Plutonium-238 at Brandeis-Bardin

This paper is in response to various recent queries by DTSC[1] and statements by a member of the public[2] regarding plutonium-238 results for soil on Brandeis-Bardin property.

Background

In 1992 Rockwell International[3] conducted a media sampling project on the Brandeis-Bardin Institute (BBI) and the Santa Monica Mountains Conservancy – Sage Ranch (SMMC). The project was conducted in coordination with the US Environmental Protection Agency (USEPA), the California Environmental Protection Agency Department of Toxic Substances Control (Cal/EPA-DTSC), the Los Angeles Regional Quality Control Board (RWQCB), the California Department of Health Services Environmental Management Branch (DHS-EMB), BBI consultants, SMMC personnel, the Committee to Bridge the Gap (CBG) and local community members. Sampling was performed by Rockwell's consultant, McLaren/Hart Environmental Engineering Corporation. The report documenting this sampling program was issued in 1993[4]. Subsequently, a follow-on sampling program was conducted by the same participants in 1994 and documented in 1995[5].

During the initial 1992 study soil/sediment samples were taken from location RD-51 watershed (BB-15), plutonium-238 results ranged from <0.05 pCi/g (non-detect) to 0.22 pCi/g. Subsequently, during the follow-on sampling program in 1994, the same location (BB-15-001) plus additional upstream and downstream locations were sampled by McLaren/Hart, USEPA and the BBI consultant (See Appendix G for locations). As can be seen from Table 1 and Appendix D, neither was the original sample result confirmed nor was Pu-238 detected in the larger sampling area.

Table 1. Plutonium-238 Results for RD-51 Watershed Area

Sample ID	1992		1994		
	M/H	USEPA	M/H	USEPA	BBI
BB-15-001	0.22 +/- 0.07	-	< 0.01	< 0.03	-
BB-15-002	0.067 +/- 0.025	-	-	-	-
BB-15-003	< 0.05	-	-	-	-
BB-15-004	< 0.05	-	-	-	-
BB-15-005	0.055 +/- 0.042	< 0.02*	-	-	-
BB-15-006	-	-	< 0.01	-	< 0.05
BB-15-007	-	-	< 0.01	< 0.04	-
BB-15-008	-	-	< 0.01	-	-
BB-15-009	-	-	< 0.009	-	< 0.1
BB-15-010	-	-	< 0.009	-	-

< indicates that Pu-238 was not detected above the detection limit

[1] Lara Rainey/Gerard Abrams (DTSC). Verbal Communication. October 2007

[2] Christina Walsh. Public Meeting on Proposed ENTS Designs for SSFL. July 17, 2007.

[3] Rockwell International was the prior owner of the Santa Susana Field Laboratory before The Boeing Company

[4] McLaren/Hart, "Multi-Media Sampling Report for the Brandeis-Bardin Institute and the Santa Monica Mountains Conservancy. Volume I. Final Report." March 10, 1993. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/MultMedSamRep_V1.pdf

[5] McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf

Table 2 describes the Appendices that provide original supporting information.

Table 2. Supporting Documentation

Appendix	Source	Source Document / Web Link
A	Executive Summary. Pages ix to xi. *"Plutonium-238 was not detected in any samples collected in RD-51 and Building 59 watersheds in 1994. The 1994 study results therefore do not confirm 1992 study results and plutonium-238 is therefore not a concern."*	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf
B	Section 7.10 RD-51 Watershed (BB-15). *"On March 10, 1994, ten sediment samples were collected from the creek bed according to the approved work-plan."* *"Five new locations up-gradient from the 1992 samples (closer to the Rocketdyne property boundary) were sampled for isotopic plutonium. In addition, location 001 was re-sampled for isotopic plutonium because plutonium-238 was detected at location 001 at 0.22 picocuries per gram of dry soil [pCi/g(dry)] in 1992. A split sediment sample was collected for the USEPA at location 001 and location 007 for isotopic plutonium."* *"A split sediment sample was collected for the Brandeis-Bardin consultant at location 006 and 009 for isotopic*	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf

Appendix	Source	Source Document / Web Link
	plutonium. A field duplicate sample was collected at location 009 for isotopic plutonium." *"The sample locations and the results are shown on Figure 24."* *"Isotopic plutonium was below detection limits in all six samples collected at the RD-51 Watershed in 1994. Radionuclide analytical results for the sediment samples are summarized in Table 31."*	
C	Section 9. Conclusions. Pages 9-2 to 9-3. *"Plutonium-238 was not detected in any samples collected in either watershed in 1994. The results of the 1992 study were not confirmed by 1994 study results."*	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf
D	Table 31. Radionuclide Results for Sediment samples at the RD-51 Watershed (BB-15)	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf
E	Figure 1. Summary of the 1992 Multi-Media Sampling	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf
F	Figure 31. Summary of the 1994 Sampling Results Distinguishable from Background and Mercury Sampling Results	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf
G	Figure 24. RD-51 Watershed BB-15 Sample Locations	McLaren/Hart, "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." January 19, 1995. http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/AddSoilandWaterSamp.pdf

Appendix	Source	Source Document / Web Link
H	EPA Update. *"EPA has determined that the radionuclides do not pose a threat to human health or the environment."* *"Furthermore, based on EPA's calculations, the theoretical cancer probability or risk to campers and camp counselors is less than EPA's threshold level for action of one in 1,000,000."*	EPA Update. "The U.S. EPA Announces Results of Rocketdyne's Off-Site Sampling Program for the Santa Susana Field Laboratory." July 1995 http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/EPABrandeis.pdf

Conclusions

The 1994 follow-on study failed to confirm the 1992 Pu-238 results. Furthermore, the USEPA concluded that trace levels of radionuclides found on Brandeis-Bardin did not pose a threat to human health or the environment (Appendix H)[6].

It should also be noted from Appendix D that all samples were non-detect for plutonium-239 which is the plutonium isotope usually associated with nuclear reactor operation. Plutonium-238 is associated with radioisotope thermal generators (RTGs) used to power satellites. No RTG work was performed at SSFL.

If the 0.22 pCi/g Pu-238 level had been real, and assuming conservatively that Pu-238 background was zero, and assuming conservatively that all the soil in the RD-51 watershed was contaminated to the maximum 0.22 pCi/g level, then the theoretical residential EPA risk[7] would be $0.22/2.97 = 7.4 \times 10^{-8}$, which is less than the lower end of the USEPA CERCLA 10^{-6} to 10^{-4} acceptable risk range. The RD-51 watershed area of Brandeis-Bardin is of course open-space parkland and not residential. Consequently conservative, hypothetical risks would be even less.

The Pu-238 issue has been addressed several years ago in Boeing's response to the UCLA Cohen report on off-site exposure potential[8].

