specified set of measurement parameters. These parameters include the sample size, counting time, counting efficiency, self-absorption and decay corrections. If the laboratory instrument reports a concentration that is less than the MDC, the radionuclide is not considered to be detected in that sample. The laboratory typically qualifies its data report by indicating the concentration in that sample is not detected above the MDC.

Cs-137, Sr-90, Pu-238 and Pu-239/240 that can be present in the soil. This knowledge was used to calculate an upper-bound estimate of risks from the expected land use on this property.

2.3.1 Treatment of Non-detects

Non-detects, if present in the data sets, must be considered along with positively detected results when determining the descriptive statistics for data sets. EPA guidance (USEPA 1989) allows for best professional judgment in determining the most appropriate assignment of values for non-detected results. In some cases, the risk assessor is encouraged to use ½ the MDC as the representative concentration in that sample. In other cases EPA guidance suggests using either the MDC or zero as the appropriate value for the radionuclide's concentration in that sample. In the past, the California Department of Public Health's Radiologic Health Branch (RHB) has accepted the use of the value reported by the laboratory instrumentation as the representative concentration, even though it was below the laboratory's MDC.

In this risk assessment, two of these methods were used to estimate radionuclide concentrations in a sample when the lab reported the actual concentration was below the MDC for that sample. In one method, value reported by the laboratory instrumentation was used as the exposure point concentration when a radionuclide was not detected in a sample. The second method used the full value of the sample MDC to represent a radionuclide's concentration in a sample if the radionuclide is not detected in that sample. The second technique is the most health-protective method of assigning a concentration value to a non-detect as it maximizes the amount of a radionuclide that can be present in the sample.[2] Using both methods produced a range of concentrations that most likely bound the actual concentrations found in the samples taken from the site (Tables A.1 through A.4).

2.3.2 Determination of Background

In EPA's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program, risks from background concentrations of radionuclides are considered when evaluating a site. These risks are commonly subtracted from site risks to estimate risks that may be present above normal background levels as a result of the radiological condition of the site. Thus, it is important to determine the background concentrations of radionuclides in the area. Summary background concentrations from McLaren/Hart background study discussed in Section 2.2.2 are presented in Table 2-1.

[2] If it were higher than the MDC it would have been detected.

It is expected that very low levels of plutonium isotopes exist in regional soils as a result of fallout deposition, but the McLaren/Hart report did not contain comparable information on the local plutonium background. Because no information was available, the local area background for the plutonium isotopes was assumed to be zero in this report. This is a health protective assumption and results in a slight overestimation of the concentrations that may be attributable to local sources (as compared to global fallout).

3. HUMAN HEALTH EXPOSURE ASSESSMENT

3.1 Characterization of Exposure Setting

3.1.1 Physical Setting

The Centex Homes-Sterling Residential Development property encompasses approximately 100 acres of undeveloped land. The principle drainage feature on the property is Dayton Canyon Creek, which receives water from the Happy Valley area to the west. This intermittent creek flows from west to east across the property and subsequently empties into the Los Angeles River. Hills rise to either side of the creek, and the property contains a mixture of habitat types including grassland and oak woodland.

3.1.2 Local Climate

The Site is arid, typically receiving approximately eight inches of rain a year. The average January low temperature is 46ºF, and the average high temperature in July is 90 ºF.

3.1.3 Proposed Land-Use

The City of Los Angeles has approved construction of single-family detached homes plus associated roadways and utility infrastructure improvements on about 100 acres of the Site. In addition to the developed land an additional 255 acres of land will be permanently dedicated to open space as part of the Santa Monica Mountains Conservancy.

When complete, this Site will host a suburban residential neighborhood. The lots are large enough to accommodate a small garden, so residents may supplement their diet with food grown on the property.

Residents will use municipal water supplied by a distant water treatment plant for domestic purposes. This municipal system will supply abundant, clean water to the neighborhood and groundwater will not be used by residents.

3.2 Conceptual Site Model

Conceptual site models facilitate evaluations of the risks to human health by creating a framework for identifying the paths by which human health may be affected by radionuclides of concern. The conceptual model used in this assessment is a relatively simple one. It describes the source of the radionuclides of concern, the receptors that may be exposed, and the mechanisms or pathways by which these radionuclides expose those receptors.

3.2.1 Source Term

The postulated source of contamination for this risk assessment is distributed radioactivity in surface soil. For the purposes of this risk assessment, the surface soil is assumed to contain Cs-137, Sr-90, and isotopes of plutonium.

3.2.2 Receptors

This Site is anticipated to house a residential neighborhood. It is expected that adults and children will spend a large portion of each day on the Site. Typical receptors in that environment would include adults who work outside the home, adults who do not work outside the home, visitors, delivery people, construction/utility workers, and children of various ages.

The receptor with the greatest potential for exposure is the full-time resident gardener, as that receptor spends the most time on the Site, and is assumed to be directly exposed to surface soil through gardening. Unlike the other receptors, the resident gardener also consumes food grown on the Site.

3.2.3 Exposure Pathways

Radionuclides in surface soil can produce exposures in humans by a variety of mechanisms. Cs-137, for example, can directly irradiate humans with gamma radiation, or be ingested or inhaled when the soil particle it is attached to is ingested or inhaled. Neither Sr-90 nor its daughter, Y-90, produce a gamma particle. They emit beta radiation when they decay, so their significant exposure mechanisms are limited to routes that allow internal exposures to Sr-90, like ingestion and inhalation.

Depending on the source, land use, and receptors, a number of exposure pathways are possible. Table 3-1 lists the exposure pathways evaluated for this Site, and lists the ones selected for inclusion in the quantitative risk assessment.

Table 3-1 Selection of Exposure Pathways

Pathway	Included?	Comment
Direct irradiation	Yes	
Inadvertent ingestion of soil	Yes	Children playing in dirt and adults working in the lawn and gardens may inadvertently ingest small quantities of dirt.
Inhalation of dust suspended from the soil	Yes	Some dust production possible, particularly during early construction.
Ingestion of fruit and vegetables grown on-site	Yes	Planned land use allows gardens. Exposure evaluation includes food from a garden.
Ingestion of meat or eggs grown on-site	No	Planned land use does not include housing livestock or poultry.
Ingestion of groundwater	No	Planned land-use includes municipal water supply.
Dermal adsorption	No	Radionuclides of concern are metals, measurable dermal absorption is not credible.

3.3 Description of Exposure Scenarios Evaluated

As discussed in Section 3.2.2, the receptors with the highest potential for exposure on the Site are residents. Some of these residents may supplement their diet with vegetables and fruit grown on the Site. This scenario, called the residential gardener in this assessment, was selected to estimate the radiological risks from the Site. The residential gardener scenario assumes the receptor is directly exposed to:

- Gamma radiation from Cs-137 in the soil,
- inhalation of suspended dust,
- inadvertent ingestion of soil containing Cs-137, Sr-90, Pu-238, and Pu-239/240, and
- ingestion of home-grown fruit and vegetables.

Exposures from these pathways depend on a number of uncertain variables. For example, in this case exposures to Cs-137 will be heavily dependent on how long and how often people are exposed to surface soil. EPA has assembled a great deal of information on human behavior in an attempt to resolve these uncertainties (USEPA, 1997). This information was used by EPA to establish several common receptor scenarios, including a generic resident and a resident gardener. As part of that effort, the receptor behavior in each scenario was quantified and default numerical values were assigned the parameters used to describe the receptor behavior in each scenario. These values are generally health protective (e.g. they will systematically over-estimate risks).

EPA expects the published default values will be used in a risk assessment unless more accurate site-specific information exists. The default values describing receptor behavior were accepted and used without change in this risk assessment with two exceptions. The value for the fraction of homegrown food used was changed to 7% (0.07). This is the default residential value used by the State of California in their Lead Spread model to calculate risks from lead. (DTSC, 2002). The climatic zone was changed from Minneapolis to Los Angeles to reflect local conditions. Table 3-2 lists the input values used to describe receptor exposures.

