1994-95 Area IV Radiological Survey

(with focus on use of soil data)

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Presented to the Environmental Protection Agency
(Region IX and Las Vegas)

October 4, 2002

Focus

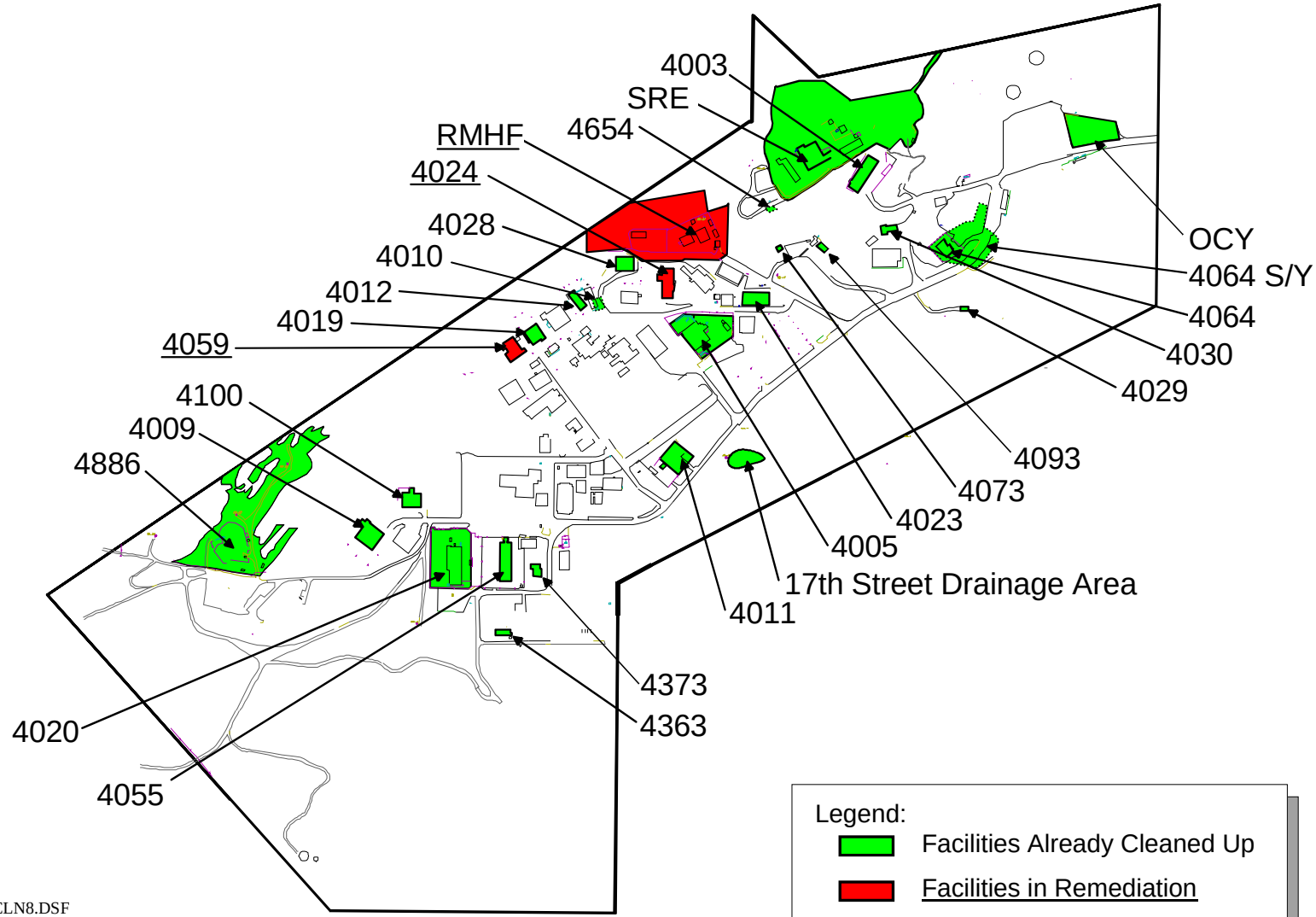
- Methodology of Area IV Survey
- Discussion of data quality
- Validity of use of data
- Not focussed on presenting results or conclusions of survey

Outline

- Stakeholder Oversight
- Radiation Surveys
- Soil Sampling
- Quality Assurance & Quality Control
- Use of Area IV soil data in the EA
- Other post-remedial soil sampling
- Post “Area IV Survey” soil sampling

Area IV, Santa Susana Field Laboratory (1994)

Santa Susana Field Laboratory (SSFL) Area IV Radiological Facility Status



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Purpose of Area IV Survey

- Survey the balance of Area IV to address stakeholder concerns
  - "The purpose of the study was to locate and characterize any previously unknown areas of elevated radioactivity in Area IV. The study provided a comprehensive investigation of the radiological status of regions in Area IV which had not previously been characterized."
    - Response to "Any other Burn Pit areas?"
  - Not required by regulation

Principal Plans and Procedures

Milestone	Date
Radiological Characterization Plan	October 1993
Health & Safety Plan	October 1993
Radiation Survey Procedure	February 1994
Quality Assurance Plan	February 1994
Project Management Plan	March 1994
Soil Sampling Procedure	April 1994
Sampling, Analysis and Data Mgmt. Plan	July 1994
Water Sampling Procedure	March 1995
Survey	3/94 – 9/95

Chronology of Agency Oversight

- Draft Radiological Characterization Plan issued to SSFL Workgroup (both agencies & public members) for review & comment — Oct 1993
- Issued final Radiological Characterization Plan (including H&S plan, QA plan) — Mar 1994
- Initiated radiation survey field work — Mar 1994
- DHS/EMB observation of field work — Apr-May 1994
- Initiate soil sampling field work — Nov 1994

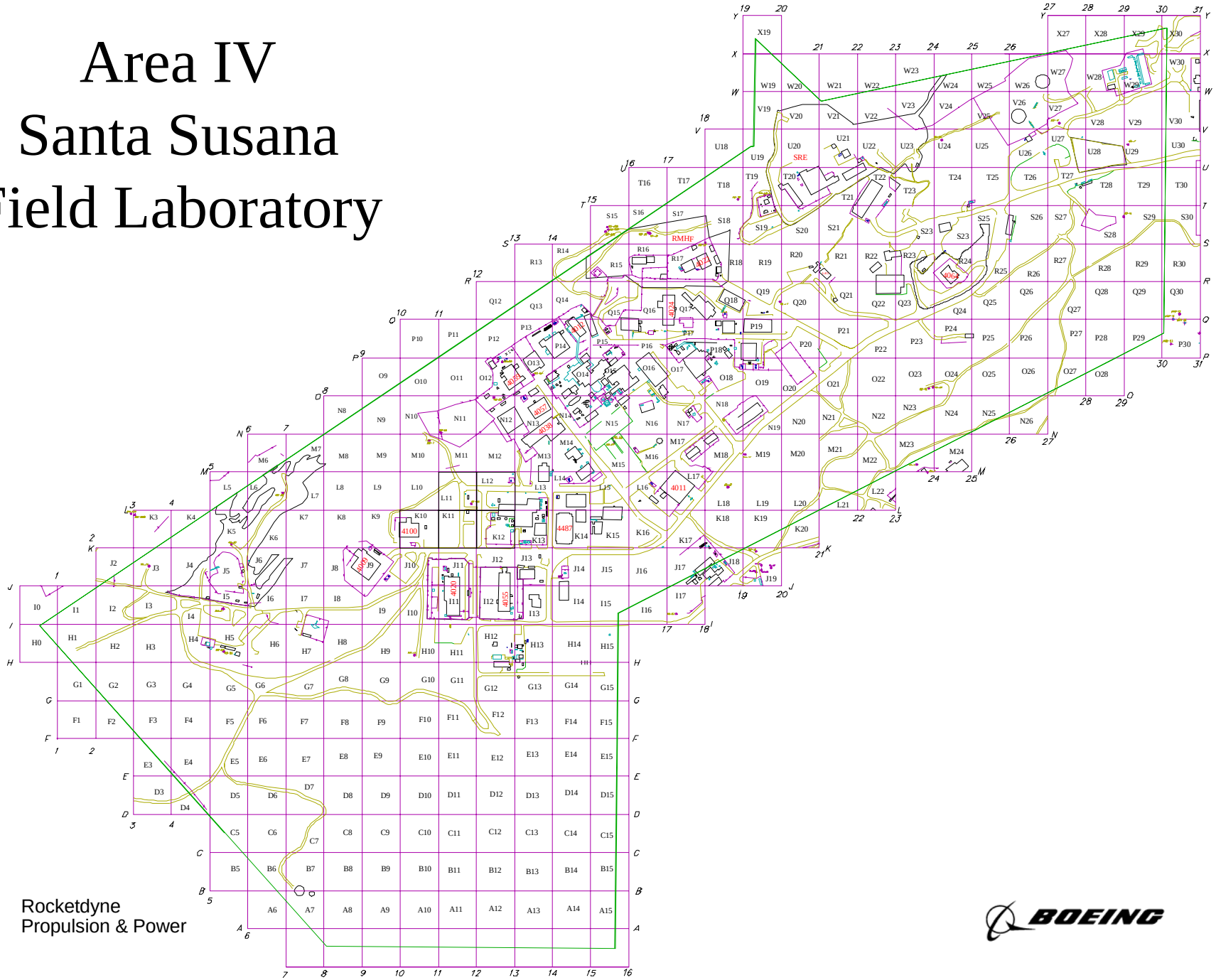
Chronology of Agency Oversight (Continued)

- DHS/EMB split soil sampling — Apr 1995
- DHS/EMB split soil sampling — May 1995
- DHS/EMB split soil sampling — Jun 1995
- Field work completed — Sep 1995
- Draft report to DOE for review — Apr 1996
- Final report to Agencies, WorkGroup, libraries — Aug 1996

Summary of Area IV Survey

- Workplan Development
  - DOE response to stakeholders, not regulatory requirement
  - Additional scope to ’92- 94 off-site sampling
  - Open process
- Survey included complimentary measurements
  - Ambient gamma exposure mapping (1-meter)
  - Surface scan (walk about) survey
  - Soil sampling