[6] EPA Update. "The U.S. EPA Announces Results of Rocketdyne's Off-Site Sampling Program for the Santa Susana Field Laboratory." July 1995
http://www.etec.energy.gov/Health-and-Safety/Documents/BrandeisBardin/EPABrandeis.pdf

[7] The EPA residential 10^{-6} preliminary remediation goal for Pu-239 is 2.97 pCi/g. http://epa-prgs.ornl.gov/radionuclides/

[8] Boeing Comments on the UCLA Cohen Report. September 29, 2006. Pages R-3, R-5, R-6, R-10, R-11 and R-23.
http://www.etec.energy.gov/Health-and-Safety/Documents/CancerStudies/Boeing_Comments_on_UCLA_Exposure_Report.pdf

Appendix A

Executive Summary of McLaren/Hart Report on BBI/SMMC Sampling

EXECUTIVE SUMMARY

This document presents the results of the Additional Off-Site Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy. This additional sampling was conducted in 1994 as a follow-up to the multi-media sampling program conducted in 1992. This program was conducted to determine if chemicals or radionuclides had migrated or had been deposited on two properties adjacent to the north/northwest property line of Rockwell International Corporation, Rocketdyne Division's Santa Susana Field Laboratory (SSFL). The two properties (referred to as study areas) were the Brandeis-Bardin Institute and the Santa Monica Mountains Conservancy. Results from this 1992 investigation indicated that additional sampling would be required to try to address a number of issues.

The issues that were recommended to be addressed, and their action items, are the following:

1) Re-evaluation of tritium in areas where the original data were analyzed by the gas counting method and later withdrawn by the laboratory because the laboratory could not validate the data. Ten areas were resampled and samples were analyzed for tritium.

2) Confirmation of the State of California Department of Health Services laboratory reported values of 2,470 $\pm$197 and 392 $\pm$153 picocuries per liter (pCi/L) for tritium at Campsite Area 2. The area was resampled.

3) Remediation of mercury from the Sodium Burn Pit Watershed. The site containing mercury-bearing sediment, identified in 1992, was excavated and resampled after excavation to confirm the removal of sediment containing mercury.

4) Determination whether the plutonium-238 reported in the vicinity of the RD-51 and Building 59 Watersheds is statistically different from background. Additional samples were collected in the watersheds and results were statistically compared to background.

5) Determination whether the strontium-90 and cesium-137 reported in the Sodium Reactor Experiment Watershed is statistically different from background. Additional samples were collected in the watershed and results were statistically compared to background.

6) Determination whether the concentrations of tritium, cesium-137, and strontium-90 reported at Radioactive Materials Disposal Facility (RMDF) Watershed are greater than background. Additional samples were collected in the watershed and the results were compared to background.

7) Further characterization of tritium and cesium-137 at the Building 59 Watershed to determine if tritium and cesium-137 concentrations were greater than background. Additional samples were collected in the watershed and the results were compared to background.

8) Characterization of the distribution of tritium, strontium-90, and cesium-137 in the drainages between the RMDF/Building 59 Watersheds and Campsite Area 1. Samples were collected in the drainages and the results were evaluated.

9) Collection of additional background data, at the request of the Work Group, from sites away from the SSFL.

Number and Types of Analyses. To address these issues 40 soil/sediment samples were collected from background areas and 124 soil/sediment samples were collected from the study areas. All the background area samples were analyzed for tritium, strontium-90, isotopic plutonium, and gamma emitting radionuclides. The samples collected in the study areas were primarily analyzed for tritium with additional analyses for strontium-90, isotopic plutonium, and gamma emitting radionuclides conducted to address the issues listed above. In addition seven soil samples collected in the Sodium Burn Pit Watershed were analyzed for mercury.

Two surface water samples were collected from the Campsite Area 1 and Campsite Area 2 - Drainage. The surface water samples were analyzed for tritium and for gross alpha and gross beta radiation.

Quality Assurance/Quality Control. A rigorous quality assurance/quality control (QA/QC) program was implemented during the sampling to assure that the data are valid. Comparison of the QA/QC samples (blind field duplicates, pre-spiked blind duplicates, laboratory duplicates, field splits samples, rinsate samples, and matrix spike samples) to their respective scheduled sample showed an overall agreement of approximately 94 percent. This level of agreement demonstrated that the data are valid.

Data Evaluation. Soil radionuclide data from the study areas were evaluated statistically by comparing to background data. Surface water samples were not evaluated statistically because there were no background data points.

Radionuclide Results and Conclusions. The investigation was conducted during March 4 and March 15 of 1994 and revealed that with the exception the Building 59 and RMDF Watersheds, none of the other sites had radionuclides present at concentrations statistically higher than background values. Tritium was found at concentrations significantly above background values in sediment samples collected from the ravine of the Building 59 Watershed. Cesium-137 concentrations in samples collected from the Building 59 Watershed are statistically different from background levels established for this study. However the cesium-137 levels are below the literature values for background cesium (see Table 20).

Strontium-90 concentrations measured in sediment samples collected from the RMDF Watershed are statistically different from background values established for this study. However, the level of strontium-90 is below literature values for background level (see Table 20).

Plutonium-238 was not detected in any samples collected in RD-51 and Building 59 watersheds in 1994. The 1994 study results therefore do not confirm 1992 study results and plutonium-238 is therefore not a concern.

Appendix B

Section 7.10 of McLaren/Hart Report on BBI/SMMC Sampling

On March 7, 1994, five soil samples were collected from previously sampled grid locations according to the approved Workplan. The USEPA collected a split sample at Block 094. The Brandeis-Bardin consultant collected a split sample at Block 079. The radiation survey of the area by the USEPA showed an ambient radiation field of 15 to 17 μR/hr. The sampling grid is shown on Figure 22.

Tritium was below detection limits in all five samples collected at the Old Well Campsite in 1994. Radionuclide data for soil samples is summarized in Table 29.

7.9 Former Rocketdyne Employee Shooting Range (SM-03)

The Former Rocketdyne Employee Shooting Range was approximately 1,700 feet west of the main Rocketdyne gate, bordering the property line. The soil sampling grid was located on a level area on the north/northeast side of the dirt road where lead shot was observed and was only one block wide. The area had moderate growth of annual grasses and forbs. Several stakes from the 1992 round of sampling were identified when reestablishing the grid.

On March 7, 1994, five soil samples were collected from previously sampled grid locations according to the approved Workplan. A lab duplicate was analyzed from the sample collected at Block 012. A rinsate sample was also collected at Block 012. The radiation survey of the area by the USEPA showed an ambient radiation field of 15 μR/hr. The sampling grid is shown on Figure 23.

Tritium was below detection limits in all five samples collected at the Former Rocketdyne Employee Shooting Range in 1994. A summary of the analytical results is presented in Table 30.

7.10 RD-51 Watershed (BB-15)

The RD-51 Watershed is approximately 4,800 to 5,600 feet northeast of Building 59. This area represents the watershed northwest of the well WS-13. The sampled area was a narrow creek bed that connected to the main ravine which appeared to be connected to the stream bed near Campsite 2.