Table 3-2 Exposure Parameters

Parameter	Evaluated for On-site Residential Gardener	EPA Default Value?	Value	Units
Exposure duration, adult	Yes	Yes [a]	24	years
Exposure duration, child	Yes	Yes [a]	6	years
Exposure duration, composite	Yes	Yes [a]	30	years
Exposure frequency	Yes	Yes [a]	350	days/year
Fraction of site time spent indoors	Yes	Yes [a]	0.073	unitless
Fraction of site time spent outdoors	Yes	Yes [a]	0.68	unitless
Indoor shielding factor	Yes	Yes [a]	0.4	unitless
Soil ingestion rate	Yes	Yes [a]	0.1	grams/day
Ingestion of homegrown produce	Yes	Yes [a]	47.36	kilogram/year
Fraction of homegrown produce in diet	Yes	No [b]	0.07	unitless
Inhalation rate	Yes	Yes [a]	20	cubic meters/day

[a] Standard EPA exposure parameters: http://epa-prgs.ornl.gov/radionuclides/prg_search.shtml
[b] DTSC, 2002.

3.4 Determination of Exposure Point Concentrations

As discussed in Section 2.2.1, the 2005 and 2007 sampling programs collected samples of various environmental media from Dayton Canyon. However, some of the media sampled are not appropriate for inclusion in a risk assessment of a residential scenario. Based on the exposure scenario presented in Section 3.3, the exposure to the hypothetical receptors will be dependent on the concentrations in surface soil. Tables A-1 through A-4 in Appendix A present the radioanalytical results of these sampling programs for Cs-137, Pu-238, Pu-239/240, and Sr-90 in surface soil, respectively. Radionuclide concentrations in subsurface soil and concrete were not included when calculating the exposure point concentrations in this assessment.

Table 3-3 and Table 3-4 present brief statistical summaries of the surface soil data. The first four lines of the table list the number of samples and the minimum, median, and maximum values.

The US EPA recommends that the distribution of the data population be determined before calculating exposure point concentrations. To determine the distribution of the data sets, the concentration data for each radionuclide were plotted and examined. In addition, the skewness[3]

[3] Skewness is a measure of the degree of asymmetry of a distribution.

of the data was calculated using the SKEW() function included in Microsoft Excel™. The fifth lines of Table 3-3 and Table 3-4 present the results of the SKEW() function for each dataset. Based on these two methods, a statistical distribution was assigned for each radionuclide's data set:

- The Cs-137 and Sr-90 data sets each exhibit a slight positive skewness, but they can be considered to be consistent with a normal distribution for this purpose.
- The Pu-238 and Pu-239/240 data sets each exhibit a slightly stronger positive skewness and their distributions were not as clearly defined. In order to simplify the calculations and presentation, the Pu-238 and Pu-239/240 data sets were treated as normally distributed during this assessment. This is a health protective assumption that will slightly overestimate the exposure point concentration and subsequent risk estimates.

The sixth lines of Table 3-3 and Table 3-4 list the distribution assigned to the concentration data set for each radionuclide.

Once the distribution was identified, the upper 95% confidence limit (95% UCL) on the mean for that distribution was calculated and used as the exposure point concentration (USEPA 2002a, and USEPA 2002b). The resulting values are presented on the last line of Table 3-3 and Table 3-4.

Two sets of statistics are reported for each radionuclide in these tables. One set of statistics describes the instrument results reported by the laboratories (the "Results" column). The second set describes the dataset after all non-detects were replaces with the samples MDC value (the "Upper-Bound" column). This is consistent with the approach described in Section 2.3.1 of this report.

Table 3-3 Statistics for Surface Soil Concentrations of Cs-137 and Sr-90, in pCi/g

Statistics	Cs-137 Results	Cs-137 Upper-Bound	Sr-90 Results	Sr-90 Upper-Bound
Number	169	169	133	133
Minimum	-0.19	0.002	-0.092	0.20
Median	0.043	0.18	0.05	0.25
Maximum	0.38	0.42	0.48	0.48
Skewness	0.77	a	1.31	a
Distribution	Normal	a	Undefined [b]	a
Mean, normal distribution	0.056	0.098	0.057	0.11
Standard Deviation, normal distribution	0.094	0.038	0.085	0.018
95% UCL of the Mean, normal distribution [c]	0.071	0.10	0.071	0.12
Representative exposure point concentration	0.07	0.10	0.071	0.12

[a] Non-detects replaced by MDCs. Normal distribution assumed for calculations.
[b] Normal distribution used as described in Section 3.4.
[c]. USEPA 2002b, Equation 21:

$$95\%\ UCL_{mean,\ normal} = \text{arithmetic mean} + 1.96 \times \text{standard deviation}) / \sqrt{\text{number of samples}})$$

Table 3-4 Statistics for Surface Soil Concentrations of Pu-238 and Pu-239/240, in pCi/g

Statistics	Pu-238 Results	Pu-238 Upper Bound	Pu-239/240 Results	Pu-239/240 Upper Bound
Number	81	81	81	81
Minimum	-0.0031	0.0039	-0.008	0
Median	0.00000	0.016	0.0020	0.011
Maximum	0.016	0.046	0.026	0.048
Skewness	2.38	b	1.37	b
Distribution	Undefined [a]	b	Normal	b
Mean, normal distribution	0.0004	0.016	0.003	0.014
Standard Deviation of normal distribution	0.0029	0.0079	0.0059	0.0085
95% UCL of the Mean, normal distribution [c]	0.0010	0.018	0.005	0.016
Representative exposure point concentration	0.001	0.018	0.005	0.016

[a] Normal distribution used as described in Section 3.4.
[b] Nondetects replaced by MDCs. Normal distribution assumed for calculations.
[c]. USEPA 2002b, Equation 21:

$$95\%\ UCL_{mean,\ normal} = \text{arithmetic mean} + 1.96 \times \text{standard deviation}) / \sqrt{\text{number of samples}})$$

4. QUANTIFICATION OF RISKS

The US Environmental Protection Agency developed risk assessment methodology (USEPA 1989, USEPA 1991) to evaluate risks at Superfund sites being administered by EPA under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). While this methodology is inherently conservative and generally overestimates the risks in a given scenario, it is a widely accepted methodology and provides reproducible risk estimates. This risk assessment was performed using EPA methods and default parameters.

4.1 Development of Soil Screening Levels for Dayton Canyon

The US Environmental Protection Agency maintains a risk calculator on their website.[4] The EPA radiological risk calculator estimates the soil concentration that produces a risk of 10^{-6} for potential exposures to given radionuclide. This concentration is called the Soil Screening Level (SSL).

The EPA model allows the user to select the pathways and receptors to be evaluated. The calculations are performed using algorithms and code developed by EPA, and uses EPA default values unless the user over-rides the model.

The exposure pathways and parameters presented in Section 3 were input into the EPA risk calculator. EPA default scenarios and parameter values were used with one exception: The location ID/climate selector was changed to Los Angeles to better represent the local climate. Table 4-1 lists the resulting SSL's for each radionuclide and each pathway selected for evaluation in Section 3.3.

Table 4-1 SSL's for Radionuclides of Concern in Surface Soil, in pCi/g

Parameter	Cs-137	Pu-238	Pu-239/240	Sr-90
EPA Soil Screening Levels for Selected Pathways [a]				
Direct radiation	0.061	1700	560	8
Inadvertent soil ingestion	25	3.3	2.9	7.7
Inhalation of fugitive dust	2,100,000	610	540	220,000
Ingestion of home-grown produce	9.3	67	58	0.49

[a] Calculated using EPA methodology for a risk of 10^{-6}.

The numbers in Table 4-1 represent the concentration that corresponds to a risk of 10^{-6} for each of the radionuclides and pathways listed.

[4] Web site URL: http://epa-prgs.ornl.gov/radionuclides/prg_search.shtml

4.2 Calculation of Risks

Once one knows the SSL that is associated with a risk of 10^{-6} for a given radionuclide a pathway, the CERCLA risk from any concentration of the same radionuclide to the same receptor can be calculated as:

$$Risk_{r,n} = \frac{SoilConc_n}{SSL_{r,n}} \times 10^{-6} \qquad \textbf{EQ. 1}$$

Where:

$Risk_{r,n}$ = CERCLA risk to receptor "r" from nuclide "n",
$SoilConc_n$ = Exposure Point Soil Concentration of radionuclide n, and
$SSL_{r,n}$ = Soil Screening Level for receptor "r" from radionuclide "n".

For example, if 0.061 pCi/g Cs-137 in surface soil produced a risk of 1 x 10^{-6} via the direct radiation pathway, then a concentration of 0.12 pCi/g would produce a risk that was two times greater than 1 x 10^{-6}, or a risk of 2 x 10^{-6}.

Table 4-2 presents the background concentrations (from Table 2-1), and the estimated risks calculated using Equation 1 and the SSL's in Table 4-1. The values are provided as a comparative tool only and are not offered as the actual risks associated with living in Dayton Canyon.