Area IV
Santa Susana
Field Laboratory



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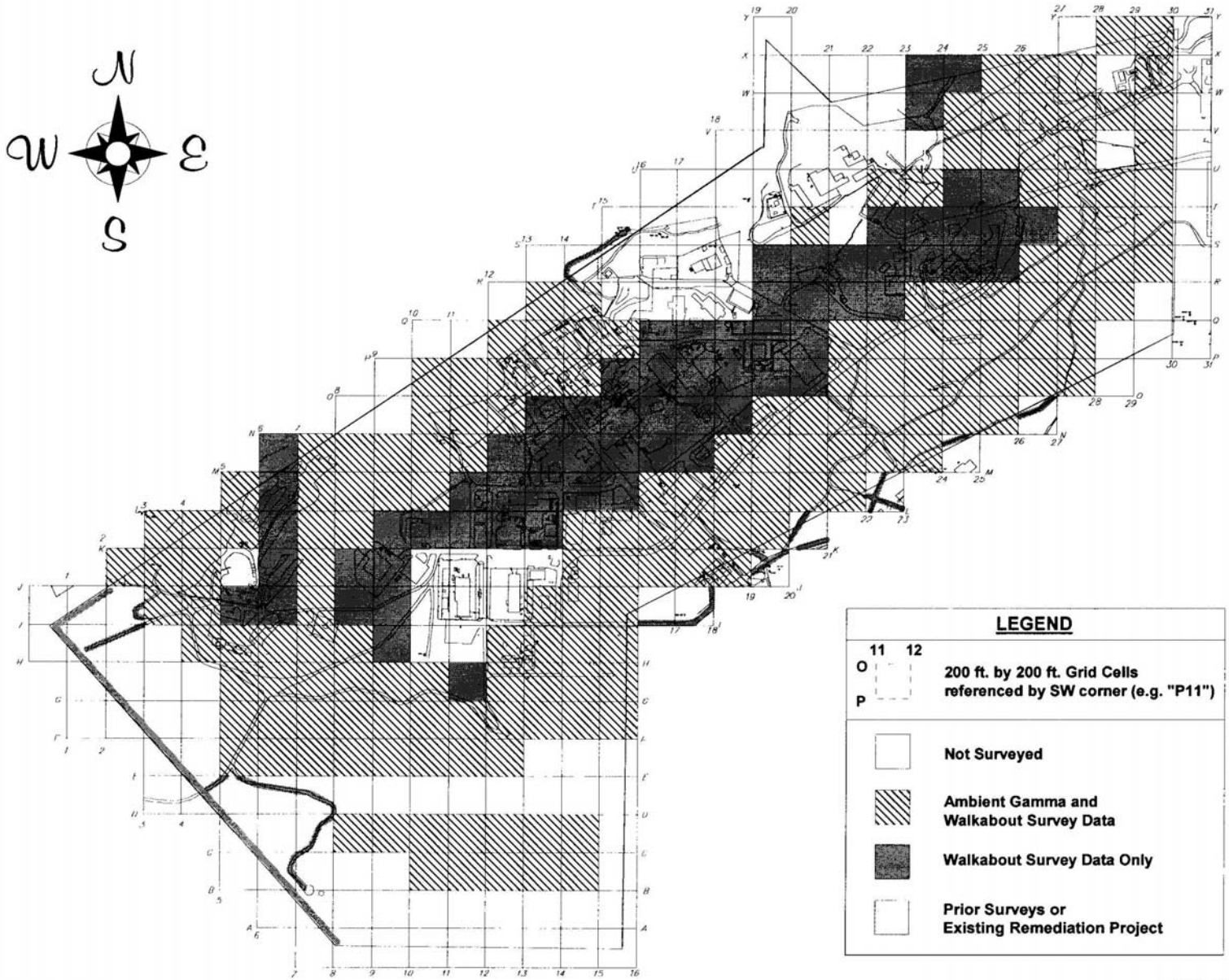
BOEING

Grid Blocks Surveyed in the Area IV Survey (1994-95)



Ambient Gamma Mapping

- Within each 200’ X 200’ grid block, for 1 meter, 1-minute gamma exposure measurements were taken at 25’ x 25’ spacing
- Dual redundant I” x 1” NaI detectors with Ludlum 2221 scaler counters
- These measurements were used to map gamma exposure at 1 meter for Area IV to compare to DOE’s 5400.5 20 μR/hr action level and Rocketdyne’s 5 μR/h action level
- Not designed or intended to detect all potential levels of contamination at all depths
- Surface scanning of ground over every square foot designed to detect hot spots
- Off-site survey, whose objective was the same, did not do any 1-meter exposure mapping or surface scanning

Ambient Gamma Radiation Survey Summary

		Gamma Radiation (μR/hr)			
Data Set	**No. Data Points**	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Background	91	15.6	1.8	10	21
Area IV Total	10,479	14.6	1.8	6.0	21.4
Alluvium, Disturbed	2,020	14.3	1.3	8.9	19.0
Alluvium, Undisturbed	2,849	15.3	1.3	10.3	18.5
Developed	2,283	13.6	1.8	6.0	19.4
Drainage	355	14.9	1.3	11.1	18.2
Martinez-Chaparral	1,330	13.0	1.3	8.9	17.0
Rock outcroppings	1,642	16.3	1.3	11.5	21.4

Correlation of μR/h to cpm

- Cpm from NaI detectors used in the field were correlated with the μR/h of a pressurized ionization chamber (PIC) at a fixed location
  - Correlation measured thrice daily and applied to daily field measurements
  - Later measurements with DHS/RHB at different locations at SSFL, verified that correlation varied by no more than +/- 5%, which was less than the daily variability at a fixed location
  - When tested against against radwaste at RMHF, NaI detectors over-respond (conservatively) compared to PICs

5 microR/hr vs. 15 mrem/y

- The 5 microR/hr action level used and its translation into 44 mrem/y is of course a red herring
- Instrument readings were not used exclusively to determine where we would take soil samples
- Only 12 of 149 samples were taken because the 5 microR/hr level was exceeded
- Use of a 1.7 microR/hr action level (equivalent to 15 mrem/y) would not be practical. Indeed use of 5 microR/hr is often problematic
- Full range of exposure in Area IV was 6 to 21.4 microR/hr (mean = 14.6 +/- 3.6 microR/hr)
- Thus 5 microR/hr is less than the +/- 2sigma spread
- There was no correlation between measured contamination in soil samples and exposure levels
- Exposure levels in Area IV are primarily a function of ground cover (grass, soil, concrete, asphalt), proximity to buildings, tree cover, and proximity to sandstone rock.

Surface Scan

- Procedures required a side-to-side scan speed of approximately 1 foot per second across a 5 foot wide strip while standing stationary. Surveyor then steps forward one foot and repeats. Thus, the probe head is no more than 6 inches away from any point on the soil surface
- Subsequent surface scanning, based on the same protocol, performed for the MARSSIM survey survey of the Hot Lab, have a actual scan sensitivity of 10.3 pCi/g cesium-137, compared to a required scan sensitivity, $DCGL_{EMC}$, of 12.9 pCi/g
- No surface scan can guarantee detection of all trace levels of contamination at all depths

Surface Scan Sensitivity*

Required Scan MDC

Scanning of soil sample grids will be performed to ensure small areas of contamination did not remain undetected. The $DCGL_W$ was calculated in RESRAD 5.6 using default of 10,000 m^2. Running RESRAD with smaller areas to a relatively higher release criteria. From Table 5.6 of MARSSIM, the Area Dose Factor for 117 m^2 for Cs-137 is 1.4. Therefore the elevated measurement concentration $DCGL_{EMC}$ is: $DCGL_{EMC} = DCGL_W$ x Area Factor = 9.2 x 1.4 = 12.9 pCi/g

Required Scan MDC = 12.9 pCi/g

* Extracted from RS-00010, Hot Lab MARSSIM Final Status Survey Report

Surface Scan Sensitivity* (Cont.)

Actual Scan MDC

Surface scans were performed with a 1 in. x 1 in. NaI detector moving at 1 ft/sec. Actual scan MDC for this technique was calculated below following the procedure outlined in page 6-45 of MARSSIM, Reference 6.1.

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

* Extracted from RS-00010, Hot Lab MARSSIM Final Status Survey Report

Surface Scan Sensitivity* (Cont.)

Minimum Detectable Count Rate (MDCR) =

$1.38 \times (3000 \times 1.5/60)^{0.5} / ((1.5/60) \times 0.5^{0.5}) = 676$ counts/min

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

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

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

* Extracted from RS-00010, Hot Lab MARSSIM Final Status Survey Report

Surface Scan Sensitivity* (Cont.)

Since the actual scan MDC of 10.3 pCi/g is less than the required scan MDC (or $DCGL_{EMC}$) of 12.9 pCi/g, the scanning technique is adequate for detecting hot spots above $DCGL_{EMC}$ between the soil sample locations.

* Extracted from RS-00010, Hot Lab MARSSIM Final Status Survey Report

Criteria for Selecting Soil Sample Locations

- Proximity to Radiological Buildings
- Leachfields
- Drainage Areas
- Sodium Disposal Facility Surrounds
- Topographical regions (alluvial, developed, drainage, Martinez-chaparral, rock outcroppings)
- SRE Pond
- Locations of elevated surface radiation exposure

Types of Soil (and Water) Samples

Reason for Sampling	**# Samples**
Proximity to Radiological Buildings	38
Leachfields	10
Drainage Areas	37
Sodium Disposal Facility Surrounds	28
Topographical Regions	22
Locations of Elevated Radiation	12
SRE Pond Sediment	2
SRE Pond Water	2
Total Scheduled Samples	**151**
Background	6
QA/QC	17
DHS QA/QC	15

Figure 5g. Soil Sampling Locations - Elevated Gamma

Elevated Gamma Exposure

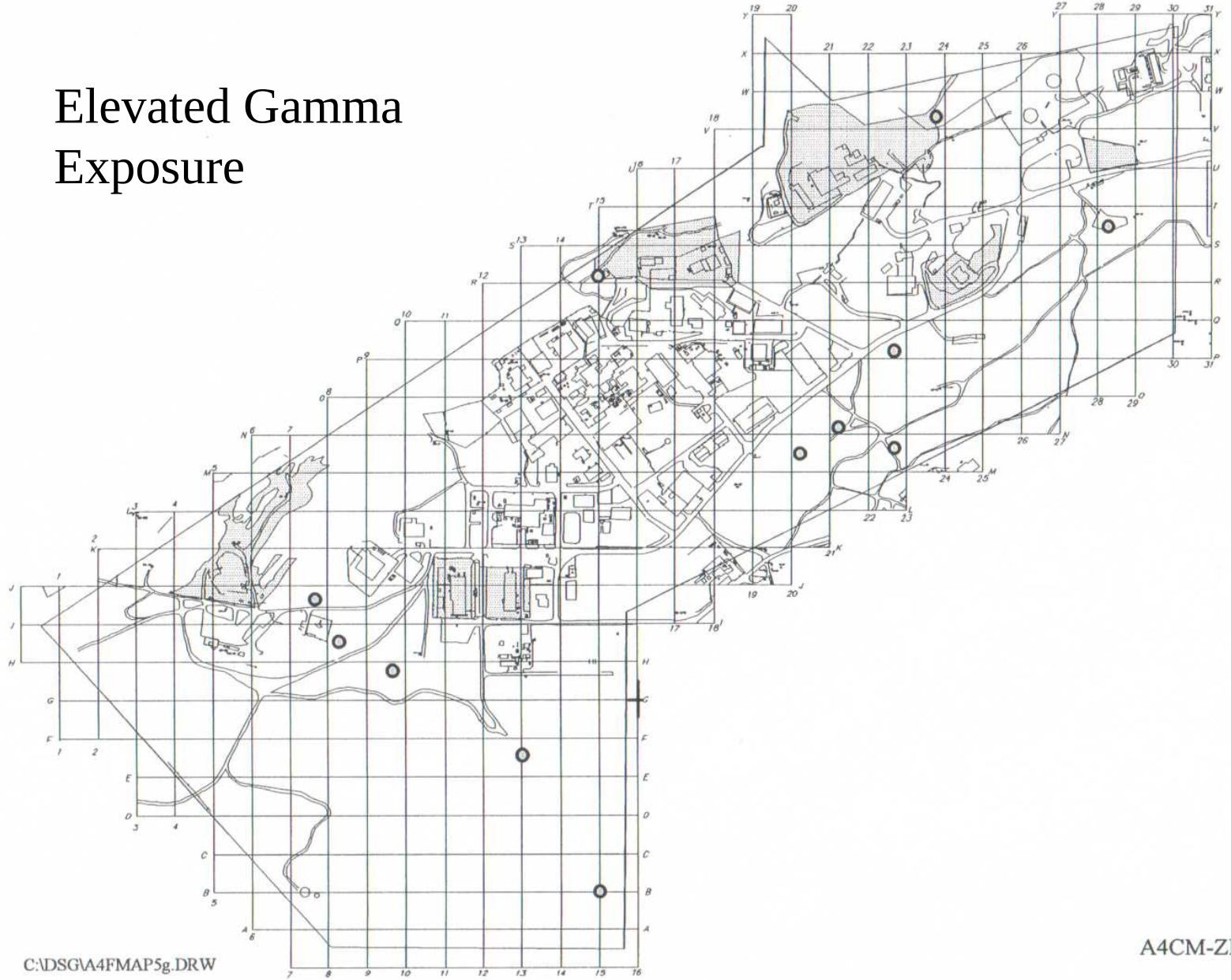


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Figure 5a. Soil Sampling Locations - Radiological Buildings