The drainage area was vegetated with tall grasses and some woody scrub. The drainage channel was followed from the top of the hill (near the east end of the parking lot where the cluster wells RD-51 A, B, and C are located) to the edge of the cliff where the water falls off into the main ravine that originates to the northwest of WS-13. An attempt was made to locate the property line from tanks on the Rocketdyne facility and the fence. The tanks were not always visible and the location of the sample points relative to the fence line is only an approximation. Some stakes from the 1992 round of sampling were identified when reestablishing the grid.

On March 10, 1994, ten sediment samples were collected from the creek bed according to the approved Workplan. Five samples were collected from locations 001 through 005, which were previously sampled in 1992, and reanalyzed for tritium. Five new locations upgradient from the 1992 samples (closer to the Rocketdyne property boundary) were sampled for isotopic plutonium. In addition, location 001 was resampled for isotopic plutonium because plutonium-238 was detected at location 001 at 0.22 picocuries per gram of dry soil [pCi/g(dry)] in 1992. A split sediment sample was collected for the USEPA at location 001 and location 007 for isotopic plutonium. The USEPA also collected a split sediment sample at location 001 for tritium. A split sediment sample was collected for the Brandeis-Bardin consultant at location 006 and 009 for isotopic plutonium. A field duplicate sample was collected at location 009 for isotopic plutonium. A rinsate sample for isotopic plutonium was also collected. The radiation survey of the area by the USEPA showed an ambient radiation field of 16 to 17 μR/hr. The sample locations and the results are shown on Figure 24.

Tritium was below detection limits in all five samples collected at the RD-51 Watershed in 1994. One split sample collected at location 003 and analyzed by the Brandeis-Bardin consultant indicated a tritium level of 550$\pm$350 pCi/l. Isotopic plutonium was below detection limits in all six samples collected at the RD-51 Watershed in 1994. Radionuclide analytical results for the sediment samples are summarized in Table 31.

7.11 Radioactive Materials Disposal Facility Watershed (BB-16)

The Radioactive Materials Disposal Facility (RMDF), consists of Buildings 075, 621, 021, 022, 044, and 034. The watershed was sampled approximately 200 feet north of the north-

Appendix C

Conclusions of McLaren/Hart Report on BBI/SMMC Sampling

Issue 1. **Re-evaluation of locations for which tritium results were withdrawn or dried by the Teledyne Isotopes laboratory. Results of resampling and analyses.**

Tritium samples were collected in nine human activity areas and one ravine to replace the 1992 data withdrawn by Teledyne Isotopes. All tritium results in the nine human activity areas and one ravine were below detection limits.

Issue 2. **Confirmation of the 1992 DHS sample result of 2,470 ±197 pCi/L at Campsite Area 2. Results of resampling.**

Tritium in all samples collected at Campsite Area 2 in 1994, was below detection limits.

Issue 3. **Remediation of mercury present in the Sodium Burn Pit Watershed (BB-18) at Brandeis-Bardin in the vicinity of previously detected mercury. Results of excavation and follow-up sampling.**

Based on the sample results within the excavation, mercury previously measured in the watershed (0.35 mg/kg) has been removed within the area subsequently excavated. Mercury was not detected (<0.1 mg/kg) in the four samples collected from within the excavation area. A concentration of 0.12 mg/kg of mercury, slightly above the detection limit, was reported in one of the samples upgradient from the excavation. However, an analysis of a laboratory duplicate of the sample and analysis of an interlaboratory duplicate by the USEPA were below the detection limit (<0.1 and <0.09 mg/kg, respectively). Analysis of the interlaboratory duplicate by Brandeis-Bardin indicated a concentration of 0.14 mg/kg. Thus, the mercury (0.35 mg/kg) detected in the Sodium Burn Pit Watershed in 1992 was removed by excavation. Mercury at near detection level may be present upgradient from the excavation.

Issue 4. **Determination whether the plutonium-238 detected in 1992 in the RD-51 and Building 59 Watersheds is representative of a concentration distinguishable from background plutonium-238. Results of additional sampling and statistical comparison.**

Plutonium-238 was not detected in any samples collected in either watershed in 1994. The results of the 1992 study were not confirmed by 1994 study results.

Issue 5. **Determination whether strontium-90 in the Sodium Reactor Experiment Watershed is statistically different than background. Results of additional sampling and statistical comparison.**

The collection of additional data in 1994 allowed for a statistical comparison of strontium-90 concentrations in the Sodium Reactor Experiment Watershed. Based on these results, watershed concentrations were not considered statistically different than background.

Issue 6. **Determination whether concentrations of tritium, cesium-137, and strontium-90 in the Radioactive Materials Disposal Facility Watershed are greater than background. Results of additional sampling and comparison of the results with the background data.**

Since a significant number of background results for tritium were below the detection limit, an analysis of variance for tritium was not conducted on the data set. Tritium results for the RMDF watershed samples collected in 1994 indicate that the RMDF is not significantly different from background results. Strontium-90 results are statistically different from the background results. Cs-137 results were not statistically different from background results.

Issue 7. **Determination whether concentrations of tritium and cesium-137 in the Building 59 Watershed are greater than background. Results of additional sampling and comparison of the results with the background data.**

Since significant number of background results for tritium were below the detection limit an analysis of variance for tritium was not conducted on the data set. Tritium at elevated levels, but about 50 percent or more below the MCL for drinking water (20,000 pCi/l), was measured in the samples collected in the ravine of the Building 59 Watershed. These elevated tritium levels were confirmed by split samples by the USEPA and the Brandeis-Bardin consultant, and are significantly different than background. Based on results using the Behrens-Fisher t-Test cesium-137 results are statistically different from background sampling.

Appendix D

Table 31 of McLaren/Hart Report on BBI/SMMC Sampling

TABLE 31

Radionuclide Results for Sediment Samples at the RD-51 Watershed (BB-15)

	Cesium-137 [pCi/g(dry)]	Plutonium-238 [pCi/g(dry)]	Plutonium-239 [pCi/g(dry)]	Strontium-90 [pCi/g(dry)]	Iodine-129 [pCi/g(dry)]	Tritium (pCi/L)
BB-15-001						
Sample*	0.045 +/- 0.026	0.22 +/- 0.07	< 0.01	0.01 +/- 0.01	< 0.3	W
Field Duplicate*				0.02 +/- 0.02	< 0.3	316 +/- 152
DHS*	0.04 +/- 0.01					< 200
Sample^		< 0.01	< 0.01			< 270
USEPA^		< 0.03	< 0.03			
BB-15-002						
Sample*	0.044 +/- 0.022	0.067 +/- 0.025	< 0.005	< 0.01	< 0.3	< 200
Field Duplicate*	< 0.04					< 100
Sample^						< 200
BBI^						550 +/- 350
BB-15-003						
Sample*	0.039 +/- 0.020	< 0.05	< 0.01	0.01 +/- 0.01	< 0.3	< 200
Interlab Duplicate*						< 200
Sample^						
BB-15-004						
Sample*	0.043 +/- 0.025	< 0.05	< 0.01	< 0.01	< 0.2	W
BBI*	< 0.3			< 0.6		< 200
Sample^						< 400
BBI^						
BB-15-005						
Sample*	0.052 +/- 0.025	0.055 +/- 0.042	< 0.01	< 0.01	< 0.2	W
USEPA*	0.041 +/- 0.013	< 0.02	< 0.011	< 0.73	< 0.17	< 171
Sample^						< 200

pCi/g(dry) -- Picocuries per gram of undried sample
pCi/L -- Picocuries per liter of water
< -- Less than

* -- 1992 Sample
^ -- 1994 Sample
Blank -- Not analyzed
+/- -- Plus or minus

BBI -- Brandeis-Bardin Institute split sample
DHS -- Department of Health Services split sample
USEPA -- United States Environmental Protection Agency split sample

W -- Samples results could not be verified by the laboratory and subsequently were withdrawn by the laboratory.