Table 4-2 Background Concentrations and Calculated Risks from Background

Parameter	Cs-137	Pu-238	Pu-239/240	Sr-90	Total
Background concentration (pCi/g) [a]	0.087	0.0	0.0	0.052	na
Receptor Risks by Pathway					
Risks from inadvertent soil ingestion	3.5 x 10^{-9}	0	0	6.8 x 10^{9}	1.0 x 10^{-8}
Risks from ingestion of home-grown produce	9.4 x 10^{-9}	0	0	1.1 x 10^{-7}	1.2 x 10^{-7}
Risks from inhalation of fugitive dust	4.1 x 10^{-14}	0	0	2.4 x 10^{-13}	2.8 x 10^{-13}
Risks from direct radiation	1.4 x 10^{-6}	0	0	6.5 x 10^{-9}	1.4 x 10^{-6}
Total Risks					
Risks to the Proposed Residential Gardener	1.4 x 10^{-6}	0	0	1.2 x 10^{-7}	1.6 x 10^{-6}

The following table (Table 4-3) presents the exposure point concentrations (from Table 3-3 and Table 3-4) and the estimated risks calculated using Equation 1 and the SSL's in Table 4-1. These exposure point concentrations include the normal background concentration of Cs-137 and Sr-90 found in the area, so the estimated risks in Table 4-3 include risks from background.

Table 4-3 Exposure Point Concentrations and Calculated Risks (Including Background)

Parameter	Cs-137	Pu-238	Pu-239/240	Sr-90	Total
Representative exposure point concentration (pCi/g) [a]	0.071	0.001	0.005	0.071	na
Receptor Risks by Pathway					
Risks from inadvertent soil ingestion	2.8×10^{-9}	3.0×10^{-10}	1.6×10^{-9}	9.3×10^{-9}	1.4×10^{-8}
Risks from ingestion of home-grown produce	7.6×10^{-9}	1.5×10^{-11}	8.1×10^{-11}	1.5×10^{-7}	1.5×10^{-7}
Risks from inhalation of fugitive dust	3.4×10^{-14}	1.6×10^{-12}	8.7×10^{-12}	3.2×10^{-13}	1.1×10^{-11}
Risks from direct radiation	1.2×10^{-6}	5.9×10^{-13}	8.4×10^{-12}	8.9×10^{-9}	1.2×10^{-6}
Total Risks					
Risks to the Proposed Residential Gardener	$1.2.\times 10^{-6}$	$3.2.\times 10^{-10}$	$1.7.\times 10^{-9}$	$1.6.\times 10^{-7}$	$1.3.\times 10^{-6}$

[a] From Table 3-3 and Table 3-4.

Table 4-4 presents the upper-bound concentrations (from Table 3-3 and Table 3-4), and the estimated risks calculated using Equation 1 and the SSL's in Table 4-1. These exposure point concentrations include the normal background concentration of Cs-137 and Sr-90 found in the area, so the estimated risks in Table 4-4 include risks from normal background levels.

Table 4-4 Upper-bound Concentrations and Calculated Risks (Including Background)

Parameter	Cs-137	Pu-238	Pu-239/240	Sr-90	Total
Representative exposure point concentration (pCi/g) [a]	0.10	0.018	0.016	0.12	na
Receptor Risks by Pathway					
Risks from inadvertent soil ingestion	4.1×10^{-9}	5.4×10^{-9}	5.4×10^{-9}	1.5×10^{-8}	3.0×10^{-8}
Risks from ingestion of home-grown produce	1.1×10^{-8}	2.7×10^{-10}	2.7×10^{-10}	2.4×10^{-7}	2.5×10^{-7}
Risks from inhalation of fugitive dust	4.9×10^{-14}	2.9×10^{-11}	2.9×10^{-11}	5.3×10^{-13}	5.9×10^{-11}
Risks from direct radiation	1.7×10^{-6}	1.1×10^{-11}	2.8×10^{-11}	1.5×10^{-8}	1.7×10^{-6}
Total Risks					
Risks to the Proposed Residential Gardener	$1.7.\times 10^{-6}$	$6.\times 10^{-9}$	$6.\times 10^{-9}$	$3.\times 10^{-7}$	$2.0.\times 10^{-6}$

[a] From Table 3-3 and Table 3-4.

4.3 Discussion of Risk Calculations

As can be seen by comparing the risks presented in the previous section, the radiological risks to the postulated resident gardener are small, ranging from normal background (1.6×10^{-6}) up to an upper-bound risk of 2×10^{-6}. This calculated upper-bound risk is about 4×10^{-7} above the background risk. The majority of these risks are attributable to direct radiation exposure from

Cs-137 in the surface soil (~86%). Another 13% of the calculated risks are associated with ingestion of Sr-90 via home-grown produce.

5. SUMMARY AND CONCLUSIONS

Based on the concentration data and land use information provided, the calculated upper-bound radiological risks to the postulated residential receptor is about 4 x 10^{-7} above background. Risks of this magnitude are below 10^{-6}, a level that is generally considered by EPA to be an acceptable risk when evaluating Superfund sites.

This calculated risk can also be compared to radiological risks from other common radiation sources. See Table B-1 in Attachment B for a list of nine other radiation sources and their associated radiological risks.

Finally, it should be emphasized that these risks were calculated using conservative assumptions and a methodology which tends to overestimate risk. For example, the upper-bound exposure concentrations used in this assessment are calculated by using a sample's MDC as the sample's concentration if a radionuclide was not detected in a sample. In reality, the concentration of the radionuclide is apt to be less than the MDC and it will actually lie somewhere between the detection limit and the local background for that radionuclide. Substituting the MDC creates a systematic overestimation of the risk from that radionuclide. This is just one example, but it illustrates that the upper-bound risk estimates presented in this report likely overestimate any real radiological risks that may be incurred by living on the Site.

6. CITATIONS

ALLWEST, 2005	"Preliminary Endangerment Assessment, Workplan, Dayton Canyon Site, West Hills, CA". ALLWEST Remediation, Inc. 1201 North Barsten Way, Anaheim, CA 92806, November 22, 2005.
ALLWEST 2007	"Supplemental Radiological Investigation, Sampling and Analysis Results, Sterling Homes Development, West Hills, CA". ALLWEST Remediation Inc. 1201 North Barsten Way, Anaheim, CA 92806, June 4, 2007.
Auxier 2007	"Radiological Characterization of Dayton Canyon, West Hills, California", Draft For Comment, Auxier & Associates, Inc. 9821 Cogdill Rd, Suite 1, Knoxville TN 37922, November 30, 2007.
DTSC 2005	"Responses to Public Comments on Centex Homes-Sterling Property Site Characterization and PEA Workplan", Department of Toxic Substances Control, October 27, 2005.
DTSC 2002	"Leadspread, Version 7", http://www.dtsc.ca.gov/AssessingRisk/ leadspread.cfm Department of Toxic Substances Control, October 27, 2005.
ISCORS, 2003	"Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE) ISCORS Technical Report No. 1". U.S. Department of Energy Office of Environmental Policy and Guidance Air, Water & Radiation Info Brief DOE/EH-412/0015/0802 rev.1, January 2003.
McLaren/Hart 1995	"Additional Soil and Water Sampling, The Brandeis-Bardin Institute and Santa Monica Mountains Conservatory". McLaren/Hart Environmental Engineering Corporation, Irvine, CA., January 19, 1995.
UIHC 2001	"Radiation Exposure: The Facts Verses Fiction". University of Iowa, 2001.
UNSCEAR 1993	"Sources and Effects of Ionizing Radiation". United Nations Scientific Committee on the effects of Atomic Radiation. United Nations, New York, 1993.
UNSCEAR 2000	"Sources and Effects of Ionizing Radiation". United Nations Scientific Committee on the effects of Atomic Radiation. United Nations, New York, 2000.
USEPA 1989	"Risk Assessment Guidance for Superfund, Volume1, Human Health Evaluation Manual (Part A)". EPA/540/1-89/002, US EPA Office of Emergency and Response, Washington, DC., December 1989.
USEPA 1991	"Risk Assessment Guidance for Superfund, Volume1, Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals)". EPA Publication 9285.7-01B, US EPA Office of Emergency and Response, Washington, DC., October 1989.