Radiological Buildings

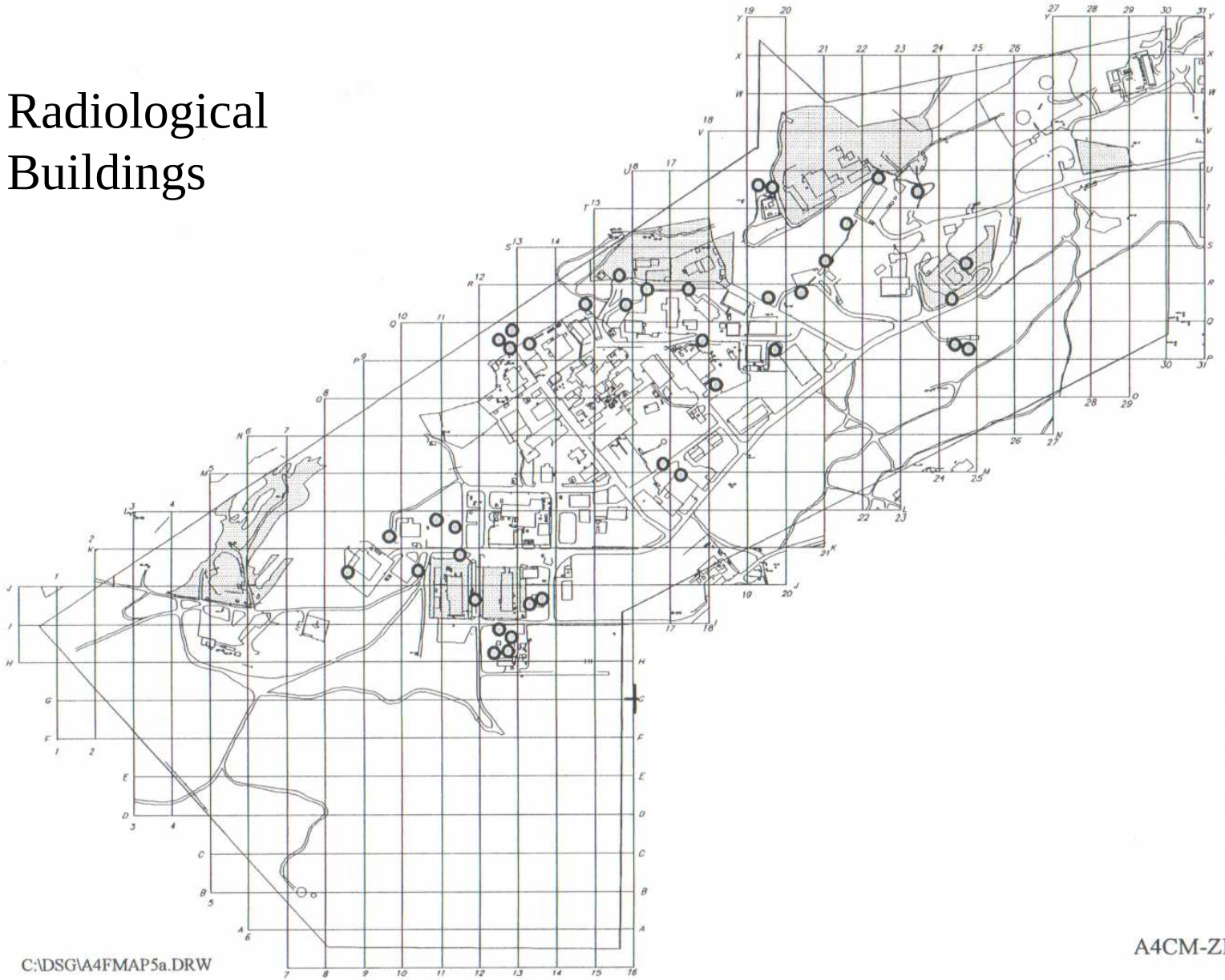

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Figure 5d. Soil Sampling Locations - Sodium Disposal Facility

FSDF

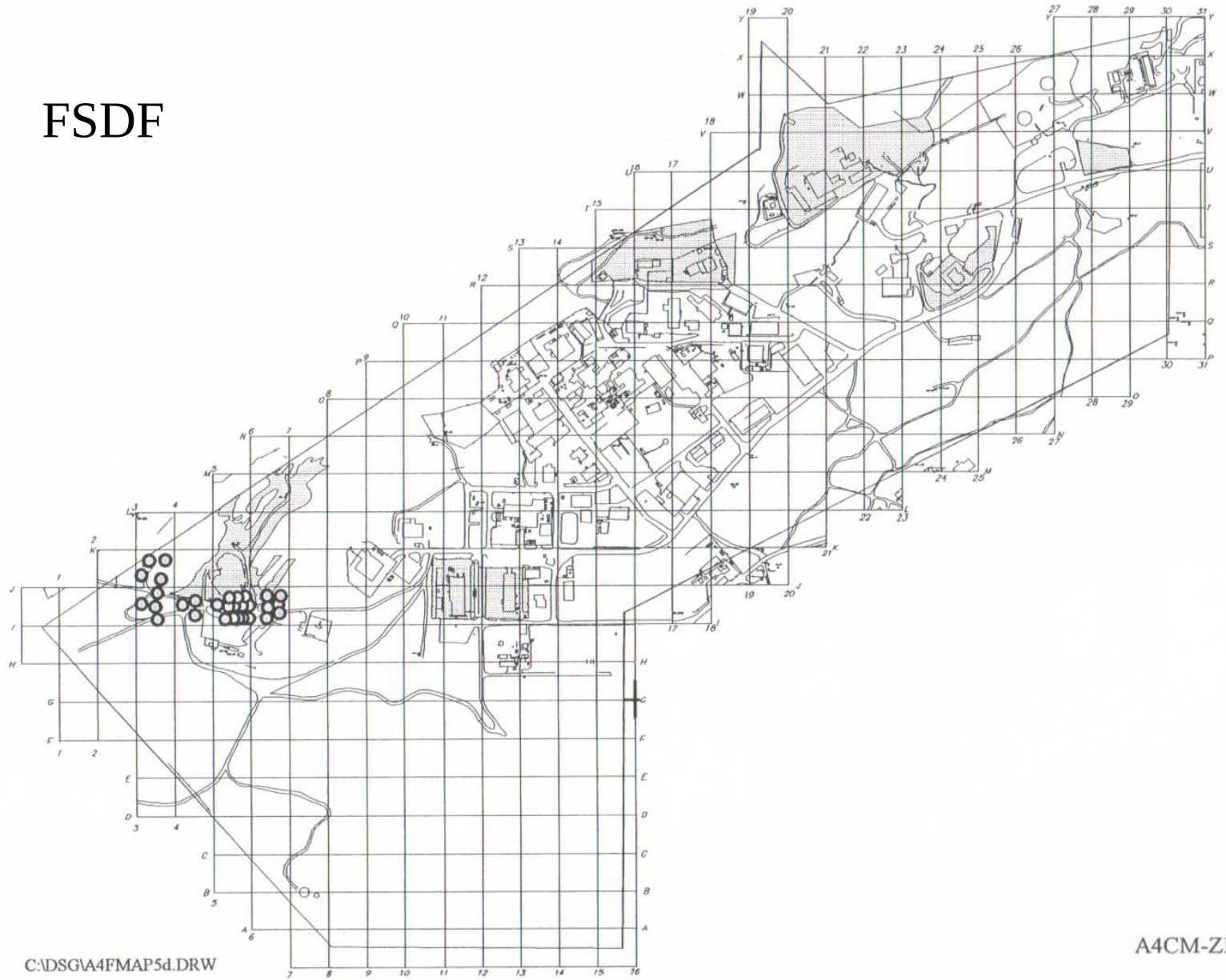

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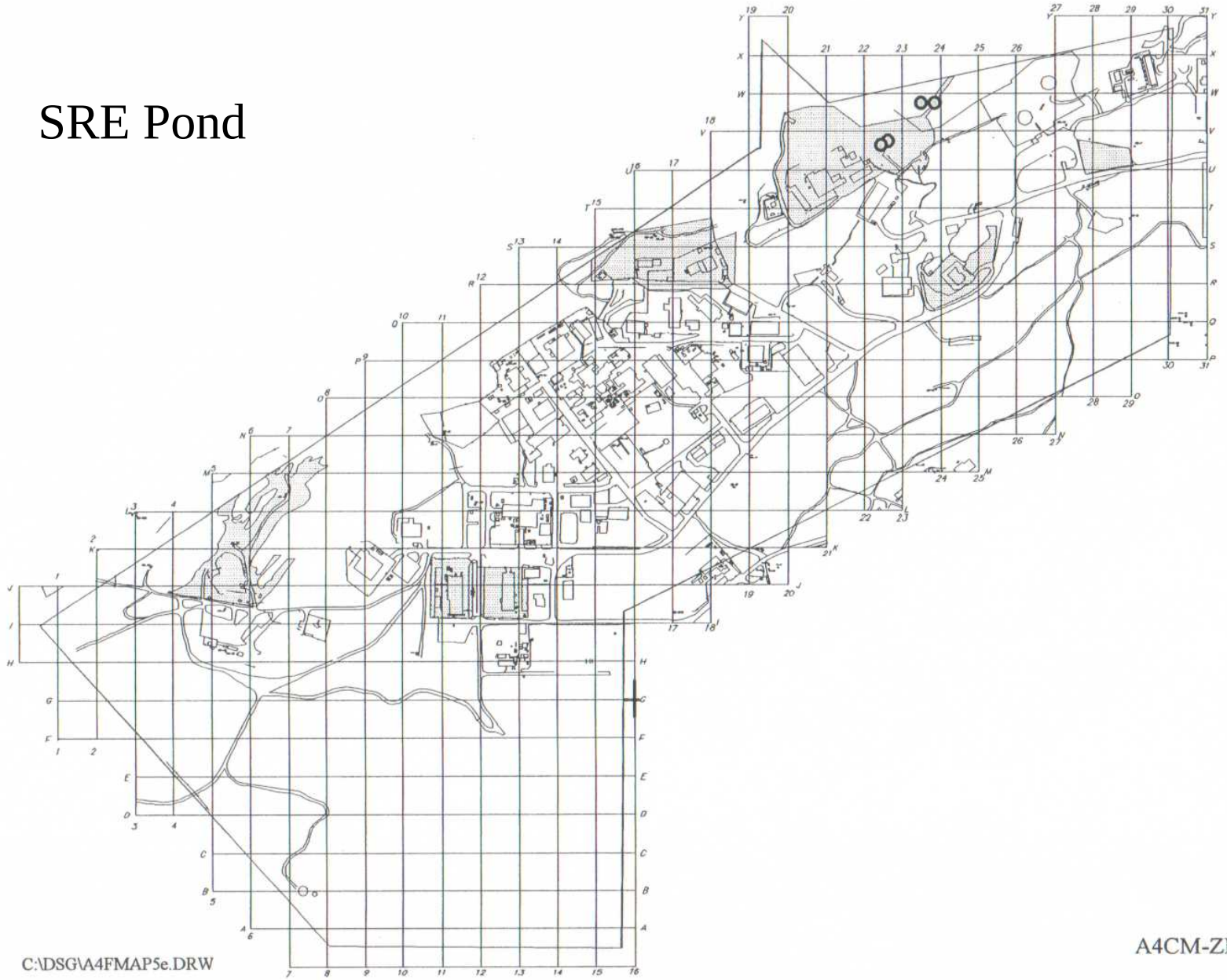
Figure 5e. Soil Sampling Locations - SRE Pond