Cesium-137 was the only man-made radionuclide detected in the gamma scan analysis.

TABLE 31 (continued)

Radionuclide Results for Sediment Samples at the RD-51 Watershed (BB-15)

	Cesium-137 [pCi/g(dry)]	Plutonium-238 [pCi/g(dry)]	Plutonium-239 [pCi/g(dry)]	Strontium-90 [pCi/g(dry)]	Iodine-129 [pCi/g(dry)]	Tritium (pCi/L)
BB-15-006						
Sample^		< 0.01	< 0.01			
BBI^		< 0.05	< 0.05			
BB-15-007						
Sample^		< 0.01	< 0.01			
USEPA^		< 0.04	< 0.03			
BB-15-008						
Sample^		< 0.01	< 0.01			
BB-15-009						
Sample^		< 0.009	< 0.009			
Field Duplicate^		< 0.008	< 0.01			
BBI^		< 0.1	< 0.05			
BB-15-010						
Sample^		< 0.009	< 0.009			

pCi/g(dry) -- Picocuries per gram of undried sample
pCi/L -- Picocuries per liter of water
< -- Less than

* -- 1992 Sample
^ -- 1994 Sample
Blank -- Not analyzed
+/- -- Plus or minus

BBI -- Brandeis-Bardin Institute split sample
DHS -- Department of Health Services split sample
USEPA -- United States Environmental Protection Agency split sample

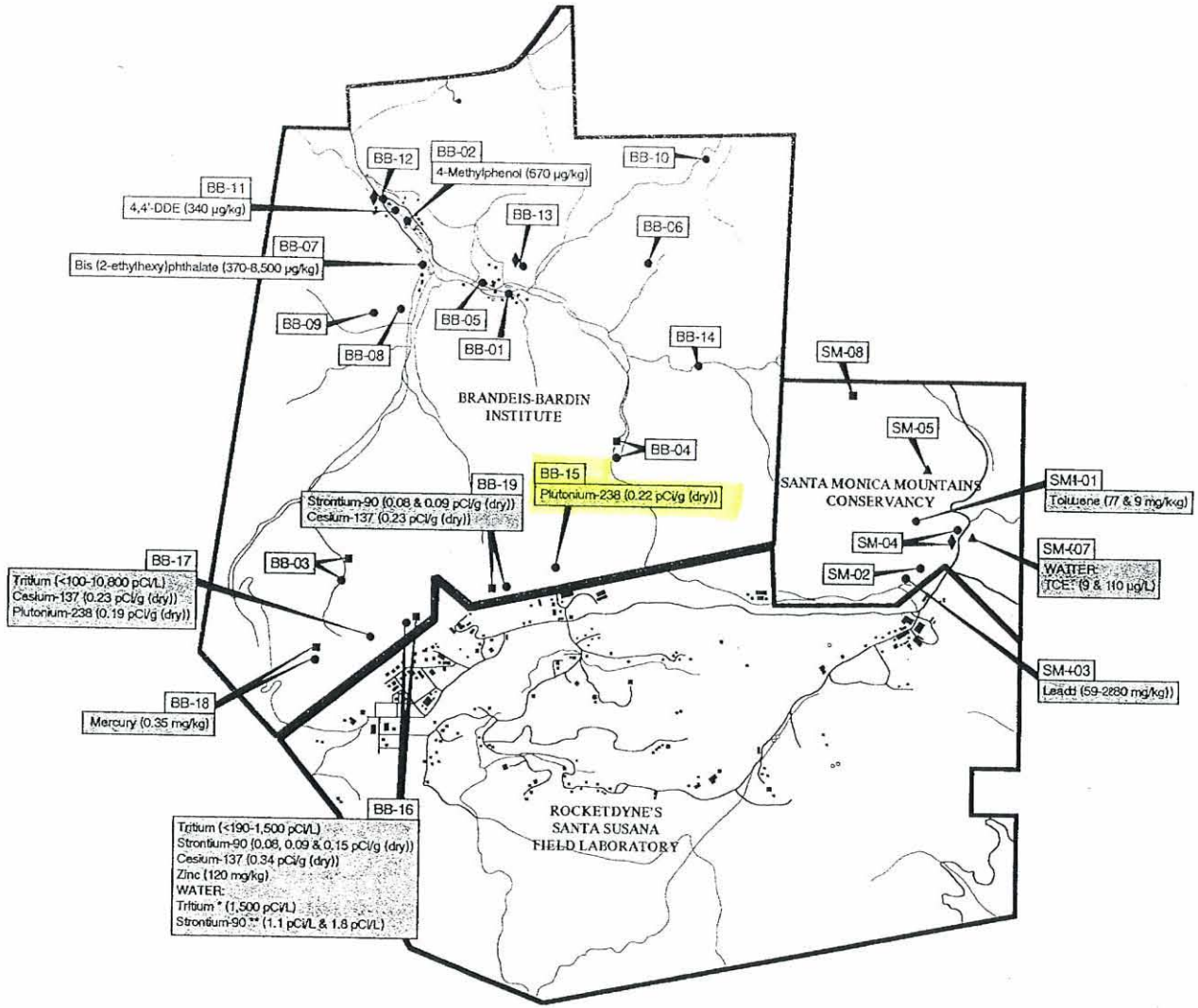
Field Duplicate -- A duplicate sample is collected in the field and submitted under an anonymous sample identifier.

Cesium-137 was the only man-made radionuclide detected in the gamma scan analysis.

Appendix E

Figure 1 of McLaren/Hart Report on BBI/SMMC Sampling

FIGURE 1
SUMMARY OF 1992
MULTI-MEDIA SAMPLING



LEGEND

▲	Groundwater Sample
●	Soil / Sediment Sample
♦	Fruit Sample
■	Surface Water Sample
µg/kg	Micrograms Per Kilogram
µg/L	Micrograms Per Liter
mg/kg	Milligrams Per Kilogram
pCi/L	Picocuries Per Liter
pCi/g (dry)	Picocuries Per Gram (Dry)
DDE	Dichlorodiphenyldichloroethene
TCE	Trichloroethene
<	Less Than
*	Below The Maximum Contaminant Limit (MCL) of 20,000 pCi/L
**	Below The MCL of 8 pCi/L

NOTE: Only McLaren/Hart results are shown. Results are for soil samples unless otherwise indicated.