USEPA 1997	“Exposure Factors Handbook, Volumes 1-3”. EPA/600/P-95/002Fa, EPA/600/P-95/002Fb, and EPA/600/P-95/002Fc, US EPA Office of Research and Development, Washington, DC., August 1997.
USEPA 2002a	“Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites”. OSWER 9285.6-10, US EPA Office of Emergency and Remedial Response, Washington, DC., December 2002.
USEPA 2002b	“Estimation of the Exposure Point Concentration Term Using a Gamma Distribution”. Technology Support Center Issue, EPA/600/R-02/084, US EPA Office of Solid Waste and Emergency Response, Washington, DC., October 2002.

Additional References:

Gilbert, 1987	“Statistical Methods for Environmental Pollution Monitoring”. Van Nostrand Reinhold, New York, New York, 1987.
NCRP 2006	“Cesium-137 in the Environment: Radioecology and Approaches to Assessment and Management”. NCRP Report No. 154, National Council of Radiation Protection & Measurements, Bethesda, MD., November 21, 2006.
USEPA 1996	“Radiation Exposure and Risks Assessment Manual (RERAM)”. EPA/402-R-96-016, US EPA Office of Air and Radiation, Washington, DC., June 1996.
USEPA 2000a	“Soil Screening Guidance: User’s Guide”. EPA/540-R-00-007, US EPA Office of Solid Waste and Emergency Response, Washington, DC., October 2000.
USEPA 2000b	“Soil Screening Guidance: Technical Background Document”. EPA/540/-R-00-006, US EPA Office of Solid Waste and Emergency Response, Washington, DC., October 2000.

ATTACHMENT A. DATA TABLES

Table A.1 Cs-137 Concentrations

Sample ID	Reported Cs-137 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
A2 -N	0.00201 ± 0.0326 (nr)	0.00201	0.00201
A4 -W	0.0552 ± 0.0349 (nr)	0.0552	0.0552
B15 -W	0.0769 ± 0.039 (nr)	0.0769	0.0769
B5 -S	0.167 ± 0.0615 (nr)	0.167	0.167
B7 -W	0.215 ± 0.0652 (nr)	0.215	0.215
C10 -W	0.0578 ± 0.0332 (nr)	0.0578	0.0578
C4 -N	0.15 ± 0.0596 (nr)	0.15	0.15
D1 -N	0.0424 ± 0.036 (nr)	0.0424	0.0424
D2 -S	0.031 ± 0.0403 (nr)	0.031	0.031
D6 -W	0.217 ± 0.0713 (nr)	0.217	0.217
E16 -W	0.0127 ± 0.0211 (nr)	0.0127	0.0127
F4 -N	0.134 ± 0.0532 (nr)	0.134	0.134
G13 -W	0.262 ± 0.0806 (nr)	0.262	0.262
G7 -S	0.133 ± 0.0609 (nr)	0.133	0.133
G9 -W	0.31 ± 0.0892 (nr)	0.31	0.31
H5 -W	0.0889 ± 0.0442 (nr)	0.0889	0.0889
I15 -W	0.187 ± 0.0668 (nr)	0.187	0.187
I2 -N	0.26 ± 0.0728 (nr)	0.26	0.26
I4 -S	0.0316 ± 0.034 (nr)	0.0316	0.0316
J4 -N	0.093 ± 0.0481 (nr)	0.093	0.093
K6 -S	0.0965 ± 0.0538 (nr)	0.0965	0.0965
K7 -N	0.0408 ± 0.0293 (nr)	0.0408	0.0408
LCR -16	0.0368 ± 0.0313 (nr)	0.0368	0.0368
LCR -24	0.0388 ± 0.0372 (nr)	0.0388	0.0388
LCR -32	0.0689 ± 0.0504 (nr)	0.0689	0.0689
LCR -46	0.0585 ± 0.0365 (nr)	0.0585	0.0585
M10 -W	0.377 ± 0.0884 (nr)	0.377	0.377
M5 -N	0.0434 ± 0.034 (nr)	0.0434	0.0434
N6 -S	0.055 ± 0.0543 (nr)	0.055	0.055
N8 -W	0.378 ± 0.0811 (nr)	0.378	0.378
NDR -7	0.0503 ± 0.0351 (nr)	0.0503	0.0503
P3 -N	0.05 ± 0.031 (nr)	0.05	0.05
P6 -W	0.0989 ± 0.0535 (nr)	0.0989	0.0989
P7 -S	0.0356 ± 0.0303 (nr)	0.0356	0.0356
P9 -N	0.128 ± 0.0523 (nr)	0.128	0.128
R9 -W	0.036 ± 0.0348 (nr)	0.036	0.036
4000 @1'	0.096 ± 0.078 (0.122)	0.096	0.122
4001 @1'	-0.075 ± 0.08 (0.164)	-0.075	0.164
4003 @1'	0.093 ± 0.094 (0.148)	0.093	0.148
4005 @1'	0.033 ± 0.086 (0.151)	0.033	0.151
4006 @1'	0.049 ± 0.061 (0.099)	0.049	0.099
4007 @1'	0.05 ± 0.074 (0.124)	0.05	0.124
4008 @1'	0.07 ± 0.098 (0.168)	0.07	0.168
4009 @1'	0.049 ± 0.072 (0.199)	0.049	0.199
4011 @1'	0.057 ± 0.098 (0.165)	0.057	0.165

Table A.1 Cs-137 Concentrations (cont.)

Sample ID	Reported Cs-137 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
4012 @1'	0.039 ± 0.066 (0.11)	0.039	0.11
4013 @1'	0.024 ± 0.068 (0.116)	0.024	0.116
4014 @1'	0.025 ± 0.058 (0.098)	0.025	0.098
4015 @1'	0.115 ± 0.079 (0.121)	0.115	0.121
4016 @1'	0.021 ± 0.068 (0.115)	0.021	0.115
4019 @1'	-0.018 ± 0.072 (0.14)	-0.018	0.14
4020 @1'	-0.042 ± 0.064 (0.117)	-0.042	0.117
4021 @1'	-0.05 ± 0.12 (0.23)	-0.05	0.23
4023 @1'	0.127 ± 0.093 (0.138)	0.127	0.138
4024 @1'	0.16 ± 0.1 (0.14)	0.16	0.16
4026 @1'	0.18 ± 0.1 (0.15)	0.18	0.18
4027 @1'	0.087 ± 0.08 (0.123)	0.087	0.123
4028 @1'	0.085 ± 0.094 (0.15)	0.085	0.15
4029 @1'	0.15 ± 0.11 (0.16)	0.15	0.16
4030 @1'	0.03 ± 0.11 (0.19)	0.03	0.19
4031 @1'	0.018 ± 0.057 (0.097)	0.018	0.097
4032 @1'	0.037 ± 0.071 (0.122)	0.037	0.122
4034 @1'	0.11 ± 0.1 (0.16)	0.11	0.16
4035 @1'	0.24 ± 0.11 (0.14)	0.24	0.24
4036 @1'	0.36 ± 0.16 (0.21)	0.36	0.36
4037 @1'	0.09 ± 0.1 (0.17)	0.09	0.17
4038 @1'	0.032 ± 0.075 (0.13)	0.032	0.13
4039 @1'	0.09 ± 0.088 (0.139)	0.09	0.139
4040 @1'	-0.071 ± 0.082 (0.167)	-0.071	0.167
4042 @1'	-0.051 ± 0.081 (0.159)	-0.051	0.159
4045 @1'	0.021 ± 0.092 (0.165)	0.021	0.165
4046 @1'	0.12 ± 0.11 (0.17)	0.12	0.17
4047 @1'	-0.019 ± 0.074 (0.14)	-0.019	0.14
4048 @1'	0.17 ± 0.12 (0.18)	0.17	0.18
4049 @1'	0.018 ± 0.081 (0.144)	0.018	0.144
4050 @1'	0.019 ± 0.094 (0.168)	0.019	0.168
4051 @1'	0.021 ± 0.07 (0.123)	0.021	0.123
4052 @1'	0.117 ± 0.085 (0.122)	0.117	0.122
4053 @1'	0.058 ± 0.086 (0.144)	0.058	0.144
4054 @1'	0.07 ± 0.1 (0.17)	0.07	0.17
4056 @1'	0.077 ± 0.075 (0.117)	0.077	0.117
4057 @1'	0.123 ± 0.096 (0.142)	0.123	0.142
4058 @1'	0.006 ± 0.068 (0.125)	0.006	0.125
4060 @1'	0.039 ± 0.083 (0.144)	0.039	0.144
4062 @1'	0.098 ± 0.096 (0.152)	0.098	0.152
4063 @1'	0.19 ± 0.12 (0.17)	0.19	0.19
4066 @1'	0.27 ± 0.13 (0.17)	0.27	0.27
4068 @1'	0.109 ± 0.091 (0.14)	0.109	0.14
4069 @1'	0.047 ± 0.088 (0.15)	0.047	0.15
4070 @1'	0.016 ± 0.064 (0.116)	0.016	0.116

Table A.1 Cs-137 Concentrations (cont.)