SRE Pond



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Leachfields

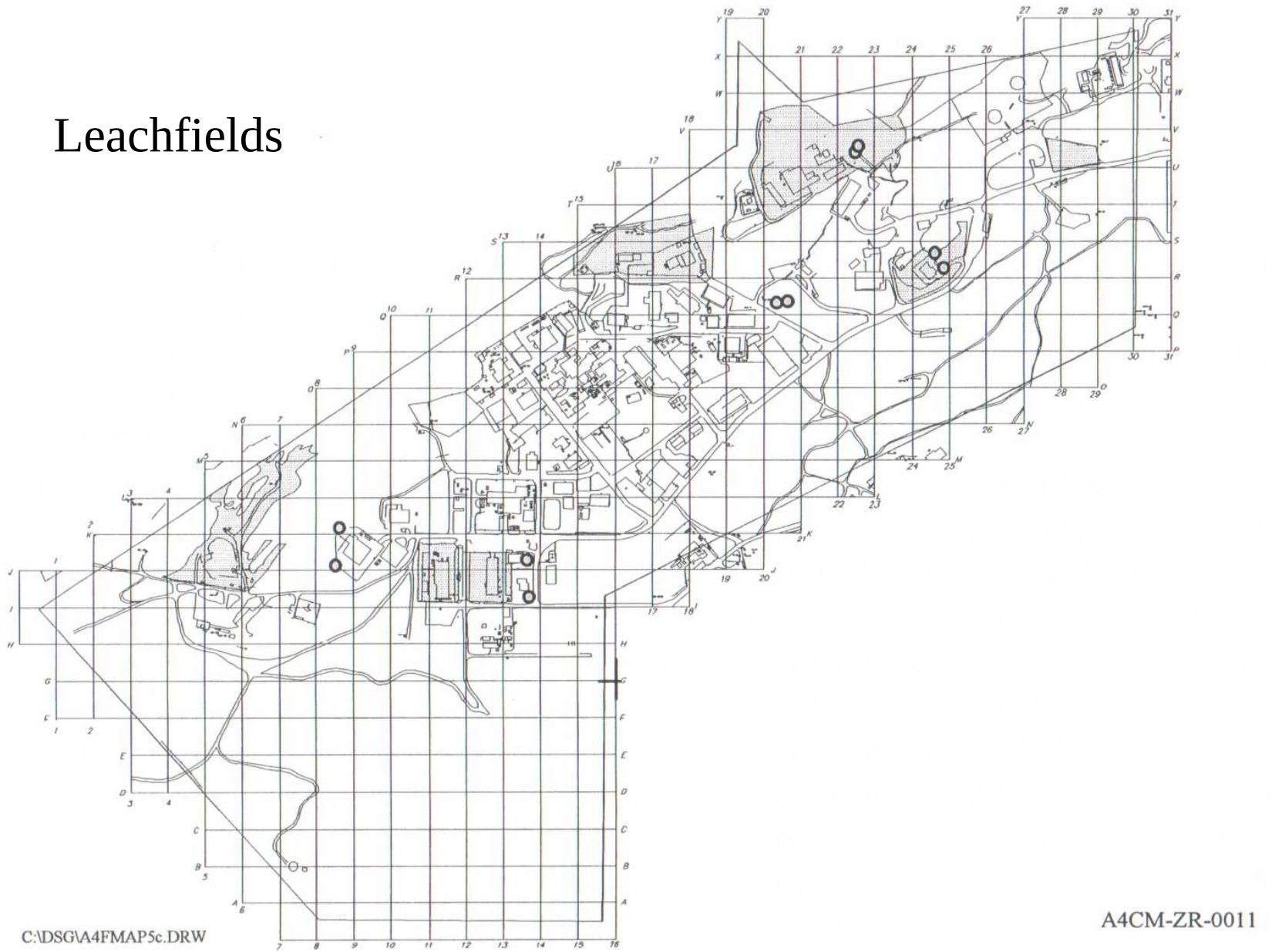

Figure 5b. Soil Sampling Locations - Drainage Areas

Drainage Areas

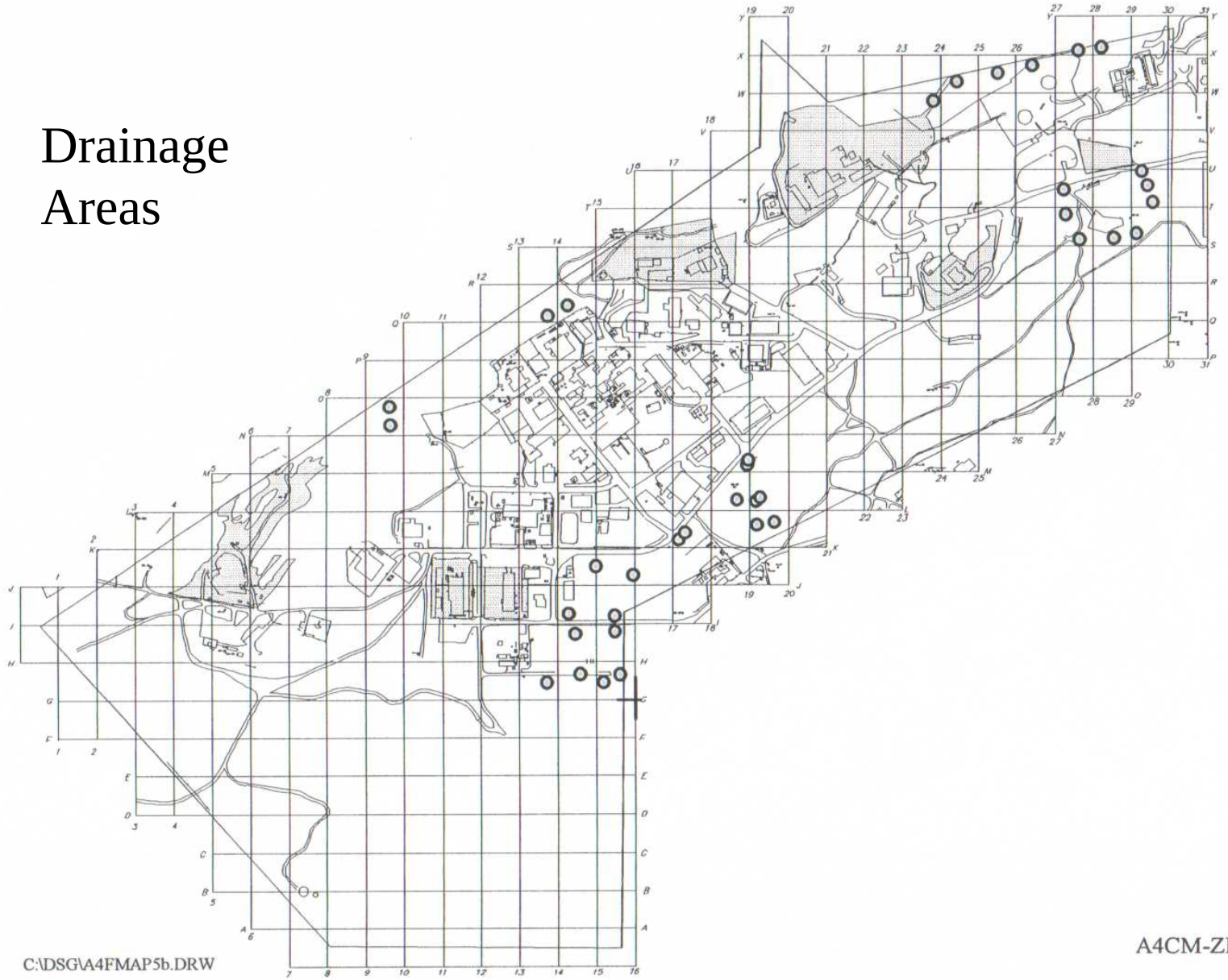

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Figure 5f. Soil Sampling Locations - Random Topographic