N

0 2,500'

SCALE

Brandeis-Bardin Institute	
BB-01	Perimeter of the Playground
BB-02	Dormitory Area
BB-03	Campsite Area 1
BB-04	Campsite Area 2
BB-05	Picnic Area
BB-06	House of The Book
BB-07	Counselor-in-Training Area
BB-08	Potential Development Site 1
BB-09	Potential Development Site 2
BB-10	Potential Development Site 3
BB-11	Vegetable Garden
BB-12	Main House Orchard
BB-13	Avocado Grove
BB-14	Old Well Campsite
BB-15	RD-51 Watershed
BB-16	Radioactive Materials Disposal Facility (RMDF) Watershed Building 59 Watershed
BB-17	Sodium Burn Pit Watershed
BB-18	Sodium Reactor Experiment (SRE) Watershed
BB-19	

Santa Monica Mountains Conservancy	
SM-01	Visitor Center Parking Lot
SM-02	Existing Road System
SM-03	Former Rocketdyne Employee Shooting Range
SM-04	Orange Groves
SM-05	Antenna Well
SM-07	Well by the Gate
SM-08	A Spring

McLaren Hart

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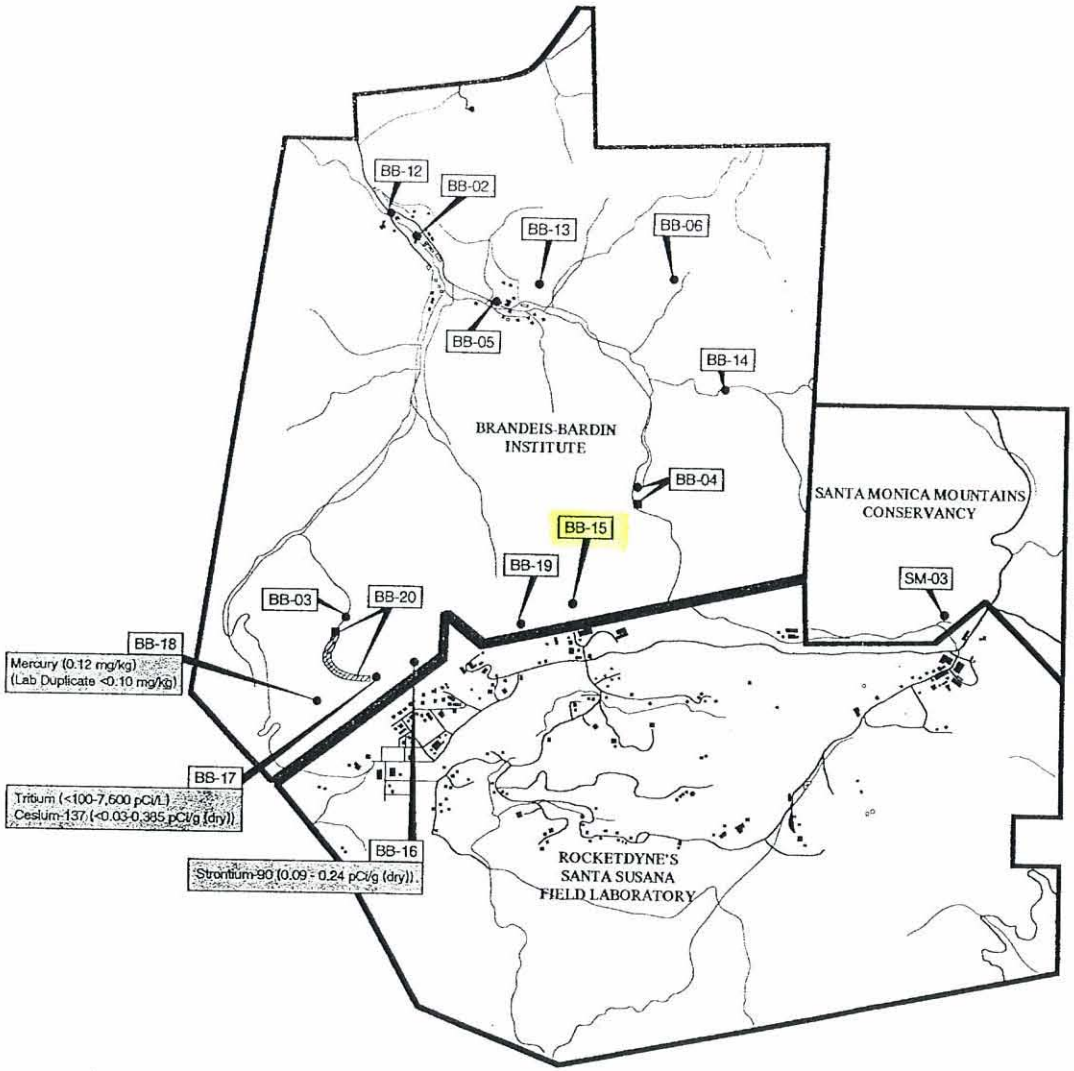
Appendix F

Figure 31 of McLaren/Hart Report on BBI/SMMC Sampling

FIGURE 31
SUMMARY OF 1994 RADIONUCLIDE SAMPLING RESULTS DISTINGUISHABLE FROM BACKGROUND AND MERCURY SAMPLING RESULTS



LEGEND

- ● Soil / Sediment Sample
- ■ Surface Water Sample
- mg/kg Milligrams Per Kilogram
- pCi/L Picocuries Per Liter
- pCi/g (dry) Picocuries Per Gram (Dry)
- < Less Than

NOTE: Only McLaren/Hart results are shown. Results are for soil samples.