Sample ID	Reported Cs-137 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
4071 @1'	0.09 ± 0.097 (0.155)	0.09	0.155
4072 @1'	0.044 ± 0.07 (0.118)	0.044	0.118
4073 @1'	-0.006 ± 0.086 (0.158)	-0.006	0.158
4074 @1'	0.031 ± 0.079 (0.138)	0.031	0.138
4075 @1'	0.04 ± 0.1 (0.17)	0.04	0.17
4077 @1'	0.057 ± 0.095 (0.16)	0.057	0.16
4080 @1'	0.2 ± 0.12 (0.18)	0.2	0.2
4081 @1'	0.01 ± 0.095 (0.171)	0.01	0.171
4082 @1'	0.1 ± 0.1 (0.17)	0.1	0.17
4083 @1'	0.08 ± 0.1 (0.17)	0.08	0.17
4084 @1'	0.15 ± 0.11 (0.15)	0.15	0.15
4085 @1'	-0.025 ± 0.066 (0.128)	-0.025	0.128
4086 @1'	0.06 ± 0.1 (0.17)	0.06	0.17
4088 @1'	0.3 ± 0.14 (0.17)	0.3	0.3
4091 @1'	0.04 ± 0.096 (0.166)	0.04	0.166
4092 @1'	0.013 ± 0.092 (0.166)	0.013	0.166
A4 @1'	0.01 ± 0.12 (0.2)	0.01	0.2
A4NE @1'	-0.01 ± 0.15 (0.27)	-0.01	0.27
A4NW @1'	-0.01 ± 0.11 (0.2)	-0.01	0.2
A4SE @1'	-0.05 ± 0.22 (0.41)	-0.05	0.41
A4SW @1'	0.1 ± 0.15 (0.26)	0.1	0.26
B7 @1'	0.01 ± 0.12 (0.2)	0.01	0.2
B7NW @1'	0.12 ± 0.14 (0.23)	0.12	0.23
B7SE @1'	-0.01 ± 0.13 (0.26)	-0.01	0.26
B7SW @1'	-0.04 ± 0.13 (0.28)	-0.04	0.28
D6 @1'	0.05 ± 0.12 (0.2)	0.05	0.2
D6/B7 @1'	-0.14 ± 0.12 (0.23)	-0.14	0.23
D6NE @1'	0.044 ± 0.099 (0.175)	0.044	0.175
D6NW @1'	0.04 ± 0.12 (0.26)	0.04	0.26
D6SE @1'	0.05 ± 0.18 (0.32)	0.05	0.32
F4 @1'	0.07 ± 0.15 (0.26)	0.07	0.26
F4NE @1'	-0.06 ± 0.15 (0.3)	-0.06	0.3
F4NW @1'	0.13 ± 0.14 (0.21)	0.13	0.21
F4SE @1'	-0.02 ± 0.15 (0.28)	-0.02	0.28
F4SW @1'	-0.03 ± 0.12 (0.21)	-0.03	0.21
G13 @1'	0.04 ± 0.15 (0.27)	0.04	0.27
G13NE @1'	-0.03 ± 0.12 (0.23)	-0.03	0.23
G13NW @1'	-0.04 ± 0.11 (0.2)	-0.04	0.2
G13SE @1'	-0.047 ± 0.097 (0.177)	-0.047	0.177
G13SW @1'	-0.19 ± 0.13 (0.29)	-0.19	0.29
G9 @1'	-0.07 ± 0.12 (0.26)	-0.07	0.26
G9NE @1'	0.01 ± 0.099 (0.186)	0.01	0.186
G9NW @1'	0.07 ± 0.13 (0.22)	0.07	0.22
G9SE @1'	-0.05 ± 0.13 (0.27)	-0.05	0.27
G9SW @1'	0.05 ± 0.12 (0.21)	0.05	0.21

Table A.1 Cs-137 Concentrations (cont.)

Sample ID	Reported Cs-137 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
I2 @1'	0.05 ± 0.11 (0.18)	0.05	0.18
I2NE @1'	0.04 ± 0.15 (0.27)	0.04	0.27
I2NW @1'	-0.057 ± 0.098 (0.203)	-0.057	0.203
I2SE @1'	0.06 ± 0.16 (0.28)	0.06	0.28
I2SW @1'	0.02 ± 0.13 (0.25)	0.02	0.25
I4 @1'	-0.08 ± 0.13 (0.28)	-0.08	0.28
I4NE @1'	-0.04 ± 0.13 (0.24)	-0.04	0.24
I4NW @1'	0 ± 0.16 (0.3)	0	0.3
I4SE @1'	0.12 ± 0.14 (0.21)	0.12	0.21
I4SW @1'	-0.02 ± 0.13 (0.25)	-0.02	0.25
M10 @1'	0.04 ± 0.1 (0.19)	0.04	0.19
M10NW @1'	0.17 ± 0.14 (0.2)	0.17	0.2
M10SE @1'	0.03 ± 0.12 (0.2)	0.03	0.2
M10SW @1'	0.07 ± 0.11 (0.19)	0.07	0.19
M5 @1'	-0.06 ± 0.13 (0.27)	-0.06	0.27
M5NE @1'	-0.1 ± 0.12 (0.26)	-0.1	0.26
M5NW @1'	0.03 ± 0.16 (0.29)	0.03	0.29
M5SE @1'	-0.09 ± 0.11 (0.24)	-0.09	0.24
M5SW @1'	0.03 ± 0.15 (0.27)	0.03	0.27
N8 @1'	0.02 ± 0.1 (0.19)	0.02	0.19
N8/M10 @1'	0.04 ± 0.11 (0.2)	0.04	0.2
N8NE @1'	0.11 ± 0.12 (0.19)	0.11	0.19
N8NW @1'	-0.04 ± 0.15 (0.3)	-0.04	0.3
N8SE @1'	-0.19 ± 0.15 (0.32)	-0.19	0.32
P7 @1'	0.03 ± 0.14 (0.25)	0.03	0.25
P7NE @1'	-0.06 ± 0.13 (0.23)	-0.06	0.23
P7NW @1'	0.13 ± 0.12 (0.19)	0.13	0.19
P7SE @1'	0.1 ± 0.13 (0.22)	0.1	0.22
P7SW @1'	0.01 ± 0.12 (0.23)	0.01	0.23
R9 @1'	0.13 ± 0.14 (0.21)	0.13	0.21
R9NE @1'	-0.11 ± 0.12 (0.26)	-0.11	0.26
R9NW @1'	-0.03 ± 0.17 (0.32)	-0.03	0.32
R9SE @1'	0.18 ± 0.25 (0.42)	0.18	0.42
R9SW @1'	-0.07 ± 0.14 (0.3)	-0.07	0.3