Topographic

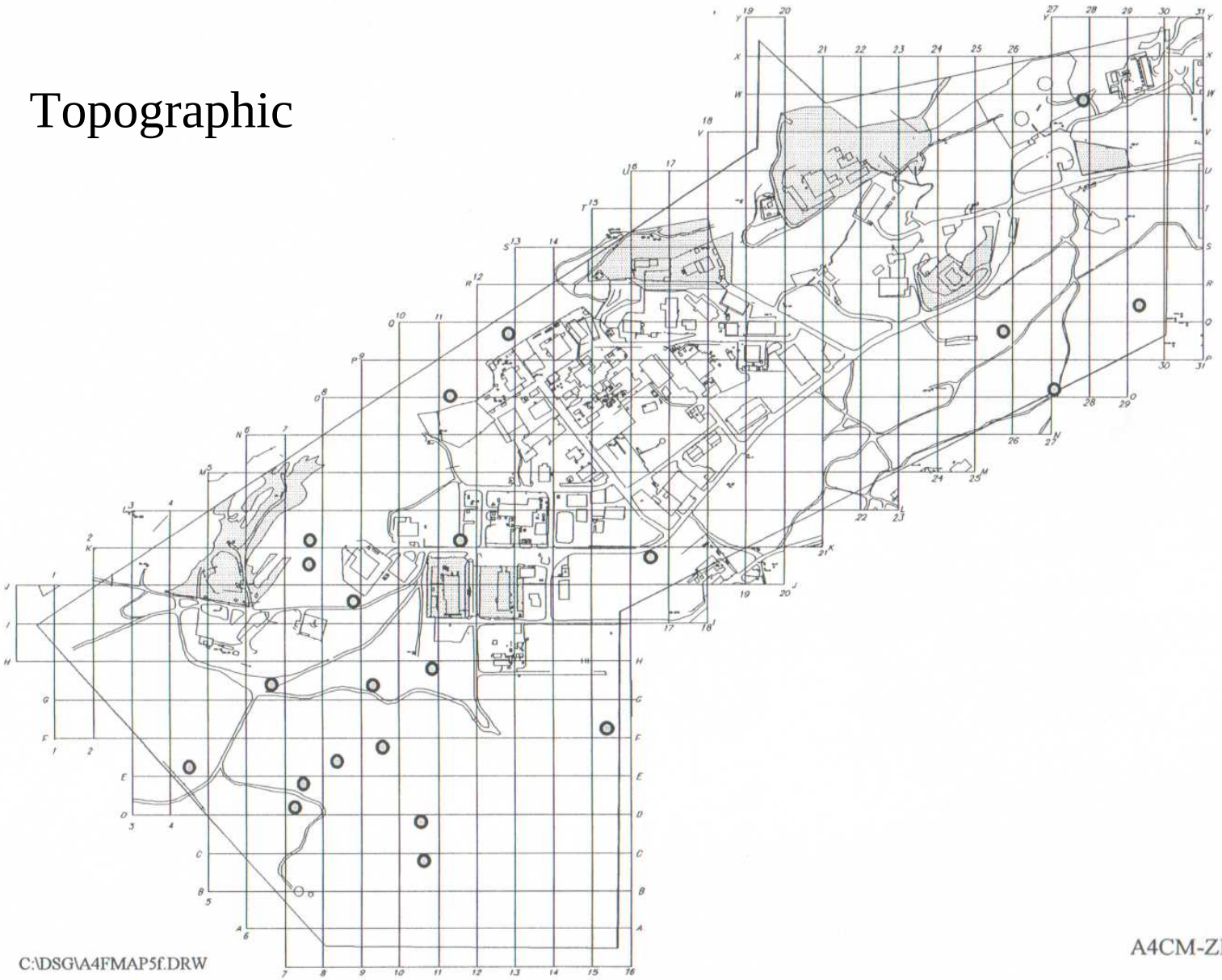

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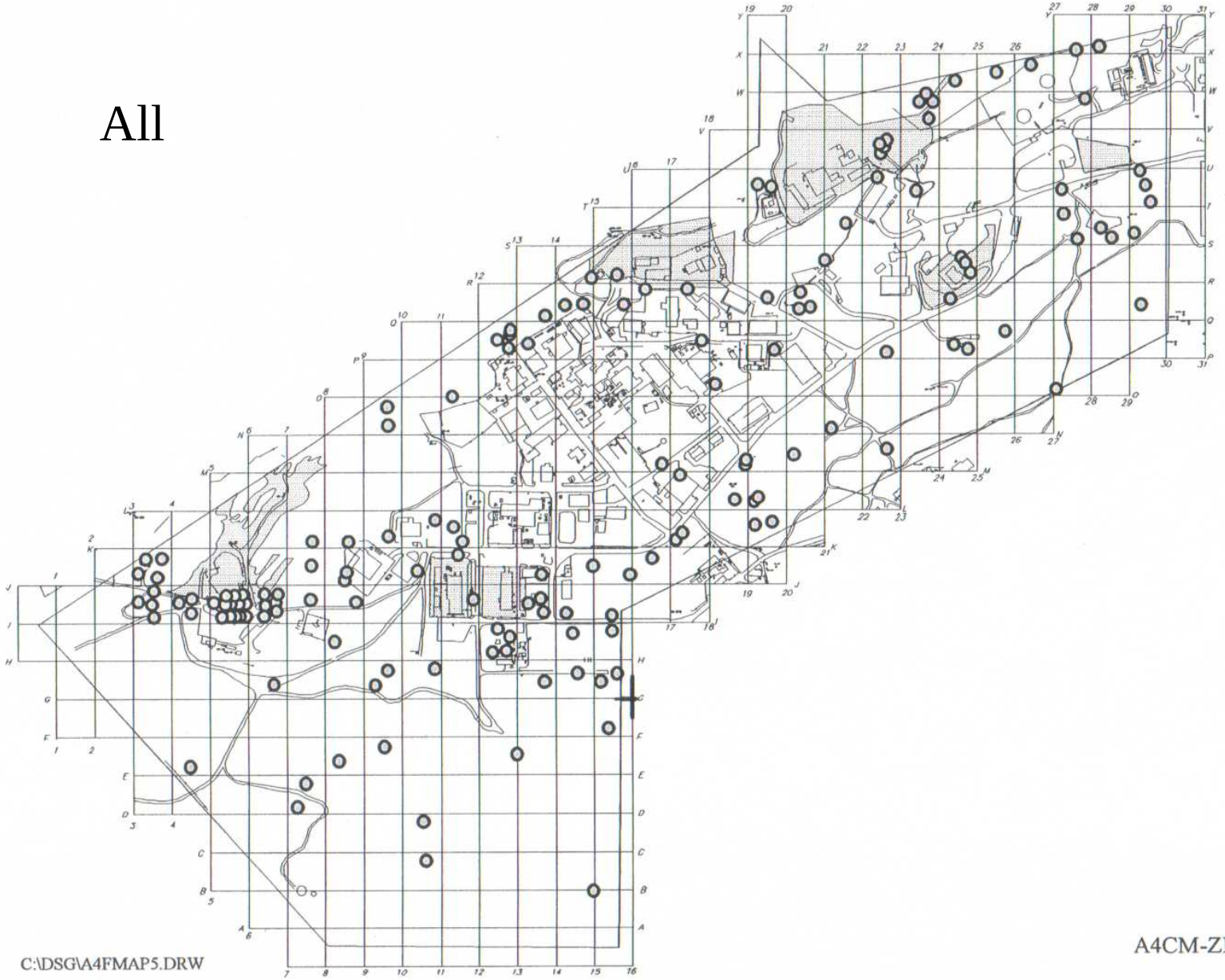
Figure 5. Soil Sampling Locations - All

All



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Comparison of Soil Radioactivity to Cleanup Standards

Isotope	Units	Area IV Range	Approved Cleanup Standards (DOE & CA DHS)
Tritium	pCi/L	ND - 8,500	20,000
Cesium-137	pCi/g	ND - 2.4	9.2
Strontium-90	pCi/g	ND - 0.22	36
Uranium-234	pCi/g	0.4 - 2.1	30
Uranium-235	pCi/g	ND - 0.1	30
Uranium-238	pCi/g	0.4 - 2.0	35
Thorium-228	pCi/g	0.4 - 2.5	5
Thorium-230	pCi/g	0.3 - 2.3	-
Thorium-232	pCi/g	0.35 - 2.1	5
Plutonium-238	pCi/g	ND	37
Plutonium-239	pCi/g	ND - 0.026	34

ND = No detectable activity.

These data do not include the remediated locations which had cesium-137 up to 271 pCi/g and uranium-238 up to 255 pCi/g.

Data Validation

- The Sampling and Analysis Plan describes the data validation process for soil sample analysis in section 7.1.1.2 and includes the following:
  - Field data-sheets were reviewed for completeness and clarity.
  - Laboratory analysis reports were reviewed for completeness and conformance to the lab request and to verify that sample serial numbers in each batch corresponded to serial numbers reported in of analysis reports.
  - Chain-of-custody forms were reviewed for continuity.
  - Analysis results were reviewed to ensure reported radionuclide concentrations were consistent with method detection limits.
  - Anomalous or questionable results were reported to the laboratory and re-analyses requested. This was done for only 4 samples.

Quality Control

- All QC sample results were analyzed to determine factors such as precision and accuracy for each isotope. These results are reported in Section 5.0
  - Blind Field Duplicates. 5% of scheduled samples. 88% pass rate
  - Laboratory Duplicates. 7% of scheduled samples. 93% pass rate
  - Laboratory Control Samples. 9% of scheduled samples. 99% pass rate
  - Laboratory Blanks. 9% of scheduled samples. 96% pass rate
  - Rinsate Samples. 5% of scheduled samples. 97% pass rate
  - DHS Field Duplicates. 8% of scheduled samples. 69% pass rate

Quality Control

- Each data package received from the lab. for every batch of soil samples (either 10 or 20 samples per batch) consisted of:
  - Case Narrative (provided in the report Appendix)
  - Data Summary (provided in the report Appendix)
  - Chain-of-Custodies (CoC)
- In addition the laboratory prepared for each batch of samples:
  - aliquot information
  - preparation log for QC samples
  - calibration data for liquid scintillation counter
  - copies of raw data sheets including calibration data for gamma spectrometer

Quality Control

- Tabulation of QC samples of in Appendix G of the A4CM-ZR-0011 is comprehensive and thorough

Quality Assurance

- Data Quality Objectives
  - Precision
  - Accuracy
  - Representativeness
  - Comparability
  - Completeness

Radiation Measurement Quality Control

- Instrument calibration
- Duplicate instruments
- Diverse instruments
- Performance checks
- Duplicate measurements
- Hidden sources

Radiation Measurement Quality Control

- Quarterly instrument calibration
- Double redundant instrumentation used
- Thrice daily cross correlation of field instruments with ionization chamber
- Thrice daily performance checks to control instrument response to +/-2σ
  - ~5,000 background checks
  - ~5,000 source checks
- 9% duplicate measurements demonstrated a relative percent difference of -0.2% +/- 6.1%
- 100% success in finding daily “hidden” cesium source

Soil Sampling Quality Control

QC Sample	% of total samples	% pass rate
Laboratory Duplicate	7	93
Field Duplicate	5	88
DHS Field Duplicate	8	69
Lab. Control Sample	9	99
Laboratory Blank	9	96
Equipment Rinsate	5	97
Aggregate Total		90

Soil Sampling Quality Control

- Laboratory Duplicates
- Blind Field Duplicates
- DHS Field Duplicates
- Lab. Control Standards
- Laboratory Blanks
- Equipment Rinsates
- QC samples were 43% of the scheduled samples
- QC samples had aggregate pass rate of 90%

Table G-1. Quality Assurance Summary - Soil

	Pass Rate of Quality Control Samples						
Radioisotope	**Lab Duplicates**	**Field Duplicates**	**DHS Duplicates**	**Lab Controls**	**Blanks**	**Rinsates**	**Aggregate Total**
Tritium	100%	100%	-	92%	100%	100%	98%
Strontium-90	100%	100%	-	100%	100%	100%	100%
Thorium-228	89%	86%	-	-	100%	100%	94%
Thorium-230	82%	88%	-	100%	56%	86%	82%
Thorium-232	100%	88%	-	-	100%	100%	97%
Uranium-234	82%	75%	-	100%	100%	100%	91%
Uranium-235	91%	100%	-	100%	100%	100%	98%
Uranium-238	82%	75%	-	100%	100%	86%	89%
Plutonium-238	100%	100%	83%	100%	100%	100%	97%
Plutonium-239	82%	100%	67%	100%	100%	100%	91%
Potassium-40	100%	75%	25%	-	100%	86%	77%
Cesium-137	100%	88%	100%	100%	100%	100%	98%
Radium-226	100%	75%	-	-	100%	100%	94%
Aggregate Total	93%	88%	69%	99%	97%	97%	90%