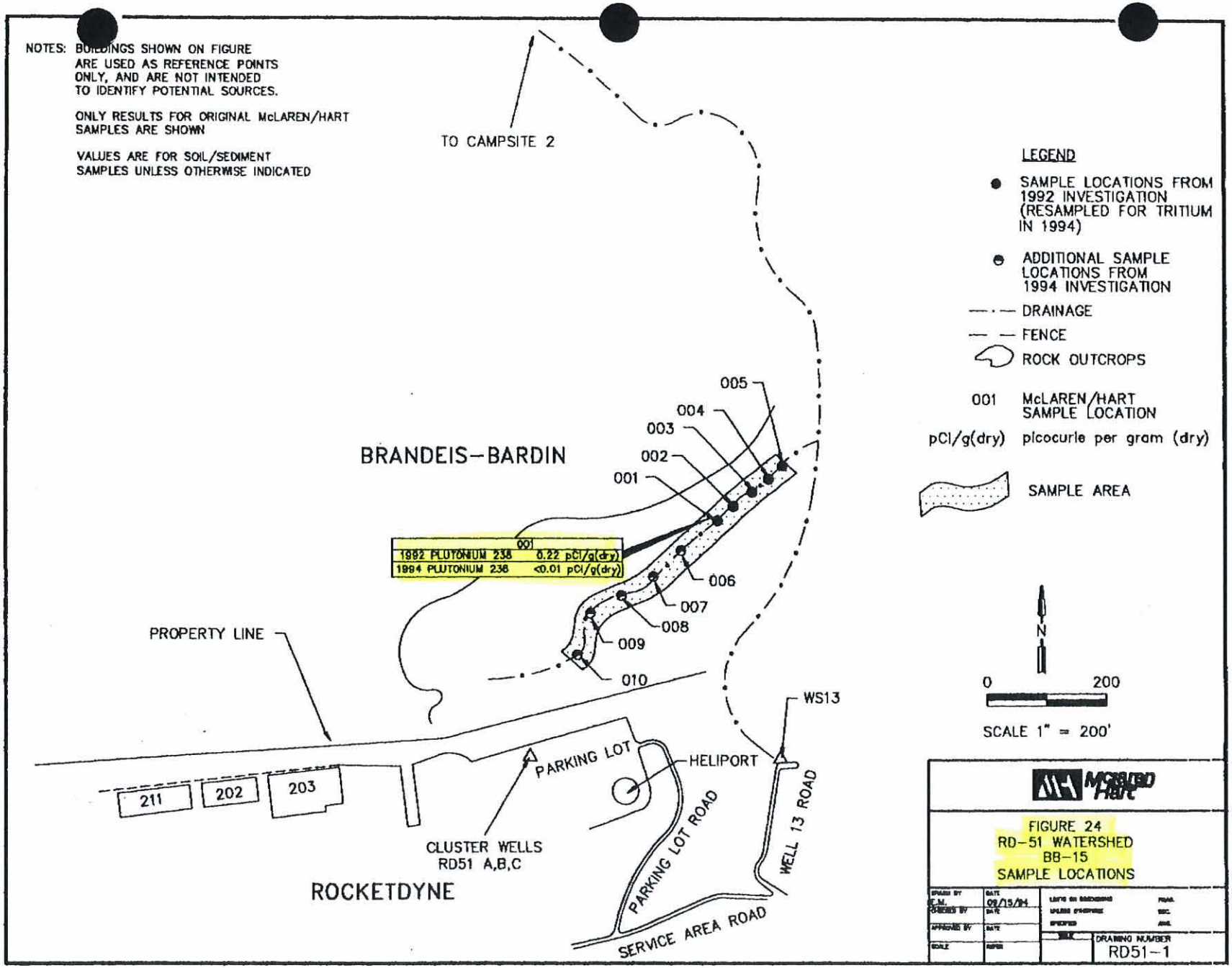
Brandeis-Bardin Institute	
BB-02	Dormitory Area
BB-03	Campsite Area 1
BB-04	Campsite Area 2
BB-05	Picnic Area
BB-06	House of The Book
BB-12	Main House Orchard
BB-13	Avocado Grove
BB-14	Old Well Campsite
BB-15	RD-51 Watershed
BB-16	Radioactive Materials Disposal Facility (RMDF) Watershed
BB-17	Building 59 Watershed
BB-18	Sodium Burn Pit Watershed
BB-19	Sodium Reactor Experiment (SRE) Watershed
BB-20	Camp Site Area 1 - Drainage
Santa Monica Mountains Conservancy	
SM-03	Former Rocketdyne Employee Shooting Range

McLaren Hart

T9501019**

Appendix G

Figure 24 of McLaren/Hart Report on BBI/SMMC Sampling


NOTES: BUILDINGS SHOWN ON FIGURE ARE USED AS REFERENCE POINTS ONLY, AND ARE NOT INTENDED TO IDENTIFY POTENTIAL SOURCES.
ONLY RESULTS FOR ORIGINAL McLAREN/HART SAMPLES ARE SHOWN
VALUES ARE FOR SOIL/SEDIMENT SAMPLES UNLESS OTHERWISE INDICATED
TO CAMPSITE 2
LEGEND
SAMPLE LOCATIONS FROM 1992 INVESTIGATION (RESAMPLED FOR TRITIUM IN 1994)
ADDITIONAL SAMPLE LOCATIONS FROM 1994 INVESTIGATION
DRAINAGE
FENCE
ROCK OUTCROPS
001 McLAREN/HART SAMPLE LOCATION
pCi/g(dry) picocurie per gram (dry)
SAMPLE AREA
BRANDEIS–BARDIN
001
1992 PLUTONIUM 238 0.22 pCi/g(dry)
1994 PLUTONIUM 238 <0.01 pCi/g(dry)
002
003
004
005
006
007
008
009
010
PROPERTY LINE
WS13
PARKING LOT
HELIPORT
211
202
203
CLUSTER WELLS RD51 A,B,C
ROCKETDYNE
PARKING LOT ROAD
WELL 13 ROAD
SERVICE AREA ROAD
N
0
200
SCALE 1" = 200'
FIGURE 24
RD–51 WATERSHED
BB–15
SAMPLE LOCATIONS
DRAWN BY C.M.
DATE 09/15/94
DRAWING NUMBER RD51–1

Appendix H

EPA Update on BBI/SMMC Sampling

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA Update

US Environmental Protection Agency, Region IX • San Francisco, California • July 1995

The U.S. EPA Announces Results of Rocketdyne's Off-Site Sampling Program for the Santa Susana Field Laboratory

The U.S. Environmental Protection Agency (EPA) has completed its review of Rocketdyne's "Off-Site" Study. Rocketdyne initiated the study to find out if past operations at its Santa Susana Field Laboratory (SSFL) contaminated areas next to the site. The study focused on the Brandeis-Bardin Institute and the Santa Monica Mountains Conservancy's Sage Ranch Park (**Figure 1**). It confirmed the presence of radionuclides (radioactive elements) in two areas near the SSFL on Brandeis-Bardin property. Specifically, Rocketdyne found Tritium, a radioactive form of hydrogen, and Cesium in one area and Strontium in another; however, EPA has determined that the radionuclides do not pose a threat to human health or the environment.

The Brandeis-Bardin Institute is a Jewish educational center also used for camping, hiking and horseback riding. Sage Ranch Park is used as a wildlife habitat, as open space, and for hiking and camping. These two areas are downhill from the SSFL, where contamination would travel with rainfall runoff.