[a] “nr” indicates no results were reported

Table A.2 Pu-238 Concentrations

Sample ID	Reported Pu-238 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
A2 -N	-0.003 ± 0.006 (0.025)	-0.003	0.025
A4 -W	0.004 ± 0.009 (0.012)	0.004	0.012
B5 -S	0.002 ± 0.011 (0.016)	0.002	0.016
C10 -W	0.003 ± 0.012 (0.009)	0.003	0.009
D6 -W	0 ± 0 (0.012)	0	0.012
F4 -N	0.005 ± 0.011 (0.016)	0.005	0.016
G13 -W	-0.003 ± 0.005 (0.023)	-0.003	0.023
G9 -W	0 ± 0 (0.011)	0	0.011
I4 -S	-0.002 ± 0.004 (0.02)	-0.002	0.02
LCR -24	0.016 ± 0.032 (0.043)	0.016	0.043
LCR -40	0 ± 0 (0.046)	0	0.046
LCR -8	0 ± 0 (0.043)	0	0.043
M10 -W	-0.002 ± 0.012 (0.02)	-0.002	0.02
M5 -N	0.002 ± 0.009 (0.019)	0.002	0.019
N6 -S	0.002 ± 0.009 (0.021)	0.002	0.021
N8 -W	0.003 ± 0.013 (0.019)	0.003	0.019
P6 -W	0 ± 0 (0.01)	0	0.01
R9 -W	0 ± 0 (0.01)	0	0.01
A4 @1'	0 ± 0.0058 (0.0039)	0	0.0039
A4NE @1'	0.0028 ± 0.0063 (0.0121)	0.0028	0.0121
A4NW @1'	-0.0006 ± 0.0062 (0.0152)	-0.0006	0.0152
A4SE @1'	0.0012 ± 0.0059 (0.0113)	0.0012	0.0113
A4SW @1'	0.0003 ± 0.0061 (0.0135)	0.0003	0.0135
B7 @1'	-0.003 ± 0.012 (0.023)	-0.003	0.023
B7NW @1'	0.006 ± 0.012 (0.009)	0.006	0.009
B7SE @1'	0.007 ± 0.011 (0.019)	0.007	0.019
B7SW @1'	-0.002 ± 0.012 (0.021)	-0.002	0.021
D6 @1'	0 ± 0.011 (0.008)	0	0.008
D6/B7 @1'	-0.001 ± 0.011 (0.017)	-0.001	0.017
D6NE @1'	0.001 ± 0.011 (0.019)	0.001	0.019
D6NW @1'	-0.003 ± 0.012 (0.023)	-0.003	0.023
D6SE @1'	-0.002 ± 0.011 (0.02)	-0.002	0.02
F4 @1'	-0.003 ± 0.012 (0.024)	-0.003	0.024
F4NE @1'	-0.002 ± 0.011 (0.02)	-0.002	0.02
F4NW @1'	0 ± 0.012 (0.009)	0	0.009
F4SE @1'	-0.001 ± 0.011 (0.016)	-0.001	0.016
F4SW @1'	0.005 ± 0.012 (0.021)	0.005	0.021
G13 @1'	0.002 ± 0.011 (0.016)	0.002	0.016
G13NE @1'	-0.003 ± 0.012 (0.024)	-0.003	0.024
G13NW @1'	0.007 ± 0.012 (0.023)	0.007	0.023
G13SE @1'	-0.001 ± 0.011 (0.016)	-0.001	0.016
G13SW @1'	-0.002 ± 0.01 (0.018)	-0.002	0.018
G9 @1'	0.001 ± 0.011 (0.02)	0.001	0.02
G9NE @1'	0 ± 0.012 (0.009)	0	0.009
G9NW @1'	0 ± 0.012 (0.023)	0	0.023

Table A.2 Pu-238 Concentrations (cont.)

Sample ID	Reported Pu-238 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
G9SE @1'	-0.001 ± 0.011 (0.017)	-0.001	0.017
G9SW @1'	0.001 ± 0.013 (0.022)	0.001	0.022
I2 @1'	0 ± 0.011 (0.008)	0	0.008
I2NE @1'	0.003 ± 0.011 (0.022)	0.003	0.022
I2NW @1'	0 ± 0.012 (0.009)	0	0.009
I2SE @1'	-0.002 ± 0.012 (0.02)	-0.002	0.02
I2SW @1'	0.001 ± 0.012 (0.021)	0.001	0.021
I4 @1'	0.0006 ± 0.0064 (0.01)	0.0006	0.01
I4NE @1'	0 ± 0.011 (0.008)	0	0.008
I4NW @1'	-0.0003 ± 0.006 (0.0117)	-0.0003	0.0117
I4SE @1'	-0.002 ± 0.011 (0.019)	-0.002	0.019
I4SW @1'	0.003 ± 0.011 (0.008)	0.003	0.008
M10 @1'	-0.0009 ± 0.0058 (0.0091)	-0.0009	0.0091
M10NW @1'	-0.0031 ± 0.0069 (0.0152)	-0.0031	0.0152
M10SE @1'	-0.0008 ± 0.0055 (0.0087)	-0.0008	0.0087
M10SW @1'	0.0006 ± 0.0057 (0.0089)	0.0006	0.0089
M5 @1'	-0.002 ± 0.011 (0.019)	-0.002	0.019
M5NE @1'	-0.002 ± 0.011 (0.019)	-0.002	0.019
M5NW @1'	0 ± 0.012 (0.009)	0	0.009
M5SE @1'	0.002 ± 0.011 (0.017)	0.002	0.017
M5SW @1'	-0.002 ± 0.012 (0.021)	-0.002	0.021
N8 @1'	0 ± 0.011 (0.022)	0	0.022
N8/M10 @1'	-0.0006 ± 0.0057 (0.0089)	-0.0006	0.0089
N8NE @1'	-0.002 ± 0.011 (0.019)	-0.002	0.019
N8NW @1'	-0.002 ± 0.012 (0.02)	-0.002	0.02
N8SE @1'	0 ± 0.012 (0.009)	0	0.009
P7 @1'	0 ± 0.0059 (0.004)	0	0.004
P7NE @1'	-0.0009 ± 0.006 (0.0093)	-0.0009	0.0093
P7NW @1'	0.0031 ± 0.0063 (0.0042)	0.0031	0.0042
P7SE @1'	-0.0009 ± 0.006 (0.0094)	-0.0009	0.0094
P7SW @1'	-0.0026 ± 0.0058 (0.0128)	-0.0026	0.0128
R9 @1'	-0.001 ± 0.011 (0.015)	-0.001	0.015
R9NE @1'	0.002 ± 0.012 (0.017)	0.002	0.017
R9NW @1'	0 ± 0.011 (0.008)	0	0.008
R9SE @1'	0.003 ± 0.011 (0.008)	0.003	0.008
R9SW @1'	0 ± 0.012 (0.009)	0	0.009

Table A.3 Pu-239/240 Concentrations

Sample ID	Reported Pu-239/240 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
A2 -N	0.002 ± 0.011 (0.025)	0.002	0.013
A4 -W	0.006 ± 0.014 (0.023)	0.006	0.02
B5 -S	0.019 ± 0.016 (0.009)	0.019	0.035
C10 -W	-0.001 ± 0.012 (0.017)	-0.001	0.011
D6 -W	0.005 ± 0.009 (0.012)	0.005	0.014
F4 -N	0.006 ± 0.011 (0.008)	0.006	0.017
G13 -W	0.026 ± 0.022 (0.012)	0.026	0.048
G9 -W	0.008 ± 0.012 (0.011)	0.008	0.02
I4 -S	-0.002 ± 0.004 (0.02)	-0.002	0.002
LCR -24	0 ± 0 (0.043)	0	0
LCR -40	0 ± 0 (0.046)	0	0
LCR -8	0 ± 0 (0.293)	0	0
M10 -W	0.016 ± 0.016 (0.023)	0.016	0.032
M5 -N	0.002 ± 0.008 (0.019)	0.002	0.01
N6 -S	0.016 ± 0.016 (0.011)	0.016	0.032
N8 -W	0.019 ± 0.018 (0.023)	0.019	0.037
P6 -W	0.012 ± 0.014 (0.01)	0.012	0.026
R9 -W	0.004 ± 0.008 (0.01)	0.004	0.012
A4 @1'	-0.0009 ± 0.0058 (0.0091)	-0.0009	0.0049
A4NE @1'	0.0046 ± 0.0063 (0.0042)	0.0046	0.0109
A4NW @1'	0.0021 ± 0.0062 (0.0096)	0.0021	0.0083
A4SE @1'	0.002 ± 0.0059 (0.0091)	0.002	0.0079
A4SW @1'	-0.0003 ± 0.0077 (0.0184)	-0.0003	0.0074
B7 @1'	-0.001 ± 0.012 (0.017)	-0.001	0.011
B7NW @1'	0 ± 0.012 (0.009)	0	0.012
B7SE @1'	-0.007 ± 0.011 (0.029)	-0.007	0.004
B7SW @1'	0.001 ± 0.012 (0.021)	0.001	0.013
D6 @1'	0.002 ± 0.011 (0.016)	0.002	0.013
D6/B7 @1'	0.003 ± 0.011 (0.009)	0.003	0.014
D6NE @1'	-0.002 ± 0.011 (0.019)	-0.002	0.009
D6NW @1'	0.007 ± 0.014 (0.029)	0.007	0.021
D6SE @1'	-0.001 ± 0.011 (0.017)	-0.001	0.01
F4 @1'	-0.001 ± 0.012 (0.018)	-0.001	0.011
F4NE @1'	-0.002 ± 0.011 (0.02)	-0.002	0.009
F4NW @1'	0.007 ± 0.012 (0.009)	0.007	0.019
F4SE @1'	-0.002 ± 0.011 (0.019)	-0.002	0.009
F4SW @1'	-0.008 ± 0.012 (0.033)	-0.008	0.004
G13 @1'	0.001 ± 0.011 (0.02)	0.001	0.012
G13NE @1'	-0.001 ± 0.012 (0.018)	-0.001	0.011
G13NW @1'	0.005 ± 0.012 (0.017)	0.005	0.017
G13SE @1'	-0.001 ± 0.011 (0.016)	-0.001	0.01
G13SW @1'	0.008 ± 0.01 (0.015)	0.008	0.018
G9 @1'	0.002 ± 0.011 (0.017)	0.002	0.013
G9NE @1'	0.013 ± 0.014 (0.009)	0.013	0.027
G9NW @1'	0.009 ± 0.012 (0.017)	0.009	0.021

Table A.3 Pu-239/240 Concentrations (cont.)