Table G-2. Laboratory Duplicates - Soil

	Sample Batch												
Radioisotope	**1A**	**1B**	**2A**	**2B**	**3**	**4**	**5**	**6**	**7**	**8**	**Number of Lab Duplicates**	**Percent Lab Duplicates**	**Percent Acceptable**
Tritium	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Strontium-90	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Thorium-228	-	-	P	P	P	PP	P	P	P	**F**	9	6%	89%
Thorium-230	P	P	P	P	P	PP	P	P	**F**	**F**	11	7%	82%
Thorium-232	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Uranium-234	P	P	P	**F**	P	**F**P	P	P	P	P	11	7%	82%
Uranium-235	P	P	P	P	P	**F**P	P	P	P	P	11	7%	91%
Uranium-238	P	P	P	**F**	P	**F**P	P	P	P	P	11	7%	82%
Plutonium-238	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Plutonium-239	P	P	P	P	P	PP	**F**	P	**F**	P	11	7%	82%
Potassium-40	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Cesium-137	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Radium-226	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
									Totals		141	7%	93%

Pass (P) The relative percent difference between the two duplicates is less than 3σ

Fail (**F**) The relative percent difference between the two duplicates is greater than 3σ

\- Not analyzed

σ Standard deviation of the two measurements

Table G-3. Laboratory Control Samples - Soil

	Sample Batch												
Radioisotope	**1A**	**1B**	**2A**	**2B**	**3**	**4**	**5**	**6**	**7**	**8**	**Number of Lab Control Samples**	**Percent Lab Control Samples**	**Percent Acceptable**
Tritium	P	PP	P	P	P	PP	P	P	**F**	P	12	8%	92%
Strontium-90	PPP	P	P	P	P	PP	P	P	P	P	13	9%	100%
Thorium-228	- - -	-	- -	-	- -	- -	-	- -	-	-	-	-	-
Thorium-230	PPP	P	PP	P	PP	PP	P	PP	P	P	16	11%	100%
Thorium-232	- - -	-	- -	-	- -	- -	-	- -	-	-	-	-	-
Uranium-234	P	P	P	P	P	PP	P	P	PP	P	12	8%	100%
Uranium-235	P	P	P	P	P	PP	P	P	PP	P	12	8%	100%
Uranium-238	P	P	P	P	P	PP	P	P	PP	P	12	8%	100%
Plutonium-238	- - P	- -	P	P	P	PPP	PPP	P	P	P	13	9%	100%
Plutonium-239	PPP	PP	P	P	P	PPP	PPP	P	P	P	17	11%	100%
Potassium-40	-	-	-	-	-	- -	-	-	-	-	-	-	-
Cesium-137	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Radium-226	-	-	-	-	-	- -	-	-	-	-	-	-	-
									Totals		118	9%	99%

Pass (P) The percent recovery is within +/- 3σ

Fail (**F**) The percent recovery exceeds +/- 3σ

\- Not analyzed

σ Standard deviation of the known and measured values

Table G-4. Laboratory Blanks - Soil

	Sample Batch												
Radioisotope	**1A**	**1B**	**2A**	**2B**	**3**	**4**	**5**	**6**	**7**	**8**	**Number of Lab Blanks**	**Percent Lab Blanks**	**Percent Acceptable**
Tritium	P	PP	P	P	P	PP	P	P	P	P	12	8%	100%
Strontium-90	PPP	P	P	P	P	PP	P	P	P	P	13	9%	100%
Thorium-228	- - P	-	PP	P	PP	PP	P	PP	P	P	13	9%	100%
Thorium-230	**FFF**	P	PP	P	PP	P**F**	**F**	**FF**	P	P	16	11%	56%
Thorium-232	PPP	P	PP	P	PP	PP	P	PP	P	P	16	11%	100%
Uranium-234	P	P	P	P	P	PP	P	P	PP	P	12	8%	100%
Uranium-235	P	P	P	P	P	PP	P	P	PP	P	12	8%	100%
Uranium-238	P	P	P	P	P	PP	P	P	PP	P	12	8%	100%
Plutonium-238	PPP	PP	P	P	P	PPP	PPP	P	P	P	17	11%	100%
Plutonium-239	PPP	PP	P	P	P	PPP	PPP	P	P	P	17	11%	100%
Potassium-40	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Cesium-137	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
Radium-226	P	P	P	P	P	PP	P	P	P	P	11	7%	100%
									Totals		173	9%	96%

Pass (P)	The measured value is less than the method MDA
Fail (**F**)	The measured value is greater than the method MDA
-	Not analyzed
MDA	Minimum Detectable Activity

Table G-5. Equipment Rinsates - Water

	Sample Batch												
Radioisotope	**1A**	**1B**	**2A**	**2B**	**3**	**4**	**5**	**6**	**7**	**8**	**Number of Rinsates**	**Percent Rinsates**	**Percent Acceptable**
Tritium	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Strontium-90	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Thorium-228	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Thorium-230	**-**	**-**	**-**	P	P	P	P	P	P	**F**	7	5%	86%
Thorium-232	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Uranium-234	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Uranium-235	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Uranium-238	-	-	-	P	**F**	P	P	P	P	P	7	5%	86%
Plutonium-238	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Plutonium-239	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Potassium-40	-	-	-	P	P	**F**	P	P	P	P	7	5%	86%
Cesium-137	-	-	-	P	P	P	P	P	P	P	7	5%	100%
Radium-226	-	-	-	P	P	P	P	P	P	P	7	5%	100%
									Totals		91	5%	97%

Pass (P)	The measured value is less than the method MDA
Fail (**F**)	The measured value is greater than the method MDA
-	Not analyzed
MDA	Minimum Detectable Activity

Table G-6. Field Duplicates - Soil

	Sample Batch												
Radioisotope	**1A**	**1B**	**2A**	**2B**	**3**	**4**	**5**	**6**	**7**	**8**	**Number of Field Duplicates**	**Percent Field Duplicates**	**Percent Acceptable**
Tritium	P	-	-	P	P	P	P	P	P	P	8	5%	100%
Strontium-90	P	-	-	P	P	P	P	P	P	P	8	5%	100%
Thorium-228	-	-	-	P	P	P	P	P	**F**	P	7	5%	86%
Thorium-230	P	-	-	P	P	P	P	P	**F**	P	8	5%	88%
Thorium-232	P	-	-	P	**F**	P	P	P	P	P	8	5%	88%
Uranium-234	P	-	-	P	P	P	P	**F**	P	**F**	8	5%	75%
Uranium-235	P	-	-	P	P	P	P	P	P	P	8	5%	100%
Uranium-238	P	-	-	**F**	P	P	P	P	P	**F**	8	5%	75%
Plutonium-238	P	-	-	P	P	P	P	P	P	P	8	5%	100%
Plutonium-239	P	-	-	P	P	P	P	P	P	P	8	5%	100%
Potassium-40	P	-	-	P	**F**	**F**	P	P	P	P	8	5%	75%
Cesium-137	P	-	-	P	P	P	P	P	P	**F**	8	5%	88%
Radium-226	P	-	-	**F**	P	P	**F**	P	P	P	8	5%	75%
									Totals		103	5%	88%

Pass (P) The relative percent difference between the two duplicates is less than 3σ

Fail (**F**) The relative percent difference between the two duplicates is greater than 3σ

\- Not analyzed

σ Standard deviation of the two measurements

Table G-8. Field Duplicates from Batch 2 - Soil

Sample ID	95-0014				95-0015						
Radioisotope	Mean pCi/g	2σ pCi/g	MDA pCi/g	Undetect ?	Mean pCi/g	2σ pCi/g	MDA pCi/g	Undetect ?	RPD %	3σ Limit	Pass/ Fail
Tritium*	58	450	800	U	-99	480	800	U	-	-	P
Strontium-90	0.026	0.099	0.1	U	0.097	0.08	0.1	U	-	-	P
Thorium-228	1.3	0.26	0.2		1.4	0.21	0.08		7%	37%	P
Thorium-230	1.3	0.24	0.08		1	0.16	0.04		26%	38%	P
Thorium-232	1.5	0.27	0.08		1.2	0.19	0.04		22%	37%	P
Uranium-234	0.84	0.051	0.008		0.95	0.054	0.009		12%	12%	P
Uranium-235	0.034	0.01	0.005		0.049	0.011	0.004		36%	54%	P
Uranium-238	0.87	0.051	0.007		1	0.056	0.008		14%	12%	**F**
Plutonium-238	-0.001	0.001	0.004	U	0.001	0.002	0.005	U	-	-	P
Plutonium-239	0	0.002	0.006	U	0.001	0.001	0.005	U	-	-	P
Potassium-40	18	0.32			18	0.48			0%	5%	P
Cesium-137	<0.01			U	<0.02			U	-	-	P
Radium-226	0.61	0.033			0.89	0.053			37%	12%	**F**

* All isotope units are pCi/g(soil) except tritium which is pCi/L of water extracted from soil

Pass (P) The relative percent difference (RPD) between the two duplicates is less than 3σ, or the mean of both duplicates is less than the MDA

Fail (**F**) The relative percent difference (RPD) between the two duplicates is greater than 3σ

MDA Minimum Detectable Activity

U Undetected. Mean < MDA

Table G-15. DHS Field Duplicates - Soil

	Sample Batch														
Radioisotope	**5A**	**5B**	**5C**	**5D**	**6A**	**6B**	**6C**	**6D**	**7A**	**7B**	**7C**	**7D**	**Number of Field Duplicates**	**Percent Field Duplicates**	**Percent Acceptable**
Tritium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium-90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thorium-228	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thorium-230	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thorium-232	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium-234	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium-235	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium-238	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plutonium-238	P	P	P	P	**F**	P	P	P	P	P	**F**	P	12	8%	83%
Plutonium-239	**F**	P	P	**F**	P	P	P	P	**F**	P	**F**	P	12	8%	67%
Potassium-40	**F**	**F**	P	**F**	**F**	**F**	**F**	**F**	**F**	P	P	**F**	12	8%	25%
Cesium-137	P	P	P	P	P	P	P	P	P	P	P	P	12	8%	100%
Radium-226	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Pass (P)	The relative percent difference between the two duplicates is less than 3σ
Fail (**F**)	The relative percent difference between the two duplicates is greater than 3σ
-	Not analyzed
σ	Standard deviation of the two measurements

Table G-17. DHS Field Duplicate from Batch 5B - Soil

Sample ID	Rocketdyne 95-0075				DHS R70323 & R70324						
Radioisotope	Mean pCi/g	2σ pCi/g	MDA pCi/g	Undetect ?	Mean pCi/g	2σ pCi/g	MDA pCi/g	Undetect ?	RPD %	3σ Limit	Pass/ Fail
Tritium*	68	350	600	U	-				-	-	-
Strontium-90	0.022	0.042	0.05	U	-				-	-	-
Thorium-228	1.3	0.12	0.04		-				-	-	-
Thorium-230	1.1	0.1	0.02		-				-	-	-
Thorium-232	1.2	0.11	0.02		-				-	-	-
Uranium-234	0.72	0.043	0.01		-				-	-	-
Uranium-235	0.042	0.01	0.004		-				-	-	-
Uranium-238	0.78	0.045	0.007		-				-	-	-
Plutonium-238	0.003	0.003	0.005	U	0.003	0.001			0%	158%	P
Plutonium-239	0.002	0.002	0.004	U	<0.002		0.002	U	-	-	P
Potassium-40	21	0.26			22.1	0.52			5%	4%	**F**
Cesium-137	0.056	0.011			0.036	0.016			43%	63%	P
Radium-226	0.68	0.022			NR				-	-	-

* All isotope units are pCi/g(soil) except tritium which is pCi/L of water extracted from soil

\- Not analyzed NR Not reported

Pass (P) The relative percent difference (RPD) between the two duplicates is less than 3σ, or the mean of both duplicates is less than the MDA

Fail (**F**) The relative percent difference (RPD) between the two duplicates is greater than 3σ

MDA Minimum Detectable Activity

Raw Laboratory Data

- A better job of segregating the laboratory data could have been done. The raw data was exhaustively tabulated, graphed, statistically analyzed, and interpreted in the main body of the report, for the very reason that the raw lab data would be impossible to assimilate for the casual reader. Perhaps because of this, less effort was devoted to indexing/annotating/titling the raw lab. data in Volumes II to IV. The laboratory reports were actually ordered chronologically, since any other way would have been even more confusing. In situations where re-analysis was requested and/or voluntarily performed by the laboratory, both original and re-analysis results are given in the chronological order in which the results were received.