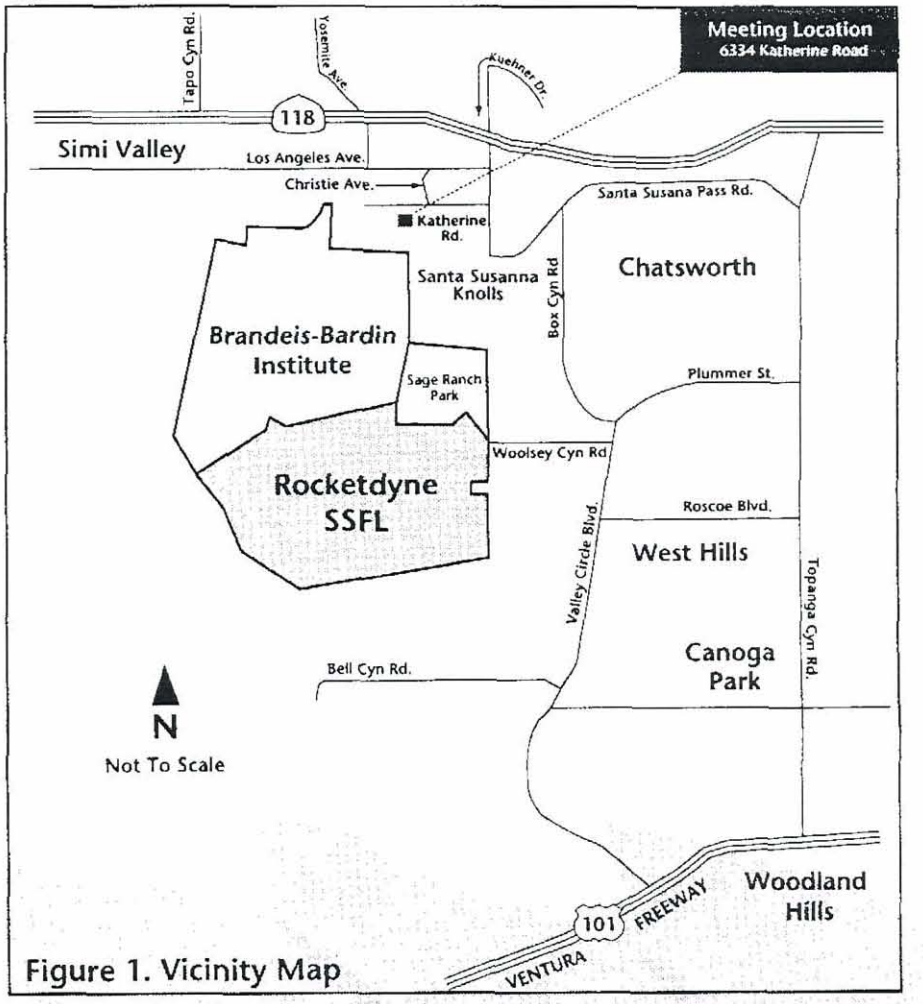


Figure 1. Vicinity Map

Special Notice

As most of you are aware, newspapers have reported that investigators from the FBI and other federal agencies, including the EPA, removed environmental documents from Rocketdyne's Santa Susana Field Laboratory. Because the investigation is ongoing, neither EPA nor Rocketdyne will be able to comment on it at our next workgroup meeting. The last page of this factsheet provides the time and date for the next meeting to discuss environmental issues about the SSFL.

Initial Off-Site Sampling

Rocketdyne began its off-site study in 1992 by collecting and analyzing 118 soil samples, seven surface water samples, four groundwater samples from two wells, and nine fruit samples. This initial study looked for both chemical and radionuclide contamination. It included many procedures to assure the quality of the study's results, such as analyzing duplicate samples. In addition to Rocketdyne's own quality assurance program, EPA, California Department of Health Services (Cal DHS) and Brandeis-Bardin independently analyzed more than 40 samples that Rocketdyne also analyzed.

Besides sampling potentially contaminated areas, Rocketdyne sampled areas, called background areas, which were unaffected by their operations. These background areas are located from 1.5 to 13 miles from the site. As expected, even the background areas contained low levels of some radionuclides. However, this background radiation comes from naturally occurring radionuclides and worldwide fallout from above-ground nuclear weapons testing. The study compared background samples with samples taken from Brandeis-Bardin and Sage Ranch Park to determine the impact of Rocketdyne's past operations.

The initial study found that Trichloroethylene (TCE), a nonradioactive industrial solvent, had contaminated the groundwater beneath Sage Ranch Park (see Figure 2). Rocketdyne already monitors and cleans up TCE -contaminated groundwater within the SSFL. Consequently, Rocketdyne decided to address the contamination through its existing program with the oversight of the California Department of Toxic Substances Control (DTSC). Rocketdyne also found mercury in the soil on Brandeis-Bardin near the Rocketdyne site boundary, and lead contamination at Rocketdyne's employee skeet shooting range on Sage Ranch Park. Since this study, Rocketdyne has removed the contaminated soil by excavating it from both areas and shipping it off-site for proper disposal. Rocketdyne confirmed that it had removed all of the contaminated soil by resampling the areas after excavation.

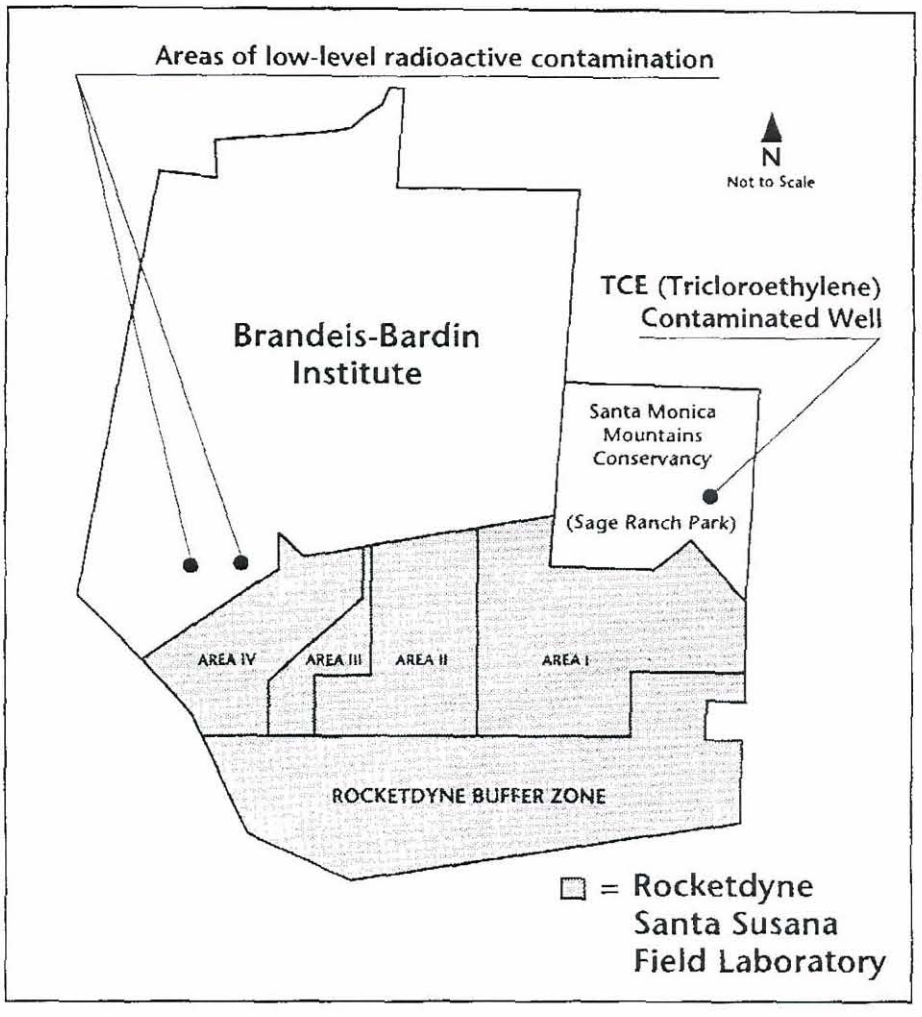


Figure 2. Site Map

The results of the study also identified a number of areas with low level radionuclides, but the study could not conclude whether they resulted from SSFL operations or were background levels. To resolve this, Rocketdyne agreed to take more samples, again in cooperation with EPA, Cal DHS, and Brandeis-Bardin.