Sample ID	Reported Pu-239/240 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
G9SE @1'	-0.002 ± 0.011 (0.02)	-0.002	0.009
G9SW @1'	-0.002 ± 0.013 (0.022)	-0.002	0.011
I2 @1'	0.005 ± 0.011 (0.016)	0.005	0.016
I2NE @1'	-0.002 ± 0.011 (0.028)	-0.002	0.009
I2NW @1'	0.01 ± 0.014 (0.024)	0.01	0.024
I2SE @1'	0.008 ± 0.012 (0.02)	0.008	0.02
I2SW @1'	-0.001 ± 0.012 (0.026)	-0.001	0.011
I4 @1'	0.0009 ± 0.0064 (0.0109)	0.0009	0.0073
I4NE @1'	0.009 ± 0.011 (0.008)	0.009	0.02
I4NW @1'	0.003 ± 0.0061 (0.0041)	0.003	0.0091
I4SE @1'	-0.001 ± 0.011 (0.016)	-0.001	0.01
I4SW @1'	-0.002 ± 0.011 (0.019)	-0.002	0.009
M10 @1'	-0.0017 ± 0.0058 (0.0112)	-0.0017	0.0041
M10NW @1'	0.0041 ± 0.0069 (0.0107)	0.0041	0.011
M10SE @1'	0.0005 ± 0.0055 (0.0087)	0.0005	0.006
M10SW @1'	0.0025 ± 0.0057 (0.0067)	0.0025	0.0082
M5 @1'	0.011 ± 0.013 (0.016)	0.011	0.024
M5NE @1'	0.002 ± 0.011 (0.016)	0.002	0.013
M5NW @1'	0.001 ± 0.012 (0.021)	0.001	0.013
M5SE @1'	0.009 ± 0.012 (0.017)	0.009	0.021
M5SW @1'	0.002 ± 0.012 (0.017)	0.002	0.014
N8 @1'	0.007 ± 0.013 (0.027)	0.007	0.02
N8/M10 @1'	0.0011 ± 0.0057 (0.011)	0.0011	0.0068
N8NE @1'	0.011 ± 0.012 (0.016)	0.011	0.023
N8NW @1'	0.009 ± 0.014 (0.025)	0.009	0.023
N8SE @1'	0.003 ± 0.012 (0.009)	0.003	0.015
P7 @1'	0.0012 ± 0.0059 (0.0114)	0.0012	0.0071
P7NE @1'	0.0012 ± 0.006 (0.0115)	0.0012	0.0072
P7NW @1'	0.0046 ± 0.0063 (0.0042)	0.0046	0.0109
P7SE @1'	-0.0003 ± 0.006 (0.0116)	-0.0003	0.0057
P7SW @1'	0.002 ± 0.0058 (0.009)	0.002	0.0078
R9 @1'	0 ± 0.011 (0.021)	0	0.011
R9NE @1'	0.002 ± 0.012 (0.017)	0.002	0.014
R9NW @1'	0 ± 0.011 (0.008)	0	0.011
R9SE @1'	0.002 ± 0.011 (0.016)	0.002	0.013
R9SW @1'	0 ± 0.012 (0.023)	0	0.012

Table A.4 Sr-90 Concentrations

Sample ID	Reported Sr-90 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
4000 @1'	0.07 ± 0.11 (0.25)	0.07	0.25
4001 @1'	0.12 ± 0.12 (0.26)	0.12	0.26
4003 @1'	0.05 ± 0.12 (0.27)	0.05	0.27
4005 @1'	0.03 ± 0.12 (0.27)	0.03	0.27
4006 @1'	0.16 ± 0.13 (0.25)	0.16	0.25
4007 @1'	0.17 ± 0.12 (0.24)	0.17	0.24
4008 @1'	0.14 ± 0.13 (0.26)	0.14	0.26
4009 @1'	0.02 ± 0.11 (0.25)	0.02	0.25
4011 @1'	0.11 ± 0.12 (0.24)	0.11	0.24
4012 @1'	0.07 ± 0.12 (0.28)	0.07	0.28
4013 @1'	0.01 ± 0.11 (0.26)	0.01	0.26
4014 @1'	-0.01 ± 0.15 (0.35)	-0.01	0.35
4015 @1'	-0.02 ± 0.14 (0.33)	-0.02	0.33
4016 @1'	0.15 ± 0.12 (0.25)	0.15	0.25
4019 @1'	0.051 ± 0.092 (0.201)	0.051	0.201
4020 @1'	-0.03 ± 0.1 (0.24)	-0.03	0.24
4021 @1'	0.08 ± 0.13 (0.28)	0.08	0.28
4023 @1'	-0.03 ± 0.11 (0.25)	-0.03	0.25
4024 @1'	-0.02 ± 0.11 (0.26)	-0.02	0.26
4026 @1'	0.11 ± 0.11 (0.24)	0.11	0.24
4027 @1'	0 ± 0.11 (0.27)	0	0.27
4028 @1'	0.1 ± 0.12 (0.27)	0.1	0.27
4029 @1'	0.16 ± 0.12 (0.24)	0.16	0.24
4030 @1'	0.05 ± 0.11 (0.25)	0.05	0.25
4031 @1'	0.48 ± 0.17 (0.22)	0.48	0.48
4032 @1'	-0.07 ± 0.1 (0.25)	-0.07	0.25
4034 @1'	0.05 ± 0.11 (0.26)	0.05	0.26
4035 @1'	0.06 ± 0.13 (0.28)	0.06	0.28
4036 @1'	0.18 ± 0.14 (0.27)	0.18	0.27
4037 @1'	0.08 ± 0.12 (0.26)	0.08	0.26
4038 @1'	0.04 ± 0.11 (0.26)	0.04	0.26
4039 @1'	0.03 ± 0.11 (0.25)	0.03	0.25
4040 @1'	0.04 ± 0.13 (0.28)	0.04	0.28
4042 @1'	-0.04 ± 0.12 (0.28)	-0.04	0.28
4045 @1'	0.14 ± 0.13 (0.26)	0.14	0.26
4046 @1'	-0.05 ± 0.11 (0.27)	-0.05	0.27
4047 @1'	0 ± 0.11 (0.26)	0	0.26
4048 @1'	0.05 ± 0.12 (0.27)	0.05	0.27
4049 @1'	0.07 ± 0.12 (0.27)	0.07	0.27
4050 @1'	-0.01 ± 0.11 (0.26)	-0.01	0.26
4051 @1'	0.05 ± 0.12 (0.26)	0.05	0.26
4052 @1'	0.15 ± 0.11 (0.21)	0.15	0.21
4053 @1'	0.056 ± 0.099 (0.217)	0.056	0.217
4054 @1'	0 ± 0.098 (0.226)	0	0.226
4056 @1'	0.09 ± 0.1 (0.22)	0.09	0.22

Table A.4 Sr-90 Concentrations (cont.)