Scope of Final Report

- Information related to the remediation activities of radiological facilities was outside the scope of survey
- The decommissioning and decontamination and radiological surveys of nuclear facilities by Rocketdyne, the independent verification surveys by third parties and regulatory agencies, and the radiological release process has been documented in numerous reports. These activities are driven and controlled by regulation.
- The (as then) current status of facilities was documented in the Area IV Radiological Characterization Plan when it was issued

Why Was Area IV Survey Soil Data used the DOE Environmental Assessment?

- The EA needed estimates of required soil excavation in Area IV, as a function of cleanup goal
- All remediation sites have had extensive pre- and post-remedial soil sampling performed, however those sites are not characteristic of the balance of Area IV
- The only comprehensive set of soil samples taken in the non-remediated portions of Area IV were the Area IV Survey samples taken in 1994-95
- Therefore this soil sample distribution was used to characterize the balance of Area IV soil

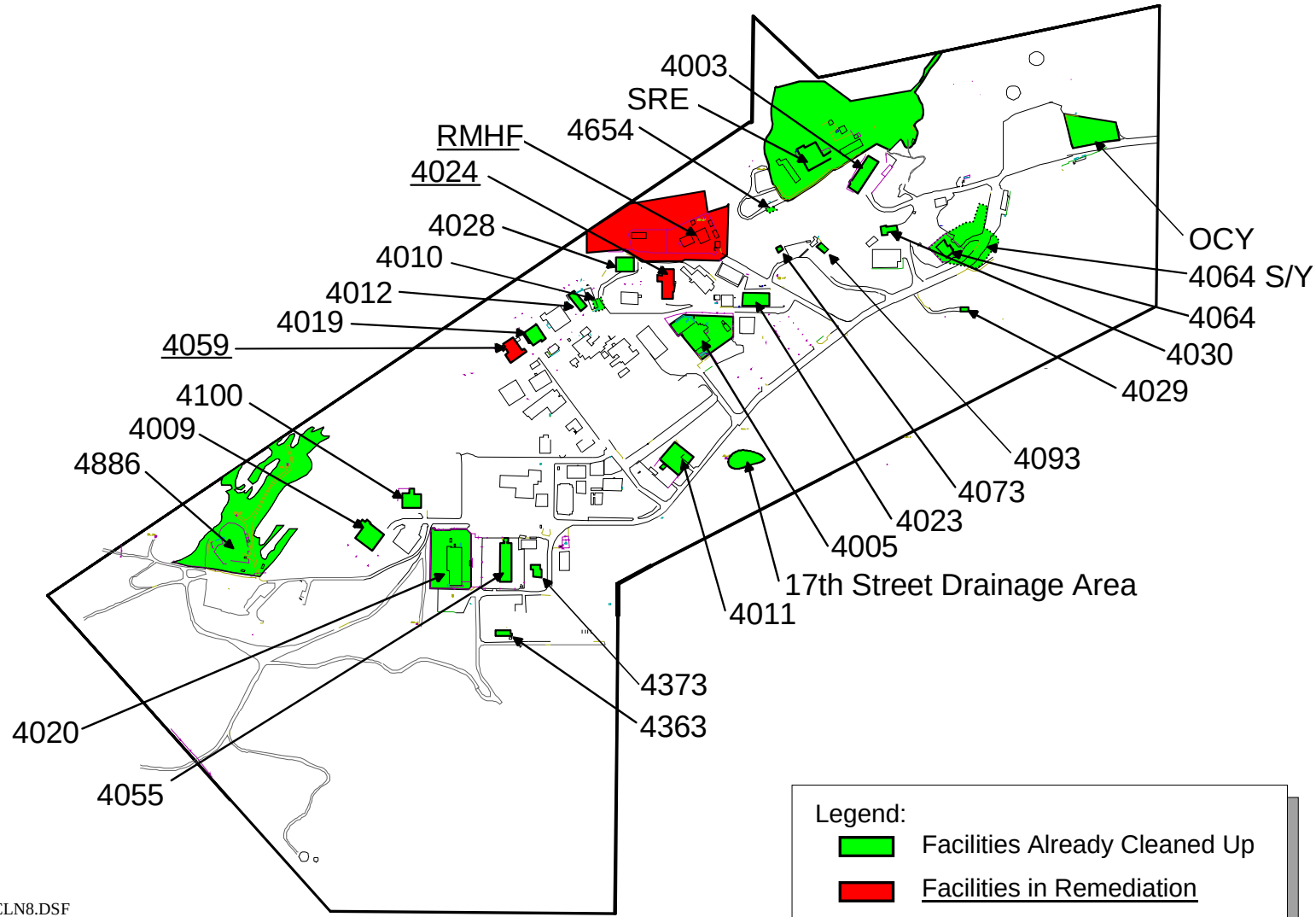
Use of Area IV Survey Data for the EA

- The assumption that the Area IV data set is representative of the all soil (including subsurface soil) at Area IV is extremely conservative
- Use of Area IV survey data does not result in a low estimate of the excavated soil volume for Alternative 2
  - Estimate is 15% of all Area IV soil …. a large fraction
- Use of Area IV survey data does not invalidate the key conclusion of the EA that a 15 mrem/y cleanup standard will not impact the health of any on-site or off-site resident. This is independent of the soil excavation estimates or Area IV data

Have only 150 soil samples been taken in Area IV?

- No
- Many thousands of pre- and post-remedial samples have been taken at remediation sites
- See next charts for summary of soil samples taken by various organizations to support final status surveys and verification surveys
- Over 1,600 post-remedial soil samples have been taken

Santa Susana Field Laboratory (SSFL) Area IV Radiological Facility Status



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SSFL - Radiological Facility Post-Remedial Soil Sampling

FACILITY NUMBER	FACILITY TITLE	ROCKETDYNE OPERATIONS	VERIFICATION SURVEYS	EPA INSPECTION	Rocketdyne	ORISE	DHS	Other
OCY	Old Conservation Yard	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	20	1	?	-
RMHF	Radioactive Materials Handling Facility	Operational	-	ECD 2005	TBD	TBD	TBD	-
003	Engineering Test Building	D&D and survey complete	ANL	EPA Area IV Survey	15	-	-	9 (ANL)
005	Uranium Carbide Fuel Facility	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	59	2	?	-
009	Organic Moderated Reactor, Sodium Graphite Reactor	D&D and survey complete	DHS	Not available for survey	199	-	-	-
011	Radiation Instrument Calibration Laboratory	Survey complete	DHS	Available for survey	-	-	-	-
010	SNAP-8 Experimental Reactor	D&D and survey complete	ANL	EPA Area IV Survey	60	-	-	25 (ANL)
012	SNAP Critical Facility	D&D and survey complete	ORISE, DHS	Jan 2000	-	-	-	-
17th St.	17th St. Drainage Area	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	22 + 24	8	?	-
019	Flight System Critical Assembly	D&D and survey complete	ORISE, DHS	ECD Unknown	-	-	-	-
020	Hot Lab Bldg.	D&D and survey complete	DHS	-	See below	See below	See below	-
020	Hot Lab Land	Survey complete	ORISE, DHS	EPA Area IV Survey	85 + 216 + 195	20+10+?	?	-
023	Corrosion Test Loop	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	-	-	-	-
024	SNAP Environmental Test Facility	Operational	-	ECD 2004	TBD	TBD	TBD	-
028	Shield Test Iradiation Reactor	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	-	-	-	-

SSFL - Radiological Facility Post-Remedial Soil Sampling

FACILITY NUMBER	FACILITY TITLE	ROCKETDYNE OPERATIONS	VERIFICATION SURVEYS	EPA INSPECTION	Rocketdyne	ORISE	DHS	Other
029	Radiation Measurement Facility	D&D and survey complete	ORISE, DHS	Jan 2000	4	-	-	-
030	van de Graaf Accelerator	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	-	-	-	-
055	Nuclear Materials Development Facility	D&D and survey complete	ORAU	ECD Unknown	36	20	-	-
059	SNAP Ground Prototype Test Building	Phase I D&D and survey complete	ORISE, DHS	Oct 2000	See below	See below	See below	-
059	059 Land	-	-	EPA Area IV Survey	TBD	TBD	TBD	-
064	Fuel Storage Facility	D&D and survey complete	ORISE, DHS	-	See below	See below	See below	-
064SY	064 Side Yard and land	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	52 + 136	21	?	-
073	Kinetic Experiment Water Boiler	D&D and survey complete	ANL	EPA Area IV Survey	23	-	-	124 (ANL)
093	L-85 Reactor	D&D and survey complete	ORAU	EPA Area IV Survey	5 + 12	6	-	-
100	Fast Critical Experiment Laboratory	D&D and survey complete	NRC	ECD Unknown	-	-	-	-
143	Sodium Reactor Experiment	D&D and survey complete	ANL	EPA Area IV Survey	~ 40 +	-	-	~ 40 (ANL)
363	R&D Laboratory	D&D and survey complete	ORISE, DHS	Jan 2000	-	-	-	-
373	SNAP Critical Facility	D&D and survey complete	DHS (document review only)	EPA Area IV Survey	-	-	-	-
654	Interim Storage Facility	D&D and survey complete	ORISE, DHS	EPA Area IV Survey	93	16	?	-
886	Sodium Disposal Facility	Rad. D&D and survey complete	DHS	EPA Area IV Survey	109	-	13	10 (RWQCB)

SSFL - Radiological Facility Post-Remedial Soil Sampling

FACILITY NUMBER	FACILITY TITLE	ROCKETDYNE OPERATIONS	VERIFICATION SURVEYS	EPA INSPECTION	Rocketdyne	ORISE	DHS	Other
Area IV	Area IV SSFL (1994-95)	Nuclear Research	DHS	EPA Area IV Survey	149	-	12	-
Area IV	Miscellaneous	Miscellaneous	-	EPA Area IV Survey	~ 50			-
Total					**1604**	**104**	**25+**	**208**

Leachfield and septic tank sampling subsequent to Area IV Survey has found no radioactive contamination

- Prior radiological buildings
  - Sodium Reactor Experiment
  - Building 4005
  - Building 4009
  - Building 4011
  - Building 4100
  - Building 4373
- Non-radiological buildings
  - Building 4006
  - Building 4353
  - Building 4487

Sampling of other areas, subsequent to the Area IV Survey has found no radioactive contamination in excess of cleanup standards

- Old Conservation Yard
  - Data Submitted to DTSC
- Building 4100 Trench
- Installation of shallow wells in Area IV
- Sodium Reactor Experiment
  - Data submitted to DHS and DTSC

Soil Sample Density

- In two recent MARSSIM designed soil surveys at Area IV, Rocketdyne used sample densities of 35 - 40 samples per acre for Class 1 survey units
  - Sample densities were calculated using MARSSIM statistical protocols
  - Based on a 15 mrem/y (~3 x 10^{-4}) cleanup standard for cesium-137 of 9.2 pCi/g, measured a priori cesium distributions, and α and β error factors of 0.05
- The EPA Area IV Survey Scoping Document is likewise proposing to use 50 samples per acre for Class 1 survey unit

What are the current radiation risks at SSFL due to soil contamination ?