Additional Soil and Water Sampling

The additional sampling focused on radionuclide contamination. As part of its additional sampling, Rocketdyne collected more than 120 soil samples and two additional surface water samples in March of 1994. Rocketdyne also collected an additional 40 background samples from eight different areas, in addition to resampling background areas from the initial study. This time, EPA, Cal DHS, and Brandeis-Bardin independently analyzed 54 samples collected by Rocketdyne.

Results and Conclusions

The additional study identified two impacted areas. These areas, or watersheds, are downhill from Rocketdyne facilities that caused the contamination. The first facility, Building 59, formerly housed a developmental nuclear reactor. The second, the Radioactive Materials Disposal Facility (RMDF), was used primarily for packaging and shipping radioactive waste off-site for treatment or disposal. For this study, the soil concentrations were measured in picoCuries per gram of soil (pCi/g) or per liter of water (pCi/L) contained within the soil.

Table 1 lists the concentrations of radionuclides in each impacted area, corresponding local background concentrations and typical concentrations for uncontaminated (except from worldwide fallout) areas throughout the United States. Although the impacted areas are above the local background levels, they are below typical levels found throughout the United States.

Furthermore, based on EPA's calculations, the theoretical cancer probability or risk to campers and camp counselors is less than EPA's threshold level for action of one in 1,000,000. A one in 1,000,000 risk means that one potential excess cancer case might occur if one million people were exposed to the contamination for long periods of time. EPA's calculation is based on two scenarios: (1) children camping one month a year for four years directly on the area of contamination and (2) camp counselors walking through the contamination repeatedly for ten years. For a more thorough discussion of the risk posed by the contamination, EPA encourages you to attend the meeting on August 10. See the last page of this update for more information on the meeting.

For tritium, EPA has yet to approve a test method to measure soil concentrations in pCi/g. Consequently, Rocketdyne measured tritium in pCi/L, which indicates the amount of tritium in water extracted from surface soil. For comparison purposes, EPA's existing standard for tritium in drinking water is 20,000 pCi/L. The water contained within this soil is not drinking water, but even if it were, the contamination would not exceed EPA's standard for tritium.

What's Next

DTSC issued a post-closure permit to Rocketdyne in April of this year. A post-closure permit is required for facilities that close certain hazardous waste management units, if the facility cannot fully clean up chemical contamination at the units. As required by the post-closure permit, Rocketdyne is continuing to cleanup and monitor solvent-contaminated groundwater. Furthermore, it requires Rocketdyne to complete a site-wide study of

Table 1. A Comparison of Radionuclide Concentrations

Radionuclide	Sampling Area on Brandeis-Bardin	Average Soil Concentration	Average Local Background Concentration	Typical U.S. Background Concentration
Strontium	RMDF Watershed	0.103 pCi/g	0.052 pCi/g	0.7 pCi/g
Cesium	Bldg 59 Watershed	0.20 pCi/g	0.087 pCi/g	0.7 pCi/g
Tritium	Bldg 59 Watershed	2,250 pCi/L	~140 pCi/L	100-300 pCi/L

chemical contamination, called a Resource Conservation and Recovery Act (RCRA) Facility Investigation. DTSC is currently reviewing Rocketdyne's RCRA Facility Investigation Workplan.

In addition, Rocketdyne is continuing a program of "decontamination and decommissioning" to cleanup buildings and areas that handled radioactive material, such as reactors, test facilities, and storage areas. This program includes post-cleanup surveys to verify the effectiveness of its actions. Rocketdyne is completing a radiological survey of on-site areas surrounding the facilities where nuclear work took place. This survey will look for radioactive contaminants that may have been carried with rainfall runoff away from radiological facilities.

Background

The SSFL is located in eastern Ventura County and covers an area of nearly 2,700 acres. Rocketdyne has divided the SSFL into four administrative areas (Area I, II, III, and IV) and a buffer zone. Rocketdyne owns most of Area I and Areas III and IV. Rocketdyne operates the Energy Technology and Engineering Center (ETEC) at Area IV for the Department of Energy (DOE). Area II and a 42-acre parcel of Area I are owned by the National Aeronautics and Space Administration (NASA).

The SSFL was established in 1946. Throughout the years, Rocketdyne has tested rocket engines at the site. During the 1950s, Rocketdyne expanded site operations to include nuclear energy research and nuclear reactor development for DOE. Work with nuclear materials, conducted in Area IV, included fabrication of nuclear fuels, testing of nuclear reactors, and disassembly and analysis of used fuel elements. Except for the investigation and cleanup of contaminated facilities, no nuclear work has occurred since 1988.

Information Repositories

Reports describing both the initial study and the additional investigation can be found at the **Simi Valley Public Library** and at the **Urban Archives Center of the Oviatt Library, California State University, Northridge.** The studies are titled "Multi-Media Sampling Report for the Brandeis-Bardin Institute and the Santa Monica Mountains Conservancy" and "Additional Soil and Water Sampling at the Brandeis-Bardin Institute and Santa Monica Mountains Conservancy." The Santa Monica Mountains Conservancy is Sage Ranch Park. The Conservancy oversees the park for the State of California.

For More Information Contact:

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EPA Project Officer
(415) 744-2070

Vicky Semones
Community Relations Coordinator
(800) 321-3075

For more information on the post-closure permit, the groundwater cleanup, or the RCRA Facility Investigation, contact Julio Narvaez, DTSC, at (818) 551-2923.

Next Meeting of the SSFL Workgroup*

Date: Thursday, August 10
Time: 6:00 pm
Location: Knolls Elementary School, 6334 Katherine Rd., Simi Valley, CA.

Tentative Agenda

(Neither the EPA nor Rocketdyne can comment at this meeting on the FBI's on-going investigation.)

1. Further Discussion of the Risk Posed by Off-Site Contamination (EPA)
2. Status Report of ETEC's On-Site Investigation Activities (ETEC)
3. The Proposed Site Treatment Plan for Radioactive/hazardous Waste (DOE)
4. Update on the Worker's Health Study of Former Rocketdyne Employees

**The SSFL Workgroup consists of federal and state regulatory agencies, four public representatives, the Department of Energy and Rocketdyne. The SSFL Workgroup meets regularly to share information on environmental issues related to the site. The public is welcome and encouraged to attend all Workgroup meetings.*