Sample ID	Reported Sr-90 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
4057 @1'	0 ± 0.1 (0.23)	0	0.23
4058 @1'	0.1 ± 0.11 (0.22)	0.1	0.22
4060 @1'	0.08 ± 0.11 (0.23)	0.08	0.23
4062 @1'	0.03 ± 0.11 (0.24)	0.03	0.24
4063 @1'	0.02 ± 0.11 (0.25)	0.02	0.25
4066 @1'	0.13 ± 0.1 (0.2)	0.13	0.2
4068 @1'	0.113 ± 0.096 (0.195)	0.113	0.195
4069 @1'	0.046 ± 0.09 (0.198)	0.046	0.198
4070 @1'	0.001 ± 0.093 (0.214)	0.001	0.214
4071 @1'	0.082 ± 0.095 (0.201)	0.082	0.201
4072 @1'	0.003 ± 0.086 (0.197)	0.003	0.197
4073 @1'	0.14 ± 0.12 (0.24)	0.14	0.24
4074 @1'	0.07 ± 0.12 (0.27)	0.07	0.27
4075 @1'	0.14 ± 0.12 (0.24)	0.14	0.24
4077 @1'	0.05 ± 0.11 (0.25)	0.05	0.25
4080 @1'	0.14 ± 0.14 (0.3)	0.14	0.3
4081 @1'	0 ± 0.11 (0.25)	0	0.25
4082 @1'	0.03 ± 0.12 (0.27)	0.03	0.27
4083 @1'	0.14 ± 0.13 (0.27)	0.14	0.27
4084 @1'	0.01 ± 0.12 (0.27)	0.01	0.27
4085 @1'	0.048 ± 0.099 (0.223)	0.048	0.223
4086 @1'	0.06 ± 0.12 (0.26)	0.06	0.26
4088 @1'	0.07 ± 0.11 (0.23)	0.07	0.23
4091 @1'	0.21 ± 0.14 (0.27)	0.21	0.27
4092 @1'	0.31 ± 0.15 (0.26)	0.31	0.31
A4 @1'	0.1 ± 0.13 (0.27)	0.1	0.27
A4NE @1'	0.11 ± 0.12 (0.26)	0.11	0.26
A4NW @1'	0.02 ± 0.11 (0.24)	0.02	0.24
A4SE @1'	-0.01 ± 0.1 (0.24)	-0.01	0.24
A4SW @1'	-0.028 ± 0.094 (0.218)	-0.028	0.218
B7 @1'	-0.02 ± 0.11 (0.25)	-0.02	0.25
B7NW @1'	0.15 ± 0.13 (0.26)	0.15	0.26
B7SE @1'	-0.05 ± 0.11 (0.28)	-0.05	0.28
B7SW @1'	0.16 ± 0.19 (0.42)	0.16	0.42
D6 @1'	0.07 ± 0.12 (0.26)	0.07	0.26
D6/B7 @1'	-0.02 ± 0.11 (0.26)	-0.02	0.26
D6NE @1'	-0.07 ± 0.11 (0.26)	-0.07	0.26
D6NW @1'	-0.05 ± 0.1 (0.26)	-0.05	0.26
D6SE @1'	-0.09 ± 0.1 (0.25)	-0.09	0.25
F4 @1'	0.12 ± 0.1 (0.21)	0.12	0.21
F4NE @1'	0.22 ± 0.12 (0.23)	0.22	0.23
F4NW @1'	0.12 ± 0.11 (0.23)	0.12	0.23
F4SE @1'	-0.024 ± 0.089 (0.213)	-0.024	0.213
F4SW @1'	0.24 ± 0.2 (0.4)	0.24	0.4
G13 @1'	0.06 ± 0.1 (0.23)	0.06	0.23

Table A.4 Sr-90 Concentrations (cont.)

Sample ID	Reported Sr-90 Concentration (pCi/g)	Exposure Point Concentration (pCi/g)	Upper Bound Concentration (pCi/g)
G13NE @1'	-0.02 ± 0.11 (0.26)	-0.02	0.26
G13NW @1'	0.02 ± 0.11 (0.25)	0.02	0.25
G13SE @1'	0.08 ± 0.11 (0.24)	0.08	0.24
G13SW @1'	0.07 ± 0.11 (0.25)	0.07	0.25
G9 @1'	-0.04 ± 0.1 (0.25)	-0.04	0.25
G9NE @1'	0.07 ± 0.11 (0.24)	0.07	0.24
G9NW @1'	0.15 ± 0.12 (0.24)	0.15	0.24
G9SE @1'	-0.04 ± 0.1 (0.25)	-0.04	0.25
G9SW @1'	0 ± 0.11 (0.25)	0	0.25
I2 @1'	0.09 ± 0.11 (0.24)	0.09	0.24
I2NE @1'	-0.063 ± 0.098 (0.245)	-0.063	0.245
I2NW @1'	0.03 ± 0.1 (0.23)	0.03	0.23
I2SE @1'	0.01 ± 0.11 (0.25)	0.01	0.25
I2SW @1'	0 ± 0.1 (0.24)	0	0.24
I4 @1'	0.042 ± 0.099 (0.219)	0.042	0.219
I4NE @1'	-0.059 ± 0.098 (0.239)	-0.059	0.239
I4NW @1'	-0.018 ± 0.089 (0.206)	-0.018	0.206
I4SE @1'	0.05 ± 0.11 (0.26)	0.05	0.26
I4SW @1'	0.15 ± 0.12 (0.25)	0.15	0.25
M10 @1'	0 ± 0.12 (0.27)	0	0.27
M10NW @1'	-0.02 ± 0.13 (0.3)	-0.02	0.3
M10SE @1'	0.02 ± 0.12 (0.27)	0.02	0.27
M10SW @1'	-0.05 ± 0.11 (0.26)	-0.05	0.26
M5 @1'	0.26 ± 0.15 (0.28)	0.26	0.28
M5NE @1'	0.21 ± 0.15 (0.28)	0.21	0.28
M5NW @1'	0.16 ± 0.13 (0.27)	0.16	0.27
M5SE @1'	0.03 ± 0.11 (0.26)	0.03	0.26
M5SW @1'	-0.01 ± 0.11 (0.26)	-0.01	0.26
N8 @1'	0.09 ± 0.1 (0.21)	0.09	0.21
N8/M10 @1'	0.05 ± 0.11 (0.24)	0.05	0.24
N8NE @1'	0.06 ± 0.1 (0.23)	0.06	0.23
N8NW @1'	0.1 ± 0.1 (0.22)	0.1	0.22
N8SE @1'	-0.036 ± 0.096 (0.23)	-0.036	0.23
P7 @1'	-0.002 ± 0.092 (0.21)	-0.002	0.21
P7NE @1'	-0.092 ± 0.089 (0.213)	-0.092	0.213
P7NW @1'	-0.012 ± 0.091 (0.21)	-0.012	0.21
P7SE @1'	0.061 ± 0.096 (0.208)	0.061	0.208
P7SW @1'	0.017 ± 0.097 (0.22)	0.017	0.22
R9 @1'	0.13 ± 0.12 (0.25)	0.13	0.25
R9NE @1'	0.011 ± 0.091 (0.211)	0.011	0.211
R9NW @1'	-0.04 ± 0.1 (0.24)	-0.04	0.24
R9SE @1'	0.1 ± 0.11 (0.23)	0.1	0.23
R9SW @1'	0.043 ± 0.099 (0.221)	0.043	0.221

ATTACHMENT B. RADIOLOGICAL RISKS FROM OTHER RADIATION SOURCES

Table B-1 Comparison of Radiological Risks from a Variety of Radiation Sources

Activity {a}	Dose [a] (millirem)	Risk [b, c] (___ x 10^{-6})
Living 30-years in Dayton Canyon	**nc [d]**	**0.4**
Bottom of EPA's generally acceptable risk range at CERCLA remediations	**nc [d]**	**1**
Transcontinental plane flight, one-way	4	2
Cooking or heating with natural gas	9	5
Routine chest X-ray	10	6
Annual dose from cosmic rays at sea-level	30	18
Watching a cathode-ray TV or computer screen	30	18
Annual dose from internal exposure from radionuclides such as potasium-40 that are naturally present inside the human body	39	23
Annual dose from cosmic rays in Denver	50	30
Living in a brick house	75	45
Top of EPA's generally acceptable risk range at CERCLA remediations	**nc [d]**	**100**
Smoking 1 ½ packs of cigarettes a day for one year	1300	780

[a] Dose information supplied by the University of Iowa, on their website located at: http://www.uihealthcare.com/topics/medicaldepartments/cancercenter/prevention/preventionradiation.html.

[b] Dayton Canyon risks from Table 4-1 in this report. Other risks calculated by multiplying the University of Iowa dose estimates and a dose to risk conversion factor of 6 x 10^{-4} per rem (6 x 10^{-7} per millirem) Total Effective Dose Equivalent (TEDE) recommended by EPA (ISCORS, 2003) (http://homer.ornl.gov/oepa/guidance/risk/iscors.pdf).

[c] To obtain the risk from this column, select the activity of interest and read the integer in this column, then insert that integer in the blank in the column heading. For example, the annual radiological risk from cooking with natural gas would be 5 x 10^{-6} while the risk from living in a brick house would be 45 x 10^{-6}, or 4.5 x 10^{-5}.

[d] Not calculated.