Facility /Area	Area (acres)	Cs-137 Range (pCi/g)	Average Risk ***	Max. Risk ****
Area IV *	290	ND - 2.4	1.8×10^{-6}	7.2×10^{-5}
RMHF **	3	ND - 52	1.5×10^{-4}	1.7×10^{-3}

* Based on CY 1995 Area IV survey

** Based on CY 2000 soil sampling at the Radioactive Materials Handling Facility

*** Based on full range of cesium-137 levels in Area IV or RMHF

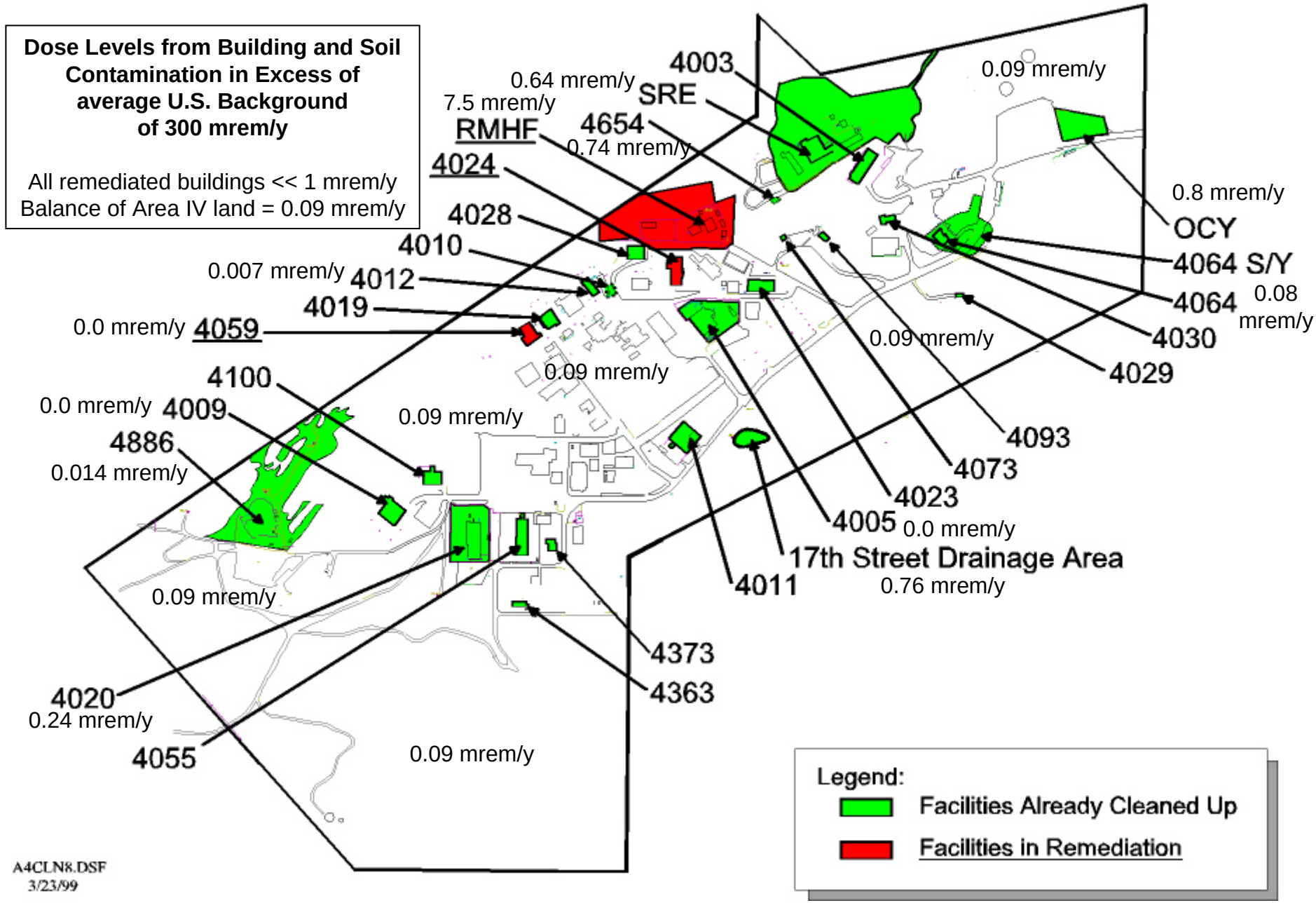
**** Conservatively assuming that all Area IV or RMHF is contaminated at the maximum cesium level

Dose and Theoretical Risk Levels[1] of Contaminated Soil in Area IV is Low

Facility /Area	Area (acres)	No. of Soil Samples	Cs-137 Range (pCi/g net)	Average Risk[2] (Dose mrem/y)[4]	Max. Risk[3] (Dose mrem/y)[4]	Comments
Area IV	290	149	ND - 2.2	1.8×10^{-6} (0.09)	7.2×10^{-5} (3.6)	No remediation required
Hot Lab	5	84	ND - 4.6	4.8×10^{-6} (0.24)	1.5×10^{-4} (7.5)	Post - remediation
FSDF	3	78	ND - 0.57	2.7×10^{-7} (0.014)	1.2×10^{-5} (0.6)	Post - remediation
RMHF	3	29	ND - 52	1.5×10^{-4} (7.5)	1.7×10^{-3} (85)	Remediation planned

1. Theoretical risk values based on the linear-no-threshold model, assuming it is valid at these low dose levels
2. Based on full range of cesium-137 sample data for that facility
3. Conservatively assumes that all the facility is contaminated at the maximum cesium-137 level for that facility
4. Calculated dose in mrem/y over and above the average background dose of 300 mrem/y

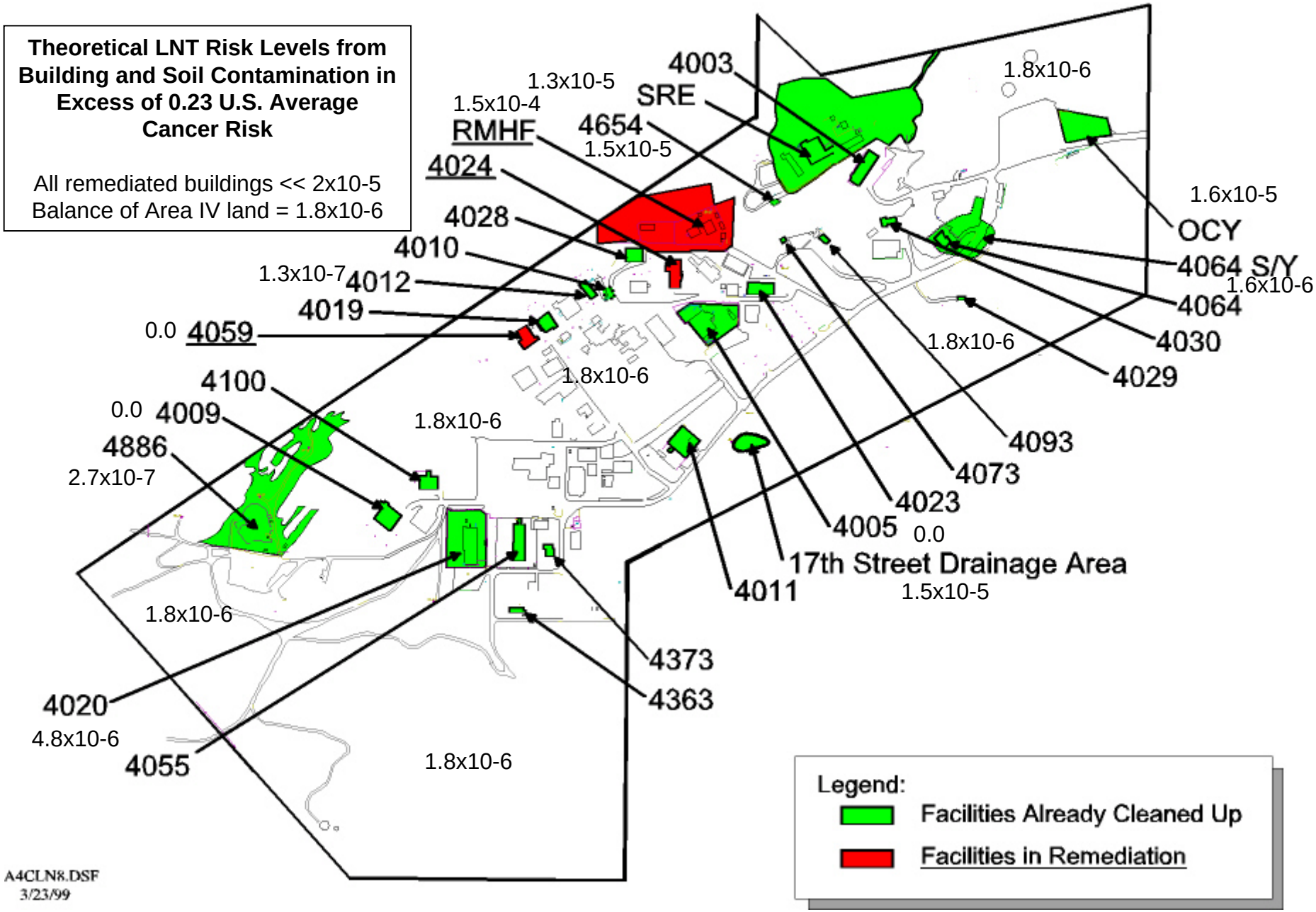
Santa Susana Field Laboratory (SSFL) Area IV Radiological Facility Status



Santa Susana Field Laboratory (SSFL) Area IV Radiological Facility Status

Theoretical LNT Risk Levels from Building and Soil Contamination in Excess of 0.23 U.S. Average Cancer Risk

All remediated buildings << 2x10-5
Balance of Area IV land = 1.8x10-6



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Conclusion

- 1994-95 Area IV Survey soil data is valid
- Use of 1994-95 Area IV Survey soil data in the EA is valid
- Overall conclusions of the Area IV survey have been confirmed by subsequent sampling
- All post-remedial sampling at locations of radiological facilities in addition to the sampling of the balance of Area IV provides assurance that Area IV soil poses no hazard to users
- All data is available for review during the HSA